MARYLAND COASTAL BAYS PROGRAM
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Ms. Betsy Salter
U.S. E.P.A.
Coastal Management Branch
1301 Constitution Avenue, N.W.
Room 7217D
Washington, D.C. 20004

Dear Ms. Salter;

Please find enclosed the Maryland Coastal Bays Program's Implementation Review submittal. To provide the review team with clear and comprehensive information we choose the option of providing existing program materials, (accordion appendices), along with a summary report, (red notebook).

We have addressed the Review's 7 topics and trust that the accompanying literature will showcase the post-CCMP implementation activities to date. We look forward to working with the Review team to assess our progress as well as gain a fresh perspective.

Should you require any further information please do not hesitate to contact our office.

Sincerely,

David Blazer

David Blazer, Executive Director MCBP

cc. Edward Ambrogio

I. CCMP IMPLEMENTATION

A. Progress in implementing actions & priority actions

The Maryland Coastal Bays Program was established in 1995, and the CCMP was approved in October 1999. The CCMP contains four Action Plans for the long-term restoration and protection of the coastal bays: Water Quality (WQ), Fish and Wildlife (FW), Recreation and Navigation (RN), and Community and Economic Development (CE). These Action Plans serve as a blueprint for the public agencies responsible for protecting the area's natural resources and present a range of strategies that ensure economic stability through environmental recovery and protection. Additionally, the CCMP is a tool for citizens interested in the programmatic steps necessary to accomplish these goals.

Because of the number and complexity of actions being undertaken in the plan, as well as the plan's emphasis on long-term solutions, implementation is characterized in three, 5-year phases. MCBP is currently in Year 3 of Phase I, which is focused on research needs, planning activities, educational efforts, and implementation of CCMP actions. The graphics below illustrate the emphasis on substantial implementation during Year 1. *(x indicates when actions associated with each Challenge began)*

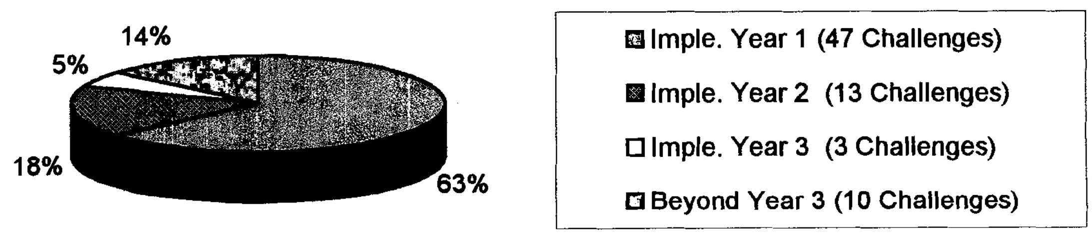
Challenges	Year 1	Year 2	Year 3
Water Quality			
1.1	X	X	
1.2	X	X	X
1.3	X		
1.4		X	X
1.5	X		
2.1	X	X	X
2.2		X	X
2.3	X	X	
2.4	X	X	
3.1	X		
4.1	X		
4.2	X	X	
4.3	X	X	X
5.1	X		
5.2		X	
6.1		X	
6.2	X	X	X
7.1	X	X	X
7.2	X		

Challenges	Year 1	Year 2	Year 3
Fish & Wildlife			
1.1	X		
1.2	X		
1.3	X		
1.4	X		
1.5	X		
1.6	X		
1.7			X
1.8	X		
1.9			X
2.1		Phase 2	
2.2	X	X	X
2.3		Phase 3	
2.4		X	
2.5	X	X	X
2.6	X	X	X
3.1	X	X	
3.2		X	
3.3		Phase 3	
3.4	X	X	
3.5		Phase 3	
4.1		Year 4	
4.2	X		
4.3		Phase 3	
5.1	X		
5.2	X		

Challenges	Year 1	Year 2	Year 3
Recreation & Navigation			
1.1	X		
2.1	X		
2.2		X	
3.1	X	X	
4.1	X	X	
4.2	X		X
4.3	X	X	X
4.4			X
5.1	X	X	
5.2		X	
6.1	X	X	
7.1	X	X	X
7.2	X	X	X

Challenges	Year 1	Year 2	Year 3
Community & Economic Development			
1.1	X	X	X
1.2	X		
2.1		X	X
2.2	X		
2.3		X	X
3.1		Phase 2	
3.2	X	X	X
3.3		X	X
3.4		X	X
3.5		Phase 2	
4.1	X	X	X
4.2		X	
4.3	X	X	
4.4		Phase 3	
4.5	X	X	
4.6		Phase 3	

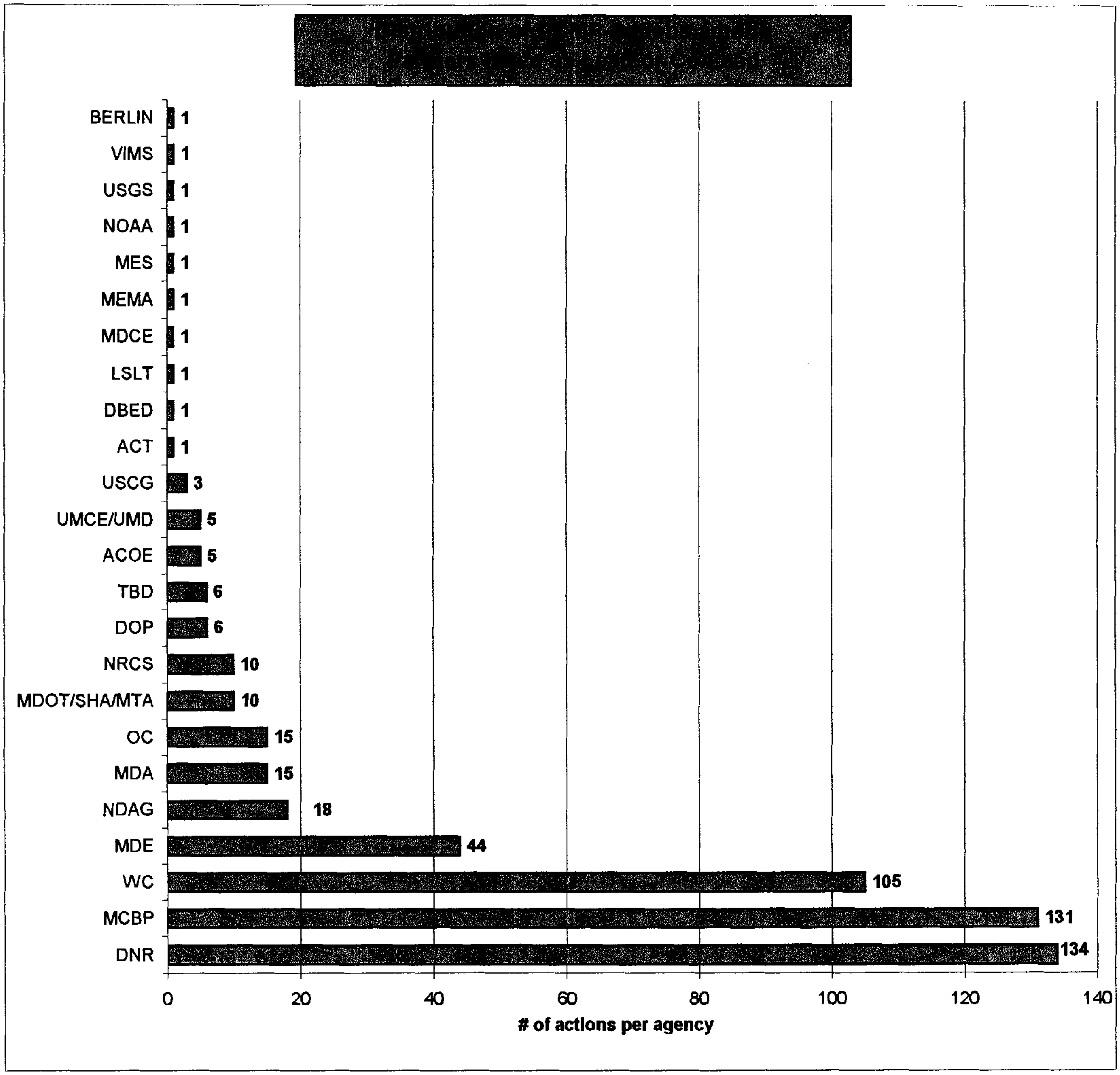
Implementation Schedule for CCMP Challenges



A Tabular Representation of Who is Doing Which CCMP Actions and When:

Lead Agency(s)	DONE	Pre-Implement.	Year 1	Year 2	Year 3	Year 4	Year 5	Phase 1	Phase 2	Phase 3	TBD	Grand Total
ACOE										1		1
ACOE, MDE									1			1
ACT			1									1
DBED						1						1
DNR	3	5	49	26	6	6		2	3	24		124
DNR, MCBP					1							1
DNR, MCBP, USCG			1									1
DNR, MDA			1									1
DNR, MDE					1							1
DNR, SHA				1								1
DNR, UMD			1									1
DNR-NRP			1								1	2
LSLT						1						1
MCBP			47	35	14	4	1		13	8	1	123
MCBP, ACOE, WC			1									1
MCBP, DNR				2						1		3
MCBP, DNR-NRP			1									1
MCBP, NRCS					1							1
MDA			5	3	1					4	1	14
MDCE			1									1
MDE		1	17	6	4	7			2	2	1	40
MDE, ACOE										2		2
MDOT				1								1
MEMA				1								1
MES											1	1
MTA										1		1
NDAG			13	4							1	18
NOAA											1	1
NRCS			3	4							2	9
OC				7	3				3	1		14
OP			1	2	1					2		6
SHA			5							1	1	7
TBD			1								5	6
UMCE			1	3								4
USCG			1		1							2
USGS			1									1
VIMS			1									1
WC		1	27	38	13	5			10	7	3	104
WSCD			1	1								2
OC, WC, Berlin				1								1
Grand Total	3	7	181	135	46	24	1	2	32	54	18	503

A Visual Representation of Who is Doing Which CCMP Actions*:



*** The charts and graphs present the responsible agency(s) that has the lead on the assigned activity and how many actions they are implementing. For numerous activities, there is usually one or more supporting agencies that is actively involved in implementing the action. The support agencies which are not reflected, have been very active in pursing implementation.**

The specific status and priority level of each implemented action is gathered annually from Implementation Committee (IC) members and their respective agencies. The Tracking and Evaluation Subcommittee (TAES), consisting of members from MCBP staff, Foundation Board, Citizen's Advisory Committee, and the Implementation Committee, was formed to consolidate the data and report on the implementation progress at the Challenge level.

Work Sheets detailing Implementation status are accumulated from all lead agencies on a scheduled, end-of-year basis.

↓

TAES evaluates end-of-year worksheets and process the weighting/editing of actions. The % completion of each action is consolidated to provide an overall % completion at the Challenge level.

↓

MCBP distributes first draft Annual Report to Foundation Board of Directors, Implementation Committee, and Citizen's Advisory Committee for review and comments.

↓

The Comments & Roadblock section for actions are evaluated and consolidated at the Challenge level.

↓

Comments from the first draft are evaluated by TAES, changes are incorporated. The MCBP Executive Director and CAC Chair has the prerogative to enter footnote comments in the final draft if opposing positions can not be resolved.

↓

Final Draft Annual Report is generated and distributed to MCBP Policy Committee. Feedback and recommendations are provided to the MCBP to be incorporated as policy.

Implementation status was rated using the San Francisco NEP style ranking:

Full:	(75-100%)	Implementation complete or nearing completion
Substantial:	(50-74%)	Major progress has been made
Moderate:	(25-49%)	Fair level of progress made
Some:	(10-24%)	Progress beginning
Minimal:	(0-9%)	Very limited progress
Unknown:		Insufficient reporting data available

Agency/Partner priority for each action (during each year) was designated as:

- High
- Medium/High
- Medium
- Medium/Low
- Low

A Progress Report On Year One Actions (Oct. 1999-Sept. 2000) and ***A Progress Report On Year One Challenge Updates and Year Two Challenges (Oct. 2000-Sept. 2001)*** are provided as Appendix I-A and Appendix I-B.

Below is a tabular synopsis of tracking and evaluation activities through 2001.
TAES is currently gathering status reports for a Year 3 report.

CCMP Implementation through Year 2 (Oct. 1999 – Sept. 2001)

CCMP is comprised of:

	WQ	FW	RN	CE	*Total*
Challenges	19	25	13	16	***73***
Actions	103	158	117	127	***503***

Implementation Schedule as laid out in the CCMP:

	Year 1	Year 2	Year 3	Year 4	Year 5	Phase 2	Phase 3
Challenges	47	13	3	1	0	3	6

Year 1 Implementation Status per the Tracking and Evaluation Subcommittee

		Full	Substantial	Moderate	Some	Minimal	Unknown	**Total**
Priority Designation	High	2	2	6	5	4	0	*19*
	Med/High	0	3	3	2	0	0	*8*
	Medium	2	1	2	1	5	0	*11*
	Medium/Low	0	2	0	2	1	0	*5*
	Low	0	0	2	0	1	1	*4*
								47

*All 47 Actions began as scheduled.

Year 2 Implementation called for an additional 13 Challenges to be initiated (Total of 60)

		Full	Substantial	Moderate	Some	Minimal	Unknown	**Total**
Priority Designation	High**	2	5	8	7	4	0	*26*
	Med/High	3	3	1	0	1	0	*8*
	Medium	2	4	3	3	3	0	*15*
	Medium/Low	0	1	0	3	1	0	*5*
	Low	0	1	1	5	4	1	*12*
								66*

**8 Challenges were elevated to Top Priority Issues to be addressed during Year 3

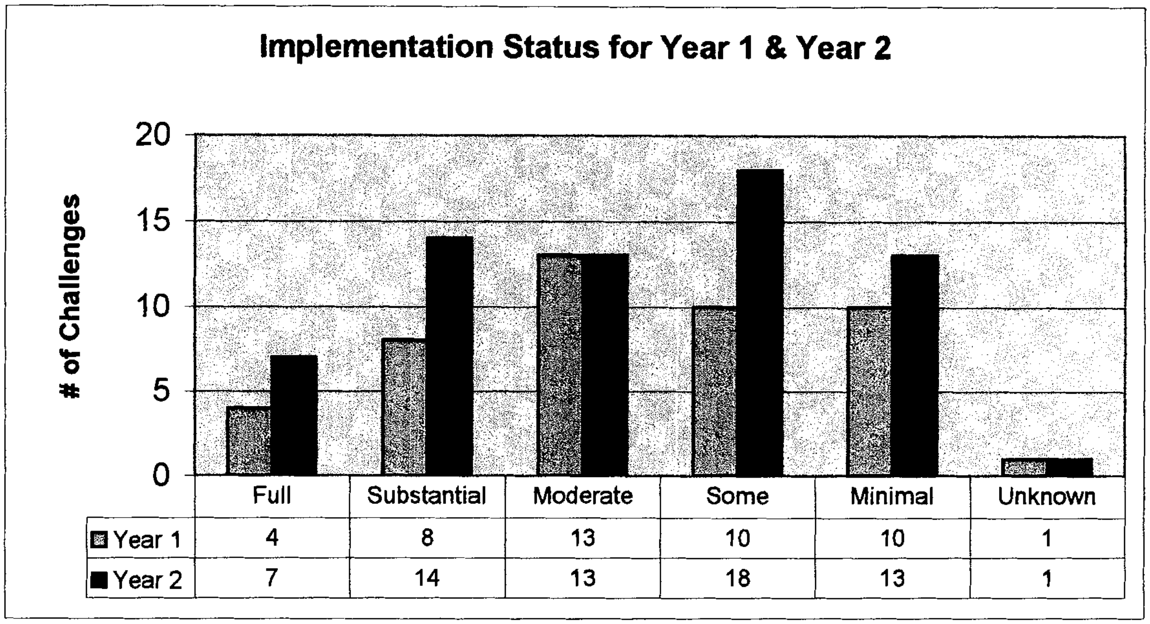
***6 Challenges, which were originally scheduled to be addressed during Implementation Year 3 or during Phases 2 and 3, have already begun. These 6 are:

Year 3
- FW 1.7 Improve water quality in dead end canals.
- RN 4.4 Increase compliance with safe boating and resource protection rules.

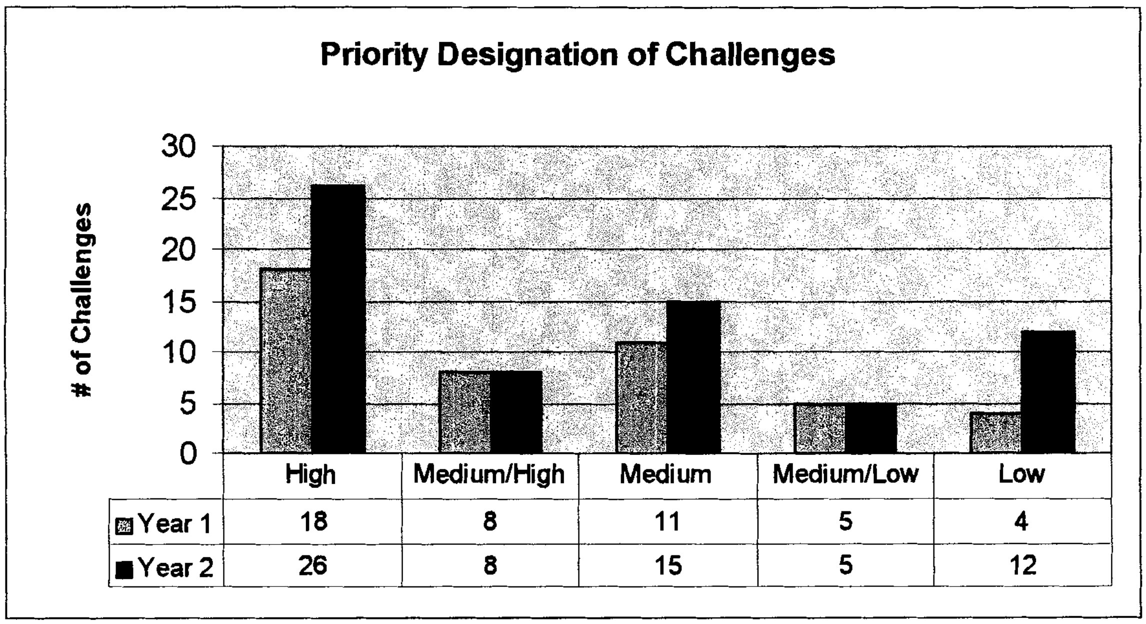
Phase 2
- FW 2.1 Determine the extent, spatial distribution and composition of forested habitat needed for Neotropical and migrating birds in order to retain viable populations.
- CE 3.1 Plan for the impacts of tourists.

Phase 3
- CE 4.4 Improve transportation efficiency and reduce reliance on automobiles
- CE 4.6 Establish a collaborative tri-state coastal bays effort.

At A Glance:



	Full	Substantial	Moderate	Some	Minimal	Unknown
Year 1	4	8	13	10	10	1
Year 2	7	14	13	18	13	1



	High	Medium/High	Medium	Medium/Low	Low
Year 1	18	8	11	5	4
Year 2	26	8	15	5	12

Work sheets from each partner serve as the foundation of the tracking system. Appendix I-C. A consolidated report of what is being accomplished and what obstacles exist allows all parties to be kept abreast of this evolving program. The Tracking and Evaluation Subcommittee (TAES) choose 6 issues that would best reflect the intent of the CCMP and the implementation of challenges overtime. These issues include: Buffers, Forestry, Measurements of Success, SAV, Water Quality, and Wetlands. A "report card" (similar to the San Francisco NEP) was developed to summarize implementation status of challenges for each issue. *A copy of this report card is provided on page 7.*

TAES members met in March 2002 to solidify plans for the Year 3 reporting process. The group determined that each partner should make their own decisions concerning which CCMP Action Items to emphasize and where to place their resources. Each Partner is expected to use the guidance provided by the Policy Committee, the forthcoming White Papers on wetlands and forestry, and the Critical Areas legislation passed by the General Assembly. Information from each Partner is expected by July 15, 2002. Two 8-hour TAES work sessions will be held in August to draft the Year 3 Report.

REPORT CARD ON YEAR 2 IMPLEMENTATION

ISSUES	FULL	SUBSTANTIAL	MODERATE	SOME	MINIMAL
BUFFERS	WQ 6.1 - Improve efficiency of sediment and erosion control program.	WQ 6.2 - Reduce shoreline erosioin rates.	CE 4.3 - Enhance the buffering capacity of the watershed's tidal and nontidal shoreline area.	WQ 2.2 - Improve stormwater quality from existing development.	
FORESTRY				FW 2.2 - Conservation of forest.	FW 2.1 - Improve songbird populations and forest habitat. FW 2.6 - Conservation and use of forested land.
MEASUREMENTS OF SUCCESS (METRICS)		FW 1.1 - Accurate fish harvest information.	WQ 3.1 - Improve understanding of atmospheric deposition of nutrients. WQ 5.2 - Improve understanding of teritary sewage treatment needs. RN 3.1 - Reduce resource impacts from water-based recreational activities.	CE 2.3 - Enhance natural disaster planning.	
SUBMERGED AQUATIC VEGETATION		FW 1.6 - Seagrass protection and expansion			RN 5.2 - Increase public awareness of resource protection needs.
WATER QUALITY		WQ 2.1 - Reduce water quality impacts from stormwater discharges. WQ 1.2 - Update septic system designs. WQ 1.3 - Improve understanding of groundwater resouce.	WQ 4.1 - Reduce nutrient pollution from farming.	WQ 1.1 - Reduce failure rate and inefficiency of on-site wastewater treatment. WQ 4.3 - Improve management of drainage systems.	FW 1.7 - Improve water quality in dead end canals.
WETLANDS				FW 3.1 - Conservation of wetland resources.	FW 3.2 - Improvement of staging, wintering, and nesting areas. FW 3.4 - Coordination of wetlands regulations.

RATING NOTES:

FULL Full implementation completed or nearing completion (75-100%)
SUBSTANTIAL Major progress has been made (50-74%)
MODERATE Fair level of progress made (25-49%)
SOME Progress beginning (10-24%)
MINIMAL Very limited progress (0-9%)

The ratings to each Challenge in this Report Card of the Maryland Coastal Bays Program's Progress Report on Year One Actions Updates and Year Two Actions are the results of an intense evaluation exercies performed by the Tracking and Evaluation Sub-committee, composed of MCBP staff, key partners, and citizens. The Implementation Committee partners provide the raw implementation status dat and also review the draft Progress Report. This evaluation seeks to measure how items listed as progress in the Progress Report stacked up against the specific language and intent of the CCMP.

CCMP IMPLEMENTATION

B. For each stakeholders group summarize their major contributions in implementing the CCMP, describe how well each supports implementation, and any issues or challenges.

Stakeholders: This table illustrates the primary contributors for implementing CCMP initiatives.

Federal Government	State Government	County Government	Local Governments
EPA	DNR	Soil Conservation	Town of Ocean City
NPS	MDE	Comprehensive Planning	Town of Berlin
ACOE	MDA	Planning, Permits, Inspections	
NRCS	MD Geological Survey	Tourism	
USCG	Dept. of Planning	Economic Development	
USFW	State Highway Administration	Public Works	
NOAA	Univ. of MD Extension Service	Emergency Services	
USGS	Univ. of MD Eastern Shore	Recreation	
FEMA	Salisbury University		

Stakeholders: This table represents supporters, many of who are equally committed but are often limited in resources necessary to fully implement actions. They're greatest contributions are often the 'on-the-ground' activity support and public input for policy makers.

Citizen Groups	Environmental Groups	Businesses
CAC	Maryland Coastal Bays Foundation	Developers
Parrot Heads	STAC	Marinas
Saltwater Fishermen	Assateague Coastal Trust	Golf Courses
OP Anglers	Surf Riders	Poultry Industry
MCBP WQ Volunteers	Ducks Unlimited	Fundraising Sponsors
	Lower Shore Land Trust	Commercial Waterman
	Worcester Environmental Trust	Hotels/Motels/Restaurants
	DELITE (Low-Impact Tourism)	Farmers
	MD Conservation Corps	Public/Private/Home Schools
	Navigation & Dredging Advisory Group	
	Fisheries Advisory Committee	

Partner	Major Contributions	Issues or Challenges
U.S. EPA	Funding for program and initiatives such as habitat restoration, invasive species studies, etc. Support also includes the 5-year National Coastal Assessment and the Mid-Atlantic Integrated Assessment Program. Supported No-Discharge Area designation for the northern coastal bays.	
National Oceanic and Atmospheric Administration	Administers the coastal change and analysis program, inventories coastal submersed habitats, wetland habitats, and adjacent uplands and monitors changes in these areas on a 1-5 year cycle. Publishes GPRA habitat information on the PIVOT website. CZM funds land acquisition and easements.	
Assateague Island National Park	Conservation, Restoration, Water & Habitat Monitoring and Research, Public Outreach and Education, (Assateague State Park coordinates annual Coast Day activities and the annual canoe clean-up.)	Highly involved with the program however as they are not a lead agency in the CCMP they do not receive the recognition the Park Service deserves.
U.S. Army Corp of Engineers	Salt Marsh restoration, Dam Removal & Habitat restoration, Maintenance Dredging, Inlet channel improvements, and Spoils Island restoration (planned), and Assateague Island beach restoration.	
USDA/Natural Resource Conservation Service	Habitat & Wetland Restoration and Protection, Forested buffer plantings (CREP), collects survey data and characteristics of soils, crops, forestry, and wildlife distributions.	Though limited in staff and time, and funding for some initiatives, NRCS perform the bulk of all restoration work in the watershed.
U.S. Coast Guard	Conducted a boater survey on possible problems at the Route 50 bridge, Provides literature through the auxiliary Safe Boaters course. Investigated concerns with some navigational aid placement. Respond to pollution spills and red/brown tides. Helping to produce the Coastal Bays Boaters Guide.	Main focus has be disaster response and more recently homeland security Major roadblock is time to dedicate to Maryland alone rather than all of Delmarva.
U.S. Fish & Wildlife Service	Active with SAVand invasive species issues and research. Promotes BayScapes program of planting native species.	
U.S. Geological Survey	Conducting analysis of groundwater flow, resistivity, and nutrient loads, age dating, etc. Ultimately, hope to determine groundwater discharge and nutrient loading rates into the bays.	Staff, time, and funds. This group along with its State of Maryland counterpart is very active in conducting environmental analysis.
MD Dept. of Natural Resources	Largest implementer (134 actions), work includes; Shore erosion/Sea level rise, Forestry work group, Fisheries management, Sensitive Areas planning, Clean Marinas program, Watershed Restoration. Worked with the State to develop the Atlantic Coastal Bays Protection Act. Produced the "Economic Assessment of the Coastal Bays" report. Held a Principal Investigators meeting where scientists presented their current research and monitoring activities and results. Coordinated a Macroalgae Conference to work on development of a macroalgae indicator. Continued monitoring of ecological conditions including Pfiesteria, brown tide, and documented increased occurrences of macroalgae.	Tracking of actions in the CCMP is a challenge for larger agencies because of the number of people involved. The Tracking and Evaluation Subcommittee has helped facilitate this effort.

Partner	Major Contributions	Issues or Challenges
MD Dept of Environment	Developed new state Stormwater guidelines to promote environmentally sensitive design measures. Providing grants/loans for stormwater retrofit projects. Established TMDL allocations for Assawoman, Isle of Wight, and Newport Bays. Working with local government to strengthen enforcement for sediment, erosion, and wetlands losses. Monitors drinking and bathing waters for bacteria and pollutants. Oversees the NPDES program.	Has found that some local governments are reluctant to borrow funds to implement Non-point Pollution source controls. Reduced funding is a major challenge for this agency. Limited staff are available for enforcement and compliance of regulations.
MD Dept. of Agriculture	Promotes aquaculture to local waterman. Encourages nurseries to grow native plant species. Promotes CREP and other wildlife enhancement programs. Provides information on agricultural issues and programs, assuring ag and natural resource issues are presented and deliberated from a balanced perspective, and works with other agricultural agencies and organizations to provide input and support to the CCMP.	
MD Geological Survey	Has conducted bathymetry surveys and produced the Coastal Bays Sediment Mapping project detailing the physical and chemical characteristics of bay sediments. Coordinates with the USGS.	
MD Dept. of Planning	Provides inventory and GIS digital coverage, build out scenarios, and long-range planning assistance, in addition to monitoring changes in land use, demographics, and economics within the watershed. Supports Smart Growth initiatives.	
State Highway Administration	The local SHA district is leading the state in making state roads bicycle accessible and developing the rails to trails and Green-way programs. Changing maintenance practices a little at a time by reducing herbicide use and developing naturally vegetated wetland ditches (bioengineering), attempting to reduce mowing. Going above and beyond permit requirements in the construction of wetlands, nutrient management areas and plantings in ditches and ponds. Also, developing a Coastal Bays Brochure for public outreach. Published "Integrating Highway Construction with the MD Coastal Bays Program", for presentations and technical transfer.	MCBP can help to educate the public regarding mowing frequency. The public demands mowed rights of ways
Univ. of MD Cooperative Extension Service	Has provided public outreach and workshops for septic tanks, integrated pest management and native plants.	
Worcester County	Large implementer, (105 actions), Developing "Area of Special Concern" which will require development to comply with additional environmental regulations. Produced Voluntary Golf Course guidelines designed to meet WQIA of 1998. Worked with the state to conduct watershed restoration assessment study and TMDL for the northern bays. Has applied for and received grants to restore habitat and implement pilot projects. Produced public education brochures regarding septic tank maintenance, native plant species, buffer considerations, and county parks inventory. Has encouraged public participation through the Route 50 & Route 611 scenic corridor plans and Isle of Wight Subwatershed Planning Committee. Currently revising the County Comprehensive Plan, Agricultural Preservation districts and Sensitive Areas protection. Leads the Wetlands Planning Group.	Challenges include lack of sanitarian staff time to fully implement the SEPTRAC computer software. This information would greatly enhance policy maker's ability to update sanitary district policy.

Partner	Major Contributions	Issues or Challenges
Town of Ocean City	Created a new Environmental Engineering position and Stormwater Program. Public education and outreach is a prime focus. Created a Coastal Resources Legislative Committee to deal with CCMP initiatives.	Challenges include raising money for implementation of large projects, including stormwater retrofits. Issues with dead end canals will require a huge outlay of resources and the utilization of new innovative technology.
Town of Berlin	Complying with stormwater and wastewater mandates	Not responsible for any CCMP Actions
Navigation & Dredging Advisory Group	Provided an updated list of recommendations to address navigation and dredging issues in the Coastal Bays. Working on a "Master Plan" and helping to develop a regional boater education map.	Challenges have been related to coordination and communication to prevent duplication of effort and ensure provision of up to date information to the public.
Fisheries Advisory Committee	Advise DNR and MCBP on fishery related issues: Development of blue crab and hard clam Fishery Management Plans. The future role will be to monitor and revise plan to help direct research.	
Citizens Advisory Committee	This group has been very active in all aspects of the program: Tracking & Evaluation, Policy Committee, Foundation Board, Implementation Committee, Sensitive Areas Task Force, Water Quality Monitoring, Fundraising, Agriculture Subcommittee, Fisheries Advisory Group, Wetlands and Forestry Workgroups	Major challenges have been having enough time to deal with all the issues in the CCMP in addition to emerging issues. Supports a more active use of the Yearly Reports for Management Reviews and action assignment.
MCBP Water Quality Monitoring Volunteers	Ambient water monitoring began in 1997. Provide data in near shore areas that would otherwise not be studied.	The majority of volunteers are deeply committed to this endeavor, despite the lack of adequate and timely feedback. A report on results from 1997-2001 is currently being drafted.
Recreational Fisherman	Several local groups and many individuals are involved in education and outreach efforts and assisting and advising DNR and MCBP on fishery related issues.	Valuable members who are very dedicated but offer very diverse opinions that sometimes is challenging to reach consensus.
Assateague Coastal Trust	Non-profit organization working to preserve Assateague Island and the living resources of the coastal ecosystem, by (1) Sponsoring outreach programs to citizens and visitors about the natural resources and their long term sustainability, and (2) Participating in advocacy efforts to influence public policies that affect the functions of these ecosystems. Co-sponsor of several programs with MCBP, including; terrapin head-start, Great Worcester Herp Search, oyster restoration, National Estuary & Coast Day activities.	Current challenge is securing funding for the new "Coast Keeper" position that will be responsible for ACT's water quality advocacy program. A principle objective of this position is to prevent pollution and habitat degradation in the coastal bays, their tributaries and watershed.
Surf Riders	Local chapter of National Surf Riders Association, a beach and surf advocacy group	Participated with MCBP, and Ocean City for Adopt a Street and Stormdrain Stenciling initiatives.
Lower Shore Land Trust / Worcester Environmental Trust	Has partnered with Worcester County to implement the Coastal Bays Rural Legacy Program. 4,200 acres of waterfront property has been protected along southern Chincoteague Bay.	

Partner	Major Contributions	Issues or Challenges
MCBP Staff	- Several advisory committees meet and council on specific issues in the CCMP such as Fisheries Advisory Committee, Navigation and Dredging Committee, Citizens Watch Subcommittee, Dead End Canals subcommittee, Sensitive Areas Task Force, Environmental Indicators subcommittee, Tracking and Evaluation subcommittee, Wetlands Planning Group, Forestry Group. - A draft Blue Crab Fishery Management Plan has been finalized to address management issues specifically for the Coastal Bays. A coastal bays hard clam management plan is nearly completed - Helped create and disseminate size and creel signs and brochures for the entire coastal bays. Began working on comprehensive boaters guide to the coastal bays. - Provided information and recommendations on proposals related to critical shoreline areas, blue crab management, hard clam management, exotic crab species, SAV protection, water quality monitoring, road widths, and docks in shallow waters. Also, provided recommendations and guidance on No Discharge Zone designation for the Northern Coastal Bays. - Consulted on TMDL efforts through MDE and provided recommendations on process and content. - Helped promulgate, provide recommendations and information to move along sub-watershed planning process and related legislation. - Provided recommendations to State Highway administration on habitat restoration projects and use of Kindrigen property - Expanded volunteer base involved in the Coastal bays efforts. Projects include efforts to improve and increase SAV groundtruthing surveys, near shore citizen water quality monitoring and worked with DNR to develop and implement a stream waders survey using volunteers. Began task of getting better inventory of watershed's reptiles and amphibians by holding annaul Great Worcester Herp Search with help from DNR, NRCS and ACT. Facilitated a one-acre oyster shell restoration site which will be populated by volunteer oyster gardeners. - Funded and provided educational assistance with several school environmental projects and activities. Assisted the application and designation of Berlin Intermediate School as a "Green" School highlighting the environmental education programs and successes. Developed a curriculum and began field trip experiences for summer camp projects at a local waterfront farm to teach about estuarine ecology. Established an internship program with local universities. - Assisted with the application of Ocean City to become an "All American City". The program was highlighted as one of the components of cooperation and success in making the town a model for others to emulate. Ocean City won this distinction after being one of 30 finalists, out of over 100 applicants. - Produced and distributed 30,0000 hotel/motel door hangers to allow visitors to OC to learn how to conserve water, energy and the environment. Began Adopt-A-Street Program in OC that will allow property owners to clean their streets on a regular basis and include storm drain stenciling throughout the resort. - Produced water and energy conservation handout for events and shows to let visitors, restaurants, and hotels learn what they can do to be more efficient and less wasteful. - Researched and produced a homeowners guide to the coastal bays educating property owners on how they can help protect the watershed. - Continued outreach and education efforts with more than 600 columns in local papers, TV and radio PSA's, snapshots of the week, clean up events, fund raising events, speaking engagements, conference presentations, festivals and other public events. Continued to produce quarterly newsletter received by over 3,000 coastal bays supporters. -Planned for and designed educational podiums for the new OC Park & Ride in West Ocean City. Signs will be viewed by hundreds of thousands annually. - Organized and held MD Coast Day, the day-long festival of food, fun, and environmental education with 3,000-5,000 people participating. Developed and purchased outdoor display materials. - Continued native species planting with more than 5 new indigenous public planting projects. Produced seagrass identification fact sheet for contractors, homeowners and developers. - Consulted with numerous developers to better their projects. Partially funded and facilitated design charette for environmentally sensitive development along the shores of Sinepuxent Bay. Received MD Smart Growth Award for Visioning, Alternative Future and Speaker Series. -Produced "Envisioning the Future: A New Tool for Coastal Managers" for technical transfer. - Developed and taught environmental policy and regulatory continuing education course for real estate professionals and developers. - Created poll to be conducted by Salisbury University on the feeling of Worcester residents on the coastal bays estuary and the program. - Worked with non-profit agencies to step up land preservation in the coastal bays watershed.	

I. CCMP IMPLEMENTATION

C. Changes in Priorities

During the CCMP planning phase the stakeholders prioritized the actions and determined the implementation schedule. As a result 63% of the CCMP Challenges were initiated during Year 1. The Foundation Board discussed and prioritized the Year 2 actions assigned to MCBP Appendix I-D, and assigned top priority status to eight challenges from Years 1 and 2. The CAC, IC, and Policy Committee have all agreed to focus attention on the following areas:

- WQ 1.1 Reduce failure rate and inefficiency of on-site wastewater treatment
- WQ 2.1 Reduce water quality impacts from stormwater discharges
- FW 1.6 Seagrass protection and expansion
- FW 3.1 Conservation of wetland resources
- RN 3.1 Reduce resource impacts from water-based recreational activities
- RN 5.2 Increase public awareness of resource protection needs
- CE 2.3 Enhance natural disaster planning
- CE 4.3 Enhance the buffering capacity of the watershed's tidal and non-tidal shoreline area

As issues arise, whether via the CAC, Foundation Board, Implementation Committee, etc., the program director coordinates further discussion among all interested partners and committees. The culmination of consensus based issues or initiatives are then presented to the Policy Committee for final guidance. Various committee members then address this guidance. The Policy Committee meeting agendas and meeting minutes for 2000 and 2001, are provided for review. Also provided are examples of the Foundation Board minutes addressing guidance issues. In addition to the prioritization of specific actions, the most recent Policy Committee meeting directed the program to produce white papers in the areas of wetlands, forestry, and water quality. These white papers are in production now. Below are two other specific examples of the program's re-evaluation of priorities and goals, and the guidance offered:

Maryland Coastal Bays Program
Future Areas of Focus

In addition to the continuing work on the Year 1 priorities, the following discussion paper contains some of the priority issues listed for implementation during Year 2. *Issues in italic are not directly in the Management Plan but will likely demand attention.* **Issues in bold were added by the PC at the meeting on December 13, 2000**

Initiatives

- Wetlands -Committee will be convened to assess strengths and weaknesses of wetland programs (especially non-tidal wetlands) and develop recommendations for pilot program.
- Septic Systems - promote and develop incentives for alternative systems for pre-treatment and nutrient reduction
- Wastewater Treatment - investigate adequacy of systems and encourage spray irrigation..
- Emergency Management Planning - Existing plans will be updated and strengthened.
- Storm Water Management - encourage innovative plans for local activities to be brought into compliance with new state guidelines.

- Forestry Conservation and Planning - review Forest Conservation Program and establish priorities for forest retention and open areas to be reforested.
- Boating Safety/Education - programs to inform boaters of safety issues and resource protection problems.
- *Total Maximum Daily Loads (TMDL) - final TMDL will be released for the northern coastal bays*
- *Coastal Research Lab - state and federal funds have been appropriated for building.*
- **Minority Participation- develop a policy and plan to improve**
- **Harmful Algal Blooms – monitor and educate about HAB's**
- **Smart Growth – Although the "name" is not used, the watershed, municipalities and county should continue to implement and address the principles of the concept.**

Legislation

- Fishery Management Plans - draft legislation which would allow DNR to prepare and implement fishery management plans specific to the coastal bays.
- Submerged Aquatic Vegetation - draft legislation designed to make existing law that prohibits hydraulic clam dredging in SAV beds more effective.
- **Smart Growth package expected from the Governor with funding initiatives. Last year's Septic legislation is not expected but issue is still present and education should be emphasized.**

Funding

- Monitoring - seeking funds to implement basic elements of Comprehensive Environmental Monitoring Program
- Program Implementation for demonstration projects and research grants- new national funding guidance will result in higher level of state, local and private commitment of matching funds (cash or in-kind)
- *Research and Education - Seek funding commitments for the proposed Coastal Lab*
- **Funds for enforcement and GIS.**

Draft Policy and Implementation Strategy for Minority Inclusion and Outreach
September 2001

Introduction

During the brief history of the MCBP, Minority participation and activity has been relatively minimal. The Maryland Coastal Bays Program wants to take steps to improve the efforts to reach, communicate, inform and involve the minority community.

Historically across the country many environmentally unsafe areas are found in communities with high minority populations. Steps to inform and involve the community need to be taken to prevent future impacting issues. The minority community can become a strong ally of the environmental community.

African American, Asians, Native Americans, multi race and Hispanic people represent a growing segment of the population and are currently 20% of the 46,543 people who live in Worcester County according to the 2000 census.

MCBP□s focus is on environmental issues. The entire coastal bays community needs to be educated regarding environmental issues. The MCBP therefore, focuses to educate the entire community but will aim to reach out to minority communities through uncovering and addressing environmental issues specific to them.

However, while certainly not all minority communities are faced with other pressing issues like health, employment, and poverty, some are. Because a substantial portion of the minority community faces issues more concerning than environmental issues, the MCBP aims to assist in meeting the needs of the minority community concerning health, employment, and poverty through incorporating environmental education within these programs intended to meet a variety of minority needs. Furthermore, there are environmental concerns specific to the minority community that needs to be researched and addressed.

Initial efforts of the strategy will focus on education efforts to inform the members of the minority community of watershed ecology and issues. These actions to improve understanding and education will ultimately foster a movement to improve job training and career opportunities and encourage additional involvement in the decision making process of the community and the ecosystem. The MCBP has and will continue to exercise <u>all reasonable effort</u> to inform all citizens in the area of MCBP meetings, events, and outreach programs and assures equal opportunity of all participants

Goals:

1) Expand outreach and education efforts to specifically include minority populations of the Coastal Bays watershed

2) Identify specific actions to address challenges of the communities where historically poor water and environmental conditions have contributed to disproportional health, economic or social impacts.

3) Incorporate a proactive approach by informing citizens on how to participate in program activities with emphasis on increasing the participation of low income, minority and non-english speaking communities.

There are three basic areas that this strategy will target in an effort to achieve the goals for improvement of minority inclusion and outreach. Theses areas are Environmental Awareness, Career and Job Training and Stewardship and Involvement.

Objective 1: Environmental Awareness

Increase the understanding, and the personal and community involvement of low-income, minority, and non -English speaking populations, especially in schools, with the coastal bays and their tributaries, watershed restoration and preservation, and personal stewardship.

ACTIONS:

1. Identify existing minority programs and locations of target audience
2. Develop coastal bay educational programs for elementary, middle and high school level classes throughout the watershed, especially training teachers to teach environmental issues that impact the local communities
3. Develop After School Programs which incorporate Environmental education curriculum into the programs in the minority community. Offer scholarships to ensure participation.
4. Offer and Include summer camp and field trip opportunities to minority youth groups, church groups
5. Develop multi-media materials and new communication tools to educate and involve affected communities
6. Provide docent program speakers to after school programs, churches, and other members in the community:

Progress:	all actions will begin immediately.
Schedule:	fully implemented by Spring 2002
Partners:	MCBP Partners, UMES, NAACP, Worcester County Department of Education, Wor-Wic Community College, Salisbury University, local churches and community organizations.

Objective 2: Career and Job Training

Increase the involvement of low-income, minority, and non-English speaking populations in environmental careers.

ACTIONS:

1. Work closely with local schools, community colleges, universities (focusing on historically black colleges and universities (HBCU□s) to recruit minorities and develop internship opportunities
2. Support the development and activity of the UMES Coastal Ecology Lab and encourage involvement and links to the minority community with the lab (church, school, community associations).
3. Advertise positions in minority papers, universities, and programs.
4. Use local Minority Business Enterprises
5. Sponsor a workshop in combination with interested parties to define criteria to determine interest and gaps in recruiting minorities into environmental careers.
6. Sponsor a series of forums or workshops in conjunction with HBCU□s to provide information on job training and career opportunities
7. Develop a scholarship program for UMES coastal ecology lab graduate students.

Progress:	1, 2, 3 and 4 will begin immediately and will become incorporated in the MCBP Standard Operating Procedures. Initiate 5, 6 and 7 by the end of 2001 and will be accomplished by 2003
Schedule:	Fall 2001 through 2003
Partners:	MCBP Partners, Minority Business enterprises, Lower Shore Private Industry Council, UMES, NAACP, Worcester County Department of Education, Wor-Wic Community College, Salisbury University, Local Chambers of Commerce.

Objective 3: Stewardship

Demonstrate the opportunity to effect change through involvement in policy decision-making forums and increase participation in stewardship actions.

ACTIONS:

1. Identify and implement pilot projects to demonstrate the opportunity to effect change focusing on issues such as stream restoration, wetlands, reduction of nutrient/sediment inputs, buffer tree plantings, habitat restoration projects, water quality monitoring and public access
2. Recruit participation for advisory committees and Encourage more involvement in policy-making forums.
3. Work with the Governor's and the Chesapeake Bay Program's Environmental Justice Task Forces to assist in developing a comprehensive report that defines criteria to characterize impacted communities and examines the most effective approaches for dealing with estuarine-related conditions that contribute to the impacts.

Progress:	1 and 2 efforts will begin immediately. Contact will be made with CBP for 3.
Schedule:	completion by 2005
Partners:	MCBP Partners, Chesapeake Bay Program Environmental Justice Task Force, NAACP, UMES, SU, Wor-Wic, other local community organizations.

Objective 4: Professional "OMBUDSMAN TYPE" Staff Person

1. Recruitment and development of a staff person to implement the stated objectives and other duties contained in this strategy.

Progress:	efforts to recruit and find funding for will begin immediately
Schedule:	completion by 2005
Partners:	MCBP Partners, Chesapeake Bay Program Environmental Justice Task Force, NAACP, UMES, SU, Wor-Wic, other local community organizations.

II. Environmental Results

A. Status of MCBP's environmental monitoring program:

The MCBP Scientific and Technical Advisory Committee (STAC), with the Department of Natural Resources as the lead agency, is coordinating monitoring environmental progress for the Maryland Coastal Bays Program. Other organizations that are critical to implementation and monitoring in the coastal bays include the National Park Service, U.S. Geological Survey, VA Institute of Marine Sciences, MD Department of the Environment, and Worcester County. To aid in implementation of the Coastal Bays Environmental Monitoring Program, DNR received funds from the Maryland General Assembly to initiate a long-term water quality-monitoring program. The funds included salaries for a Coastal Bays Monitoring Coordinator, 3 field personnel, and a data manager (all positions will be filled during FY03). MD DNR also incorporates federal monitoring programs/grants (e.g. Pfiesteria, National Coastal Assessment, and NOAA Coastal Zone Management macroalgae study) and coordinates with the University of Maryland on monitoring programs (e.g. Brown Tide and macroalgae). NEP staff helps sponsor and manage volunteer monitoring programs including water quality, horseshoe crabs, reptiles and amphibians, and Submerged Aquatic Vegetation.

Actions in the CCMP address five priority problems: degraded water quality, loss of habitats, changes in living resources, unsustainable growth and development and detrimental recreational use of the bays. Appendix A of the MCBP CCMP is the **Eutrophication Monitoring Plan**, (Appendix II-A in this document) which was developed with the following goals in mind:

- To measure the effectiveness of implementing the management actions identified in the CCMP
- To provide information that can be used to redirect and refocus the CCMP over time.
- To provide information that will assist in predicting future trends related to implementation of management actions.

Eutrophication and its impacts to living resources was identified in the MCBP Characterization Report ***Today's Treasures for Tomorrow*** (MCBP 1998-2001, Appendix V-B) as the most pressing environmental issue facing the coastal bays. As a result, the Scientific and Technical Advisory Committee (STAC) recommended that the initial focus of the monitoring plan be on nutrient and sediment inputs to the coastal bays and their impacts on living resources. The framework of the eutrophication monitoring plan focuses on five general categories of monitoring:

1) Track management actions
2) Nutrient and sediment inputs from the watershed and airshed
3) Ambient water quality
4) Eutrophication impacts to habitat
5) Eutrophication impacts to living resources

As issues emerge (harmful algal blooms, blue crab parasite, SAV wasting disease) and as resources and new technologies (remote sensing) are secured, the reprioritization of monitoring efforts may occur. A more complete monitoring strategy has been outlined that touches on additional monitoring needs (see supplement C of Appendix II-A). A summary is provided here:

Eutrophication Monitoring Plan & Detailed Water and Sediment Monitoring Strategy

Level I. Landscape / Management Action Tracking

Landscape monitoring tracks the actual activities going on in the watershed; (i.e. nutrient & chemical application rates, sediment inputs, implementation of best management practices and landcover). This can often be directly related to implementation of management actions and does not normally require intense field monitoring. Instead, existing tracking of management implementation efforts may be sufficient and new measures can be defined overtime.

Goal 1. Provide data on nutrient inputs to the landscape in order to assess over time the effectiveness of management measures taken to reduce nutrient inputs to the coastal bays. This goal can be met by tracking actions related to nutrient application to agricultural land, residential/developed lands, and upgrades to septic tanks. Nutrient application on agriculture land will be available from MDA as part of the nutrient management planning process. Tracking application of nutrients on residential lands will need to use the best available information (for example, sales in the county). Upgrades to septic systems will be tracked using a septic tracking system (SEPTRAC).

Goal 2. Provide data on sediment inputs to the stream system to assess over time the effectiveness of management actions taken to reduce sediment inputs to the coastal bays. The number and location of best management practices implemented is currently collected by MDA and NRCS for agricultural land. The county and/or state has information on sediment controls for residential areas. The data for both goals could be used as part of a comprehensive nutrient or sediment loading model.

Level II. Stressor Monitoring (Watershed & Airshed Inputs)

Stressor monitoring measures the actual pollutant loading to the bays (nutrient, sediment, or chemical) via atmospheric deposition, groundwater input, oceanic inputs, erosion rates, surface runoff, ditches, and point sources. Currently, nutrient loading data in the bays is limited to point sources and estimates of surface runoff nutrient loads "modeled' using runoff coefficients and land use. Projects are underway to get better information on groundwater nutrient loading and limited sediment loading due to shoreline erosion. Therefore, baseline data will need to be collected to achieve a better quantification of nutrient and sediment loads.

Goal 1. Characterize status and assess trends in nutrient inputs form surface water runoff (including ditches in the headwater of streams), point sources, ground-water (direct discharge and base flow), atmospheric deposition, and oceanic inputs to the coastal bays. Data from surface runoff and groundwater will be collected using automated flow driven sampling devices at stream gage stations to capture event (surface runoff) and baseflow (groundwater) inputs as well as non-tidal ambient monitoring stations. Point source monitoring data will continue to be collected through NPDES permits.

Goal 2. Characterize status and assess trends in sediment inputs form surface water runoff, erosion, shoaling and overwash to the coastal bays. Sediments will be collected using automated flow driven sampling devices. Sediment loadings from the ocean (via inlet and overwash) has recently ben monitored by tracking the size of the flood and ebb shoals using aerial photography. Estimating inputs due to erosion may monitor additional sediment loading. This process includes shoreline interpretation and delineation using aerial photography, erosion rates determination, sediment volume, grain size, and mass calculations based on the character of the shoreline.

Level III. Response Monitoring

Using indicators to show how the system is able to balance/absorb the stressors it receives: Ambient water quality and sediments, SAV abundance, fish health IBI, macroalgal abundance, benthos structure, abundance, and toxicity. This information will be very valuable for public education. However, relating management actions to ecosystem changes will require long-term data sets to determine trends.

Goal(s): Characterize status and assess trends in ambient water quality in the coastal bays: parameters will be measured that relate to important living resources, management control measures or that which are important to the analyses of ecological relationships. Fixed stations will be used to monitor trends and to determine status in localized areas for key water quality parameters.

To reiterate, implementation of the monitoring plan will involve multiple partners including local governments, volunteers, academic institutions, State and Federal agencies, and will be coordinated by the MD Department of Natural Resources, Resource Assessment Service, through a Monitoring Subcommittee of the STAC. Coordination of the program through DNR, which conducts other statewide aquatic and wildlife monitoring programs, will insure consistent methodologies and analyses, rigorous quality assurance, integration with statewide monitoring data bases. Data will be analyzed by the respective group collecting the monitoring data and compiled into a comprehensive review, on a bi-annual basis, and presented to STAC for review. Data and results will be made available using a distributed internet system and possibly posted to partner websites. GIS and bi-annual "State of the Bays" reports will be used to display data and analyses (first one due in 2003).

The first field sampling began February 21, 2001 with the addition of 17 new water quality monitoring sites. A complete list of the parameters measured is listed in the eutrophication monitoring plan attached to the MCBP CCMP.

Information required to develop an effective monitoring program was obtained from a compendium of over 70 existing or highly relevant monitoring programs within the coastal bays and its watershed. Historic and ongoing monitoring information, including plan elements and parameters were considered. This information was compiled to produce ***A Compendium of Monitoring Programs in the Coastal Bays*** (Wazniak, 1998 Appendix II-B).

The organizations and their respective programs involved in monitoring include:

Federal

U.S. Environmental Protection Agency

- EMAP / Mid-Atlantic Integrated Monitoring and Assessment
- National Coastal Assessment
- Multi-Resolution Land Characteristics

National Park Service

- Water Quality Monitoring Program
- Surf Water Bacteriological Monitoring
- Assateague Island Vegetation Community Monitoring
- Feral Horse Population Dynamics and Grazing Effects
- Peregrine Falcon Migration Population
- Piping Plover Monitoring Program
- Pilot SAV Monitoring Program
- Marine Species Stranding
- Mosquito / Eastern Equine Encephalitis Monitoring

- North End Vegetation Monitoring
- Meteorological Monitoring Program
- Bay Tide Stage / Water Level Monitoring Program

U.S. Geologic Survey

- National Water Quality Assessment Program
- Water Level and Chloride Monitoring
- Water Resources Data
- Historic Stream Gauges

National Oceanic and Atmospheric Administration

- Status and Trends Program – Sediments and Shellfish Tissue
- Blue Crab Pathogen Study
- Coastal Change and Analysis Program
- National Water Level Observation Network

U.S. Department of Agriculture

- Agriculture Best Management Practices
- Forest Inventory and Analysis
- NRCS Soil Classification of Sinepuxent Bay

National Air Deposition Program

- Nutrient and Particulate Deposition - Monitoring Location MD18 Assateaque Island

State of Maryland

Department of Natural Resources

- Pfiesteria Related Monitoring
- Statewide Groundwater Quality Network
- Sediment Characteristics
- Benthic Inventory
- Colonial Waterbird Survey
- Game Management Program
- Hard Clam Survey
- Horseshoe Crab Survey
- Marine Fisheries Project
- Biological Stream Survey
- Mid-Winter Waterfowl Survey
- Neotropical Migratory Songbird Study
- Non Tidal Benthic Monitoring Program
- Rapid Biologic Assessment
- Threatened and Endangered Species
- Waterfowl Breeding Survey
- Forest Resource Inventory
- Land Cover GAP Analyses

Department of the Environment

- Point Source Permit Discharge
- Total Maximum Daily Loads
- Shellfish Pathogen Program
- Fish Kill Monitoring
- Non Tidal Wetland Monitoring
- Tidal Wetland Monitoring

Maryland Office of Planning

- Land Use Monitoring

Local Government

Worcester County

- Beach Monitoring Program
- SEPTRAC – Upgrades to septic systems
- Sediment Control
- Wetlands Planning Group

Other Groups

Maryland Coastal Bays Program

- Volunteer Water Quality Monitoring
- Herp Search
- SAV groundtruthing

National Audubon

- Bird Survey/Breeding Bird Atlas
- Cornell Lab of Ornithology- Birds in Forested Landscapes

Virginia Institute of Marine Science

- Submerged Aquatic Vegetation Aerial Survey

The main strength of the current program is the coordinated effort by multiple partners. Some planned improvements include expanding the parameters measured by the NPS water quality program to include all parameters currently measured by the state program (e.g. organic nutrients, Carbon, Hydrogen, and Nitrogen) and adding photosynthetically active radiation measurements to the State's monitoring program as well as expanding the volunteer water monitoring program to include sampling nutrients at all stations based on recommendations from the Scientific and Technical Advisory Committee, STAC. The major limitation of current program is lack of a focused monitoring strategy for 'terrestrial' habitat and living resources (including wetlands). The STAC has suggested that the NEP hire a consultant to develop this strategy so that it can be used to obtain funding like the water quality program.

B. Environmental indicators

The STAC is in the process of developing environmental indicators for the Maryland Coastal Bays Program that will be used to track the response of the environment to the implementation of the CCMP. The Coastal Bays Program has hired a professional facilitator to lead a workshop, June 6, 2002, to finalize these indicators and develop associated numeric goals. Indicator experts from outside the Program have been invited to bring in new ideas and to share their expertise with the participants. A final report will be issued by the facilitator and will be used as a component of future workshops to develop a regional science agenda for the Coastal Bays.

The STAC has divided into three Workgroups : aquatic habitat; terrestrial habitat; and water quality. Through various agencies, institutions, and funding sources, numerous aspects of the Coastal Bays environment are currently being monitored. There are no environmental models (except for 2 approved TMDL's) developed for the Coastal Bays that can be used to make predictions based changes in inputs. Therefore, each of these Workgroups are basing their estimations through historic and current monitoring data, analysis of trends, and best professional judgment. Assuming that the CCMP will be fully implemented, the STAC has developed the following preliminary environmental indicators:

Aquatic Habitat

Submerged Aquatic Vegetation: SAV were decimated in the 1920s – 1930s by a slime mold caused by unknown environmental conditions. The abundance of submerged aquatic vegetation (SAV) has been increasing in the Bays for at least the last 15 years. SAV is important habitat to other species, particularly blue crabs and juvenile fishes, and reduces suspended sediment. *DRAFT INDICATOR: Protection of existing SAV and expansion into other appropriate areas, particularly the western shore and deeper depths should continue as sediment and nutrient loading is reduced as well as enhanced protection from boat scaring.*

Forage Fish: Forage fish are an important aspect of the fish food chain. Forage fish tend to eat plankton and are in turn eaten by larger fish. In the Bays four forage fish species predominate, silver sides, anchovies, menhaden, and spot. Silver sides and anchovies live their entire life within the Bays while the other two spawn in the ocean. These species are critical to the health and growth of predatory fish such as striped bass and flounder. *DRAFT INDICATOR: Reverse the current negative trend in the forage fish index.*

Blue Crab: Blue crabs spawn off the continental shelf. As the larvae grow they enter coastal estuaries at a stage called megalopae. Because blue crabs spawn offshore the inshore population is dependant water currents. It is important for meglopae and juvenile crabs to have the food resources and protection areas (such as SAV) to grow and enter the fishery. *DRAFT INDICATOR: Enhanced recruitment to adult blue crabs of the megalopae that enter into Bays.*

Hard Clam: The entire life cycle of the hard clam takes place within the Bays. They live in the benthos (bottom) and can therefore be adversely impacted by low levels of dissolved oxygen.
DRAFT INDICATOR: Enhanced hard clam recruitment into the fishery.

Introduced Species: Numerous species have been introduced to the Coastal Bays from a variety of human induced sources. The green crab is sold as live bait and has been found along the shore of the Bays (independent of the fisherman). Other introduced species include mute swans, *Phagmites*, and MSX (oyster parasite). *DRAFT INDICATOR: Decrease the abundance (or number) of specific introduced species within a target geographic area and/or period.*

Terrestrial Habitats

Wetlands: It has been well established that wetlands are critical at filtering water (removing nutrients, sediment, and other pollutants) prior to its entry into the river or estuary. Maryland has committed to creating, restoring, or enhancing 60,000 acres of wetlands. The Coastal Bays watershed is a critical part of that commitment. *DRAFT INDICATOR: Create, restore, or enhance 10,000 acres of wetlands by 2015.*

Forests: Large, diverse, intact forests can maintain a high species diversity of birds and mammals. Almost all forestland in Worcester County is managed for the wood products and pulp industry. These forests are typically loblolly pine. *DRAFT INDICATOR: Environmental indicators have yet to be developed.*

Riparian Buffers: Riparian buffers can serve a variety of functions in the river and coastal areas of the watershed. They provide habitat, shading which reduces local surface water temperature, can take up ground and surface water nutrients, and provide a source of woody debris to the water for habitat and detrital matter. *DRAFT INDICATOR: Environmental indicators have yet to be developed.*

Water Quality

Dissolved Oxygen: Through the process of photosynthesis algae and SAV release oxygen. Additional oxygen can enter the Bays from the wind mixing with the water surface. All animals take up oxygen as well as plants (when they are not photosynthesizing they are net consumers), and some bacteria. Typically, if too much algae grows oxygen consumption can be greater than production, particularly during darkness. When algae dies it is broken down by bacteria which typically consume oxygen thus lowering levels. Animals that swim can leave the low oxygen areas but many benthic organisms can die. *DRAFT INDICATOR: Dissolved oxygen should be above a minimal level (5 mg/L) regardless of time of day and season.*

Chlorophyll a: Chlorophyll *a* is a plant pigment which can be used to determine the amount of algae in the water. Large algal blooms typically take place in the spring due to warming water temperatures and high nutrient loading from the freshet. The Coastal Bays tributaries would typically have higher levels of chlorophyll *a,* due to the local nutrient loading, then the Bays they run into which are influenced by the low nutrient ocean waters. *DRAFT INDICATOR: Chlorophyll a should remain below a maximum level (50 ug/L) for tributaries and a lower maximum level (15 ug/L) for the Bays.*

Ratio of Nutrients: Waters which have been minimally impacted by man have ratios of nitrogen to phosphorous around 16:1. While human induced runoff typically increases nitrogen and phosphorous, the loading tends to be greater. This excess nitrogen can put the system out of balance because nitrogen is typically the limiting nutrient to plant growth in salt water. Therefore the more nitrogen the less algae growth will be limited. *DRAFT INDICATOR: The ratio of dissolved nitrogen to phosphorous on the order 10:1, or slightly higher, will stimulate maximum algal growth rates.*

Nitrates: Groundwater & Atmospheric: Groundwater nutrient concentrations were chosen as an indicator of nutrient loads(could be measured in shallow subsurface groundwater or as baseflow). One important source of nitrates in Maryland streams is deposition from the atmosphere. However, leaching into groundwater and direct runoff of fertilizers and animal wastes used on agricultural lands, discharges from sewage treatment plants, and leaking of septic systems are more important sources of nitrates to streams. *DRAFT INDICATOR: Stream nitrate concentrations greater than 1 mg/L are elevated compared to undisturbed streams.*

The STAC considers the development of environmental indicators as an iterative process. Every 3 – 5 years the Coastal Bays monitoring data should be reviewed to evaluate progress toward existing indicators or if these indicators should be changed and determine if new indicators should be developed. Ultimately, these indicators should assist the public and the policy makers to understand the reasons for implementing the CCMP. The STAC will continue to work with the scientific community to garner a better understanding of the Coastal Bays watershed so that it can be optimally managed. Plans for future deliverables include:

State of the Bays Report using the suite of indicators related to the four priority sections of the CCMP; (Water Quality, Fish & Wildlife, Recreation & Navigation, and Community & Economic Development). *Target Audience: estuary residents and elected officials. Produce triennially to serve as a submission for EPA Implementation Reviews.*

Status and Trends of Key Indicators in Maryland's Coastal Estuaries A periodic update describing ecological conditions, gaps in information, and critical monitoring needs. To include strategies, with proposed methodologies and indicators, to track programmatic and ecological implementation progress and results. *Target Audience: local, state, and federal natural resource managers, policy makers, and the research community.*

C. Environmental results and trends

It is too early to determine if there have been any environmental improvements in the bays that can be attributed to (directly or indirectly) CCMP actions. However, environmental results from specific projects, such as an APDP and demonstration projects have resulted in *improvements in or restoration of habitat (e.g., number of acres)*. The MCBP Year 1 APDP report and the GPRA Reports for 2000 and 2001 illustrate the programs progress in these early improvements.

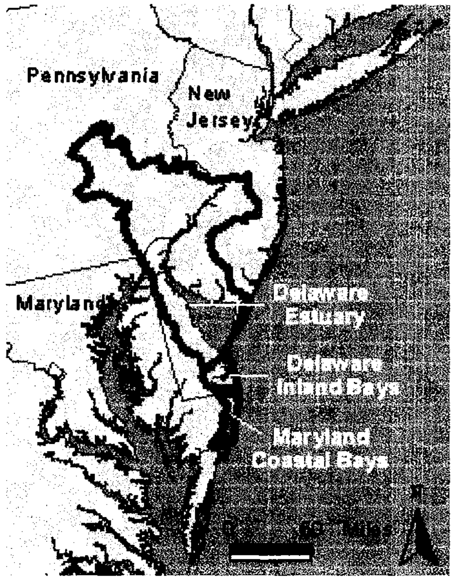
FIRST YEAR ACTION PLAN DEMONSTRATION PROJECTS

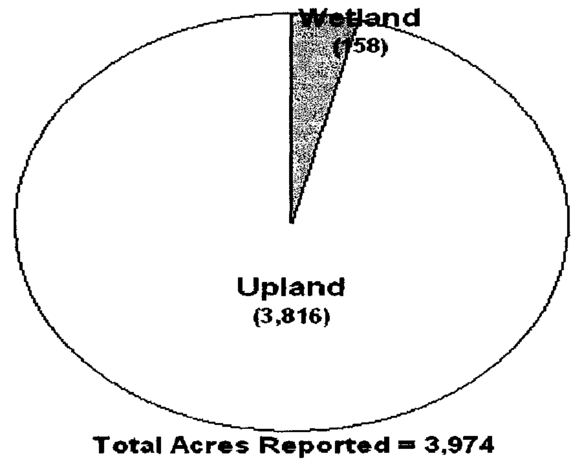
PROJECT TITLE AND DESCRIPTION	*START DATE*	*END DATE*	*RECIPIENT*	*LESSONS LEARNED*	*CONTACT*
Community-Scale BayScaping to Benefit Local Waters - BayScapes is a program developed by the US Fish and Wildlife Service and the Alliance for Chesapeake Bay to promote citizen action to reduce nutrient inputs and other threats to water quality and encourage the development of environmentally sound landscapes that benefit people, wildlife and watersheds.	5/15/98	12/31/99	US Fish & Wildlife Service	Several BayScapes planting projects were completed throughout the Coastal Bays watershed, teaching local citizens that native plantings are an attractive alternative to exotic ornamentals and also has the benefits of reduced water use, habitat creation, reduced fertilizer/pesticide use improvements to water quality	Brit Slattery 410-573-4581
Bay Scallop Restoration in Chincoteague Bay - In 1997and 1998 MDDNR began a project to test the viability of reintroducing bay scallops into Chincoteague Bay. Seed stock were placed into predator exclusion pens and began reproducing. It is hoped that continued reproduction would help reestablish the bay scallop in its former natural habitat, coincident with the recovery of sea grasses.	6/1/98	5/31/99	MD Dept. of Natural Resources	The combined reproductive effort of the protected scallops along with the seed scallops progeny have shown signs of overwhelming predation pressure sufficiently to allow a self-sustaining population of bay scallops to become established, marking the return of this ecologically and economically important species to Chincoteague Bay.	Mark Homer 410-326-1417
SAV Preservation and Restoration in Maryland's Coastal Bays - This project located existing SAV beds in the Coastal Bays, distinguished characteristics of areas supporting SAV vs. those not supporting SAV, determined the effects of clamming on extant SAV beds and transplanted vegetation into areas where SAV does not	5/1/98	5/1/99	Salisbury State University	SAV is returning to the Coastal Bays. Existing beds are expanding, Zostera is moving into areas previously dominated by Ruppia and previously unidentified beds were located. The primary factors affecting SAV distribution in the upper and lower Coastal Bays were noted and areas that are promising for SAV transplantation efforts were identified.	Harry Womack 410-543-6492

currently exist.					
Wave Exposure and Sediment Characteristics as Habitat Requirements for Eelgrass in Chincoteague Bay - This project investigated the cause(s) for the restriction of most of the SAV beds in Chincoteague Bay to the eastern shoreline: sediment characteristics vs. wind/wave exposure.	4/1/98	11/30/98	University of Maryland - Horn Point Lab	Statistically significant results indicate that both wave exposure and sediment type tend to restrict SAV growth along the western shore of Chincoteague Bay. Wave energy is greater on the western shore as well as the distribution of finer sediments and these factors need to be taken into account when planning SAV restoration and transplantation activities.	Evamarie Koch 410-221-8418
Coordination of Nutrient Enrichment with Seagrass Growth: Coupling Research and Education - This is a combination of 2 proposals that coupled SAV research with a middle school science class in field lab project. Middle school students went out to unvegetated areas of Chincoteague Bay and placed artificial SAV (ribbons) to study the effects of water quality, sediments and epiphytes on the limitations of SAV propagation.	5/1/98	5/1/99	University of Maryland; Stephen Decatur Middle School	The students found that using artificial substrates in place of SAV could be useful in determining why SAV is absent in portions of Chincoteague Bay. The project coupled estuarine researchers from a university with local middle school science students. The middle school teacher presented this study at an international conference in Turkey and tied for a first place award for best in conference.	Laura Murray 410-221-8418; Pat Chambers 410-641-2846
Sea Grass Protection in Isle of Wight Bay - The purpose of this project was to assess the impact of intense recreational boating activity on seagrass beds in Isle of Wight Bay and evaluate management strategies for seagrass protection.	4/1/98	11/30/98	MD Dept. of Natural Resources	Isle of Wight Bay is one of the most heavily utilized of the Coastal Bays by recreational boaters. Propeller scarring is having a significant effect on the reestablishment of seagrasses in this northern bay. This study helped lead to the State placing buoys around the most sensitive grassbeds, making them off limits to boaters as well as fact sheets explaining this program to the boating public.	David Goshorn 410-260-8639
Stephen Decatur Middle School Friendly Courtyard Garden - Students with the EARTH Club converted a bare school courtyard into a garden using native plants and pond.	3/1/98	9/30/98	Stephen Decatur Middle School	This educational project helped students learn how to design and build a "natural" habitat by researching which native plant species would be appropriate to help reduce nutrient runoff and create habitat.	Evan Hudson 410-641-2846

Mosquito Control Using Starch - Starches modified with fatty acids were tested for their ability to form a temporary layer at the air-water interface to suffocate mosquito larvae in lieu of commercially available pesticides in ecologically sensitive marshlands.	3/1/98	3/1/99	University of Wisconsin	Mosquito spraying of marshes by the MD Dept. of Agriculture has been controversial within segments of the Coastal Bays community. The field testing of these compounds in salt marshes within the Coastal Bays watershed proved that these nontoxic, biodegradable starch compounds can be a viable mosquito larvacide.	Barry Pittendrigh 608-251-3211

Maryland Coastal Bays GPRA 2000 Report Summary by Habitat Category





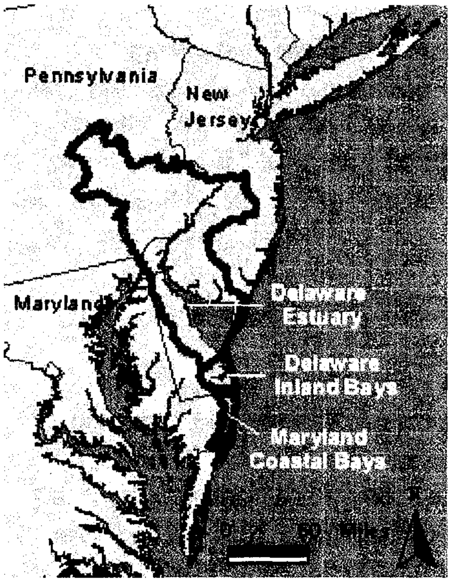
View the Habitat Categories

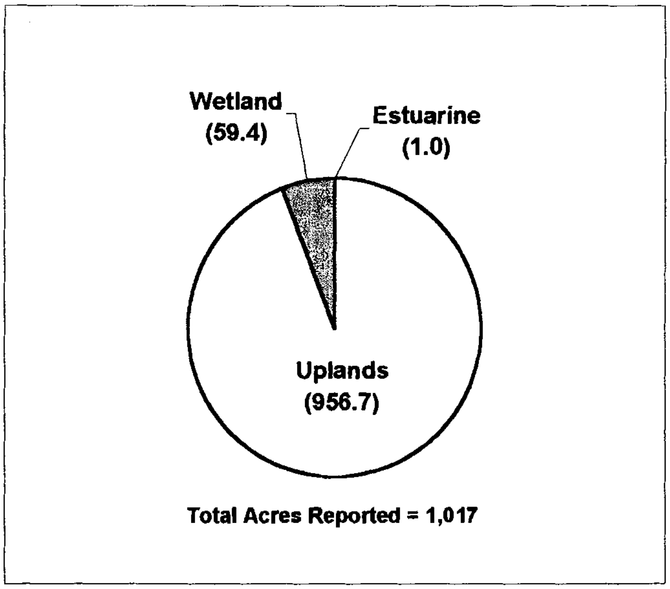
CCMP Action	Project Name	Activity	Habitat Type	Habitat Category	Acres Restored
FW 1.9, WQ 6.2	Wetland Reserve Program	Protection, Restoration	Wetland with various upland	Wetland	40.0
FW 1.9, WQ 6.2	CREP: Conservation Reserve Program	Protection, Enhancement	Wetlands	Wetland	31.6
FW1.9, WQ6.2	CREP Riparian or Forest Buffers Program	Restoration, Creation, Enhancement	Herbaceous and Forested Buffers	Upland	204.0
WQ 7.1, 7.2, 4.1, 4.3, 6.1, 6.2; CE 2.1, 3.2, 4.2, 4.3; FW 2.5, 2.6 ,3.1	Rural Legacy Program	Protection, Enhancement	Agricultural, Forested, Tidal Wetlands, Aquatic, and Brush	Upland	2700.0
FW 1.9, 2.1, 2.2, 2.3, 2.6	CREP	Protection, Restoration	Wildlife & Plant Communities	Upland	908.0
FW 1.9, 2.1, 2.6, 3.1	Herring Creek Nature Park	Conservation, Protection	Wetland	Wetland	50.0
FW 2.1, 2.2, 2.3, 2.6	County Planting w/ Forest Conservation Funds	Restoration, Conservation	Forest	Upland	4.0
FW 1.9, 2.1, 2.6, 3.1	Assateaque Parks Gateway Corridor Project	Protection, Conservation	Wetland, Riparian Buffer	Wetland	36.4
Total					3974.0

Revised: 03/22/2002 16:00:29 http://www.csc.noaa.gov/products/nepweb/htm/mapping/mary.htm

(Source: http://www.csc.noaa.gov/products/nepweb/htm/habitat/hab_fr.htm),

Maryland Coastal Bays GPRA 2001 Report Summary by Habitat Category



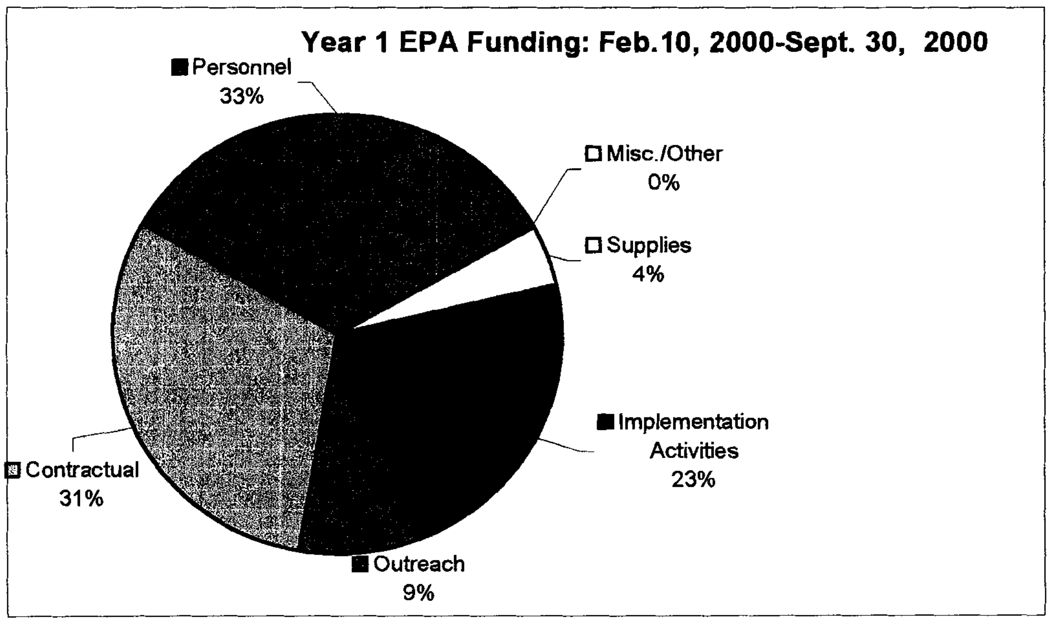


View the Habitat Categories

CCMP Action	Project Name	Activity	Habitat Type	Habitat Category	Acres Restored
FW 1.3	Assawoman Bay Oyster Shell Habitat	Reestablishment	Estuarine	Estuarine	1.00
FW 2.5	CREP	Reestablishment	Wetland restoration	Wetland	5.50
FW 1.9, 2.1, 2.2	CREP	Enhancement	Uplands	Uplands	100.10
FW 1.9, 2.5	CREP	Enhancement	Uplands- forested buffers	Uplands	226.90
FW 2.5	CRP	Reestablishment	Wildlife habitat	Wetland	6.40
WQ 2.1	EQIP	Enhancement	Uplands-agriculture	Uplands	2.00
FW 3.1	Ocean Pines Saltmarsh Restoration	Rehabilitation	Tidal saltmarsh	Wetland	6.30
WQ 4.1, 4.3, 6.1, 6.2, 7.1, 7.2	Rural Legacy Program	Protection	Uplands-agriculture	Uplands	18.00
WQ 4.1, 4.3, 6.1, 6.2, 7.1, 7.2	Rural Legacy Program	Protection	Uplands-agriculture	Uplands	609.67
FW 2.5	WRP	Reestablishment	Wetland restoration (freshwater 38.2 acres, salt marsh 3 acres)	Wetland	41.20
Total					1,017.07

The following is a more detailed breakdown of the Year One Expenses of the EPA funding.

	Feb 2000-Sept 2000
2000-EPA Expenses	
2000-Expenses	
2000-Administration	
2000-Contractual	76,674.37
2000-Personnel	83,423.88
2000-Miscellaneous/Other	1,133.11
2000-Supplies	10,627.15
2000-Travel	5,089.91
Total 2000-Administration	176,948.42
2000-Implementation Activities	57,108.76
2000-Outreach	21,867.47
Total 2000-Expenses	255,924.65

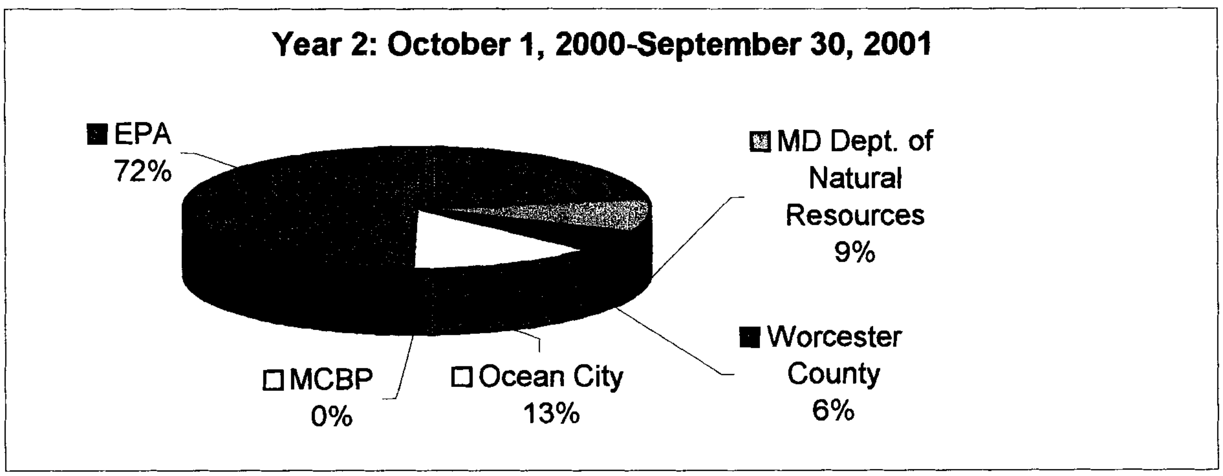


Year 1 Implementation Activities funded:
Printing and distribution of "Envisioning the Future" book.
Printing of Maryland Coastal Bays Program's Comprehensive Conservation Management Plan.
Native plant gardening.
Volunteer Water Quality Monitoring
GIS Support
Sponsor Smart Growth Speaker Series
Funded air deposition studies
Funded groundwater studies
Quarterly newsletters

POST CCMP FUNDING - YEAR TWO

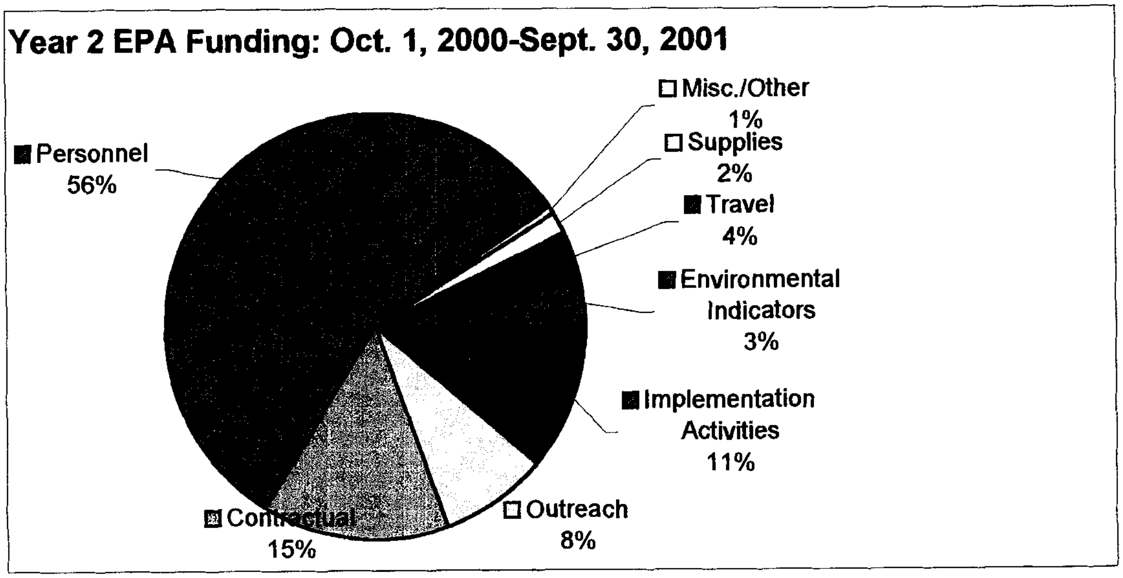
The second year expenditures came to $425,639. The following is a breakdown of grant funds and in-kind services expended from each agency. The required 25% match was achieved through in kind services of WC, OC and DNR.

Source	Amount
MD Department of Natural Resources	$39,157.80
Worcester County	23,725.90
Town of Ocean City	56,486.00
Maryland Coastal Bays Program	1,015.30
U.S. Environmental Protection Agency	305,254.52
Total	**$ 425,639.52**



The following is a breakdown of Year Two Expenses of the EPA base Grant.

	Oct 2000 - Sept 2001
2001-EPA Expenses	
2001-Administration	
2001-Contractual	44,407.74
2001-Personnel	172,807.14
2001-Miscellaneous/Other	1,672.96
2001-Supplies	4,799.67
2001-Travel	12,417.81
Total 2001-Administration	236,105.32
2001-Environmental Indicators	10,143.93
2001-Implementation Activities	33,232.50
2001-Outreach	25,772.77
Total 2001-Expenses	305,254.52



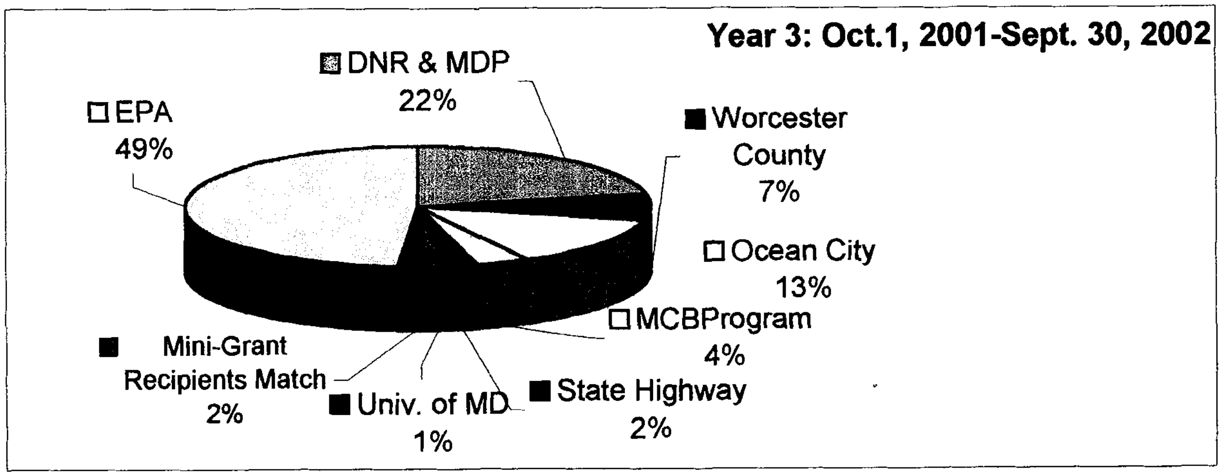
Year 2 Implementation Activities funded:
Printing and distribution of "Adopt-A-Street" brochures
Printing and distribution of SAV brochures
Printing and distribution of Safe Boating posters
Storm drain markers in Ocean City
Printing and distribution of door hangers for Ocean City hotels and motels.
Printing and distribution of Homeowners Guide To The Coastal Bays.
Purchase and planting of native plants for native plant gardens at Berlin Intermediate School and Ocean City.
Purchase of computer and printer for GIS mapping.

Year 2 Outreach
Printing and distribution of quarterly newsletters
Public Service Announcements on local television stations
Booth space at Commercial Waterman's Expo, Boat Show, Surf Expo, and speaking at various community organizations.
Printing and distribution of Coast Day brochures for local newspapers.

POST CCMP FUNDING - YEAR THREE

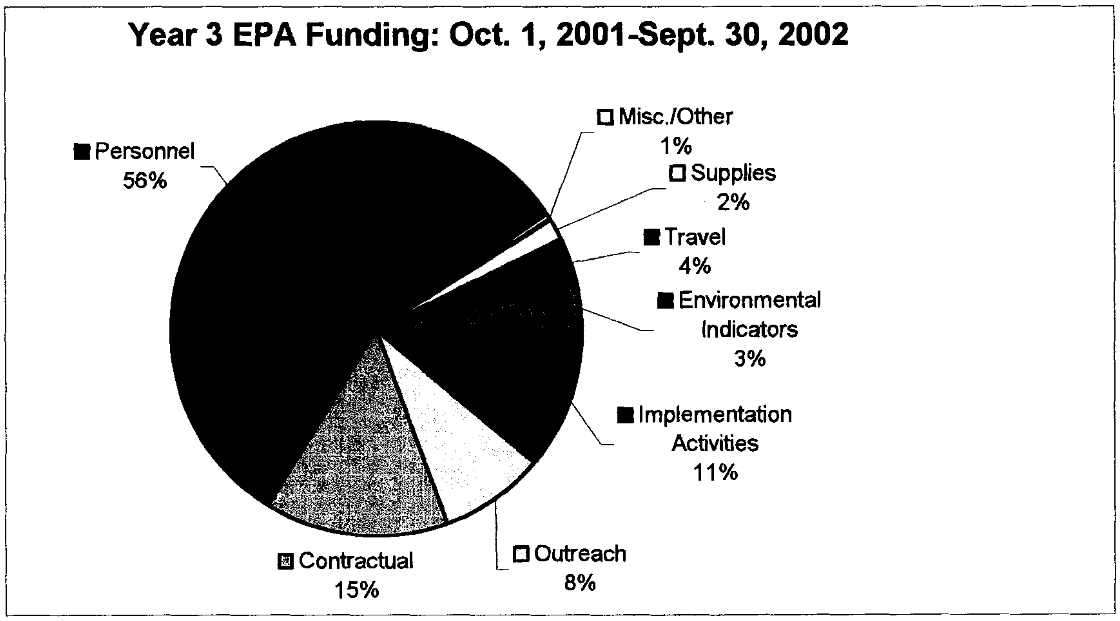
The third year of implementation, the budget from EPA is $381,204. With the increased match requirement of 50% from the reauthorization of the CWA, the total grant became $783,303. All of the partners increased their in-kind match and MCBP contributes matching funds. The following is a breakdown of each source of funds or in-kind match.

Source	Amount
State of Maryland (DNR & MDP)	$169,720.00
Worcester County	56,461.00
Town of Ocean City	104,021.00
Maryland Coastal Bays Program	28,745.00
Maryland State Highway Administration	16,793.00
University of Maryland	11,359.00
Mini-Grant Recipients Match	15,000.00
U.S. Environmental Protection Agency	381,204.00
Total	**$783,303.00**



Since we are still in year three grant cycle, the following is a breakdown of the anticipated expenses to be done during Year three of implementation by September 2002.

	Oct 2001 - Sept 2002
2002-EPA Expenses	
2002-Administration	
2002-Contractual	72,043.00
2002-Personnel	189,481.00
2002-Miscellaneous/Other	500.00
2002-Supplies	7,400.00
2002-Travel	13,750.00
Total 2002-Administration	283,174.00
2002-Environmental Indicators	40,204.00
2002-Implementation Activities	32,526.00
2002-Outreach	25,300.00
Total 2002-Expenses	381,204.00



B. Amounts and sources/types of other funding:

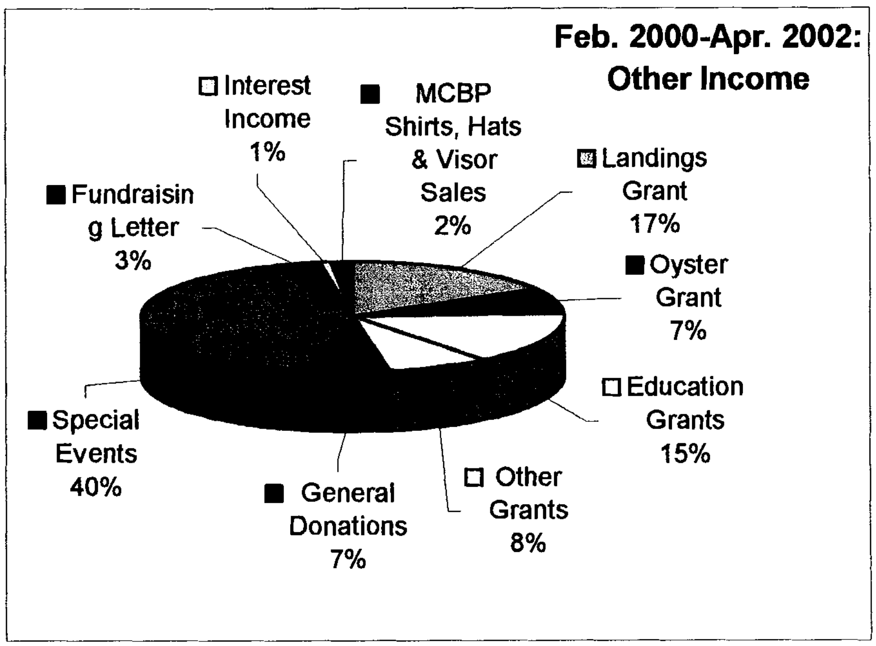
MCBP and the program partners have had some success in receiving additional grants and funds for implementation activities.

Our grant writing efforts have led to several awards to the program. Additionally, the efforts of the fund raising committee have got off to an initial positive start. One of the difficulties that we have found is finding the grant sources in a timely manner. Staff has been networking to become more involved with grant opportunities but the timing of grant cycles leads to difficulties in putting together a grant. Staff members and the fundraising committee have attended several grant writing trainings with the hopes to address many of the issues of getting "in-tune" with the grant cycles. One of the other initial difficulties that developed was that of experience and age of the non-profit organization. Many of the foundation and grants that were applied for were initially denied since the MCBP did not have significant enough time of grant management or fiscal history. As the program ages, this issue should dissolve.

One of the difficulties will be to maintain the level of enthusiasm of the community to continue to contribute through fund raising efforts.

The following is a list of additional income the MCBP has received since the creation of the non-profit organization.

Landings Grant (EPA)	45,000
Oyster Grant	20,000
Education Grants	41,000
Other Grants	20,930
General Donations	17,772
Special Events	107,703
Fundraising Letter	9,335
Interest Income (Fundraising Savings Account)	2,743
MCBP Shirts, Hats & Visor Sales	4,285
Total Other Income	**268,768**



The following is a list of specific additional grants and funds received for the various activities.

Education		
Grants		
Jun-00	Wareheim Foundation	10,000
Aug-00	Clayton Baker Trust	10,000
Jan-01	Schulderberg Foundation	500
May-01	Wareheim Foundation	5,000
Sep-01	Clayton Baker Trust	5,000
Nov-01	Schulderberg Foundation	500
Dec-01	Burbage Foundation	10,000
Total Education Grants		**$41,000**
Other Grants		
Feb-00	Chesapeake Bay Trust	3,530
Dec-00	Burbage Foundation	10,000
May-01	Ocean City Beautification Con	500
Nov-01	Worcester County	4,000
Apr-02	Community Foundation of the Eastern Shore	2,900
Total Other Grants		**$20,930**
Special Events		
Sep-01	Battle for the Bays	1,010
Oct-00	Coast Day	345
Sep-01	Coast Day	58
Apr-00	Earth Day Boat Tour	795
Apr-01	Earth Day Boat Tour	613
May-00	Macky's Fish Fry	3,560
May-01	Macky's Fish Fry	7,577
Aug-00	Jolly Roger Day	26,125
Aug-01	Jolly Roger Day	13,980
Oct-00	Triathlon	22,950
Oct-01	Triathlon	29,750
Jun-01	Arts Alive	894
May-01	Surf Trade Show	46
Total Special Events		**$107,703**

In addition to the direct funding and in kind services to the Coastal Bays Program, there have been several new initiatives, grants and funding that have been leveraged and developed through the indirect influence and involvement of the coastal bays management plan. The following is a list of additional projects and activities with estimated funds that have been directed towards coastal bays information, monitoring, research and actions by state, federal, and local governments and citizens.

DNR Coastal Bays Water Quality Monitoring - $428,018
Coastal 2000 - $200,000
Isle of Wight Watershed Restoration Action Strategy - $40,000
Coastal Bays Macroalgae research and Workshop, $25,000
UMES Coastal Research Lab - $3 million construction
UMES NOAA research grant $15 million over 5 years
USACE Ocean City and Vicinity Water Resources Study
Ocean City Stormwater Retrofit Grant from 319 funds - $50,000
Dept. Of AG Manure Transport Project - $224,000
Maryland Agricultural Water Quality Cost share Program (cover Crops) $281,000
Ag. Public Drainage - Cost share for maintenance from 319 funds $78,000
State Highway Administration Highway and enhancement funds $2 million (wetland restoration, forestry, storm water, native gardens,)
MDE wetlands work
MDE wastewater work
Coast Guard and CG Auxiliary time and fuel
CAC time 4,000 hours yr one and 2,500 yr two
Research on SAV and Wetlands at U. of MD - Horn Point
Atmospheric Deposition Monitoring - $6,500 and NPS match $7,300
USGS/NPS projects $500,000 (groundwater, watershed model, base flow nutrients, groundwater evaluation, resistivity, seismic work)
USGS Gage station on St. Martins River
NPS Water Quality Monitoring - $50,000 per year plus extra $25,000 for tide gage grant)
MBSS and Stream waders Study
DNR Fisheries Monitoring
Hard Clam Survey
MDE TMDL Monitoring
Brown Tide investigation and analysis work $3,000
Rural Legacy--$6.75 million in State grants to date; $400,000 in County matching funds
New Worcester County Staff—Comprehensive Planning and new enforcement staff; approx $240,000/yr (some of this covered by grants)
CZM funding—approx $30,000 to $50,000/yr
Section 319 funding—approx $50,000 to $70,000/yr
GIS equipment purchases of $10,000
State grants to WC and OC for implementation of the Critical Areas program
Use of the Weidman Farm for Education Purposes
Maryland Conservation Corps efforts
Trust for Public Lands easements and acquisitions (from NOAA CZM) —$350,000

C. Current efforts of the program to obtain additional sources of funding

The Program has created a successful nonprofit organization that has had very good success since initiating the many fundraising activities. Fund-raising efforts have helped generate $107,703 from local citizens and businesses. And additionally, grant writing and applications to private foundations have generated $61,930. These efforts will continue to expand with efforts targeted toward tourists and other foundations as they are identified.

Long-term core funding is a challenge. Funds to operate the program and maintain its education, outreach, and research involvement in issues will determine the long-term success of the program and health of the ecosystem. There has been success at the Congressional and federal level to increase the base funding for the Estuary program for FY 2003. It would be extremely helpful to continue this funding.

The Policy Committee and the Board of Directors have recognized and discussed the long-term funding of the program and have agreed it needs to be addressed. The Policy Committee recommended a financial needs assessment be accomplished to determine the level of funding that would be needed and to identify potential sources for funding. The needs assessment will be conducted in the future.

Agencies are beginning to look into potential funding sources for assistance to implement their specific actions of the CCMP. Beyond the minimum match requirements, the program does not expect similar or other sources of funding from the state and local governments. There is no line item in either the state of local governments budgets. The likelihood of continued State and local funding will be in the form of in kind service and match. The program efforts to obtain dedicated State or local funding for the NEP (e.g., a State line item) have been explored and requested. The likelihood of obtaining such dedicated funding appears to be minimal at this time.

IV. Institutional Coordination and Public Involvement

A. Maryland Coastal Bays Program Staff

Dave Blazer, director
Dave Wilson Jr., public outreach coordinator
Carol Cain, technical coordinator
Susan Krause, education coordinator
Kelli Michaud, administrative specialist
Julia Moore, environmental education specialist
To be filled: staff science coordinator

The staff makeup of the Coastal Bays Program is fashioned in accordance with the makeup of directives in the Coastal Bays Conservation and Management Plan. The director oversees all implementation activities and all program staff who are equal under him/her. Specific CCMP actions undertaken directly by the director involve legislative, policy, and program changes such as CCMP actions regarding these changes in stormwater management, development, forestry, wastewater management, boating, and related fields. The technical coordinator tackles the science-related CCMP actions such as those that call for monitoring, studies, research or investigation into fisheries, wildlife, water quality or technical upgrades or challenges. Because 56 percent (74 of 133) Coastal Bays Program actions in the CCMP are education actions, much staff time is allocated to these directives. Specifically, the outreach coordinator tackles those actions which involve public events and production of brochures, videos and television programs for boating, fishing, stewardship, and water and energy conservation. The many actions that require media involvement are the responsibility of the outreach coordinator. For those that require, demonstration projects, full-scale school and organization educational programs, community cleanups and group-related education, the education coordinator takes charge along with the education specialist who implements and manages many of these programs. The education specialist organizes cleanups, plantings, events and workshops called for in the CCMP and serves as the primary grant administrator. Finally, the administrative specialist ensures the efficient functioning of this system through budget, personnel, and management conference management. All staff work together at 9609 Stephen Decatur Highway, Berlin Maryland.

Dave Blazer: (100% EPA funded) As director, Blazer is responsible for overseeing initiatives to implement the Coastal Bays Comprehensive Conservation and Management Plan (CCMP). This entails oversight and coordination of federal, state, local, and private organizations involved in this implementation. The director supervises staff; coordinates with local, state, and federal programs (DNR, MDE, EPA, MDA, Worcester County, NRCS, Ocean City, National Park Service); develops and implements budgets (outreach budget, staff budget, implementation budget); administers grants; oversees contractual obligations; participates on committees and work groups such as the Fisheries Advisory Committee, Implementation Committee, Wetlands Planning Group, and CCMP-associated subcommittees; provides technical and policy advice to committees and program managers; ensures initiatives complement local, state, federal, and private projects; writes progress reports; solicits public and private dollars; and institutes a program to track success in implementing the CCMP (Tracking and Evaluation Program).

Dave Wilson: (100% EPA funded) As public outreach coordinator, Wilson develops and implements watershed public involvement and education programs to engage public and private sectors and elected officials on bay-related matters. He produces quarterly newsletter, brochures, booklets and publications designed to educate watershed residents and visitors (CCMP summary, size and creel brochure, homeowners guide, boaters guide); produces and coordinates Maryland Coast Day, cleanups, boat trips, Herp Search and other community involvement projects, including workshops, seminars and public meetings. Coordinate all television, radio and print media related to ongoing activities (600 newspaper articles, 30 TV and 20 radio shows per year). The coordinator will also set up educational materials at no less than least 9 events such as the MD Commercial Watermen's Expo, OC Boat Show, annual Farm Bureau meeting, MACO, Springfest and Sunfest. Presentations to private and public community groups reach at least 30 groups per year and include the Eastern Shore Builders Associations, Eastern Shore Golf Superintendents, Delmarva Poultry Industry, OC Hotel-Motel-Restaurant Association and the Ocean City, Snow Hill, and Berlin chambers of commerce. Coordinator is also responsible for fielding complaints questions, or elaborations conveyed via telephone, writing or in person. Coordinator must serve as supervisor to volunteers corps of 200 people.

Carol Cain: (100% EPA funded) As technical coordinator, Cain's job is to track and manage CCMP implementation projects that are the responsibility of the Program as well as coordination and tracking of federal, state, and local government activities impacting the coastal bays. She conducts research and identifies resources and administrative steps needed for project completion in consultation with program director. She compiles implementation progress reports, triennial review materials, GPRA, and habitat improvements, and other management tools for local, state, and federal interests. The technical coordinator also acts as a liaison between the MCBP and partners in facilitating the implementation of a comprehensive management plan. Ensures MCBP participants have necessary information regarding policies, programs, data, and other information to assist in implementation of the CCMP. She provides technical assistance to help implement land use and environmental laws and coordinates with STAC to identify and prioritize research needs, set up meetings, deliver minutes, manage grants, and tackle like administrative duties. The coordinator manages and administers projects including the volunteer water quality monitoring, horseshoe crab spawning surveys, Streamwaders, and SAV groundtruthing programs. She is responsible for organizing research-related volunteer events, recruiting new volunteers, managing laboratory contracts, maintaining data banks, and procuring supplies. She analyzes, researches, and interprets water quality data for determination of current water quality status, long-term trends, and linkages to biological monitoring data and environmental indicators. She provides responses to data requests for state managers, environmental groups, students, and private citizens; solicits and oversee interns, volunteers, and contractors helping with data management and analyses; prepares and manages supplemental grants to expand WQ program. Cain represents the Coastal Bays region on the State Water Quality Advisory Board.

Susan Krause: (100% Fundraising funded) As education coordinator, Krause is responsible for the creation, research, and development of the environmental education program as well as acquiring funds to implement this program. Criteria for curriculum of the environmental education program are as follows: interdisciplinary, experiential, and meet MSPAP standards. She is responsible for writing curriculum for the outdoor and indoor education programs; recruiting and coordinating with community organizations and schools to participate in the program; acquiring funding via fund raisers and grant writing; maintaining database of funding sources; coordinating various outreach programs such as "Adopt a Street", minority policy, and Terrapin Head Start; supervising and guiding assistants and interns; and assisting staff at MCBP in meeting CCMP education activities or related actions. She also is in charge of developing and coordinating volunteer and service learning opportunities for students and members of the community.

Julia Moore: (100% fundraising funded) As Environmental Education Specialist, Moore develops and implements year-round environmental education programs geared towards, but not limited to, the youth throughout the coastal bays watershed. She educates and informs in an attempt to increase public participation and ensure a future generation of citizens who can make knowledgeable decisions concerning the environmental health of the coastal bays watershed. She develops all education programs and environmental curriculum to meet the county's MSPAP teacher requirements, coordinates a mid-summer education events, including the 800-acre Weidman Farm programs, and is directly involved in all community involvement projects such as cleanups, plantings, workshops, and other outreach events such as MD Coast Day. She writes environmental newspaper columns, and appears on Coastal Bays cable show to teach education-related actions in the CCMP. She raises funds through continual grant writing efforts, produces, coordinates, and implements a mini-grants program, while chairing the judging committee. Moore produces coastal bays educational publications such as a yearly calendar and placemats to be used in local establishments. She is responsible for keeping the public, officials, and all those affiliated with the MCBF updated on the progress of the education program through biannual updates and power point presentations. Other administrative duties as assigned.

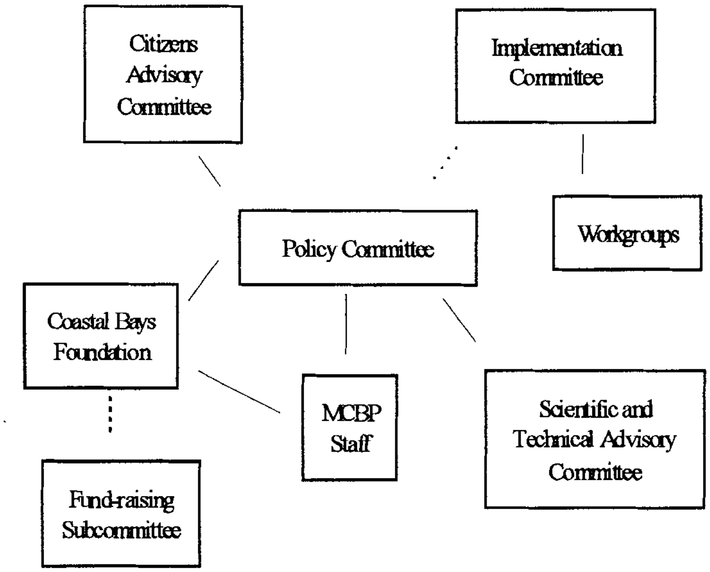
Kelli Michaud: (100% EPA funded): As administrative specialist Michaud is responsible for financial and administrative duties for the program, including payroll, tax filings, budget preparation and tracking, database maintenance, and office management. Additional duties include preparing and distributing committee minutes, answering phones, interaction with the general public, and other duties as needed. The specialist tracks EPA grant income and expenses; develops and maintains database tracking the CCMP; prepares payroll and all related taxes and reports.

Staff Science Coordinator - On May 23, 2002, The MCBP Board of Directors approved a proposal to add a science coordinator position to the staff of the program. The basic job duties of this position will include tasks to monitor existing research projects and provide guidance on future and potential research projects, analyze existing data to be able to provide guidance and consultation on coastal bay environmental issues, analysis and evaluation of technical and scientific reports; preparation of scientific reports and documents; administer research and scientific grants, responsible for obtaining additional funds for research on coastal bay related issues, provide staff support to Scientific and Technical Advisory Committee. This position will be included in the fiscal 2003 budget with the planned hire date of October 1, 2002.

B. Management Conference Structure

Below is the management conference framework as set up beginning with CCMP implementation in 1999. Three key elements differ from the CCMP planning phase which began in 1996.

1) What is now the Implementation Committee was formerly called the Management Committee. Meeting schedules and committee makeup remain the same but the committee now meets to discuss implementation issues rather than planning ones. Work groups associated with the Implementation Committee now work on implementation activities.
2) The Coastal Bays Foundation now administers the EPA grant and directs employment. Pre-implementation direction in these areas was provided first by the state of Maryland and later by Worcester County. MCBP staff are now foundation employees.
3) A Fundraising Committee now exists to facilitate implementation of the CCMP by raising private dollars and fostering public involvement and outreach.



The implementation structure is designed to have components that:

- promote a continuous federal, state, local, private, and public partnership
- provide avenues for effective public involvement in decision making
- promote an efficient process for decision making
- provide opportunities for private financial contributions
- promote efficient coordination of CCMP implementation
- promote scientific credibility, and
- ensure high-level political and governmental commitment

Coordination among local, state, and federal partners is the greatest strength of the program. Although unveiled below, the workings of this collaboration require elaboration here. The Policy Committee, made up of all local, state, and federal department heads and their elected officials, establishes policy based on public input and input from their respective local, state, and federal partners implementing the CCMP. The Implementation Committee, comprised of all of these partners meets every other month to discuss progress and address any hitches in implementation. These staff share information with decision-makers and the Coastal Bays Program highlights issues for Policy Committee review. The Scientific and Technical Advisory Committee, which houses the partners' top local, state, and federal ecologists, also offers scientific data for Policy Committee perusal. MCBP staff contact with local, state and federal partners is daily. The Coastal Bays Foundation Board, made up of local, state, and federal partners, helps ensure the free flow of information in this time-tested endeavor.

Likewise with public input, the Citizens Advisory Committee (CAC), made up of each of the primary stakeholder groups including the farming, development, golf, tourism, recreational and commercial fishing industries, meets monthly to share ideas on the direction of implementation and recommends needed emphasis or process changes. Each CAC meeting is advertised in seven local papers and on two television public access stations to invite other members of the public. Citizen input from these monthly public forums is relayed directly to staff which assimilates the desires for addressing by the Policy Committee. On average, the Coastal Bays Program provides four avenues per month via events, subcommittee meetings, and work groups for input into CCMP implementation (examples include Fisheries Advisory Committee, Wetlands Work Group, Forestry Work Group, Coastal

Resources Committee, Sensitive Areas task Force, Dredging and Navigation Group, Catch and Creel Subcommittee and Tracking and Evaluations Committee). Staff assimilates all of this information to relay to partners to address needed issues. The Policy Committee rules upon public desires left unaddressed by CCMP partners. The Coastal Bays Program has designed an organization that ensures program efficiency, is consensus-based, and is driven largely by citizen involvement.

A tangible challenge has been the difficulty in getting the Scientific and Technical Advisory Committee to meet on a regular basis to address the growing scientific and research needs of the partners. This difficulty has evolved because some of the scientists' required are not as intimate with the Program as their agency colleagues who attend regular meetings. The STAC is devised mostly of PhDs who are engrossed in numerous issues. A new chair appointed to the STAC this winter will help remedy this peccadillo.

Our structure was set up with the specific responsibilities and overlapping participants. It provides for much participation by the local citizens. All of the program committees, even the policy committee, have significant citizen participation. One of the challenges of extensive citizen participation is the lack of detailed regulatory or issue specific information and education that citizens may not possess early in an issue. The learning curve for volunteers or people not involved in everyday issues is a challenge that remains constant. At times this has led to some frustration among agency representatives and citizens alike. It has been difficult for some agency partners and more particularly for elected officials to adjust to the eagerness of the public to be involved and active in environmental issues.

Another major challenge in our structure is the perspective of the general public locally. Things do not happen quick enough or decisively enough for the public. Much of the public is more likely to take immediate action or state positions on issues or events that may not reflect the coverage or timing prescribed in the CCMP or the consensus of the program or its committees.

The strengths of our structure are the communication level that it affords, the partnership that it fosters and the citizen buy-in that it provides. The other and probably most important strength is found in the diversity of the Foundation Board, the comradeship and respect for each other by those who now serve on that Board and the complimenting talents that each member brings to that Board. The challenge will be maintaining these strengths as the makeup of the Board changes over time.

Policy Committee

The Policy Committee provides a forum where bay related issues are discussed annually by policy makers, resource officials and the public with information necessary to make informed decisions about the management of the Coastal Bays. Members establish policies and priorities for the protection of the Coastal Bays and serve as advocates for the implementation of the CCMP.

The Policy Committee:

- Provides broad policy direction
- Approves priorities for CCMP implementation
- Approves CCMP workplans and budgets (for federal and non-federal funding)
- Seeks and develops funding sources to carry out the CCMP
- Approves CCMP changes that further the goals of the CCMP

Policy Committee Members
Secretary, DNR
Secretary, MDE
Secretary, MDA
Director, OP

EPA Regional Administrator
Superintendent, Assateague INS
Worcester County Commissioners (Dist. 1 thru 5 by basin)
Mayor, Ocean City
President, Ocean City Town Council
Mayor, Berlin
CAC Chair
STAC Chair
2 Fund-raising Committee Members

Maryland Coastal Bays Foundation
The Coastal Bays Foundation is the non-profit organization responsible for administration of the Maryland Coastal Bays Program. The 7-member foundation will not establish policy and is only intended to be administrative in nature. The foundation is the EPA grant recipient and guides the development of the annual work plan as well as approve budget shifts greater than 10% of the total annual budget. Collaboration with the Executive Director facilitates timely implementation of the CCMP and helps resolve issues that surface during implementation. This group hires the Executive Director and establishes performance criteria. The Foundation also assists the Executive Director in hiring staff by serving as an interview panel for new hires.

The Coastal Bays Foundation:

- Serves as a not-for-profit organization capable of receiving private and public dollars
- Serves as the grant recipient for the MCBP
- Administers the MCBP along with the Executive Director
- Provides administrative assistance in hiring staff and managing the Executive Director
- Works with the Executive Director in developing the annual work plan
- Obtain and act as a clearinghouse for funding sources

Coastal Bays Foundation Members
Board Members:
Assateague Island National Seashore Official
State Official (DNR)
Worcester County Official
Ocean City Official
CAC Chair
2 Fund-raising Committee members
Staff attendance:
Executive Director
Public Outreach Coordinator
Technical Coordinator
Administrative Assistant
Education Coordinator

Fundraising Committee
The Fundraising Committee facilitates implementation of the CCMP by raising private dollars to support activities outlined in the plan. Members work with area businesses and individuals to develop support for program initiatives. Members are comprised of interested citizens such as business owners, farmers, fishermen, developers, and religious leaders.

The Fundraising Subcommittee:
- Supports the program by soliciting private dollars to support implementation activities
- Facilitates public involvement and outreach activities
- Sponsors public events that raise awareness and funding for CCMP activities
- Provides representation to the Foundation, Policy, and Implementation Committees
- Seeks innovative avenues to advance the goals of the CCMP

Implementation Committee
The Implementation Committee meets every other month to discuss progress and oversee implementation of the CCMP. The Committee develops implementation tracking reports that are provided to the MCBP for purposes of reporting progress to the general public and the Policy Committee. The Implementation Committee resolves any contentious issues that may arise during implementation of the CCMP. Issues that cannot be resolved are directed to the Policy Committee for consideration through the Executive Director via the Foundation.

The Implementation Committee:
- Coordinates implementation activities of responsible entities
- Obtains commitments from all sectors implementing CCMP actions
- Identifies barriers to CCMP implementation
- Develops remedies that remove barriers to implementing actions
- Assures that "plans" identified in the CCMP are developed by responsible entities
- Recommends CCMP changes to the Policy Committee through the Executive Director and Foundation.
- Recommends priorities for CCMP implementation
- Solicits resources and direct programs to implement actions in the CCMP

<u>Implementation Committee Members:</u>
US Environmental Protection Agency
US Army Corps of Engineers
Natural Resource Conservation Service
US Coast Guard
US Fish and Wildlife Service
Assateague Island National Seashore
National Oceanic and Atmospheric Administration
Maryland Dept. of Natural Resources
Maryland Dept. of the Environment
Maryland Dept. of Agriculture
Maryland Geological Survey
Maryland Office of Planning
Maryland Dept. of Business and Economic Development

Executive Director, MCBP
Town of Berlin Department Heads
Town of OC Department Heads
MD Dept. of Transportation, State Highway Administration
MD Dept. of Transportation, Mass Transit Administration
Worcester County Soil Conservation District
Assateague Coastal Trust
Lower Shore Land Trust
Maryland Environmental Service
Federal Emergency Management Agency
Maryland Emergency Management Agency
Worcester County Dept. of Planning Permits and Inspections
Worcester County Dept. of Tourism
Worcester County Dept. of Economic Development
Worcester County Dept. of Public Works
Worcester County Dept. of Emergency Services
Worcester County Dept. of Recreation
Citizens Advisory Committee Chair
Scientific and Technical Advisory Committee Chair
Fund-raising Committee Member

Workgroups

Ad hoc workgroups support the Implementation Committee by providing technical support on various issues identified in the CCMP. Resource experts are called upon to support the Committee by providing technical advise, scientific information, and assessment services. These workgroups come and go as needed and have focused on issue areas such as septic system management, navigation and dredging, ecotourism, pesticides, canals, grants, and sensitive areas.

Additionally, MCBP representatives and participants have been involved in several statewide efforts to address issues on a variety of topics. For example, several members of the IC and STAC were involved in the creation of a publication dealing with recommendations on how to manage Public Drainage Associations and agricultural drainage ditches. Several Members were involved in the Wetlands restoration Task Force and the State Wetlands Comprehensive Management Plan. Members worked with the state invasive species task force, SAV work groups, Boat Act Advisory Committee, Sport Fisheries Advisory Committee, State Forestry Task Force, and Statewide Growth Advisory Committee.

Citizens Advisory Committee

This committee is comprised of various stakeholders in the watershed interested in furthering the goals of the Coastal Bays Program. Local fishermen, developers, golf course managers, business owners, community associations, recreational boaters, farmers, and environmentalists continue to work together to protect the Coastal Bays. This committee continues to meet almost monthly.(~ 10 times/year)

The Citizens Advisory Committee:

- Ensures public involvement during implementation of the CCMP
- Recommends changes to the CCMP through continuing planning exercises
- Functions as a watchdog and advocate for implementation of the CCMP
- Ensures that public involvement and education are a central component of the Program
- Recommends legislative changes necessary to further the goals of the CCMP

Scientific and Technical Advisory Committee
This technical committee is comprised of the region's most knowledgeable natural resource scientists and is responsible for providing important scientific information for program decision-making.

The Scientific and Technical Advisory Committee:

- Provides a scientific and technical review function for CCMP implementation
- Solicits funding for assessments, studies, and research in the Coastal Bays
- Carries out the Eutrophication Monitoring Plan in coordination with DNR
- Completes the Coastal Bays Comprehensive Monitoring Plan
- Coordinates and implements research and monitoring in the Coastal Bays
- Provides technical support for CCMP implementation activities
- Alerts the Implementation Committee to new pertinent scientific information
- Recommends any necessary changes to the Monitoring Plan
- Produces environmental indicators for implementation monitoring

C. Mechanism for Public Involvement

Perhaps the greatest strength of the Maryland Coastal Bays Program has been its proficiency with public involvement. The Citizens Advisory Committee, made up of each of the primary stakeholder groups including the farming, development, golf, tourism, recreational and commercial fishing industries, meets monthly to share ideas on the direction of implementation and recommends needed emphasis or process changes. Each CAC meeting is advertised in seven local papers and on two television public access stations to invite other members of the public. Citizen input from these monthly public forums is relayed directly to staff, which assimilates the desires for addressing by relevant committees. On average, the Coastal Bays Program provides six avenues per month via events, subcommittee meetings, and work groups for input into CCMP implementation. For example, the Fisheries Advisory Committee is made up of local recreational and commercial fishermen who come to the monthly meetings to give input on fisheries management. Wetlands Work Group which meets every other month is attended by locals and agency personnel who give input on wetland problems and solutions. The Forestry Work Group, Coastal Resources Committee, Sensitive Areas Task Force, Dredging and Navigation Group, Catch and Creel Subcommittee and Tracking and Evaluations Committee, to name a few are also made up of 30-50 percent local citizenry. Staff assimilates all of this information to relay to partners to address needed issues. Public desires left unaddressed by CCMP partners are ruled upon by the Policy Committee. The Coastal Bays Program has designed an organization that ensures program efficiency, is consensus-based, and is driven largely by citizen involvement.

Other directly CCMP-related public involvement activities have included the 1998 "Your Community Your Choice: Picturing Tomorrow" workshops in Berlin and Snow Hill. The surveys allowed the 250 residents who attended to rate their feelings on land use and growth in the county. The results were incorporated into the bays' management plan. This was followed by an alternative futures workshop which allowed locals to choose which growth path they would like the county to take. Since 1998, the program has given informational presentation to more than 25 local organizations per year, including the Berlin, Ocean City and Snow Hill chambers of commerce, Realtors, Golf Superintendents, lions clubs, property rights and farming groups, anglers clubs, and the Hotel-Motel-

Restaurant Association to name a few. Given at the clubs' monthly meetings, the presentations have provided a forum for much needed input for presenters to relay to the Implementation Committee, CAC, and Policy Committee for addressing.

These presentations, meetings and public input opportunities are part of the average annual 600 local newspapers stories, 32 local television appearances and 10 radio shows the Coastal Bays Program uses annually to advertise events and solicit public input. Even the program's extensive school education programs have resulted in significant student and teacher input in the Water Quality and Fish & Wildlife areas of the CCMP.

All told, Coastal Bays Program events and regular meetings have given residents of Worcester County about six opportunities every month every year to give their input on the progress, priorities, and direction of the CCMP and the program which it supports. Networking via phone, letters and the MCBP extensive e-mail list has added to the deluge of public involvement.

The strength of this approach is revealed in the sheer number of people (about 780) who have given input into the CCMP, its implementation and progress. The limiting factor in this approach has been staff, agency personnel and committee member ability to assimilate or address every single public comment that is given. Often whether the comment is rational or viable enough to be addressed by the IC, PC or CAC is at the discretion of the receiver.

D. Changes in Agency Programs and Priorities, New Initiatives and Partnerships with Other Organization/ Agencies

Because the Coastal Bays Program has so many active partners, there have been numerous shifts and upgrades in agency priorities, new initiatives and partnerships over the past six years. There is much overlap between sections V (a), IV (d) and V(c) because new initiatives and partnerships spawned by the MCBP generally require technical assistance, information sharing and technology transfer. For example, the MCBP has had strong influence on development practices in the watershed through its **Visioning and alternative futures** exercises and **design charettes** described in section V (a). Likewise in section V(a), **The Rural Legacy Program, Regional Heritage Plan, Golf Course Guidelines, Septic, Oyster, and Terrapin programs** are all examples of new initiatives started in other programs as a result of assistance from MCBP.
The best fits for this section follow:

Eutrophication monitoring: Thanks to a call in the CCMP for more eutrophication monitoring and shortcomings in coastal bay monitoring as compared to the Chesapeake, the program's influence in the state has led to an annual $300,000 earmark for Maryland DNR eutrophication monitoring in the coastal bays. Coastal Bays water quality data suggesting the need for the new initiative played the primary role in its actualization. See section II for specifics on this plan.

Other water monitoring: Coastal Bays Program presence and volunteer water quality data indicating problems helped establish annual state pfiesteria and brown tide monitoring in the coastal bays. These two new program are now an essential part of the comprehensive coastal bays water quality monitoring efforts.

Macroalgae monitoring: Likewise with this important water quality indicator, Coastal Bays Program presence and volunteer water quality data indicating problems helped establish annual state macroalgae monitoring in the coastal bays. In turn this has sparked a host of new DNR and University of Maryland studies on the algae in the coastal bays.

Worcester County Long-Range Planning: In 1996 during the planning phase for the coastal bays management plan, discussion in the growth subcommittee pinpointed the need for better planning in the county. Within two years, persistence from the Program regarding this need resulted in the first ever Worcester County Long-Range Planning Department, replete with a director and six staff members. This department has proved essential in helping to pinpoint, protect and preserve wetlands and forest buffers and to administer more than four open space programs. The new department is also undertaking most of the county's actions in the CCMP.

Subwatershed Planning Group/Buffer law: Recognizing that the 25-foot buffer law in the county was inadequate, the Coastal Bays CCMP called for subwatershed planning in year 1 to determine needed buffer requirements. As a result of this action Worcester County created a subwatershed planning group to devise buffer recommendation for each subwatershed. The group is devised of local, state and county business people, scientists, and regulators. The new partnership helped not only pass buffer legislation but also went a long way toward educating less sympathetic factions. After a year of subwatershed meetings, the county and state worked together to pass legislation submitted by the governor to create a 100-foot buffer within a 1,000-foot critical area in the entire coastal bays watershed.

Trust for Public Land: A fortuitous seating arrangement at an Urban League Institute conference lunch in Atlanta has resulted in annual federal requests for earmarks to the watershed. A casual conversation between the Trust for Public Land (TPL) and MCBP staff was enough to spark the non-profit agency into asking for $2-$4 million dollars a year from the NOAA CZM budget for land acquisition and easements in the coastal bays watershed. After months of meeting with staff to determine a target area. The group decided on the largest contiguous area of forest left in the watershed. The 4,000 acres also happens to be the headwaters of three coastal bays largest creeks. Five landowners in the area are interested in selling and one 430-acre parcel has a contract on it with TPL. The trust is now working with the county who will receive the money and hold the land. Last year the county received $350,000 for the site and TPL is asking for a federal appropriation of $2 million this year. Both senators and the district's congressman have asked for the appropriation and lobbied for its approval. Each year, the program and TPL will ask for a similar amount.

Regional GIS: Citing the need for better mapping capabilities, the MCBP lobbied in 1998 for a GIS person to help with watershed planning efforts. In response to this, the county, the National Park Service and the MCBP joined in a cooperative agreement to hire a GIS person to help conservation efforts. The position is now funded mostly through the Park Service and Worcester County. Following suit, the Town of Ocean City is now developing its own GIS system and is coordinating with MCBP.

Fishery Management: The CCMP recommends managing fish stocks in the coastal bays separately from those in the Chesapeake. The Maryland DNR has responded to this need by revamping their fishery program and in 2000 passing a law separating coastal bays fishery management from the Chesapeake. In the past two years, the state, with direction from MCBP Fisheries Advisory Committee (FAC), has created a blue crab plan and shellfish plan unique to the coastal bays. Fashioned by Coastal Bays Program partners and locals, the FAC has united scientists and commercial watermen for common goals. The committee meets every other month. Appendix IV-A

SAV Protection: SAV loss from hydraulic clamming has been a problem in the coastal bays. Using coastal bays research data and anecdotal information, the Maryland DNR wrote and passed a state law prohibiting hydraulic dredging in SAV beds in all waters of the state. The new state program now monitors SAV with aerial flights, scientific information and groundtruthing volunteers.

Wetland Planning Group: Recognizing shortcomings in state enforcement of wetland laws, the Coastal Bays CCMP called for an upgrade. In response, the county, the program, planners, regulators and wetland delineators formed what is called the Wetland Planning Group. The group meets every other month to discuss projects, laws and issues affecting wetlands. It has served as an excellent coordinator among agencies and will spawn a wetlands "white paper" on ways to better protect wetlands in the coastal bays watershed.

Forestry Group: Forest loss and loblolly pine plantation planting over the past two years have highlighted the need for better forest planning. To find ways to preserve forests, diversify them, and link contiguous areas, the MCBP formed a Forestry Group made of private foresters, USDA representatives, county planners, property owners, state foresters, and the county's economic development director. The initiative is recommending more than 30 changes to local and state law that will encourage forest retention, and hardwood planting, give incentives for retaining old growth and limit wetland losses due to draining for forestry. DNR Forestry has already agreed to undergo a philosophy change in the watershed to promote hardwood planting. The group's final paper also recommends moving up to year 4 more than a dozen actions in the CCMP.

Sensitive Areas Task Force: Several actions in the CCMP call for mapping of sensitive areas in the coastal bays. To do this, the Maryland DNR formed a work group of local, state, and federal agencies and citizens to devise a comprehensive map of sensitive areas in the bay. The map is being used by the county, the state, and several federal agencies to target areas for protection.

Ocean City Storm Water Program: To help compliment implementation actions in the CCMP the Town of Ocean City developed a new stormwater management program in coordination with MDE. The program requires high level stormwater treatment and retention for all new projects. In addition, Ocean City is developing a comprehensive retrofit program for the entire town as a partner in the CCMP. The wife of the Coastal Bays Program director is directing the program.

BayKeeper: The Coastal Bays CCMP calls for a "Bay Watch" group to keep tabs on violations. After lack-luster efforts to form such a committee, the program summoned the services of the non-profit Assateague Coastal Trust (ACT). With MCBP backing, the trust put together a powerful appeal to bring the national BayKeeper program to the coastal bays. Their dreams were realized this spring with acceptance into the program. ACT will organize the "The Assateague Coast Keeper Program" which will serve to keep an eye out for water quality and wildlife through an on-the-water presence.

Ocean City Coastal Resources Legislative Committee: This Ocean City Council formed this committee in 2000 to help the city address its CCMP actions and to address the resort's environmental problems. Made up of Ocean City business people, councilmen and a Coastal Bays representative, the city-run committee has been integral in addressing stormwater, community stenciling, and critical areas issues.

Salisbury University Poll: The political direction in the coastal bays watershed is both a function of residents' attitudes and of politicians' beliefs of what those attitudes are. To gauge those, share them with decision-makers, and to help determine CCMP direction, the program summoned Salisbury University to conduct an objective watershedwide phone survey of residents' opinions on a host of environmental issues. The results have been used to help the program, county, and city officials determine courses of action, particularly in the boating, land preservation and buffer sectors Appendix IV-B

Non-Stormwater Permit Program: As a result of its stormwater actions in the CCMP, Ocean City created a non-storm water permit program which requires permits and a pollution prevention plan for discharges, especially from carwashers or carpet cleaners, into the coastal bays. To facilitate this new program, the MCBP will co-sponsor workshops this year.

Artificial Reef Creation: The Ocean City Reef Foundation and the town of Ocean City have been working together to create artificial reefs in the coastal bays. The coalition began looking to the bays, rather than just the ocean, after Coastal Bays Fisheries Advisory Meetings and CCMP actions pointed to the need to re-establish reefs in the bays. MCBP is helping to fund their latest project along 3rd Street in Ocean City.

Boating Survey: The need to determine boater preferences, needs and problems is highlighted in several sections of the Recreation and Navigation part of the CCMP. After calls for dockside, and mailed questionnaires, the MCBP worked with University of Delaware SeaGrant to create a comprehensive questionnaire to pinpoint boater needs and problems. After funding the 2000 survey, Maryland DNR has championed the cause and now organizes and funds the survey which is helping put emphasis on CCMP actions and their implementers. Appendix IV-C

Herpetology Research: In 2001, the Maryland Coastal Bays Program, Assateague Coastal Trust, USDA NRCS, DNR Wildlife and Heritage Division and Salisbury University came together to sponsor the first ever Great Worcester Herp Search to help document the coastal bays' declining amphibian and reptile populations. With MCBP as the lead, the watershed-wide search and the year-round anecdotal data gathered from participants has resulted in NRCS and DNR efforts to target specific watershed areas for protection of their reptile and amphibian life. The partnership has also created a complete "Guide to Reptiles and Amphibians of Worcester County." Appendix IV-D

TMDLs: The Total Maximum Daily Load represents the total allowable amount of pollutants a water body can assimilate without harming wildlife and water quality. During development of coastal bays TMDLs, the MCBP played a significant role in making sure all needed coastal bays subwatersheds were involved and in directing determinations for nutrient load assimilation. Guidelines and nutrient allocations are tougher thanks to MCBP.

Delmarva Low Impact Tourism Experiences: The presence of the MCBP in Worcester helped spawn the Delmarva Low Impact Tourism Experiences (DLITE) which is a partnership between MCBP, the National Park Service, the Nature Conservancy and local hotels to encourage ecotourism and to train providers in an eco-sensitive way. Senator Mikulski helped fund a directorship for the program which is now overseeing many of the ecotour and heritage goals in the CCMP.

Size and Creel sign/brochures: Incredibly, until the MCBP stepped in two years ago, there was no way for coastal bays anglers to easily get size and creel limits for coastal bays fish and crabs without relying on word of mouth, makeshift tackle shop guides or state brochures made mostly for Chesapeake anglers. That changed in 2000 when MCBP formed a subcommittee to create coastal bay only brochures and 14 X 21 signs. After creating the signs, DNR agreed to fund them and with help from the town of Ocean City DNR Natural Resources Police and legions of volunteers, more than 100 signs and 20,000 brochures are distributed to anglers every year. Appendix IV-E

Ocean City Cleanups/Hazardous Waste Collection: Thanks to its involvement in the creation of the CCMP, Ocean City now sponsors a Household Hazardous Cleanup day, funds and coordinates an Adopt-a-Street Program, has a Dune Patrol, and has started a Clean Streets Clean Water Initiative.

Salisbury University: The MCBP has helped equalize emphasis from Chesapeake to coastal bays through involvement of faculty and students. The new chair of the Coastal Bays Scientific and Technical Advisory Committee is Dr. Tom Jones, the dean of the Henson School of Science. Dr. Bill Grogan is a Forestry Group member and the lead reptile man working on herpetology issues with coastal bays and professor Erin Fitzsimmons is on the Coastal Bays Board of Directors. Dr. Harry Womack has helped MCBP tremendously with its seagrass work. These professors have shared their knowledge with fellow professors and fused it into the classroom creating a shift in emphasis at the university toward coastal bays issues. The MCBP also has an internship program set up with the school, provides regular guest lecturers, and works with its environmental science club.

Coastal Ecology Lab: The University of Maryland Eastern Shore received funding to build a coastal ecology lab next to the Assateague Visitors Center in 1998. The MCBP has played an integral role in ensuring the money remained for the lab, in ensuring the building was an environmentally friendly one, and in keeping the research and ecology theme. The MCBP also helped reserve a spot for its offices in the new building.

Enhanced Hazard Mitigation Plan: The town of Ocean City is in the process of working with Maryland Emergency Management Agency to create an enhanced Hazard Mitigation Plan. The new plan to halt and reverse the environmental conditions that cause flooding blossomed out of CCMP subcommittee discussions on the need for better hazard mitigation in the resort.

Status and trends report: This planning document was produced with all local, state, and federal partners input with MCBP as the lead. It delineates the status of a host of environmental parameters in the coastal bays and notes trends. This has served to guides resource agencies through the planning phase and now with individual implementation actions. Appendix IV-F

Not yet up the Creek: This proceeding from the original coastal bays conference in 1995 serves as the grounds and justification for all implementation activities. The administrative and ideological changes that took place in all of the MCBP partners over the past seven years stem from this original document. Appendix IV-G

Lower Eastern Shore Heritage Area and Committee: Tri-county group using a variety of partnerships and planning tools to preserve, protect, and promote the cultural, historical, and natural assets significant to the lower Eastern Shore.

Maryland Coastal Bays' Water Use Assessment: Understanding User's Behaviors, attitudes and perceptions - April 2002 - DNR Fisheries Service recently funded a survey by University of Delaware which completed this survey to interview boat users of the coastal bays. This effort was designed to investigate the activities, perceptions, and recommendations from the group of people who are on the water and use the coastal bays. The effort will help policy makers understand the issues in an effort to resolve any potential conflicts or management issues that exist or may develop.

Atlantic Coastal Bays Protection Act of 2002: The Maryland General Assembly passed and the Governor signed this new law to add the coastal bays to the Chesapeake Bay Critical Areas Program. This new law will require 100-foot buffers and added protection mechanisms, such as stormwater management, impervious surfaces, density limits, forest conservation, etc. from the waters edge to 1000 feet along the tidal shores of the coastal bays. This significant piece of legislation is designed to protect water quality and vital habitats from destructive land uses.

V. Technical Assistance and Public Education

A. TYPES OF TECHNICAL ASSISTANCE

Laid out below are examples of the types of technical assistance which the Coastal Bays Program has shared with the community and with our partner agencies. Obviously the day-to-day assistance we give to Ocean City, the county, and local groups is impossible to describe in this paper, but it would suffice to say that there is a wealth of information exchanged daily. There is much overlap between sections V(a), IV(d) and V(c) because new initiatives and partnerships spawned by the MCBP generally require technical assistance, information sharing and technology transfer.

For example, in the previous section IV (d), **eutrophication, water quality, and macroalgae monitoring** required significant scientific data from the MCBP to get started and to keep them going. MCBP growth and resource loss numbers have facilitated the new **long-range planning department and the subwatershed planning group**. Technical assistance from MCBP has also played an integral role in the **Trust for Public Land** lobby to convince federal lawmakers they should allocate millions to preserve land in the coastal bays watershed. Likewise with the **Fisheries Advisory Committee, Wetland Planning Group, Forestry Group, Sensitive Areas Task Force, SAV protection law, TMDL modification, Salisbury University environmental attitudes poll, Ocean City Non-Stormwater Permit Program, the boating survey, herpetology research, new GIS program and Salisbury University instruction,** technical assistance from the Coastal Bays Program enabled these things to happen. See IV(d) for elaboration on these programs.

Still, the best examples of technical assistance are enumerated below.

Community Visioning: Three very important workshops have helped residents in the coastal bays watershed contemplate how they want their community to grow. In May of 1998, the program held two **"Your Community Your Choice: Picturing Tomorrow"** workshops in Berlin and Snow Hill. Surveys conducted at the workshops allowed the 250 residents who attended to rate their feelings on land use and growth in the county. The results, revealed at a follow-up public meeting in October 1998, showed that preservation of natural and agricultural land is foremost in the minds of Worcester County residents. Later, in 2000, the county held the same workshops and received the same results. The Mass Transit Administration and the EPA funded the workshops. The results are being incorporated into the county's comprehensive plan and are helping direct land preservation efforts. Four large development projects, built since the meetings, embrace the visioning results with clustering, mixed use, and contiguous open space on the parcels. This visioning effort also helped the MCBP win the state "Smart Growth" award for 2001. (Appendix V. a)

Alternative Futures: An associated meeting in February 1999 in Berlin showed residents specific growth scenarios in their watershed based on zoning and population projections. The "**Alternative Futures Workshop"** helped further elaborate fiscal and planning issues related to the growth and development scenarios asked for by participants during the **"Picturing Tomorrow"** workshops. The feedback from the Alternative Futures Workshop was not just an educational experience for the community, its results have been used to direct growth in and around existing infrastructure.

Rural Legacy Program: The new Long-Range Planning Department and MCBP combined efforts with the Lower Shore Land Trust (LSLT) and the Conservation Fund to create the first ever Rural Legacy

Area for Worcester County. The MCBP scientific information and conservation plans were essential in the initial push to establish the program in Worcester. The 15,000-acre area is now targeted annually for easements by the self-sustaining trio of the planning department, LSLT and the Conservation Fund. Called the "best and most successful Rural Legacy Area in the state," by the state board who allocates funding, the Coastal Bays Rural Legacy Area has had 4,200 acres in easements secured in it since 2000. Appendix V-A

Regional Heritage Plan: Using Smart Growth and the Coastal Bays Visioning exercise as their guide, the Lower Eastern Shore Heritage Committee has developed a regional heritage plan which targets reinvestment in certain areas of downtown Ocean City, Princess Anne, and Pocomoke City. The plan also calls for more open space preservation, particularly around historical sites. MCBP staff and volunteers helped craft the plan which promotes green space preservation through redevelopment in and around existing infrastructure.

Voluntary Golf Course Guidelines: The Coastal Bays CCMP calls for numerous guidelines for golf course managers to abide by. With logistical help from the MCBP and work shop assistance, Worcester County has created a Voluntary Golf Course Guidelines booklet and now has staff at the ready to facilitate golf course managers in their efforts to improve nutrient, pesticide and wildlife management on their properties. Appendix V-A

Realtor Courses: In a unique partnership with Wor-Wic Community College, the MCBP has begun teaching Realtor training courses for Realtors to earn credit toward their licenses. The environmental science-oriented classes help Realtors learn the positives of natural shoreline, forest and wetlands and the negatives of bulkheads, canals, piers and natural land loss. The college and the program now share an important role in the real estate community's understanding the coastal ecosystem.

Design charette: When forward-thinking minds meet for a common cause good things can happen. Such was the case when nationally recognized architects, engineers, wildlife biologists, planners and builders locked themselves together for three days in a modest meeting room to create a first-of-its-kind development project that protects the environment while remaining lucrative for the developer. The charette, funded and facilitated by the Coastal Bays Program, was the ultimate demonstration project for developers and planners. The subsequent plan not only avoids disturbance of wetlands and forest but creates more, reduces impervious surfaces and turf grass, and maintains or creates wildlife habitat and corridors that also function as stormwater collection, retention and groundwater recharge. The final product is a brilliant amalgam of capitalism and conservation and Coastal Bays made it happen.

Minigrant Program: The Coastal Bays Minigrant Program has proved to be an essential component of community involvement and an avenue for sharing coastal bays scientific resources. The program has funded 42 local projects totaling over $200,000. For the native plants demonstration projects, nutrient monitoring, TV programs, educational initiatives, birding guides, farming assistance, phragmite eradication, shellfish, seagrass and habitat restoration projects, the program provided significant scientific resources. Appendix V-A

STAC Assistance: The Scientific and Technical Advisory Committee of the Maryland Coastal Bays Program has provided scientific data and assistance for more than two dozen coastal bays issues over the past five years. This has included opinions on seagrass studies and fish populations to the FAC, water quality data for DNR, buffers impact information for Worcester County, and a host of land use issues to aid implementors of the CCMP.

Conservation Corridor: Real protection for ecosystems and the species they harbor is impossible without large contiguous areas of protected land. With this in mind the MCBP began holding meetings with the Nature Conservancy, Conservation Fund, Assateague Coastal Trust, and Maryland DNR to document areas of remaining open space in the region. With MCBP at the lead, the process of pinpointing areas needed for protection to ensure contiguity has begun. A final map will show high, low, and medium priority areas to target for easements and acquisition.

B. METHODS OF PUBLIC OUTREACH

Informed decision-making is contingent on an enlightened public. With this in mind, the Coastal Bays Program has defined its successes by its ability to help residents of Worcester's coastal bays watershed learn the ins and outs of protecting the resources that support and define their community.

With hundreds of local farmers, developers, fishermen and other residents involved in producing a management plan for the bays, the Coastal Bays Program has been working to ensure that the fruits of their efforts are scrutinized by a public well-versed in issues involving their land, water, and ultimately their pocketbooks.

The sections below depict the nature and emphasis of outreach efforts. This multi-faceted approach infuses media coverage, outdoor events, educational workshops, local project funding, and public feedback opportunities into an effort which has transformed this coastal community's vision for its future. Such efforts are limited only by the innate and learned intellectual faculties of the defined populace.

USING EVENTS TO EDUCATE AND INSPIRE

Annual Events:
Maryland Coast Day is the largest annual program event— an opportunity for the Maryland Coastal Bays Program to bring together a host of local organizations and some 40 businesses to sponsor a day of environmental fun and education on Assateague. Every year some 50 environmental entities at the festival inform some 5,000 attendees about local ecology through numerous demonstrations and workshops. The day of coastal exploration includes free demos in sand castle building, kite flying, surf casting, and duck carving. Live animal displays, Native American dances, bays cruises, helicopter search and rescue shows and native species plantings also highlight the festivities. Every Coast Day, Ocean City, Worcester County, local businesses and individuals support the festival with more than $15,000 worth of goods, services and monetary donations. Each September Maryland Coast Day will serve to remind local residents and tourists alike what is special about this estuary. (Press releases, press coverage, flyers, insert in Appendix V.-B)

National Estuaries Day, too, has been an annual event celebrated by the Coastal Bays Program with an October boat tour of the coastal bays. There, locals and scientists relate the lore of the coastal ecosystem and expound on the ecological uniqueness of its waters. The boat's 75 passengers also enjoy a stop on Assateague where they seine for mollusks, crabs, and fish. The trip has always sold out. Appendix V-B

Osprey Sprint Triathlon: This fundraiser and outreach tool has taken place of the National Estuaries Day Boat Tour. A distinctly different way to celebrate National Estuary Day the triathlon lets some 400 participants swim, run and bike their way through the rural countryside the program aims to protect. The television, newspaper, and radio coverage, the 150 volunteers, the 40 sponsors and the region-wide participation render this fundraiser an educational and public relations boon for the program. Appendix V-B

Earth Day Tree Planting: Until 2002, the Coastal Bays Program held an educational boat trip similar to the National Estuaries Day trip to celebrate Earth Day. This year, the program teamed with the MD State Highway Administration to unite volunteers who planted 1,000 trees on a nutrient mitigation site along the now dualized US113 April 20. It took volunteers just three hours to plant all of the 5-foot tall hardwoods. Planting project will now highlight future Earth Days. Appendix V-B

Isle of Wight Cleanup: A similar yearly event, this cleanup brings locals together on the first Sunday of every April to comb the shores of Assawoman and Isle of Wight bays for litter. More than 100 volunteers, including co-organizers the OC Parrot Head Club, have collected at least two tons of garbage over each of the past three years. Appendix V-B

Delmarva Birding Weekend: Promoted and aided in organization by the MCBP, this weekend at the end of April features more than 12 kayaking, boating, and walking tours through the coastal bays watershed and other parts of Delmarva. MCBP staff also serve as guides and story tellers during the trips which have worldwide recognition.

Macky's Fish Fry: This lucrative fundraiser marks the beginning of the May outreach efforts. Held on the second Tuesday in May, the Fish Fry brings more than 300 locals from around the watershed to feast on the fruits of the bays. The MCBF display, literature, and staff are there to answer questions about protecting the bays. The celebration lasts for four hours. Appendix V-B

Great Worcester Herp Search: This event, held by the program with help from USDA NRCS, DNR, Salisbury University and Assateague Coastal Trust, is designed to mix science with outreach. It is a highly regarded event locally. Every third weekend in May the program gathers locals who, after an a.m. training session, scour the coastal bays lands for reptiles and amphibians. Guides lead the trips, which break in the afternoon for lunch and sharing of digital photos of specimens spotted in the morning. Information from the trip is used to help DNR wildlife officials mark local populations and note absences. Go to www.mdcoastalbays.org for photos. Appendix V-B

The Canoe Cleanup: held the first Saturday in June, is another popular Coastal Bays Program event. Also sponsored by Assateague State Park, the cleanup lets canoers embark from Assateague Island to Sinepuxent Bay to collect thousands of pounds of refuse every year, including plastic, Styrofoam, discarded crabbing cages and golf balls. Appendix V-B

Seacrets Bays Bash: For the first time, the MCBF will hold an all-out bays bash this June to raise money for the Coastal Bays Foundation. The fundraiser will feature t-shirt giveaways, raffles, and coastal bays information dissemination. It is expected to raise $20,000.

Battle for the Bays Golf Tourney: This wild and wacky all-day fundraiser jam packs Mellow Beach Bar in Ocean City every second Sunday in July when duffers take their chance at winning more than 2,000 in prizes donated by local businesses. The "loosest" of all the events, the Battle for the Bays features blowup targets set in the bay for golfers to hit for points. The floating range balls are gathered by volunteers. The Coastal Bays information booth is busy on this day with more than 200 annual participants sifting through literature while sipping through margaritas. Appendix V-B

Jolly Roger Day: The second Sunday every August, 700 people storm Jolly Roger Park in Ocean City to help raise funds for the Coastal Bays Program. The park offers special deals for tickets with proceeds going to the program. The Coastal Bays booth is set up at the entrance where participants, mostly vacationers ask questions about the bays and learn what they can do to protect them while in Ocean City. Appendix V-B

These and other events not mentioned here are widely publicized and highly attended. During the implementation phase of the management plan, these efforts have continued to motivate and inspire those who call the coastal bays watershed home.

EXPANDING AWARENESS THROUGH NEWSPAPER, TELEVISION, RADIO, AND THE INTERNET

Newspaper, television and radio are three of the most important means through which information is disseminated to the public. Recognizing media as the arbiter of public opinion, the Coastal Bays Program has fostered a sense of environmental awareness through these channels like no other NEP.

In the three years of implementation the Coastal Bays Program appeared in local newspapers in **1,570 stories**. Representatives for the program also appeared on **79 television news segments** and discussed coastal bays issues via radio 36 times. Two **public service announcements** continue to air weekly on local television stations. (Press coverage examples in Appendix V-B.)

In addition to these forums, the Coastal Bays website, updated twice weekly features current events, photos and scientific information at the click of a key. Go to **www.mdcoastalbays.org**. These media will remain an important outreach tool in the coming years.

In addition to coverage of important environmental initiatives and events, the Coastal bays has a weekly column in five local newspapers, three regular television shows and four television specials:

Coastal Bays column: Since June of 1999, the Coastal Bays Program has been publishing a weekly column in the Daily Times (the Eastern Shore's Daily newspaper) on Mondays, the Ocean Pines Independent (Tuesdays), the Maryland Times Press (Wednesdays), the Worcester County Messenger (Wednesdays) and the Maryland Beachcomber (Fridays). All are owned by Gannett Publishing. The column deals with coastal bays issues facing the community and has been extremely popular. (Appendix V.b.)

Ask the Expert: This program is a twice per year 13-19-week segment on issues in the coastal bays watershed. On WMDT 47 the 3-minute show airs once weekly on the morning news segment. Topics have included growth, oysters, boating, reptiles, birds, water quality issues and algae information. The abc channel covers three Maryland counties and southern Delaware. (Film available upon request)

Coastal Homes and Gardens: On the popular local cable channel, the program has a weekly 4-minute segment on local issues relevant to homeowners. Topics have included green gardening, birdhouse building, buffers, impervious surfaces and chemical substitutes. It airs twice daily. (Film available upon request)

TV Tudors Live: The University of Maryland Eastern Shore holds a tutoring program for 7-8 graders every Thursday. On the second Thursday of each month, Coastal Bays staff goes on the show to discuss issues which young teens can relate to. Most topics involve wildlife, education programs, and things residents can do to protect water quality.

Maryland Public Television Specials: This renowned statewide PBS station filmed and aired two 11-minute specials on the coastal bays, the MCBP and the problems facing the estuary. The films included interviews with fishermen, farmers, developers and environmentalists who talked about their role in helping the program. The features, which originally aired on Thursday evenings, are still occasionally played today. Coming in several months will be an MPT feature on the Delmarva Birding weekend where staff served as guides and were interviewed on the program. *Note: Another MPT special on the coastal bays Rural Legacy Area led by the MCBP public outreach coordinator was destroyed before it could be aired. (Film available upon request)

Learning network movie: Three National Estuary Programs will be featured on this Learning Network special to air in 2003. The MCBP will be one of them!

SCHOOL PROGRAMS

Coastal Bays School program: In 2001 the Coastal Bays Program began what would become a 3-day a week K-12 school program in the winter months. The MCBP offers 14 separate classroom programs to choose from including ones on watershed dynamics, wetlands, buffers, local wildlife, marshes and forests. Appendix V-B

Weidman Farm: The warm weather of spring, summer, and fall bring the coastal bays school programs outdoors to the 800-acre Weidman Farm. There, since the beginning of 2001, Worcester County school kids, 4H clubs, boy scouts and other groups have enjoyed MCBP programs about three days per week. These have included, seining for fish and crabs, marsh walks, wetland delineations and other outdoor activities designed to develop an understanding in natural processes. (Appendix V. b.)

Storm drain stenciling: This popular school activity has helped kids learn how their behavior affects water quality. After a classroom water quality session, students are invited to nearby areas to paint stencils onto storm drains. This program is separate from the other MCBP school programs.

Terrapin program: This program is a partnership between the Assateague Coastal Trust and the MCBP to both teach terrapin behavior and protect the species. After ACT began the program in 2000, the MCBP took over the school monitoring portions of the program by going to the five classrooms in three schools once a week to weigh and measure the turtles. During the sessions, MCBP staff gives an environmental lesson related to the turtles.

Envirothon training: In 2002, the MCBP began taking over the training role for Worcester County students in the Maryland Envirothon. This prestigious event takes place once a year when students from participating Maryland counties compete to showcase their environmental knowledge. MCBP staff conducts rigorous field and classroom training sessions leading up to the spring event.

Poster contest: This year, for the third year in a row, the MCBP will be holding a poster contest for students, homeschoolers, and boy and Girl Scout troops. Winners will be placed on the 2003 MCBP calendar. The theme varies annually from topics like "why are the coastal bays important to you?" to pollution prevention and wildlife protection.

Coastal Bays Day: Every year, the Snow Hill Middle School holds Coastal Bays Day. The full day, dedicated to the bays involves fundraising, speeches, songs and artwork to celebrate the local ecosystem. A Coastal bays recipe book is a highlight of this spectacular event. Appendix V-B

VOLUNTEER PROGRAMS

Volunteers make the Coastal Bays Program work. With only four staff members to tackle more than 20 annual public events, the Coastal Bays Program would be impotent without its strong volunteer base. More than 5000 volunteer hours have gone into the production of the coastal bays management plan. Three times that has been given since its implementation. But aside from those representatives, an additional 30 volunteers have been monitoring water quality in the coastal bays since 1996. At-the-ready are some 150 additional volunteers who help make Maryland Coast Day, the Canoe Cleanup, the coastal bays triathlon, stream monitoring, workshops, and other public events and programs possible. These hundreds of individuals, who have given their time to protect the resources they cherish, will continue to serve as the pillars of the Coastal Bays Program. Some examples are below:

Water Quality monitoring: Since 1997, 30 volunteers have monitored 20-30 sites in the coastal bays every other week most of the year and once per month Dec.-Feb., for chlorophyll, turbidity, dissolved nitrogen and phosphorous, pH and salinity. Volunteerism for this has provided an excellent outreach tool as have news releases discussing the results.

Boat survey: This tool serves as a dual information gathering and outreach mechanism by enlisting some 40 volunteers to survey boaters, Jetski operators, and canoers at sites around the coastal bays. For the past three years volunteers have surveyed thousands of boaters and also passed out coastal bays information in the process. The data gleaned from the boaters helps the MCBP gauge the public's boating, fishing and recreation needs and attitudes. (See Appendix IV-C)

Horseshoe crab monitoring: The MCBP is responsible for the coastal bays portion of this DNR activity. Every year the program gets so many volunteers that they must turn would-be counters down. Volunteers go out eight nights a year to count mating crabs on beaches. DNR uses this information to keep tabs on the crabs' populations. Appendix V-B

BayScapes: Since its inception in 1996, the Coastal Bays Program has sponsored 16 native plant demonstration projects at numerous sites across the coastal bays watershed. The volunteers have planted more than 10,000 native plants and trees where once there was merely turf. These planting projects have served as great outreach components in getting people together for a common cause.

Seagrass monitoring: After aerial flights from DNR in the coastal bays watershed to define seagrass areas, MCBP volunteers have been going out to specific sites to groundtruth thickness and type of seagrass to help DNR scientists. This effort has proven to be an excellent outreach tool to teach seagrass dynamics to the volunteers and also to watershed residents who read about the program.

Adopt-A-Street Program: This Ocean City-wide stenciling program began with a partnership between the MCBP and the OC Surfrider Foundation. The program, designed to blanket Ocean City neighborhoods with storm drain stencils has enlisted hundreds of resort residents to give their hand toward protecting the bays. The Surfrider Foundation has now taken the initiative over. Appendix V-B

Streamwaders Program: Although a Maryland DNR program, the MCBP has partnered with the agency to gather its own legion of volunteers who go out every three years to extract macroinvertebrates from non-tidal streams to measure stream health. The MCBP advertises this as a co-effort and details findings in local newspapers and TV shows to relays non-tidal stream importance to watershed residents.

FUNDING LOCAL PROJECTS

To reaffirm the Coastal Bays Program as the community's program, some $280,000 has been awarded to locals for 43 projects in the watershed since 1997. In the form of "minigrants" and "early action grants" these funds have provided a host of schools, businesses, local agencies, and organizations with the means to conduct a variety of projects in eastern Worcester. Native plant restoration, buffer planting, seagrass monitoring, reef building, pesticide alternatives, and bay scallop reintroduction are just a few of the projects that have been funded. This program has served as a tremendous outreach tool by empowering the public and entrenching the program and its philosophy into community groups, schools, and business leaders. Public meetings to explain and promote the projects have accompanied the funding. (See Appendix V-A also)

DISSEMINATING INFORMATION

The foundation of intelligent decision-making is knowledge. With this in mind, the Coastal Bays Program has published more than 30 guides, fact sheets, brochures and reports, which serve to inform and motivate. This information is distributed at an average of four venues per month, which include public speaking engagements, MCBP-sponsored and non-sponsored events, and public meetings. The strategy reaches beyond the choir to disseminate this information. In addition to flyers and pamphlets for each coastal bays event, the Program has produced:

Management Plan summary: A 29-page illustrated summary of the Coastal Bays Management Plan, replete with captions for each section. (10,000 produced in 1999. Now gone) Appendix V-B

The Homeowners Guide to the Coastal Bays: A 36-page guide describing what coastal bays watershed resident scan do to protect the bays. It contains one-page inserts with the most important information. Also, every new home buyer in Ocean City gets the guide along with their city information. Appendix V-B

Hotel Doorhanger: This 3"X8" laminated paper doorhanger rests on knobs in 70 Ocean City hotels. One side asked patrons to hang their towels and washcloths if they would like to conserve water while the other lists things they can do to protect the environment while in Ocean City. The OC Hotel-Motel-Restaurant Association and Delmarva Low Impact Tourism Experiences help fund and design the MCBP project annually. Appendix V-B

Coastal Bays brochure: A short, easy-to-use tri-fold brochure describing the program and challenges in the watershed. Appendix V-B

Size and Creel brochure: Prior to the coastal bays adoption, there was no official DNR size and creel brochure for coastal bays anglers. With funding from DNR, the program made one such brochure in 2000 and has been doing so ever since. It has size and creel for the 11 primary species caught in the bays— plus crabs. Appendix V-B

Quarterly newsletter: "Solutions" is the celebrated quarterly newsletter of the MCBP. It highlights recent developments, volunteer opportunities and how homeowners can save the bays. Appendix V-B

Boaters tip card: This laminated 3"X9" card gives boaters tips on safe and environmentally friendly boating while in the bays. DNR is a partner in this effort. Appendix V-B

Native plants of Worcester: A seven-page guide to the native plants of Worcester. It contains places to purchase them, their size, soil conditions, color and what kind of wildlife they attract. Appendix V-B

Boaters Guide to the Coastal Bays: Due out in August, this guide takes the form of a map on one side and information piece on the other. It contains, boat ramps, marinas, sensitive areas, fishing, boating and Jetskiing rules, seagrass areas, channels, buoys and important information on how boaters can make their trips safe and low-impact.

Coastal Bays Comprehensive Conservation and Management Plan: After completion of the CCMP, the MCBP immediately re-did the 170-page document to add illustrations and make it user friendly. Appendix V-B

Visioning booklet: This 30-page book describing the results of the visioning workshops held in 1998 shows readers what their community wants and why smart growth consumes less natural resources and costs less to taxpayers (5,000 produced in 1999- none left). 10,000 note cards inviting residents to the sessions were also sent to all parts of the watershed. (See Appendix V-A)

State Highway brochure: This year the MCBP teamed up with the State Highway Administration to produce a brochure that shows how the SHA worked diligently in the watershed to replace forest and wetlands lost to highway construction. (See V-A)

Pfiesteria newspaper insert: This four-page folded insert on what residents should know about the insidious microalgae and what they could do to help was distributed to 40,000 homeowners via four newspapers in 1998. Assateague Coastal Trust partnered in the effort.

Backyard habitat insert: This four-page folded insert on what residents can do in the backyard to protect wildlife and water quality was distributed to 40,000 homeowners via four newspapers in 2000. Assateague Coastal Trust partnered in the effort.

Guide to Coast Day: 80,000 copies of this annual 24-page guide to Maryland Coast Day is distributed in five local newspapers. The MD Dispatch sells ads for the insert which means production is free for the program. Program heads and local, state, and federal legislators write letters in the guide to expound on their efforts. It also contains a "what can you do" section. Appendix V-B

Clean Boating poster: This 11" X 14" poster displayed at marinas, boat ramps and tackle shops highlights what boaters can do to protect themselves and water quality. Appendix V-B

Comp plan insert: After release of the first draft of the CCMP, the MCBP released a 6-page insert describing the CCMP sections and encouraging more public input. 30,000 were distributed in local newspapers. Appendix V-B

Today's Treasures for Tomorrow: a public document characterizing the condition of the coastal bays Appendix V-B

Fact sheets: Five fact sheets on nutrients, habitat, and living resources, chemicals and general coastal bays information. Appendix V-B

SAV caution guide: A tri-fold brochure made with DNR showing the aerial extent of seagrass in the northern bays that gives tips to boaters on importance of SAV and how to avoid. Appendix V-B

Voluntary Golf Course Guidelines: This booklet, made with Worcester County, gives golf course managers voluntary guidelines to follow to protect water quality and wildlife. Workshops were held in conjunction with the release. (See Appendix V-A)

Interpretive poster: The MCBP produced in 1997 and has been reprinting its full-color "Life of the Coastal Bays" poster replete with native flora and fauna numbered on the back for identity. (None left)

Association of National Estuary Programs' (ANEP) fact sheets/recipes and ANEP report to the nation: MCBP collaborated on this project by helping give input on verbiage and layout.

Coastal Bays Program bumper stickers, refrigerator magnets and folders: Magnets sport web page and phone number; folders are copy of poster with flora and fauna and stickers reveal full-color logo. Appendix V-B

These items can be found at each Worcester County library branch, the Ocean City Convention Center, OC Chamber of Commerce and local businesses throughout the county. The unyielding need for education will continue to spawn educational literature throughout the life of the Coastal Bays Program.

REACHING OUT TO THE COMMUNITY

Recognizing the need to inform all parties and solicit input from them, the Coastal Bays Program has gone into the community to reach individuals who might otherwise remain hostile or indifferent. From 1997-present the program has given informational presentations to more than 138 local organizations, including the Coastal Association of Realtors, Eastern Shore Golf Superintendents, the Delmarva Poultry Industry, the Worcester County Schools staff, Eastern Shore Builders Association, a number of anglers and garden clubs, and the Lions Clubs, and Chambers of Commerce of Berlin, Ocean City and Snow Hill. This has been one of our most important and successful outreach efforts. The majority of these presentation are in the form of half-hour long Power Point presentations. During implementation, the focus changed to highlight implementation strategies each group might help fulfill. (Appendix V-B for entire list)

Attending community events also has served as an important outreach tool. The program set up displays and disseminated information at 20 such venues every year since 1998. The events, such as the White Marlin Open, the annual conference of the Maryland Farm Bureau, Ocean City's Springfest, the Worcester County Fair, and the Maryland Association of Counties Convention, help catapult education to a new dimension by drawing in often hard-to-reach audiences. This strategy will continue throughout implementation.

PLANNING FOR THE FUTURE IN THE COASTAL BAYS WATERSHED

Three very important workshops have helped residents in the coastal bays watershed contemplate how they want their community to grow. In May of 1998, the program held two "**Your Community Your Choice: Picturing Tomorrow**" workshops in Berlin and Snow Hill. Surveys conducted at the workshops allowed the 250 residents who attended to rate their feelings on land use and growth in the county. The results, revealed at a follow-up public meeting in October 1998, showed that preservation of natural and agricultural land is foremost in the minds of Worcester County residents. (See V-A.)

An associated meeting in February 1999 in Berlin showed residents specific growth scenarios in their watershed based on zoning and population projections. The "**Alternative Futures Workshop**" helped further elaborate fiscal and planning issues related to the growth and development scenarios asked for by participants during the "Picturing Tomorrow" workshops. The feedback from the Alternative Futures Workshop will be incorporated into Worcester's community vision for itself. (See V-A.)

Following the Alternatives Futures workshop, the Coastal Bays Program held a **growth, development, and design speaker series** featuring prominent planners, architects and developers from across the country like Bill Browning, Kennedy Smith, Tom Hylton and Ed McMahon. The six speakers spread over six months gave lectures on green building, smart growth, downtown revitalization and site design. Since then, the MCBP has worked with a number of developers to design green developments and green buildings, including the new county office building, The Landings development on Route 611, Whispering Woods and Americana Bayside. Appendix V-B

FILLING IN THE GAPS

Other projects involving community outreach and problem-solving will continue to keep the Coastal Bays Program viable. The program is working with Realtor licensors to help them effectively teach coastal bays watershed dynamics to their students. The program also teaches its own Realtor certification courses using watershed dynamics as the theme (see V.a.) An initiative to preserve the venerable Assateague hunting lodges to use them for education is also being aided by MCBP staff. The program is creating a beach-to-bay kiosk on the bayside park in downtown Ocean City. Each of the four partners (MCBP, Surfrider Foundation, National Park Service, and Marine Animal Rescue Program) will have their own kiosk which celebrates their targeted part of the coastal ecosystem. The MCBP also helped create coastal bay informational kiosks at a new Ocean City Park and Ride bus terminal which looks out over the bays.

Another public display will be the Golden Osprey Award which will be awarded this August to the person who has shown the most dedication to the coastal bays over the past year. The 5-foot tall bronze statue will grace the grounds of the Ocean City Convention Center along with a plaque describing the winner. It will serve as inspiration to visitors from around the United States.

Environmental prosperity in the coastal bays watershed is wholly contingent on the public's ability to have the information it needs to make intelligent decisions. Only education can provide the means to protect this very special place in Maryland.

C. TECHNOLOGY TRANSFER AND INFORMATION SHARING

The Coastal Bays Program has been an efficient provider of tech transfer and information for other NEP's and with local as well as foreign watershed groups. In addition to the 50 examples in IV(d) and V(a), almost all of which involve information sharing, a list of a few good examples follow below:

Delaware Inland Bay NEP Involvement: The Delaware Inland Bays Program is adjacent to the Coastal Bays Program boundary. This has allowed for much collaboration and tech transfer including joint grants on aquatic nuisance species, a joint CAC meeting, a regular information stream between STAC's, a joint ANEP conference coming in November, significant brown tide, macroalgae and *pfiesteria* data sharing, and coordination of both of our education programs.

Tri-State Fisheries Conference: In 2000, the Coastal Bays Program helped coordinate a tri-state fisheries conference between MD, VA, and DE. Hundreds of resource managers, elected officials, residents, and recreational and commercial fishermen attended the conference to share data and review new management strategies for managing species on a tri-state level. Besides the information shared at the two-day event, the conference has opened new channels of communication between fisheries managers in the three Mid-Atlantic States. Appendix V-B

Turkey/Japan SAV Monitoring: As a result of technical assistance and a $10,000 SAV monitoring mini-grant which the Coastal Bays Program gave to Stephen Decatur Middle School, the MCBP method of seagrass monitoring was highlighted at an EMECS international conference in Turkey where teacher Pat Chambers was asked to present her work. Her work so impressed scientists that she was asked to present at an international environmental education conference in Japan last year. Her efforts there highlighted how science and education has worked to mold minds in the coastal bays watershed. Appendix V-C

Coastal Bays Publication Sharing: Other NEPs and countless municipalities and watershed groups nationwide have used Coastal Bays publications to aid in their watershed management efforts. Most popular have been the Envisioning the Future: A New Tool for Coastal Managers, the Visioning results books, Native plant guide, Homeowners Guide to the Coastal Bays, the CCMP summary (which several NEP's modeled their summaries after), hotel/motel conservation doorhangers, and our boating tip cards.

Evisioning the Future: A New Tool for Coastal Managers: This landmark publication prepared by MCBP and funded by EPA highlights the visioning process and the stages coastal managers need to go through in order to engage their communities to address growth issues. The coastal bays watershed and program is used as the paragon to be followed. Appendix V-C

Ocean Conservancy Workshop: In 2001, the Coastal Bays program helped coordinate an EPA sponsored workshop where staff helped groups and individuals from around the region learn how to monitor water quality and how to get and keep volunteers. As a result, Wicomico County, adjacent to Worcester is now pushing for their own watershed group to regularly monitor water quality.

Septic Haulers: In 1998 the MCBP began a series of meetings with septic haulers to help them clean up their business, discuss sewage sludge fertilizer application, and help homeowners learn to recognize their tanks need pumping. The major haulers from around Worcester attended the meetings and agreed on environmentally friendly ways to dispose of sewage sludge.

Regional NEP Technical Transfer: On Aug. 14, 2001, regional NEPs held a tech transfer meeting coordinated and facilitated by the MCBP. The MCBP played an important technology transfer role with our SAV aerial photography and historical data sets, macroalgae surveys, forest, riparian buffer, and wetland change data sets, TMDL involvement, historic coastal bays sediment shifting data, shoreline change maps, visioning and public perception polling, real estate courses, speakers series, weekly newspaper columns, dock and pier parameters, oyster reefs, buffer legislation, and the Landing charette. All of this information was shared with the six NEPs which attended the meeting.

No Discharge Zone establishment and information share: In 2001, the MCBP held numerous meetings with marina operators, and state and federal regulators to share information to help establish a no-discharge zone in the northern coastal bays. Nutrient, pumpout and boat survey information from the program helped establish the zone in 2002. Appendix V-C

Base Program Analysis: This guide to regulatory agencies, their roles, responsibilities and goals was created by the MCBP to help direct implementation and help agencies better coordinate activities among themselves. Appendix V-C

Conferences: The list below is an overview and does not contain all travel to conferences, meetings, etc. In many cases, MCBP travel funds helped partner staff and MCBP volunteers attend meetings and conferences in addition to MCBP staff.

ANEP, March 2002: At the annual meeting in Washington, D.C., the director gave a presentation on smart growth-related issues including MCBP design charettes and visioning work.

American Water Resources Association Conference, May 2002: Coastal Bays outreach coordinator helped create paper and presentation for the New Orleans American Water Resources Association Conference. The joint presentation of the Maryland State Highway Administration and the MCBP, "Integrating Highway Construction with the Maryland Coastal Bays Program," helped coastal managers learn how highway departments and resource agencies can work together to restore water quality and habitat when building highways.

Maryland Environmental Summit Jan. 2002: At the State House in Annapolis, the MCBP director gave a full-scale overview of the critical areas bill to legislators and concerned citizens from throughout the state. The summit is designed to allow groups and individuals to share their needs with the state legislature, residents, and agencies.

Atlanta All America Cities Competition, June 2001: The MCBP was chosen to be one of three reasons Ocean City should be dubbed an All-America City. MCBP outreach coordinator helped write presentations and gave speech on why Ocean City, MD should be an All-America City based on its work with the MCBP. Ocean City won.

Maryland Association of Environmental Educators Conference, Feb. 2001: MCBP outreach coordinator gave presentation to Maryland educators on how to get best results from the media, including strategies for television, radio, and newsprint. MCBP Education coordinator also attended.

National Estuary Program Outreach Conference, June 2001: At this Philadelphia conference, MCBP outreach coordinator gave presentation on the program's outreach efforts and how each has been accomplished. The conference was designed for outreach coordinators to share information on their work. The MCBP education coordinator and specialist also attended.

D.C. Federal Regulators Conference, March 2001: MCBP outreach coordinator gave presentation of community visioning workshops and the results. Discussion surrounded involving the community in growth-related issues.

Coastal America Public Outreach Conference, Oct. 2001: The MCBP outreach coordinator, education coordinator and specialist attended the two-day roundtable discussion at the Baltimore Aquarium to share ideas for informing the public on critical issues facing coastal communities. The MCBP played an integral part in sharing media strategies, education programs and event ideas.

MD Outdoor Educators conference: Aug. 2001: This state-wide conferences is held annually to help environmental educators share information to help others in their field. MCBP education coordinator gave a presentation at the conference in Lewes, DE on the Weidman Farm outdoor activities the program holds all spring, summer and fall (see V-B).

"Chesapeake Bay Country in the 21st Century: Environment, Heritage and Social Change," October 2000: At this Salisbury University 3-day conference, the MCBP outreach coordinator gave a presentation on agriculture in the coastal bays watershed— where it is going and how we might save it.

Urban Land Institute Conference "Partners for Smart Growth: Engaging the Private Sector," Dec. 2000: At this information sharing conference in Atlanta, MCBP outreach coordinator gave presentation on Visioning, alternative futures, and the MCBP planning speakers series.

Maryland Water Monitoring Workshop, Dec. 2000: this workshop in Linthicum MD, helps the program and other agencies share information on the how's where's when's and why's of water quality monitoring.

Coastal Zone '99 July, 1999: MCBP outreach coordinator attended this San Diego conference and gave presentation on how to set up a Community Visioning program and make it work.

OTHER PROGRAMS/SUPPLEMENTAL TRAVEL FUNDS:

ANEP meeting: Washington, DC. March 1997, 1998, 1999, 2000, 2001, 2002
ANEP meeting: Santa Monica, CA Oct. 1998
ANEP meeting: Sebasco Harbor, ME Oct. 2000
MD Association of Environmental Educators Conference: Dec. 2000, Ocean City, MD
"Tri-state Approaches to Managing Fisheries:" Nov. 2000, Ocean City, MD
Wetland Identification and Delineation Training: June 2000, Cambridge, MD
Maryland Association of Counties meeting: Aug. 2000, Ocean City, MD
Nanticoke Environmental Educators Symposium: Sept. 2000, Tyaskin, MD
Non-Profit Accounting training: Sept., 2000, Baltimore, MD
ANEP Conference: Nov. 2001 Tampa, FL
Perdue Agricycling information share: July, 2001, Georgetown, DE
Project Wet & Wild training: Jan. & March 2001, Baltimore, MD
SAV Restoration workshops: Dec. 2001, La Plata, MD
Grant Writing Workshop: June, 2001, Ridgley, MD
MD/DE Planning Association Conference: Sept. 2001, Rehoboth DE
Oyster Institute training and workshop by SeaGrant: Horn Point, MD, June 2001
Negotiation Training: Salisbury, MD, Nov. 2001
MD Archeological conference: March 2001, Baltimore, MD
MD State Department of Education Training: Nov. 2001, Catonsville, MD
Community and Cultural Diversity Training: Aug. 2001, Washington, DC
MD Association of Non-Profits Grant Writing Training: Jan. 2002, Easton, MD
Association for Experimental Outdoor Educators Conference: March '02, Salisbury, MD
USGS Groundwater Workshop: March, 2002 Annapolis
DNR Macroalgae Conference: Jan. 2002, Linthicum, MD
ACCESS Data Base training: Jan, 2002, Salisbury, MD

*Plus over 40 pre-implementation workshops on outreach, resource management, and volunteer programs

VI. Overall Program Strengths and Weaknesses

Program staff surveyed and interviewed members of the MCBP Implementation Committee, Citizen's Advisory Committee and the MCBF Board for input to this section. In addition, staff also provided comments. The comments reflect the opinions of many people involved in the program which gives a realistic impression of the program's strengths and weaknesses.

A. The actions or areas considered to be the program's strengths and most successful endeavors, as well as what areas the program feels need further improvement;

Program's Strengths and Most Successful Endeavors

In summary, many individuals involved in the program believe that the coordination and communication aspect of the MCBP is the most vital and important component that the program does. The education/outreach functions and the ability to reach consensuses were particular strengths. The program has been very successful at continuing the communication aspect and has achieved strong support for its emphasis on cooperation and consensus. Not conflict and confrontation. The cooperative nature is one of the strengths of the program and the staff, citizens, volunteers and agency partners all significantly contribute to making this a successful component of the program. Additionally, the program continues to focus on implementing the plan and has not deviated from the contents of the plan to get engaged in specific permit or NIMBY conflicts. The following are some of the direct comments received from the survey and interviews related to this question.

1. The level of coordination among the various partners and committees is a significant strength of the program.
2. The ability to generate consensus acceptance in changes in value systems, while creating effective working relationships and upgrading public understanding of the watershed's ecosystem through education and trust.
3. MCBP has very strong public education and outreach efforts.
4. Formation of a nonprofit foundation
5. Outreach and fundraising events that increase citizen involvement in the program
6. Estuarine research activities to differentiate coastal bays system from Chesapeake Bay
7. Public outreach
8. Having all the players organized and cooperating in a joint effort.
9. The strengths of this program are its continued citizens' participation, its attention in the CCMP and in implementation to growth and water use issues, its voluminous public outreach, its skillful leadership and its great good fortune or timing.
10. An additional major strength is that most of the participants are able to keep their focus on the partnership and do not allow themselves to be sidetracked by pet peeves.
11. Its specific most successful endeavor has been in maintaining its public image as a neutral forum working to balance human and environmental needs. It would take volumes to explain how this has been achieved, but more simply I would credit this accomplishment to the understanding and vision of our leadership and the volume and quality of our public outreach productions.
12. We have superb elected officials with specific powerful positions at the federal level in Senators Sarbanes & Mikulski and in Congressman Gilchrest. We have had a receptive Governor who wanted his legacy to be his environmental stewardship. We have chosen

our leadership well. A strong & effective county commissioner has been our sponsor. Our director during the planning process was a local boy grown up into a career within the EPA & the EPA had the good insight to lend him to us for three years. Our director during the implementation phase had previous experience in the two most significant "issues" that have arisen during implementation – fisheries and legislative - and he has a love for the event that has become our major fundraiser. Our CAC chair during planning and early implementation was skilled at keeping the focus on the larger picture and at finding consensus points and was able to participate in so much of the Program that all committees knew what others were doing and how their individual roles fit in the larger Program. A detail-oriented person came along to serve as our second CAC chair, making producing an effective tracking and evaluation system more achievable. Our public outreach director is driven by excellence so all our publicity and products are first class and who is well respected in the journalism field so has been able to "train" the entry-level reporters that always turnover constantly.

13. Community Outreach and Education
14. Coordination of CCMP implementation; stimulating action
15. Facilitation of communication between groups
16. Securing funding for implementation

Program Areas which Need improvement

Tracking to date has focused on the lead agency responsible for implementing the specific actions. A method needs to be developed to capture and report the efforts of the support agency efforts in implementing the actions. Either have the lead agency be responsible and create some sort of secondary or supplemental report to acquire the information of support agencies or create a system to allow the support agencies to report on there activity related to a specific action.

Enforcement of existing laws is a theme that is heard from many of the citizens in the coastal bays watershed. Recent state and local budget history has shown that insufficient funds have been dedicated to enforcement purposes. Funds need to be provided to the local and state regulatory agencies so they can provide sufficient enforcement of existing laws for wetlands, stormwater, sediment and erosion control, forestry and now critical areas regulations.

Most of the comments received for this section reflect the concern of funding and to keep the Program science based if it is to achieve long term continued success. The following are direct comments from the survey for areas where the program needs improvement.

1. There is a need to expand the science-based research of the ecosystem
2. Assistance with obtaining grants for the implementation of the program initiatives.
3. CCMP actions should be revisited and refined now that we have had some implementation experience.
4. There are some meetings where there is a lot of education/scientific info passed that does not necessarily move the process forward. Sometimes we can get bogged down.
5. STAC involvement and developing a long range monitoring program.
6. The major weakness in our structure has been the level of participation by the STAC. Hopefully the major cause has been the STAC's primary interest in the Chesapeake Bay and our recent changes to having the head of STAC located at Salisbury University instead of Horne Point will

alleviate this lack of time to commit to Coastal Bay efforts. The problem with STAC participation may be more a problem of lack of funding not lack of time commitment.

7. The need for line item funding commitments from state and local governments and a better level of understanding of the environmental issues by our local elected officials.
8. Better understanding by the general public of the habitat issues.
9. A greater participation by certain segments of our citizenry in the program (minority).
10. Outreach, education and funding support from our transient population. Our visitors will be our salvation, they just do not know we exist or think we are a part of the Chesapeake Bay program. Our strong property rights lobby will not influence them and they will want to preserve all the reasons they have been coming here for vacation.
11. Scientific study, interpretation and technical assistance to local government and groups
12. Need exists for a scientist on staff.

B. What have been the major roadblocks to successful implementation and achieving the program's goals;

The major roadblock identified to the implementation of the CCMP has been the lack of funding and resources to be able to accomplish all of the actions prescribed in the CCMP. The Coastal Bays CCMP is very front end loaded with many actions scheduled to begin in the first three years of implementation. Of the 73 challenges described in the plan, 66 have begun. With such a wide scope of actions and challenges, making sure that funding, staffing, time, workloads and resources are available to accomplish the actions has been a challenge.

The following are direct comments from the questionnaire.

1. Funding and staff available to implement all of the DNR actions in the CCMP remains an issue. DNR has prioritized actions and proceeded with the top priorities first.
2. The time and energy necessary to adjust the local political processes away from an "ownership" mentality and toward a "stewardship" mentality.
3. Funding and the need for new technologies to address water quality improvements.
4. CCMP is wide ranging and comprehensive in the activities that need to be accomplished. Funding and staffing constraints limit the speed and effectiveness at which different goals can be reached.
5. Diminishing budgets
6. Difficulty in measuring outcomes/results to fit formula developed for tracking system
7. Lack of funding and difficulty of finding matching funds
8. Minimal time of Agency staff that could be dedicated to the program because of other responsibilities.
9. The major roadblock to the Program is our proximity to the Chesapeake Bay. On a legislative and regulator level, those individuals tend to see the solutions to our challenges/problems/issues in terms of their previously decided solutions for the Chesapeake. Our estuary is very different and while some of their solutions will work here, others are actually harmful. In a state that likes to look for statewide programs, this has been very problematic. Year two we had some luck at turning that viewpoint around, but in year three it has become an ugly mess! On a local citizen level, many of our residents have moved here from the Chesapeake watershed and are familiar with that program. They envision our coastal bay program in those terms, forgetting that it has taken years for that Foundation to build a reputation and not realizing that much of the success of that program is founded in the national attention given to the Chesapeake Bay, particularly by

Congress. Our locals do not understand why we do not have a line item in the federal budget, why we do not have an intense monitoring program, why we do not have funding from a tax check off, a license plate – the list goes on. We must, instead of comparing ourselves to the efforts to cleanup and protect the Chesapeake, learn to piggyback on their efforts. We will always "pale in comparison"! But more importantly we must concentrate on publicizing our own identity as a major beach destination & recreational area and establishing a local protector base from those users.

10. Probably true in every estuary program – funding! In particular, long term stability in funding prospects.
11. The level of sophistication and comprehension of the local reporters and the constant need to education them on environmental issues, plus the constant turnover in reporters.
12. The strength of our local property rights group, not in numbers but in influence on the local decision makers and in their ability to gain the sympathy of the local press to their cause.
13. Impatience by many sectors of the general public with the pace of the program and its government partners creates frustration among both the citizens and government representatives. Many groups have perceived that once the CCMP was adopted, their advocacy efforts would be taken care of while the government and staff would implement the actions. In particular, much of the public gets frustrated with the inability of the program to take positions on specific, everyday issues like wetland permit applications, and of the program staff not to be able lobby for specific legislation.
14. Most important, the variety and volume of issues that staff are required to deal with on a daily basis. It can be overwhelming and frustrating.
15. Funding
16. Commitment to completion of actions by all partner parties, due to staff and other resource constraints
17. Finally, turnover in personnel, no matter what part of the Program structure. Seems to be a constant effort at training new people, giving them a history of why we are doing what and making them comfortable with the process we use and keeping them from wanting to change our priorities.
18. Implementing changes and overcoming inertia takes much time and effort.

C. How, if at all, any issues or obstacles have been or are being resolved, or any future plans to address the issues.

The Maryland Coastal Bays Program is still relatively very young in the process. The issues of Funding, staffing, time, workloads and resources that are available to accomplish the actions have been challenging. To date using the CCMP, receiving recommendations and direction from the Board of Directors, Implementation Committee, Citizen Advisory Committee and the Policy committee has been able to focus our efforts on the highest priorities and attempting to address the top issues. Efforts to continually re prioritize the goals and all committees and partners of the program with overall direction and approval from the Policy Committee will undertake objectives of the program on a periodic basis.

Long-term core funding is a challenge. Funds to operate the program and maintain its education, outreach, and research involvement in issues will determine the long-term success of the program and health of the ecosystem. There has been success at the Congressional and federal level to increase the base funding for the Estuary program for FY 2003. It would be extremely helpful to continue this funding.

The Policy Committee and the Board of Directors have recognized and discussed the long term funding of the program and have agreed it needs to be addressed. The Policy Committee recommended a financial needs assessment be accomplished to determine the level of funding that would be needed and to identify potential sources for funding. The needs assessment will be conducted in the future.

Agencies are beginning to look into potential funding sources for assistance to implement specific actions of the CCMP. State and local governments do not contribute funds directly to the program but do provide essential match funds in the form of in-kind and contractual services. The state and local governments also have the added problem of trying to accomplish their assigned actions on tight budgets with minimal staff and resources.

Since a nonprofit was established, the fund-raising arm of the organization must continue to generate income from local residents and businesses and transient visitors. The Fundraising has been successful to date but continued and expanded effort is needed to guarantee the long-term success of a stream of funding. The nonprofit has been successful early on to receive several foundation grants for specific actions in the management plan. Grant writing training and continued engagement and familiarity with private foundations should be undertaken.

Some issues are inherent in the program structure such as educating and modifying citizen and local politician actions to become more aware of environmental issues and actions. These are long term educational and outreach projects that will require constant monitoring and assessment. The program funded a public opinion survey to establish a baseline of understanding and support that will be used in the future to compare progress and changes to the understanding of the coastal bays program and watershed.

The proximity to the Chesapeake Bay has been both a blessing and a curse. The Chesapeake Bay has provided many lessons on issues and topics that have been helpful. The MCBP must continue to keep in contact and communicate with the Chesapeake Bay Program and other estuary programs to learn from their experiences. The Program will need to continue to educate the public and others about our "forgotten bays" and that it is a separate watershed with separate issues and solutions.

VII. Feedback on EPA's Involvement

EPA's involvement has been essential and critical to the success of the Maryland Coastal Bays Program and the local community. EPA's progress in assisting and carrying out its commitments to the CCMP has provided a framework for the MCBP to function effectively and efficiently. The funding provided through a base program, supplemental and other grant funds have provided the MCBP with means for implementing the actions in the CCMP and the opportunity to make significant advancements on information needed for growth, water quality, habitat, and invasive species issues.

We have also been able to take advantage of technical assistance that has been offered on consensus building, CCMP development, tracking, wetlands, habitat, boating, growth, economic evaluation, finance, sea level rise and water quality issues. The communication from EPA and the coordination among the other NEP's has allowed MCBP, as a new Tier V program, to be more focused on actions and issues and being able to learn from the other programs that have tried methods in the past. EPA has been able to communicate other tech transfer ideas to be shared so we are not "reinventing the wheel."

We have had excellent communication with both our regional (Ed Ambrogio) and headquarters (Jamal Kadri, Amy Owsley, and Gabrielle Lombardi) representatives. In reviewing the EPA regional and headquarter contact roles and responsibilities from the EPA Funding Guidance document, our contacts have been diligent in accomplishing the responsibilities. They have provided updates on issues from the federal level and potential funding opportunities. The contacts have been very helpful, flexible and valuable consultants on grant applications and reporting requirements.

In general our contact and communication with both EPA region III and HQ are very positive. Although not major issues at this time, the following is a list of recommendations to be considered. These recommendations include programmatic recommendations, specific issues and technical assistance that might be important in the future. Some of this may be already in process

1. EPA regional and HQ staff to have more visits to the NEP watershed and programs so they can become more aware of local issues. Our direct EPA regional contact is very active and is "on-site" often. Other EPA staff that are involved with NEP's should become more visible and be more aware of local issues and administration of the NEP.
2. Identify and/or provide funds to be used specifically for monitoring. One of the issues we constantly face is having enough scientific information and data to be able to determine trends. Providing some funds to help match state and local dollars to monitor water quality and habitat parameters could be critical to the long term success of NEP's.
3. Additional GIS support. GIS is a valuable tool that provides local decision makers with vital information. Any assistance EPA and/or other federal agencies might be able to provide in the way of GIS equipment, staff expertise, information, data or funding.
4. Keep reporting requirements to a minimum. MCBP understands and agrees with the need for accountability. However, many of the reports and timing are difficult to accomplish especially with other tasks of implementing the CCMP. Any new and additional reporting should be reviewed and considered carefully before requiring additional burdens on time and staff resources.
5. Emphasize and retain the successful partnership arrangements. Our NEP priorities may not be in line with EPA's major focal points and the local NEP's need flexibility to direct funds to meet the needs of the local NEP management conference and CCMP.
6. Issues on the horizon where technical assistance may be needed - groundwater contamination, additional air deposition work, marine protected areas and sanctuaries.
7. Provide funds and technical assistance for modeling of estuary systems
8. Better coordination and networking with other branches of EPA and other federal agencies, better contacts on wildlife and fishery issues (Fish & Wildlife and NOAA), dredging and Army Corps of Engineers issues.
9. Support comprehensive science and research conferences of principal investigators involved in modeling and monitoring estuary systems.
10. Coordinate and assist with internship and fellowship programs at the NEP's
11. On special grants, like Smart Growth and Invasive Species or others that may occur in the future, provide feedback on successful and unsuccessful grant applications to provide future guidance.

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Proceedings

Delmarva's Coastal Bay Watersheds: Not Yet Up the Creek

A Conference on Ecology and Economy

March 8-9, 1996
Ocean City, MD

ABSTRACT

On March 8-9 1996, 269 people attended the Delmarva Coastal Bay Watersheds Conference in Ocean City, Maryland. The purpose of the conference was to provide a forum for citizens, elected and appointed officials and other decisionmakers, and special interest representatives to discuss the economic and environmental state of the Delmarva coastal watersheds and to determine further continuing actions and activities. The design of the conference provided a unique opportunity for citizens in the Delmarva region to express their ideas and to apply their collective wisdom to begin to formulate strategies that will integrate economic, environmental, scientific and social considerations toward achieving a sustainable future.

The conference goals were:

1. To promote the concept of balancing economic well being and environmental protection and demonstrate why we should care about the coastal bays and their watersheds.

2. To encourage and secure stakeholder involvement.

3. To hear about and share local perspectives on the coastal bays and their watersheds.

4. To impart scientific information about the coastal bays and their watersheds.

5. To inform participants about the National Estuary Program and other models as vehicles for problem solving.

6. To help launch Maryland's National Estuary Program (NEP).

7. To help Delaware's Center for the Inland Bays increase public involvement.

8. To transfer lessons and encourage Virginia's participation in a Delmarva coastal bays coalition.

9. To use a conference report/summary to help communicate stakeholder views to decisionmakers.

10. To establish next steps: Where do we go from here?

It was understood that these goals were very ambitious and that this conference would open the door to future conferences, meetings and workshops — locally, Delmarva-wide and state-by-state. Future activities are now being determined in large part by citizen input to a pre-conference questionnaire (see page 28), by the 83 (31 percent) evaluation forms that were turned in at the conference (see Appendix B), and the questions raised during the conference (see Appendix C).

PREFACE

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CONFERENCE DONORS

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Northampton County, VA

South Moon Under

Accomack-Northampton Planning District Commission, *James McGowan, Planner* . . . 25

Report on Pre-Conference Questionnaire on Public Perceptions, *James M. Falk, University of Delaware, Sea Grant Marine Advisory Service* . . . 28

Sustainable Development: A Framework for a New Century, *Peggy Duxbury, President's Council on Sustainable Development* . . . 32

Report on Breakout Groups to Develop a Common Vision for Achieving Both Healthy Economy and Environment, Focusing on Specific Coastal Issues . . . 36

State of Maryland Remarks, *Verna Harrison, Assistant Secretary, Maryland Department of Natural Resources* . . . 45

Panel Discussion: What is the Environmental and Economic Status of the Coastal Bays and Their Watersheds?

Environmental Health of the Delmarva Coastal Bays and Their Watersheds, *Dr. Frederick Kutz, ORD Regional Scientist, EPA Region III* . . . 46

Economic Status of Fisheries and Aquaculture, *John Dunnigan, Executive Director, Atlantic States Marine Fisheries Commission* . . . 53

Delmarva's Tourism Industry, *Lisa Challenger, Worcester Tourism* . . . 56

Agriculture and Forestry, *John Tarburton, Secretary, Delaware Department of Agriculture* . . . 58

Question and Answer Session . . . 60

Panel Discussion: Models for Addressing Coastal Bays Issues: Where do We Go from Here?

Regional Perspectives on Coastal Bays Issues, *W. Michael McCabe, Regional Administrator, EPA Region III* . . . 63

National Estuary Program in Maryland,
Gwynne Schultz, Director, Coastal Zone Management Division, Maryland Department of Natural Resources 65

Delaware Center for the Inland Bays,
Dr. Bruce Richards, Executive Director, and *Dr. Kent Price, Chair* 67

Virginia's Approach to Sustainability: Balancing Environment and Economy, *Dr. Warren Flint, Executive Director, The Eastern Shore Institute* 70

Report on Breakout Groups to Discuss Models and Their Applications to State and Local Strategies 76

Full Conference Discussion on Issues and Strategies Best Addressed by a Delmarva-Wide Approach 81

Conference Follow Up, *W. Michael McCabe, Regional Administrator, EPA Region III* 83

APPENDIX A - Delmarva Coastal Bays Conference Participants 85

APPENDIX B - Conference Evaluation Form 98

APPENDIX C - Remaining Questions 100

AGENDA

Delmarva's Coastal Bay Watersheds: Not Yet "Up The Creek"

A Conference on Ecology and Economy

March 8-9, 1996
Carousel Hotel
Ocean City, MD

Friday, March 8th

12:30 Registration

12:55 *Call to Order and Introductions*: **Marsha Ramsay**, President, Assateague Coastal Trust

1:00 *Welcome*: **Roland "Fish" Powell**, Mayor, Ocean City and **James Barrett**, President, Board of Worcester County Commissioners

1:05 *Remarks and Introduction of Keynote Speaker*: **W. Michael McCabe,** EPA Regional Administrator

1:10 *A Framework for Landscape Planning: Alternative Futures for Monroe County, PA*: **Dr. Carl Steinitz**, Alexander and Victoria Wiley Professor of Landscape Architecture and Planning, Harvard Graduate School of Design

2:00 PANEL DISCUSSION: CHANGING CONDITIONS IN THE DELMARVA COASTAL BAY WATERSHEDS: LINKING PEOPLE, ECONOMICS AND ENVIRONMENT

Facilitator: **Dr. Kent Price**, Chair, Center for the Inland Bays

Worcester County, MD: **Phil Hager**, Worcester County Planning Department

Sussex County, DE: **Robert Stickels**, Sussex County Administrator

Accomack-Northampton Planning District Commission: **James McGowan**, Planner

2:45 Discussion Facilitator: **Dr. Kent Price**

National Estuary Program in Maryland: **Gwynne Schultz**, Director, Coastal Zone Management Division, Maryland Department of Natural Resources

Delaware Center for the Inland Bays: **Dr. Bruce Richards**, Executive Director, and **Dr. Kent Price**, Chair

Virginia's Regional Approach to Sustainability: Balancing Environment and Economy: **Dr. Warren Flint**, Executive Director, The Eastern Shore Institute

12:15 BREAKOUT GROUPS TO DISCUSS MODELS AND THEIR APPLICATIONS TO STATE AND LOCAL STRATEGIES:

(AFTER PICKING UP BOX LUNCHES)

Maryland: Facilitator: **Gwynne Schultz**

Delaware: Facilitator: **Dr. Bruce Richards**

Virginia: Facilitator: **Dr. Warren Flint**

1:20 FULL CONFERENCE RECONVENES TO IDENTIFY ISSUES AND STRATEGIES BEST ADDRESSED BY A DELMARVA-WIDE APPROACH

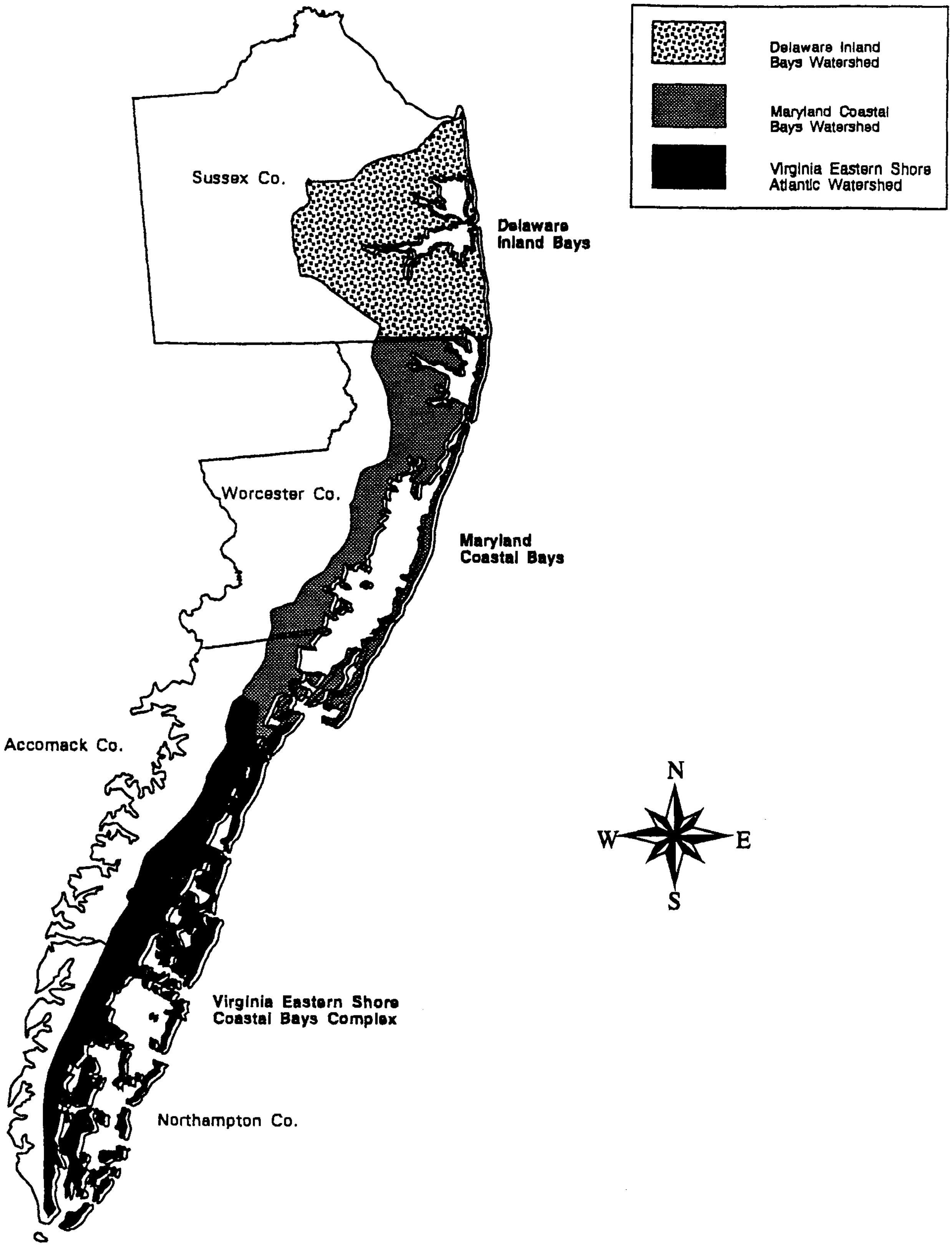
Facilitator: **Rick Johnstone**

2:15 CONFERENCE FOLLOW UP: **Michael McCabe**

PRESS CONFERENCE

All officials are invited to participate with conference planning subcommittee.

MAJOR WATERSHEDS AND BAYS OF THE DELMARVA PENINSULA'S ATLANTIC COASTLINE



CALL TO ORDER AND INTRODUCTIONS

Marsha Ramsay
President, Assateague Coastal Trust

On behalf of the 30 sponsors of this conference, welcome. I hope everyone is wearing a name tag so that we can become familiar with one another — and it's our meal ticket.

Please take a moment to look in your packets to find the list of attendees. Those people with asterisks next to their names represent our sponsors.

I would like to introduce the members of the agenda planning committee — those with double asterisks — with whom since August I have been in constant communication to put this conference together:

- Dr. Warren Flint, an ecology and coastal ecosystem scientist and Executive Director of the Eastern Shore Institute.
- Dr. Rick Kutz, a scientist from EPA's Office of Research and Development assigned to the Region III office in Annapolis.
- Rick Johnstone, Supervisor of Forestry for Delmarva Power and Light Company, serves on many state boards and public interest groups, and chairs MD's Wicomico Forestry Board.
- Dr. Kent Price is Associate Professor in the Graduate College of Marine Studies and Director of the Sea Grant Advisory Service at the University of Delaware. He chairs the Delaware Center for the Inland Bays and its Science and Technical Advisory Committee.
- Gwynne Schultz is Director of the Coastal Zone Management Division at the Maryland Department of Natural Resources, and is responsible for the start up of Maryland's National Estuary Program.

I also want to thank two Assateague Coastal Trust members: Eric Walbeck, who handled conference registration and logistics, and Terry Thompson, who coordinated the exhibits. Let's also thank Nancy Howard for coordinating publicity. Nancy is with the Maryland Department of Natural Resources. And also, Kathy Ellett and Dave Goshorn, both with the MD DNR.

In your packets is a list of conference donors to whom we extend our heartfelt thanks. I would also like to call your attention to the evaluation form in your packets. Please fill them out and put them on the registration desk before you leave tomorrow. We really want to know how you feel about this conference and where you want to go from here.

This conference is a stakeholders' conference. A stakeholder is anyone and everyone who has an interest in, or cares about, the Delmarva Coastal Bays Watershed area. The purpose of this conference is to provide a forum for all stakeholders — citizens, elected and appointed officials, and public and special interest representatives — to discuss the economic and environmental state of the Delmarva Coastal Bay Watersheds, and to begin to formulate strategies that will integrate economic, environmental, scientific and social considerations toward achieving a sustainable future.

This is a stakeholders' conference — undoubtedly, one of many to come as we work to ensure both a robust economy and a healthy environment.

The meeting will begin with a few words of welcome from our host community.

WELCOME

James Barrett
Worcester County Board of Commissioners

Good afternoon. Welcome to Ocean City and welcome to Worcester County. Mayor Fish Powell couldn't make it here today, but I would also like to welcome you here from him.

Years ago, I used to fish a lot. There were a lot of fish in the bay. This conference today is well overdue. As President of the Worcester County Board of Commissioners, I want to challenge each and every one of you to work together as a team to help our inland bays. When I say "work together as a team", I am talking about many different groups of people: builders, government officials of all the counties, town officials, boaters, land owners, DNR state officials, developers, EPA and other federal agencies, environmentalists, farmers, and citizens. This should be a partnership of how to clean up the bay. Those fish that I caught years ago are just not there because the plant life is dead in the bay.

So we need this partnership very much. It's hard work; you can talk to a lot of people and they can tell you all of the problems, but they do not have the solutions. What we need to do is not talk about the problems, but get to work and get them fixed. The greatest thing that we can leave to our children is the natural resources in this land that we have. The next generation and our generation can do that. And you people can help do that.

Thank you very much and welcome to Ocean City.

OPENING REMARKS

W. Michael McCabe
Regional Administrator, U.S. EPA Region III

W. Michael McCabe served as a top aide to Senator Joe Biden and as Staff Director of the House Energy Conservation and Power Subcommittee and the Congressional Environmental and Energy Study Conference. Mike is currently the EPA Region III Regional Administrator and is responsible for implementing environmental protection programs in PA, DE, MD, VA, WV, and DC. He is originally from Delaware.

Welcome on behalf of EPA Region III. Entire areas of the coastal bays fall within our area of responsibility and we are delighted with the amount of interest shown in the future of the coastal bays as evidenced by the large attendance here today. Your attendance at this conference demonstrates that the American people are interested in moving forward with the environmental progress made over the last 25 years.

The coastal bays of Delaware, Maryland and Virginia are an important ecological and economic resource whose physical characteristics and location make them particularly vulnerable to the effects of pollutants. These estuarine bays are affected by pollutants that come from the land as well as stresses that come from the ocean. Atmospheric deposition of pollutants represents another source of stress. About 90 percent of commercial fish, crabs and shellfish depend in some way on estuaries and associated salt marshes for their livelihood.

This is an important conference for us here in Region III for several reasons:

- First, this conference is a prime example of our ability to use scientific information to guide and evaluate our environmental decision-making. The motivation for holding this conference is largely based on a cooperative Federal and State study which you will hear more about later in the conference. Having environmental information upon which to guide management decisions is a major objective of my tenure as the Regional Administrator.

- Secondly, this conference also represents our initiative to involve community stakeholders in our resource management. Considering both the socio-economic and environmental issues in our decision-making is an absolute necessity as we move into the next century of environmental protection.

- Thirdly, this endeavor provides us with a timely illustration of the need for Regional involvement. The areas of these coastal bays crosses the boundaries of three States. Our efforts to effectively manage these bays require the full participation of all three States coordinated by a Regional presence.

I am here for the entire conference; my primary role will be as a listener and learner. I am not here today to announce new regulations or enforcement actions. I encourage this group over the next 24 hours with beginning to find new and innovative ways of addressing these issues that will be reasonable to all stakeholders. The diversity of this audience will provide many different perspectives. These perspectives will need to be considered as we move ahead to face the variety of issues associated with our protection of both these resources and our way of life.

A FRAMEWORK FOR THEORY AND PRACTICE IN LANDSCAPE PLANNING: ALTERNATIVE FUTURES FOR MONROE COUNTY

Carl Steinitz, Author
Department of Landscape Architecture
Harvard University Graduate School of Design
Cambridge, MA

Madis Pihlak, Presenter
Department of Horticulture & Landscape Architecture
University of Maryland
College Park, MD

Due to inclement weather, Dr. Carl Steinitz, was unable to attend the conference. In his place, Madis Pihlak, ASLA, AICP, delivered the presentation. Mr. Pihlak is an Associate Professor and Program Coordinator in the Department of Horticulture and Landscape Architecture at the University of Maryland. He has been involved in workshops with stakeholders and has researched the impacts of actions and inactions on communities which have similar environmental problems.

In 1990, after almost 25 years of applying GIS to many projects, I came to the realization that there was a common structure to this work, and I wrote a short paper entitled "A Framework for Theory (Steinitz 1990). Over the past three years, this framework has become the primary organizational basis of my teaching, research and projects. In this talk, I will give a brief description of this framework and show how it was applied to a recent project.

Six Questions in Search of An Answer

My proposed framework identifies six types of *questions*. Each can be considered a level of inquiry relating to a *theory-driven modeling type*. The models on which we rely must be based in usable and presumed-to-be-valid theory. They each require the management of information, and GIS can be applied—albeit differently—in each type of model.

Project managers and researchers will work through the framework at least three times in any project: first, in defining the context and scope of the project; second (and in reverse order) in specifying the project methodology; and third, in carrying the project forward to its conclusion. The six questions with their associated modeling types are listed in the usual order for initially defining the context of a landscape planning study.

I. *How should the state of the landscape be described: in content, boundaries, space, and time?*

This level of inquiry leads to *representation models.*

II. *How does the landscape operate? What are the functional and structural relationships among its elements?*

This level of inquiry leads to *process models.*

III. *Is the current landscape functioning well?*

The metrics of judgment (whether of health, beauty, cost, nutrient flow or user satisfaction) lead to *evaluation models.*

IV. *How might the landscape be altered: by what actions, where, and when?*

This is directly related to I, above, in that both are data; vocabulary and syntax.

This 4th level of inquiry leads to *change models.* At least two important types of change should be considered: changes brought about by current trends and changes caused by implementable actions, such as plans, investments, and regulations.

V. *What predictable differences might the changes cause?*

This 5th level of inquiry shapes *impact models*, in which the process models (II)) are used to simulate change. This is directly related to II, above, in that both are based on information; on predictive theory

VI. *Should the landscape be changed? How is a comparative evaluation of the impacts of alternative changes to be made?*

This is directly related to III, above, in that both are based on knowledge; on cultural values.

This sixth level of inquiry leads to *decision models.*

Implementation could be considered another level, but this framework treats it as a forward-in-time feedback to level I, the creation of a changed representation model.

Although the six levels have been presented in the order in which they are normally recognized, I believe that it is more helpful to consider them in reverse order, both as a more effective way of organizing a landscape-planning study and specifying its method, which I consider the key strategic phase, and as a more effective educational approach. The methods of a landscape planning study should be organized and specified *upwards* through the levels of inquiry, with each level defining its necessary contributing products from the models next above in the framework. This is how it works in practice:

VI To be able to decide to propose or to propose or to make a change, one needs to know how to compare the alternatives.

V To be able to compare alternatives, one needs to predict their impacts from having simulated changes.

IV To be able to simulate change, one needs to specify (or design) the changes to be simulated.

III To be able to specify potential changes (if any), one needs to evaluate the current conditions.

II To be able to evaluate the landscape, one needs to understand how it works.

I To understand how it works, one needs representational schema to describe it. (This has been the major GIS role.)

Then, in order to be effective and efficient, a landscape planning project should progress *downward* at least once through each level of inquiry, applying the appropriate modeling types: *representation*, *process*, *evaluation*, *change*, *impact* and *decision.* At the extreme, two decisions present themselves: *no* and *yes*. A *no* implies a backward *feedback* loop and the need to alter a prior level. All six levels can be the focus of feedback; "redesign" and sensitivity analysis are frequently applied feedback strategies at Level IV.

A *contingent yes* decision (still a no) may also trigger a shift in the scale or size or time of the study. (An example is the decision to locate a highway corridor made on the basis of a more detailed alignment analysis). In a scale shift, the study will again proceed through the six levels of the framework as described above.

A project should normally continue until it achieves a positive, *yes*, decision. (In my area of application, a *do not build* conclusion can be a positive decision). A *yes* decision implies *implementation* and (one assumes) a forward-in-time change to new representation models.

While the framework looks orderly and sequential, the line through any project is not a smooth path: it has false starts, dead ends, serendipitous discoveries—but the line has to pass through the questions and models of the framework as I have described it before a *yes* can be achieved.

The framework has been the basis for the organization of several regional studies and is applied in this talk to a study of the future of Monroe County.

References

Steinitz, C. "A Framework for Theory Applicable to the Education of Landscape Architects (and Other Environmental Design Professionals)," *Landscape Journal*, October 1990.

SUSSEX COUNTY, DE

Robert L. Stickels
Sussex County Administrator

Robert Stickels is the Sussex County Administrator. Mr. Stickels has a strong background in business and government management. He has been the Town Manager of Georgetown, DE, and Deputy County Administrator for Sussex County from 1988 to the present. He has also been a member of the Delmarva Advisory Council, the Executive Council of the Delaware Inland Bays Estuary Program, the Delaware Private Industry Council, as well as other organizations.

Sussex County's portion of the Delmarva Coastal Bays has changed dramatically since the 1950's. Geographically, Sussex County is one of the largest counties east of the Mississippi. This has resulted in a diversified economy. In the 1950's and 1960's, the County's primary industry was agriculture. In the 1970's, the economy started to diversify with tourism becoming the second largest industry in the County. The total County population in 1950 was 61,360; in 1990 it was 113,226. The entire population impact cannot be measured totally on census figures. Census figures do not include summer and part-time population. It is estimated that 5.4 Million people visit our County's beaches annually. This has been a dramatic change from the 1950's and 1960's, when most of the beach resorts closed at Labor Day. Sussex County beaches are located within a four hour drive of one-third of the population of the United States.

To get a true figure on how much Sussex County has grown, you can also look at the assessment base of the County. This gives an indication of the number of year-round residential homes, seasonal homes, and commercial building that has taken place in the Inland Bays Watershed. Property assessment for the Inland Bays Watershed area was $70,114,444 in 1960; in 1990 the assessment grew to $892,322,377 for the same area. This is an increase of 1,172% in four decades. As we look ahead to the year 2020, populations are estimated to increase an additional 31.59% for our County.

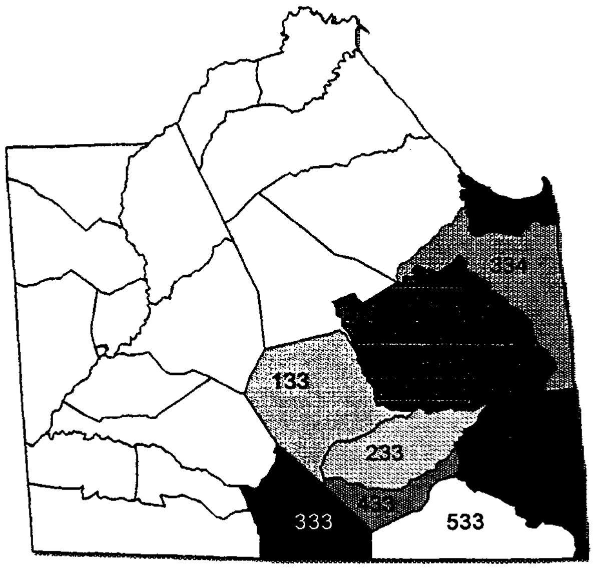
Unfortunately, rules and regulations protecting the environment and the welfare of the residents and visitors of Sussex County did not develop as quickly as our population and buildings increased. Public acceptance of regulations has been very slow. In the 1960's, it was the attitude that if you owned the property, you could do what you want with it. The 1970's led to development of zoning ordinances and regulations. A major breakthrough in the 1970's was the adoption of the Coastal Zone Act. It has been stated that former Governor Russell W. Peterson, who was the author of this legislation, led a major breakthrough that pointed the way for other states and the federal government to preserve priceless coastline resources. In the 1980's, the Sussex County Council realized that density should be reduced as well as the heights of buildings if Sussex County coastlines were to avoid duplicating Ocean City, Maryland.

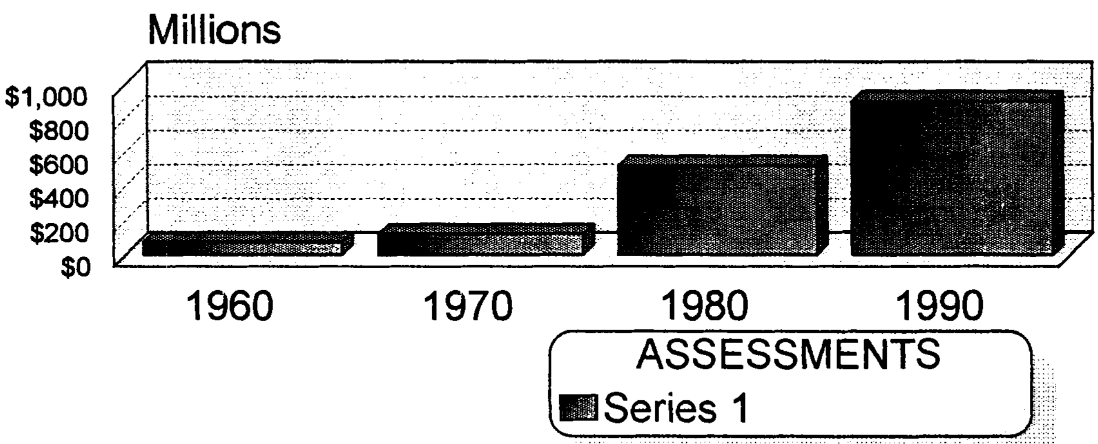
Over the decades, we have learned that it is not enough just to have zoning ordinances if we are going to protect the environment and the quality of life that has been expected in Sussex County. The infrastructure must be in place. This infrastructure should provide protection for water quality. With the completion of the West Rehoboth Sewer District, a $70 Million project, all homes located along the Atlantic Ocean have the capability of being connected to central wastewater. This is a vast improvement from the 1960's, when on holiday weekends, residents actually had wastewater flowing in the streets. The County's South Coastal Area Planning Study lays out new sewer districts in the Inland Bays area. Over 5,000 users have been connected already to Inland Bays central sewer systems. The County has plans to spend over $25 million over the next five years to connect more homes.

Creation of central water and sewer districts is not the entire answer for the protection of the Coastal Bays. Reduction in density and greater setbacks from wetlands are also important. However, public acceptance of additional regulations is not always easily obtained. It has been my experience that a majority of the people living in the Coastal Bays area are only here for a short period of time. Many people only live in the area for a three to seven year period. People who purchase summer homes may only wish to visit the area for a three to five year period before their recreational interests change to other areas. Retirees who move to the area are usually on a fixed income and wish to take advantage of Sussex County's low tax base. Many of these people are unable to pay what is needed to protect the bays. The difficulty lies in trying to come up with long-term cost effective solutions.

I hope I do not sound like a doomsayer. I do believe we are going in the right direction. Sussex Countians are willing to do their share to protect Delmarva Coastal Bays. There is evidence that water quality is already improving. If we are going to continue to make improvements, we are going to need consistency in federal, state and local regulations. Federal and state agencies cannot expect local governments to be more restrictive than their own requirements. If the state feels that there should be property line setbacks from state wetlands, local ordinances should be supported with state law. Local governments cannot be expected to develop ordinances that restrict building in federal wetlands if the federal government will still issue permits to allow for construction. Consistency in rules and regulations between the three levels of government is necessary. Once this consistency is developed, we will have to obtain public acceptance, political fortitude and administrative wisdom if we wish to see the Delmarva area continue to be a desirable place to live and vacation.

SUSSEX COUNTY, DELAWARE
ASSESSMENT TOTALS

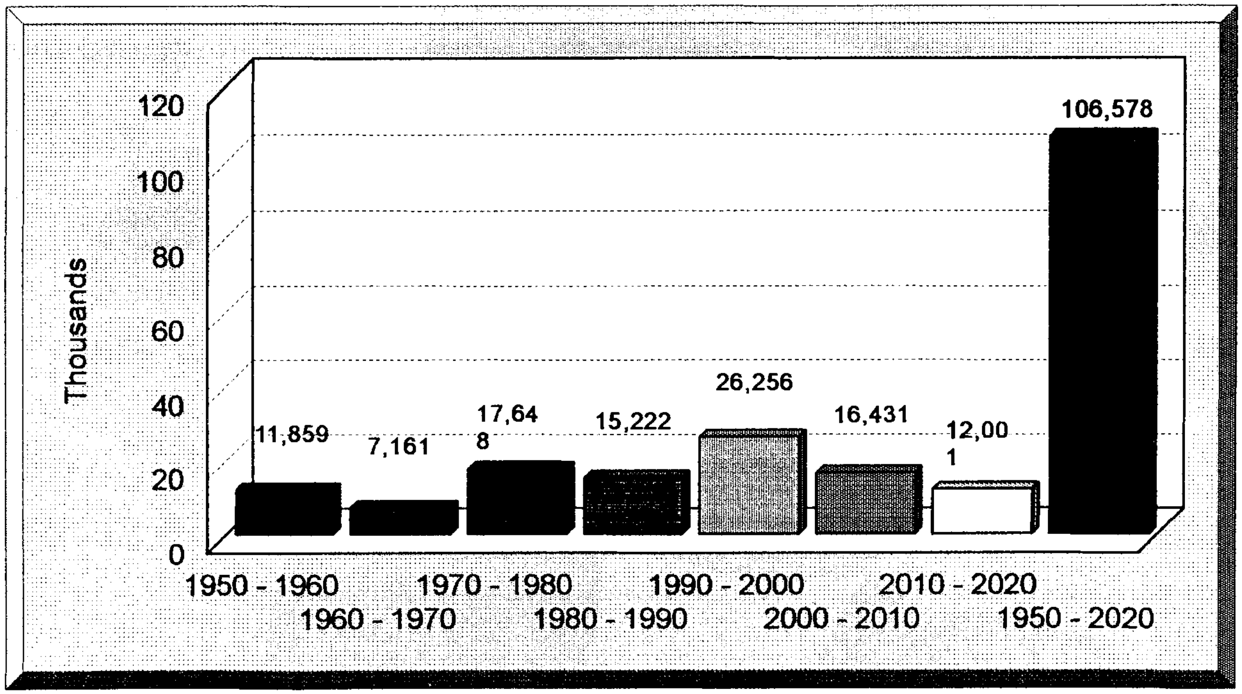


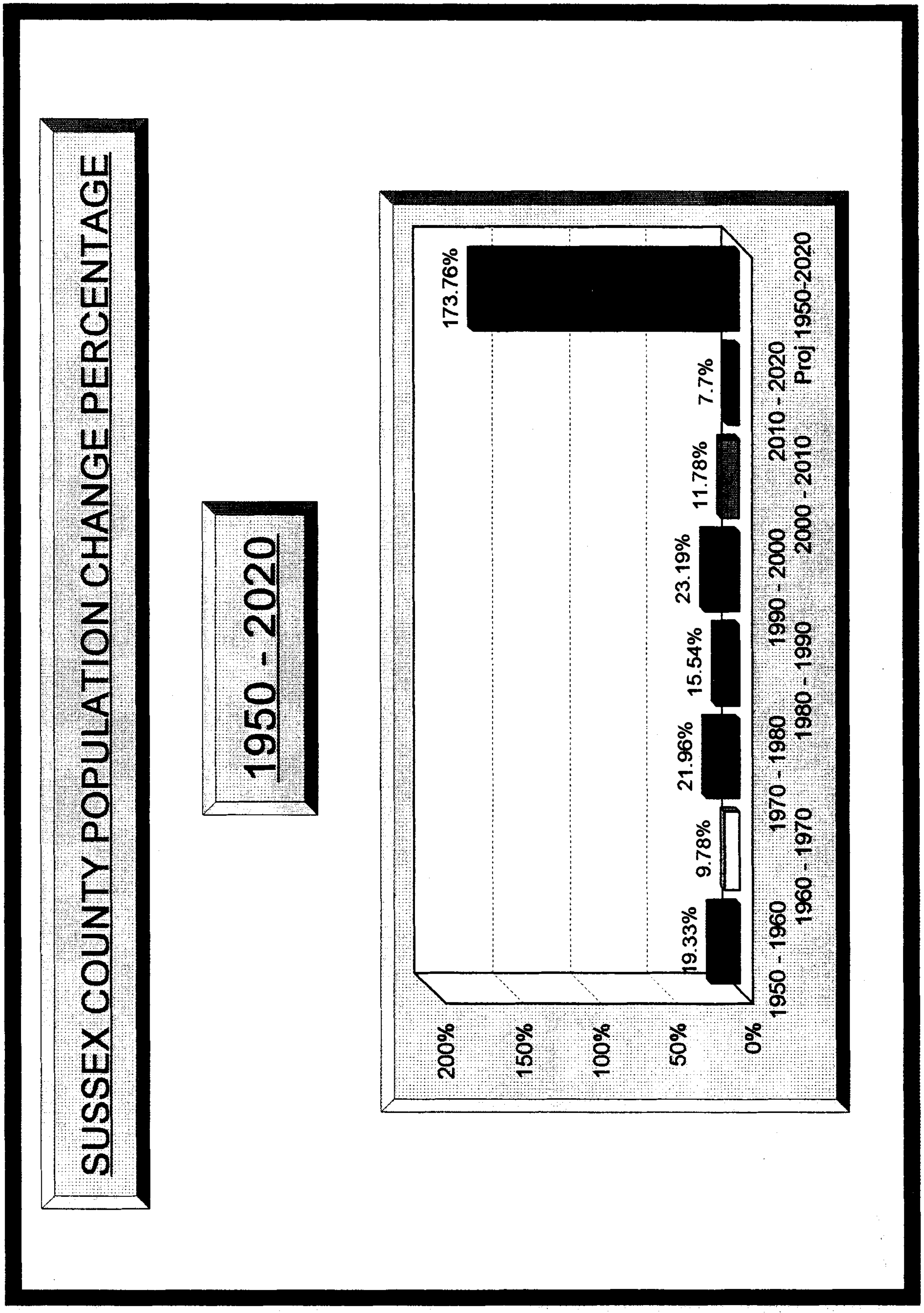


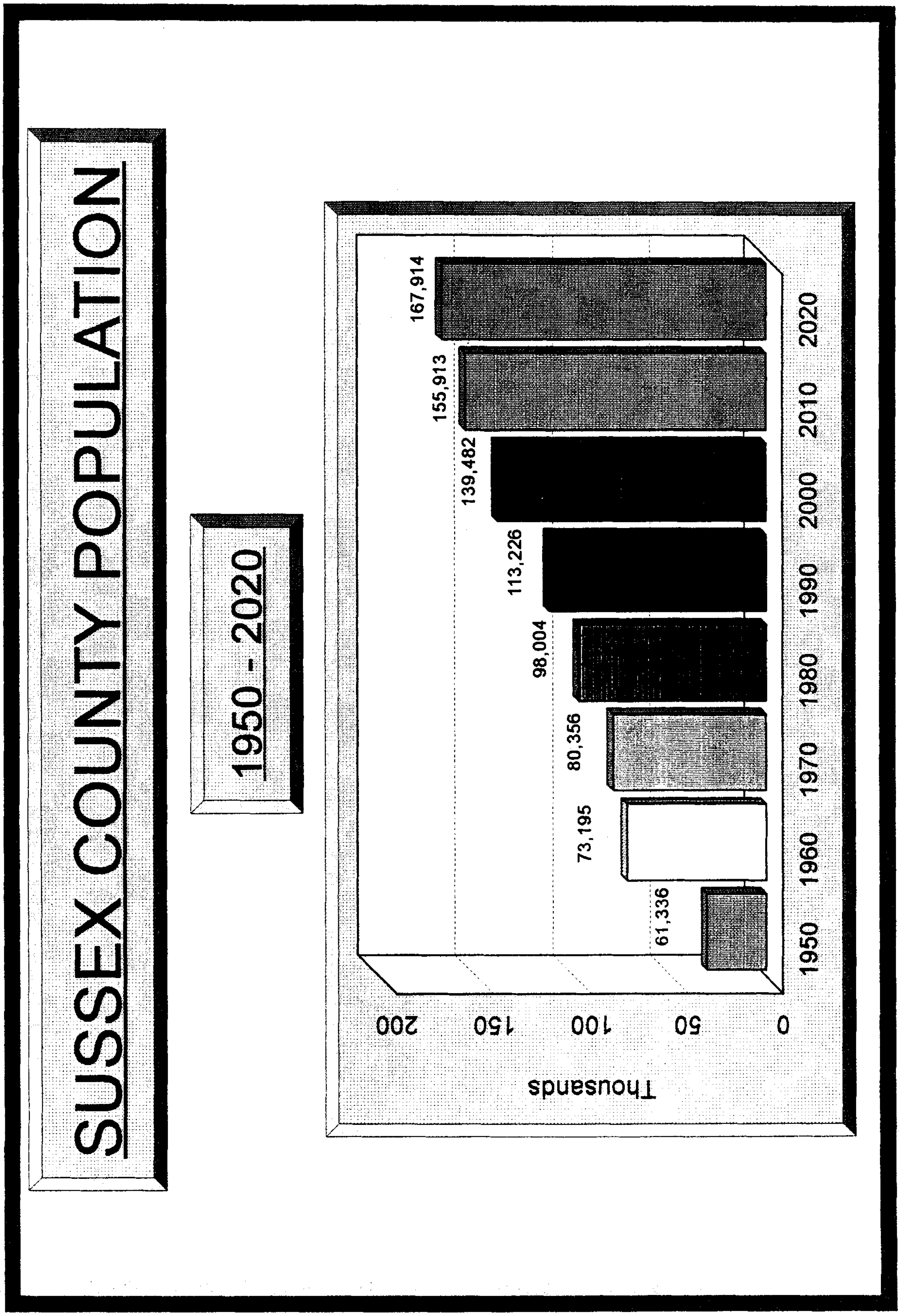
Year	133	233	333	533	134		334	335
1960 Totals	$5,756,934	$6,407,890	$1 182 830	$6,173,620	[illegible]		$24,784,704	$7,277,531
1970 Totals	[illegible]	$12,144,069	$1 859 693	$8,876,265	[illegible]		$38,257,314	$10 240 461
1980 Totals	[illegible]	$30,409,664	$4 749 773	$35,506,655	[illegible]		$163,849,159	$33 727 311
1990 Totals	[illegible]	$59,735,069	$6 596 117	$68,003,864	[illegible]		$281,874,060	$61 434 831

SUSSEX COUNTY POPULATION INCREASES

1950 - 2020




SUSSEX COUNTY POPULATION CHANGE PERCENTAGE
1950 - 2020
200%
150%
100%
50%
0%
19.33%
9.78%
21.96%
15.54%
23.19%
11.78%
7.7%
173.76%
1950 - 1960
1960 - 1970
1970 - 1980
1980 - 1990
1990 - 2000
2000 - 2010
2010 - 2020
Proj 1950-2020


SUSSEX COUNTY POPULATION
1950 - 2020
Thousands
0
50
100
150
200
1950
1960
1970
1980
1990
2000
2010
2020
61,336
73,195
80,356
98,004
113,226
139,482
155,913
167,914

WORCESTER COUNTY, MD

Phil Hager
Worcester County Planning Department

Phil Hager is a graduate of Frostburg State University and holds a Master's degree in Intergovernmental Policy Analysis from The George Washington University School of Government and Business Administration. Mr. Hager previously worked for the Maryland General Assembly and on Capitol Hill for the United States Senate. For the past 7 years, he has been actively involved in land use planning and demography. In that capacity, he has worked for the Maryland National Capitol Park and Planning Commission, and as a consultant for the telecommunications industry. Since August 1995, he has been employed as a Planner for Worcester County Maryland.

The following is a descriptive analysis of Worcester County, Maryland. In a moment, I will be delivering a brief historical overview, a series of facts and figures detailing Worcester's present conditions, and a cursory analysis for our future. Some of these demographic data are contained in the tables on the blue sheets that have been distributed, or are in the process of being distributed.

In addition to increasing our overall awareness relative to local demographic conditions, it is also my desire to go a little bit beyond the statistics and attempt to offer interpretive analysis. In short, we will look at what has been happening, what is currently happening, what we expect to happen, as well as why. This may be helpful to us as we collectively strive to address the issues before this conference.

Worcester County is Maryland's eastern-most jurisdiction. Additionally, it is the only Maryland subdivision bordering the Atlantic Ocean. Nearly 20 percent of the County experiences some form of tidal influence. A ridge extending the length of the County running roughly northeast to southwest divides the two major watersheds. The land areas on the west side of this feature flow to the Pocomoke and eventually to the Bay. Areas to the east drain into one of the four major inland bays systems. With the exception of western Garrett County, Worcester County is the only Maryland jurisdiction whose entire waters do not flow into the Chesapeake Bay.

Archaeologists believe that human contact with what is now Worcester County has been relatively brief and notably recent. Native Americans did not begin to settle in this area until sometime in the Twelfth Century. These American Indians were Worcester's first immigrants. Historians believe that there were never more than approximately 300 Native Americans in permanent residence here, but that significant numbers passed through the area or rested here briefly while enroute to other destinations. I suppose these were Worcester County's first vacationers.

Early native settlements were located along the coastal plain and adjacent to the waterway systems; primarily, this translates into the Pocomoke River, Nassawango Creek, and the Coastal Bays and their tributaries. They hunted the rich forests, fished the streams, rivers and bays, and they began to cultivate the fertile soils.

The first European settlers moved into the area through what is now Virginia in the latter portion of the 1600's. Then, as today, the region was geographically remote; consequently, the area was slow in growing. The primary activities of these peoples were little different from those of the Native Americans: principally hunting, fishing, agriculture, and similar extractive activities.

The County grew slowly through the 1700's and into the 1800's. As there was a surplus of available land, and waterways were of significant importance, the early populations tended to be well dispersed. What concentrations that existed, were primarily aligned along the transportation corridors that these waterways represented. It was not until the 1800's that people began to congregate in towns and villages in appreciable numbers.

The advent of steam and railroad spurred some economic and population growth, however, the area was never the scene of a massive influx of new residents. The economy and the population maintained remarkable stability through this era.

Despite many changes and innovations, Agriculture's importance as a mainstay of the local economy has remained undiminished. Historically, this activity has been the primary source of income and employment. Although of slightly less importance from an employment standpoint today, farming and related activities continue to determine Worcester's economic well-being.

Most of the County's most significant growth occurred after World War II. The role of the "baby boom", notwithstanding, it is no accident that this transformation occurred in conjunction with the expansion of this nation's highway and railway systems during the 1950's. The most notable alterations came about as a consequence of the Bay Bridge construction. This advent forged a closer relationship between the Eastern Shore and the balance of the state. The people of Southern Delmarva began to focus on Baltimore and Washington, and the markets in Delaware and points north declined in importance. These transportation improvements provided a tremendous boost for agricultural interests. It also had another effect. It began an unprecedented wave of tourism.

Today, agriculture and tourism share the spotlight, but other forces are at work as well. A tremendous proportion of Worcester's newest wave of immigrants are over the age of 55. Worcester County is becoming a retirement locale for increasingly larger numbers of people. Its low piggyback tax is also attracting large numbers of second home purchasers and part time residents. This is a benefit to the construction and real estate industries. The vast majority of these new citizens are establishing residence within the Coastal Bays' Watersheds. The water access, the beaches, the gulf courses, and the recreational opportunities available to these residents is a tremendous selling point.

As can be seen from the data in the handout, Worcester County is beginning to grow extremely rapidly. The County's growth from 1940 to 1969 was slow, but consistent. From 1970 onward, however, the rate of growth has increased markedly. From a statewide perspective, or when compared to East Coast regional standards, Worcester County with its current population of 40,300 is still comfortably rural. But when compared to historical trends the expansion is incredible. In 1940, the population was 21,245. In less than six decades, the population has nearly doubled. It took nearly three centuries to reach the 1940 total. Current projections indicate that we will achieve that number again by 2030. In less than 35 years, we will have tripled the 1940 figure.

This rapid growth is not consistent with this jurisdiction's history, nor is it in proportion to the growth being experienced by other Eastern Shore counties. This is vividly illustrated in the table that compares Worcester's population growth rate with the combined growth rates for the four Lower Shore Counties. These statistics suggest that there is something unique or different about Worcester County. Many would argue that it is the proximity to the Ocean and other water resources that serves as such a draw. The ramifications of that assumption are a double-edged sword. On one hand, it makes the importance of the bays and their watersheds more of a priority from an economic standpoint. Conversely, preservation issues and natural resource health take on a greater level of importance.

The second table emphasizes the importance of that assessment. Clearly, these growth trends will continue through the foreseeable future. In the coming decades, it seems that Worcester County will once again be on the receiving end of a disproportionate population expansion.

There are two additional factors that should be of significant interest to any demographic discussions relative to the bays. First, although the growth projections and the existing trends for Worcester County are noteworthy, they pale in consequence when you look at the distribution of people within the County. 1990 Census figures show that 62.2 percent of the County lived within the watersheds.

Projections suggest that this percentage will increase both in number and in speed. Nearly three-fourths of the County could live in the Coastal Bays Watersheds by the year 2020. The second item of interest is that these numbers fail to consider seasonal population. These trends reflect only permanent year-round residents. During the Summer, Worcester's population can be measured in millions. For several months of the year, the coastal bays infrastructure is faced with tasks approaching the same magnitude as the large urban centers that are the sources of these tourists.

Of equal or greater importance as "how much?" is "from what source?". Generally, a significant portion of any population increase can be attributed to natural growth (ie., total births outnumbering total deaths). This is true with Worcester County, but it cannot account for the explosive nature of this population rise. As previously stated, in-migration is the culprit. Voluntary re-location is the single greatest factor in Worcester's continuing growth trends. Since 1990, it has accounted for more than 71 percent of the County's growth. From 1980 to 1990, in-migration represented 120 percent of the total increase. During this decade, the County grew by 4,139 persons, and 4,977 people moved to Worcester County. This means that at least 838 County residents who were residents before 1980, actually moved out of the County by 1990.

One final set of data is appropriate for this forum. Since 1987, 15,887 acres of agricultural land has been converted from active farming to some other use. That represents a loss of nearly 13 percent. Simultaneously, the total number of farms has declined by nearly one-fourth, from 631 to 474. It would be tempting to conclude that this is due to development, but that assumption would not be entirely true. The majority of it is probably due to conversion for residential purposes, but some of it can be attributed to other factors, not the least of which is the conditions under which we mandate that agricultural concerns operate. Another possible explanation is the trend for assimilation of small farms by larger agricultural operations.

Because of time constraints, I have had to cover a great many variables in a short period of time. It is probably not necessary that we remember each of the statistics which I have cited here. It is more important that we recognize that Worcester County and the Coastal Bays area is undergoing a metamorphosis; it is in a constant state of change. It has been that way for centuries. What is now different is the speed and degree of those changes.

People sometimes make the mistake of seeing nature as static or stopped in time. This is probably not the case with most things, and it is definitely not the case with Worcester County and the Coastal Bays environment. It may help us to remember that the entire Delmarva Peninsula was created by change, and it is still changing, growing and evolving. The single most important and dominant factor in that evolution has been the role that man has played in it. That is why it is most important to note that this factor is also growing, changing and evolving. And the speed with which it is taking place is increasing . . . at a rate approaching geometric proportion.

COMPARATIVE HISTORICAL POPULATION GROWTH RATES

	STATE	WORCESTER	LESR[1]
1990-95	5.6 Percent	15.1 Percent	6.9 Percent
1980-90	13.3 Percent	13.4 Percent	12.3 Percent
1970-80	7.5 Percent	26.4 Percent	14.4 Percent
1960-70	26.5 Percent	2.9 Percent	4.0 Percent
1950-60	32.3 Percent	2.5 Percent	9.6 Percent
1940-50	28.7 Percent	8.9 Percent	6.3 Percent

Since 1940, Worcester County has experienced an annual average growth rate of 1.3 percent. During the same time period, the State and LESR grew by 3.3 and 1.1 percent, respectively. Since 1990, however, the state has had an annual growth rate of only 1.1 percent, the LESR has remained somewhat steady at 1.4 percent, while Worcester County more than doubled that rate to slightly over 3.0 percent. This means that Worcester County has been growing twice as fast as the rest of the Lower Shore, and more than two and one-half as fast as the State, since 1990.

COMPARATIVE RATE OF PROJECTED POPULATION GROWTH

	WORCESTER	LESR	STATE
1990-95	15.1 Percent	6.9 Percent	5.6 Percent
1995-00	7.5 Percent	5.2 Percent	5.3 Percent
2000-05	6.2 Percent	4.5 Percent	4.4 Percent
2005-10	4.8 Percent	4.0 Percent	3.5 Percent
2010-15	3.5 Percent	3.1 Percent	3.4 Percent
2015-20	3.0 Percent	2.6 Percent	3.2 Percent

If the projections for the thirty (30) year period 1990-2020 hold true, the County will experience an absolute growth of nearly 12,000 and a percentage growth rate of 134.2. It is interesting to note, that the County grew by an almost identical amount in the previous thirty (30) year time span (1960-90). This growth translates into a factored increase of 147.6 percent.

1 - LESR: Lower Eastern Shore; includes Dorchester, Somerset, Wicomico and Worcester Counties.

SOURCE: U.S. Bureau of the Census, Maryland Office of Planning, and the Worcester County Department of Planning Permits & Inspections.

As far as the economy, in 1991, services were the largest sector of the economy at 22 percent; manufacturing was 18 percent; government was 17 percent; and retail was 14 percent. Fishing and farming only employed 8 percent, but farming involves a lot more than the people who work the land and much of the manufacturing is food processing. As far as industrial expansion possibilities, the poultry industry is expanding (e.g., Tysons and Perdue), vegetable production is increasing (e.g., tomato growers are moving up from Florida, and Accomack County is the largest vegetable producer in Virginia), aquaculture is growing (e.g., clam growers), and tourism is always increasing (Chincoteague is the biggest area for tourism and coastal development, but there is some development all over the shore). One of the new programs is the sustainable development technology industrial park in Cape Charles, which just landed a new employer that is building solar panels. Also, the second home industry is slowly growing. So, we do not expect any major changes, but the potential is there. For example, if the Chesapeake Bay Bridge Tunnel toll is eliminated, there would be an immediate change since there is a $10 toll each way.

As far as land use changes, we do not have a lot of good data. Accomack County now has a GIS system so we are hoping that we can put it into a more useable form. Northampton County does not have a GIS system, but is working towards this. The major factors in development are the local ordinances and future land use plans. A ground water plan prepared a few years ago estimated that the area in the middle of the peninsula, which is the main ground water recharge area, has the potential for 37,000 more dwelling units (there are only 21,000 now). This indicates that there is a tremendous capacity here. Both counties are looking into this situation, with Accomack County updating their plan and Northampton County developing a new zoning ordinance.

In terms of the cost of public actions, while there is not a tremendous amount of growth, there is always the need to build new schools and roads as development occurs. Also, health care is a big issue as the number of retirees increases. In terms of political activity, there is a mix of interests. Local people want jobs and wealthy retirees want to protect the shore. But both groups are thinking about the future.

We are also concerned about transportation and the future of Route 13 and potential impacts on development and preservation efforts. State and federal governments are involved, such as through the Chesapeake Bay Preservation Act, which requires a 100 foot setback along preservation areas. State ground water regulations are in place, and will hopefully be improved. Also, state and federal grants help fund programs.

As far as growing pains, there is a lot of ground water but it has to be managed properly. Industries can cause cones of depression that can affect adjacent water users. The best way to deal with this is to pump water from well fields covering a larger area and store it as public water supplies, but only a few exist. Lack of sewers is a problem, although it can also slow growth. In order to provide for water and sewer to substandard housing, a central system is needed. Also, this will hopefully allow for focused growth and prevent sprawl. Currently, unsuitable soils make it difficult to cluster growth.

Farm loss is also a concern. Although agriculture only employs eight percent of the population, a lot of related businesses depend on it. We are starting to try some new techniques such as open space zoning and cluster development. We need to do better planning and zoning, but Northampton County hired their first planner in 1976, and Accomack County did not hire a planner until 1990. Without the people, it is hard to know what to do. For example, the build-out analysis conducted previously estimated that the 37,000 new dwelling units would require 5.6 million gallons per day. That is as much water as is currently used by all the houses and industry on the eastern shore. Also, it is estimated that the deep aquifers on the eastern shore only have a capacity of 5.5 to 11 million gallons per day. Therefore, we really have to look at these issues, but are not being forced to. It has been said that people are either inspired to action or do it out of desperation. I don't think we are at the desperate stage yet, but hopefully we can act before it is too late.

REPORT ON PRE-CONFERENCE QUESTIONNAIRE ON PUBLIC PERCEPTIONS

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For the past 17 years, James Falk has been a marine, recreation and tourism specialist at the University of Delaware's Sea Grant Marine Advisory Service. He is responsible for developing and tabulating the pre-conference questionnaire that was received by many participants. This questionnaire is only one of the numerous applied research studies Mr. Falk has conducted to help resource managers better understand the perceptions and attitudes of different user groups.

Introduction

During the late winter, 1996, a sample of residents living around Delmarva's coastal bays were mailed a survey instrument seeking their input and attitudes about a number of issues related to the environmental and economic health of these important coastal ecosystems. Eleven hundred questionnaires were mailed to a cross-section of individuals who represented a variety of interest groups. These groups included: farmers, private citizens, environmental organization representatives, and watermen. At the time of the current data analysis, 321 respondents had replied to the survey.

Who Are Coastal Bay Respondents

Coastal bay respondents were predominantly males (74%) and were, on average, 55 years of age. Forty-one percent of the respondents were from Maryland, 32 percent resided in Virginia, and 24 percent were residents of Delaware. Thirty-six percent of respondents indicated that they lived on the bay's waterfront. Forty percent indicated that they lived less than five miles from the water and 24 percent reported living five miles or greater from the bays. Eighty-nine percent of respondents indicated that they recreated on the bays or visited them.

Sixty percent of respondents reported that they were college graduates and one-third of all respondents indicated that they had graduate level education experiences. The largest percentage of the responding sample indicated that they were retired (34%), 15 percent were employed in the farming/agriculture industry, and twelve percent were government employees (local, state or federal). Twenty-two percent of the respondents were employed in private business, with 8 percent of this total being tourism-related employment. Fifty-two percent of all respondents had annual family incomes of greater than $50,000. Only three percent reported that they earned less than $20,000 annually. About one-third (34%) earned between $30,000 and $50,000 annually.

How Do Coastal Bay Respondents Rate Conditions Around the Bays

When bay residents were asked how they would rate the "quality of life" (e.g. jobs, clean environment, public services, etc.) around the bays, the overall rating was 2.7 (based on a 4-point scale; with 1 = poor and 4 = outstanding). Sixty-three percent of the respondents rate the "quality of life" either "good" or "outstanding".

When a rating for "environmental quality" was solicited, the average rating was 2.4 (on the 4-point scale), with 48 percent of the respondents indicating either "good" or "outstanding". When a similar rating for "economic prosperity" was solicited, the average rating was 2.1, with only one-third of the sample reporting a "good" or "outstanding" rating response. When asked what they thought of their state's efforts at managing and protecting their state's bay's resources, 38 percent responded that their state did either a "good" or "outstanding" job and rated their actions 2.2.

What Are Coastal Bay Respondents' Feelings About the Role of Citizens and the Environment

When asked what position they felt citizens should take with respect to environmental issues, 62 percent believe that individuals can do much more to improve the environment, 29 percent feel individuals would do more, but are confused about what is good and bad for the environment, 7 percent believe it is basically large companies who are responsible for environmental problems and they should solve them and 3 percent feel that since other people won't make sacrifices their contributions won't matter either.

How Do Coastal Bay Respondents Categorize Themselves on Environmental Issues

Only 3 percent of all respondents indicated that they were generally not interested in environmental matters. Thirty-one percent indicated an interest in the environment, but seldom do anything about it. Fifty-six percent of respondents support political candidates based on their environmental stands and 46 percent donate money to environmental causes. Twenty-four percent of bay-area residents belong to an environmental organization and 41 percent belong to two or more environmental groups.

What Are Coastal Bay Respondents' Environmental Factors of Greatest Concern

Respondents were asked to rank a series of environmental factors that were of greatest concern to them, using a scale of 1 to 3, with 1 being the most important. Water quality (218 total responses) and loss of fish/wildlife habitat (196 total responses) were most often mentioned by respondents as issues that were important to them. The least mentioned issues were toxic waste cleanup (25 total responses) and air quality (36 total responses). When the average importance rating was calculated for each factor (using the 3-point scale, with 1 being most important), water quality (1.7), protection of drinking water supplies (1.8) and loss of fish/wildlife habitat (1.9) were rated the highest. Wastewater management (2.4), open space preservation (2.3), and air quality (2.3) were rated the lowest.

What Do Coastal Bay Respondents Feel Are the Most Serious Water Pollution Problems Around the Bays

Since water quality was mentioned as a major concern by respondents, their opinions were also solicited on what they felt were the most serious water pollution problems around the bays. Agricultural runoff (68%) was reported as the most serious water pollution concern, followed by sewage discharge (59%) and environmental impacts caused by tourism-related development (50%).

How Do Coastal Bay Respondents Feel About Growth and Development Issues

Coastal bay respondents were quite candid about issues related to growth and development. They were requested to rate the issues using a 5-point scale, with 1 = strongly disagree and 5 = strongly agree. Respondents rated *limiting economic growth around their state's coastal bays* a'3.8 on the 5-point scale and 66 percent of the respondents "agreed" or "strongly agreed" with the statement. Fifty-six percent of the respondents "agreed" or "strongly agreed" with the statement, *I feel my state's counties are growing too fast* (3.6 rating). Sixty-three percent of the respondents "agreed" or "strongly agreed" with the statement, *industries and businesses located around my state's coastal bays contribute significantly to the local economy* (3.6 rating), however, only 27 percent "agreed" or "strongly agreed" with the statement that *developing land around my state's coastal bays provides needed economic growth* (2.6 rating).

How Do Coastal Bay Respondents Feel About Agricultural Issues

Seventy-four percent of the respondents "agreed" or "strongly agreed" with the statement, *agriculture contributes a great deal economically to the residents of my state's coastal area* (3.9 rating on the 5-point scale). Fifty-seven percent of the respondents "agreed" or "strongly agreed" with the statement, *agriculture around my state's coastal bays provides diverse employment opportunities for local residents* (3.4 rating). The lowest rated statements related to agriculture were, *environmental impacts resulting from agriculture practices are relatively minor*, with a 2.7 rating and only 28 percent of the respondents "agreeing" or "strongly agreeing" with the statement, and *taxes in my state's coastal counties are kept low because of agriculture*, with a 2.8 rating and 23 percent agreement response.

How Do Coastal Bay Respondents Feel About Tourism Issues

Coastal Bay respondents reacted both positively and negatively to statements related to tourism around the regions coastal bays. The statement that received the most support with 73 percent of the respondents "agreeing" or "strongly agreeing" was, *long-term planning by local governments can control negative impacts of tourism on the environment*--the statement received a 4.1 rating (on the 5-point scale). Respondents also reacted favorably to the statements, *the tourism industry provides many worthwhile employment opportunities for residents*, 3.6 rating and 67 percent agreement response and, *tourism is one of the bright spots in my state's coastal bay's economic future*, 3.4 rating and 54 percent agreement response. Respondents did not react positively to the statements, *the overall benefits of tourism outweigh the negative environmental impacts*, 2.5 rating and 23 percent "agreeing" or "strongly agreeing" and, *I support tourism and would like to see it become the main industry in and around my state's coastal bays*, 2.7 rating and 27 percent agreement response.

What Future Issues Do Coastal Bay Respondents Feel Are Most Important

When asked what they felt were the most important future issues they needed to be concerned about, coastal bay respondents indicated that protecting the coastal bays from environmental degradation (79%) and preserving forest, wetland and habitat areas (79%) were most important. Other issues receiving majority support included protecting drinking water supplies (65%) and controlling growth in coastal counties (54%). The least important issues as reported by respondents included, addressing global environmental issues (18%) and attracting new industries and businesses (20%).

How Do Coastal Bay Respondents Feel About Paying More to Improve the Bays

Sixty-nine percent of respondents indicated they would pay more taxes or higher prices to protect and improve the environmental quality of Delmarva's coastal bays. They felt user fees (59%) would be the most preferred mechanism to collect additional revenues to direct towards bay improvements. The only other revenue mechanism that received close to majority support was voluntary private donations, with 45 percent of the respondents supporting this revenue-generating mechanism. The least supported methods for generating revenues were property tax transfers (18%) and personal income taxes (19%).

Conclusions

This preliminary analysis of coastal bay residents provides a "snapshot" of how they feel about many issues and concerns affecting the health of the region's coastal bays. The information present is based on frequency responses for all respondents collectively and is by no means exhaustive. There are additional methods for analyzing the data which can provide a thorough picture of how respondents feel about coastal bay concerns. These could include comparing results by state of residence (Maryland vs. Delaware vs. Virginia) or by occupational status (retired vs. agriculture vs. private business). This further analysis will provide a more-effective way to approach management and policy concerns in the different jurisdictions.

This study was supported by the University of Delaware Sea Grant College Program and the Delaware Center for the Inland Bays. A special thanks is also extended to the agencies and organizations who assisted in mailing the survey questionnaires to their clientele groups and to University of Delaware, College of Marine Studies' graduate students Cecelia Linder and Lexia Valdes for their assistance during various phases of the project.

SUSTAINABLE DEVELOPMENT: A FRAMEWORK FOR A NEW CENTURY

Peggy Duxbury
President's Council on Sustainable Development

The originally scheduled speaker, Molly Harris Olson, Executive Director of the President's Council on Sustainable Development (PCSD) was unable to attend due to other commitments. Ms. Olson was represented by Peggy Duxbury, Coordinator of the PCSD's Principles, Goals, and Definitions Task Force. This Task Force was responsible for bringing together, integrating, and synthesizing all of the work of the many subcommittees and work groups that comprise the President's Council. Prior to working for the PCSD, Ms. Duxbury held a one-year faculty research appointment at Harvard Business School where she helped develop a curriculum on environmental management. She holds a Bachelor's degree in Political Science from Old Dominion University and a Master's degree in Public Administration from the Kennedy School of Government at Harvard University.

It's extremely exciting for me to be here this evening. This is the first group that we have met with since the Council members met with President Clinton and Vice President Gore 24 hours ago to deliver the PCSD's report, which is a unanimous consensus document on their vision for sustainable development in the United States. It's also very fitting that as the PCSD starts winding down our efforts, I am in a filled-to-capacity room with individuals who are interested in taking these concepts and applying them to a regional level. Without a doubt, the "just do it" crowd will be a crowd like this one.

I thought I'd begin by giving you some background on the concept of sustainable development and its genesis. It is a fairly new buzzword; I remember doing a search for the term "sustainable development" at Harvard Library and not really finding the term until about four or five years ago. Then we will talk about the work of the Council and the contents of the report.

Beginning with the environment, while a doom-and-gloom scenario is extreme, is it not a crisis when:

- 15 million people die annually from poverty-related causes?
- 35,000 children die daily from diseases that are entirely avoidable?
- 100-300 species are lost daily from this planet?
- There are holes in the ozone layer?
- The climate is undergoing changes?
- Fish stocks disappear?
- Wildlife habitats are devastated?
- Soils erode?
- 1,500 scientists, including 99 Nobel Prize Laureates, issue a warning to humanity that human beings and the natural order are on a collision course?

The planet is in a severe state of disequilibrium. Humanity cannot survive when one-third of the world is wealthy and two-thirds of the world is in poverty, and most of those, in devastating poverty. The planet cannot sustain rate, and vice versa. Equity considerations are also interrelated.

Finally, perhaps the heart of the work performed by the Council was at the community level. It quickly became apparent that the lack of a local government representative on the Council was a loss, but was compensated for somewhat by the meetings that were held. One notable success story was Chattanooga Tennessee; 20 years ago it was identified as the dirtiest city in the country and was losing jobs. Over several years, different groups collaborated and turned the city around until it was listed by EPA four years ago as one of the best places in the United States to live.

While the report contains bold ideas, the members agreed that the process was the most remarkable accomplishment of the PCSD. This process entailed really listening and learning from each other over several years. In general, it was a process of consensus that leads to better decisions and policies. The challenge is now captured by the phrase, "To plan is human, to implement, divine." The report, itself, contains a lot of good ideas, only about one-third of which are aimed at the federal government. Implementation will have to come from groups like yourselves. At the federal level, President Clinton and Vice President Gore have given a commitment to start implementing some of the ideas over the next eight or nine months. The report will help guide implementation at other levels of government and can be most easily obtained via the Internet at: PCSD@IGC.APC.ORG, or it can be purchased from the Government Printing Office.

REPORT ON BREAKOUT GROUPS TO DEVELOP A COMMON VISION FOR ACHIEVING BOTH HEALTHY ECONOMY AND ENVIRONMENT, FOCUSING ON SPECIFIC COASTAL ISSUES

Introduction

On the afternoon of the first day, a series of breakout groups were held to discuss environmental and economic issues relevant to Delmarva's coastal bays. While there are many issues, all conference participants were assigned to one of the following four areas, which best reflected both environmental and economic interests as determined by responses to the pre-conference questionnaire:

Tourism and Recreation
Residential Growth and Development
Fisheries, Shellfisheries, Aquaculture;
Agriculture: Poultry, Crops and Forestry

The goal for each group was to enable participants to better understand and respect the wide range of perceptions and opinions involved in working toward a common vision for achieving both a robust economy and a health environment for the Delmarva Coastal Bay watersheds. Due to the large number of participants, two groups were held for each topic for a total of eight groups. In assigning participants to groups, the organizers of the conference tried to maximize the diversity of backgrounds and interests represented, based on information supplied on the conference registration form. Each group was lead by facilitators who had earlier completed training to standardize the process and recording of findings.

On arrival to the breakout rooms, participants were given a brief introduction to the purpose of the session and access to copies of ground rules for effective meetings. Each group was then subdivided into three smaller groups to identify commonalities and differences among participants, and later, *to identify influential factors for their particular topic area over the past 20 years*. On an individual basis, small group members were next instructed to list their expectations as to *what the future would be like, given the factors previously identified, if nothing different was done*. Statements were shared on a round robin basis with other small group members, before reconvening the large group for discussion. Based on input from the three small groups, a single list was developed of expectations for the future if nothing different occurs. Finally, while still in the large group setting, participants were asked on a round robin basis *to identify elements of their ideal future, linking them to previously discussed themes*. Each group also selected a spokesperson to report on their findings.

Following dinner, the spokesperson for each of the eight groups reported back to all conference participants on their findings. Flip charts of the large group findings concerning the future if nothing changes and the ideal future were displayed along the walls of the meeting room (flip charts of the small group findings concerning commonalities, differences, and influential factors were compiled for future review). At the conclusion of the presentations, all participants were asked to affix colored dots next to the statements that most closely captured their own beliefs (each participant was provided with seven dots that could be used separately for seven different statements, or combined for emphasis). The different colors of the dots represented the backgrounds of the participant as follows:

Agriculture
Government
Business and Industry
Recreation and Tourism
Fisheries
Academia
Citizens
Public Interest Group

The remainder of this section presents the large group findings as listed on the flip charts. The findings do not necessarily suggest group consensus. The total number and composition of dots associated with particular statements is identified, where applicable. Statements receiving the most dots are listed at the top of each group. (Note: when several popular statements appeared next to each other, a "best guess" has been made with respect to which statement is intended based on the proximity of the dot.)

Tourism and Recreation, Group #1

Future if Nothing Changes

- Loss of habitat (1 dot: government)
- Loss of open space (1 dot: citizen)
- Transportation congestion
- Surface water quality deterioration
- Aquatic resources stress/fisheries decline
- Higher taxes and cost of living
- Increased storm damage
- Population increase
- Decline in supply and quality of ground water
- Urbanization
- Casinos
- Infrastructure demand increases

Ideal Future

- Bay ferry, bikes, public transportation (14 dots: 6 recreation and tourism, 4 government, 1 business and industry, 1 fisheries, 1 citizen, 1 public interest group)
- Restoration of bays (11 dots: 5 recreation and tourism, 3 government, 2 academia, 1 business and industry)
- More ecotourism (8 dots: 4 government, 2 recreation and tourism, 2 public interest group)
- More public water front access (6 dots: 4 government, 2 recreation and tourism)
- Limit intensive recreation to Ocean City (5 dots: 3 government, 2 recreation and tourism)
- Better fish and shellfish - more and bigger (4 dots: 2 government, 1 public interest group, 1 business and industry)
- Bring money and leave it here; just send money (don't come)
- Wider beach (3 dots: 2 government, 1 business and industry)
- Balance between business and residential
- More cultural activities - theater, arboretum, etc. (1 dot: recreation and tourism)
- Safer boating practices - licenses, education/certification (2 dots: 1 government, 1 business and industry)
- 15 more golf courses (1 dot: recreation and tourism)

Tourism and Recreation, Group #2

Future if Nothing Changes

- Decline of experience and quality of life - too many people; conflicts over diminished resources; fisheries
- West shore would have to support east shore
- Deterioration of natural resources
- Change in type of recreation - gambling
- Aging population puts increased burden on local government services

- Conflict of tourism vs. aging population - this will change the political landscape as values of society change
- Demographic changes and different recreational needs

Ideal Future

- Increase density in designated growth areas and protect agricultural land and forests from conversion to other uses (28 dots: 9 government, 8 agriculture, 4 public interest group, 3 business and industry, 2 recreation and tourism, 1 fisheries, 1 academia)
- Restrict development to areas with planned infrastructure (5 dots: 3 recreation and tourism, 1 government, 1 public interest group)
- Innovative wastewater treatment - no sewers, limit growth (4 dots: 2 government, 2 citizen)
- Transfer of development rights or purchase development rights (3 dots: all government)
- Restrict shoreline development, maintain natural habitat (3 dots: 2 public interest group, 1 government)
- Clean saltwater (2 dots: both public interest group)
- Uncongested roads
- Federally funded sewer systems
- Abundant fish and wildlife (1 dot: recreation and tourism)
- Ability of people to enjoy the area without negative impact (1 dot: citizen)
- More hands-on educational opportunities - cultural, historical, and natural resources (2 dots: 1 business and industry, 1 academia)
- Planned siting of marinas, discharge controls (1 dot: government)
- Purchase more parkland (1 dot: public interest group)
- Greenways (2 dots: 1 government, 1 fisheries)
- Sustainable recreation and tourism - only dependent on this location, low impact recreation, sustainable development, non-consumptive recreation
- Promote/encourage year-round vs. seasonal tourism
- Develop ecotourism

Residential Growth and Development, Group #1

Future if Nothing Changes

- Increase in golf courses
- Loss of habitat and sense of place
- Decline in quality of life and more development
- Decline in quality of environment
- Decline in farmland and disappearance of farms
- Water quality of bays reduced
- Development on mainland will increase
- Decline and demise of watermen
- Decline in water quality
- Increase in number of immigrants
- Shift in job availability to service jobs
- Sprawl - conversion of agricultural land to residential
- High-density on coastal highway
- Fragmentation of ecosystem
- Higher demands on government facilities
- Higher taxes
- Collapse of ecosystems
- Overcrowding
- Tragedy of the commons
- Interstate highways
- Impact of natural disasters
- Increased urban runoff
- Unplanned "strip" development
- Water shortage - polluted aquifers, amount of groundwater vs. demand, declining quality for recreation
- Lowering of expectations for quality of life
- Depletion of resources - fishing, farming, etc.
- Increased crime as population increases
- "Negative feedback" of decreasing life quality may decrease development pressure

Ideal Future

- Population control (27 dots: 13 public interest group, 10 government, 2 academia, 2 citizen)
- Mandatory environmental education as part of school (9 dots: 6 public interest group, 2 government, 1 agriculture)
- Increased stewardship (7 dots: 3 government, 2 public interest group, 1 agriculture, 1 citizen)
- Sustainable development (4 dots: all government)
- Compromise between developers and environmentalists for land restrictions (4 dots: 2 government, 2 public interest group)
- Eliminate political influence (4 dots: 2 public interest group, 1 agriculture, 1 government)
- Public education, appreciation, and awareness (3 dots: all public interest group)
- Similar environment elsewhere
- Systematic approach to planning
- Watershed planning (3 dots: 2 government, 1 public interest group)
- Stricter land use control
- Effective buffers next to water (3 dots: 2 government, 1 citizen)
- Public realization and acceptance to limit growth (3 dots: 2 public interest group, 1 government)
- Lack of effective critical areas
- Greater use of conservation easements (3 dots: 2 public interest group, 1 government)
- Restoration of wetlands and barrier islands (5 dots: 2 government, 2 public interest groups, 1 citizen)
- Better understanding of habitat (1 dot: public interest group)
- Preservation of biodiversity (2 dots: 1 government, 1 public interest group)
- Serious effect for land base runoff (2 dots: 1 business and industry, 1 public interest group)
- Sustainable economic development (1 dot: public interest group)
- Prevent litter and solid waste from entering waterways (3 dots: 1 agriculture, 1 government, 1 public interest group)
- Increased profitability of agriculture (3 dots: agriculture)
- Intensive 20-year study (2 dots: government)
- Determine carrying capacity (1 dot: government)
- "Tragedy of the Commons" required reading in high school (1 dot: public interest group)

<u>Residential Growth and Development, Group #2</u>

Future if Nothing Changes

- Failed infrastructure - water, transportation, schools, sewage, stormwater management, public utilities
- Decline in quality of life - crime, property taxes, traffic, siltation of channels, cost of living
- Increase in human population - loss of open space, decline in air and water quality, loss of habitat, loss of woodlands, loss of agriculture
- Some cause for optimism - through planning and awareness, NEP
- Loss of biological resources - habitat loss, water quality
- Economic opportunities - limited; rich get richer
- Human health related problems
- Funding shifts/ change in priorities for government
- Northern bays could serve as harbinger for future of southern bays

Ideal Future

- Ecological quality index to educate public - for *each* coastal bay (20 dots: 14 government, 3 academia, 2 citizen, 1 public interest group)

- Adaptive reuse of abandoned/degraded properties (13 dots: 6 government, 4 public interest, 1 agriculture, 1 tourism and recreation, 1 academia)
- More shoreline/marsh preservation (9 dots: 4 government, 2 citizen, 1 fisheries, 1 academia, 1 public interest group)
- More community involvement in conservation issues/decisions (8 dots: 5 government, 1 academia, 1 citizen, 1 public interest group)
- Expanded environmental education programs in schools (8 dots: 2 government, 2 business and industry, 2 public interest group, 1 academia, 1 citizen)
- County planning 50 years in future (6 dots: government)
- Habitat preservation (6 dots: 2 business and industry, 2 citizen, 2 public interest group)
- Would like to see it look like Outer Banks (3 dots: 2 government, 1 citizen)
- Control growth with adequate environmental protection
- Farmland preservation (4 dots: 2 citizen, 1 agriculture, 1 government)
- More compatible industry (2 dots: 1 government, 1 tourism and recreation)
- Increased wildlife (1 dot: citizen)
- Clean air and water (4 dots: 3 citizen, 1 government)
- Land use decisions that reflect cumulative impact (4 dots: 2 government, 1 business and industry, 1 public interest group)
- Higher standard of design applied to commercial and residential development (1 dot: business and industry)
- More restrictive land use regulations (3 dots: all government)
- Balanced ecosystem (3 dots: all government)

Fisheries, Shellfisheries and Aquaculture, Group #1

Future if Nothing Changes

- Diminished commercial and recreational opportunities
- Increase in aquaculture
- Increased degradation of water quality
- Altered species composition
- Shift away from fisheries activities to less outdoor-oriented activities
- Loss of species/biodiversity
- Increasingly restrictive regulations
- Increased development because of degradation of environment
- Decreased property values
- Public desensitization
- Biotechnology may save us
- Death of the bay

Ideal Future

- More conservation areas - land, water, wetland, forests (22 dots: 9 government, 4 public interest group, 2 recreation and tourism, 2 fisheries, 2 citizen, 1 agriculture, 1 academia, 1 business and industry)
- Fishermen more conservation-minded (10 dots: 5 government, 2 public interest group, 1 agriculture, 1 business and industry, 1 fisheries)
- Increased eco-tourism (10 dots: 5 government, 1 business and industry, 1 recreation and tourism, 1 fisheries, 1 academia, 1 public interest group)
- Eliminate nutria (8 dots: 5 public interest group, 2 government, 1 business and industry)
- Increase in aquaculture (8 dots: 1 agriculture, 1 government, 1 business and industry, 1 recreation and tourism, 1 fisheries, 1 academia, 1 citizen, 1 public interest group)
- Improved water quality (5 dots: 2 recreation and tourism, 1 government, 1 academia, 1 public interest group)

- Participative decision making by all involved parties (5 dots: 4 government, 1 recreation and tourism)
- Sustainable fisheries at level above/higher than today's (3 dots: all government)
- Fisheries at pre-settlement levels
- No aquaculture
- High quality development that increases property values (3 dots: all government)

Fisheries, Shellfisheries and Aquaculture, Group #2

Future if Nothing Changes

- Big brother regulations
- Reduced opportunities - recreational, commercial
- Economic collapse - unemployment, crime, drug trafficking, desperation
- Twilight of the sea
- Eventual environmental destruction
- Eventual end of water-based recreation
- Degraded habitat and ecosystem
- Deteriorated quality of life
- Changes in economy
- Diminished water quality
- Increased anoxic levels - algae blooms leading to deaths in higher organisms like shellfish
- Vacancy signs on tackle shops
- Increased closures of areas for swimming, fishing, and clamming
- Increased disgruntled public demanding government solutions
- No more fishing/crabbing (recreational and commercial)
- Decreased aesthetic and financial value of property
- Greater residential development of wetlands
- Total government regulation to point of socialism
- More expensive seafood
- Huge trade deficits
- No more kids with chicken necks on strings
- Imitation seafood
- Increased reliance on other fish populations and eventual destruction of those species
- More expensive and difficult to solve problems
- High unemployment
- Increased preservation of shorelines to protect commercial properties - beach restoration
- Inability to get away from jet skis - only use for water is recreational
- Fish wars - warring anglers between nations and/or states due to diminished stocks
- More steak restaurants on coastal highway
- More large commercial shopping centers - increased development
- "Coastal bays landfill project" - "Fill it in and build on it"
- Job loss due to decreased fish/shellfish stocks
- Loss of reasons to improve environment
- Need new development to replace jobs, but development will further reduce water quality
- Expensive seafood
- Loss of desirable species may encourage "trash" species
- May lose tradition of "watermen" culture
- Increased regulation of all fishing
- Loss of recreational industry
- Aquaculture will expand
- Diminished food stocks (and drinking water)
- Increasing stress on reduced fish stocks
- Further loss of habitat
- Algal blooms/"red tide"
- Anoxia
- Sediment contamination
- Altered natural landscape

Ideal Future

- No more jet skis (34 dots: 16 public interest group, 9 government, 4 recreation and tourism, 3 fisheries, 1 academia, 1 citizen)
- Restoration of submerged aquatic vegetation (22 dots: 9 government, 6 public interest, 3 academia, 2 citizen, 1 business and industry, 1 fisheries)

- Greater understanding of coastal processes and ecosystems (8 dots: 4 government, 2 public interest group, 1 academia, 1 citizen)
- Healthy economic base built on environmentally-friendly andenvironmental businesses (7 dots: 3 citizen, 2 government, 1 business and industry, 1 academia)
- Rural character of area maintained (6 dots: 4 government, 2 public interest group)
- More wetlands (6 dots: 4 government, 2 public interest group)
- No more waterfront development
- Carefully planned communities
- Partnerships between schools, government, and business to take hard science and transform it to marketable products (2 dots: both public interest group)
- Sustained natural resources
- Economic growth (4 dots: 2 business and industry, 1 citizen, 1 public interest group)
- Look like it did 75 years ago (2 dots: 1 government, 1 fisheries)
- Ocean and bay nature reserves (3 dots: government)
- Increased awareness by public of what has been done and what can be done (1 dot: citizen)
- Aquaculture developed so it is a household word (2 dots: 1 government, 1 business and industry)
- No more marine debris/trash (2 dots: 1 government, 1 public interest group)
- All shoreline development halted and beaches returned to natural state for public use (4 dots: 2 government, 1 citizen, 1 public interest group)
- Open shellfish beds
- Diversified use of bays
- Sustainable fisheries stocks/industry
- Controlled development - designate natural areas
- Local Pride (1 dot: citizen)
- Sustainable use of all resources (4 dots: all government)
- Goal of "zero discharge" (1 dot: citizen)
- Commerce, agriculture, marine industry, tourism, and residents living in harmony within the natural resource capacity; enriched by their environment and each other (3 dots: 2 government, 1 academia)
- Opportunities for present and future generations to enjoy and use resources and the natural environment - leave better than we found it

<u>Agriculture, Poultry, Crops and Forestry, Group #1</u>

Future if Nothing Changes

- Decreased land available for agricultural development due to production
- Decreased water supply due to irrigation, development demands, pollution
- Increased cost of living
- More productivity and efficiency per acre due to technologies and new products
- Decreased agricultural productivity due to soil degradation, disease, and pests
- Less farming/less family farms
- Domination by forest monoculture and many poultry farms
- Less concern for local agricultural interests
- Continued stakeholder conflicts
- Health concerns
- Increased population
- Less tourists
- Habitat and wetlands loss
- Less open space
- Reduced recreational opportunities
- Decreased surface water quality
- More transportation and infrastructure demands
- Waste management problems
- Increased pesticide and herbicide use

Ideal Future

- Regional planning based on ecosystems and better knowledge of ecosystems and function - forestry, agriculture, poultry, and other uses (31 dots: 8 government, 6 agriculture, 6 public interest group, 5 academia, 3 citizen, 2 fisheries, 1 recreation and tourism)

- Protection of sensitive and critical areas (26 dots: 14 government, 6 public interest group, 2 fisheries, 2 citizen, 1 agriculture, 1 academia)
- Education of problems and solutions, including regulated community and stakeholders (23 dots: 13 government, 5 public interest group, 3 academia, 1 recreation and tourism, 1 citizen)
- Population control (15 dots: 10 public interest group, 2 government, 2 citizen, 1 agriculture)
- Tri-state agriculture planning for estuary preservation (9 dots: 5 public interest group, 3 academia, 1 government)
- Promote "green" farming practices - reduce pesticide/herbicide use and increase recycling or containment (9 dots: 6 government, 2 public interest group, 1 academia)
- Involve stakeholders - increased cooperation (2 dots: 1 business and industry, 1 academia)
- Balanced approach to land use and management (1 dot: public interest group)
- Incentives for multiple land use (2 dots: 1 government, 1 academia)
- Agricultural diversity
- More understanding of how market forces affect local farming practices (3 dots: 1 agriculture, 1 government, 1 public interest group)
- Resource management enforcement and strengthening existing policy

Agriculture, Poultry, Crops and Forestry, Group #2

Future if Nothing Changes

- Development will swallow up forestry - short-term gains and long-term loss of sustainable use
- No forests - development of farms
- Less farmers/less land - increase in land values
- Less farmers/more poultry
- Factory farms - growing food for chickens
- Politics/less subsidies
- Less conservation planning/more adverse impacts
- Equality loss
- Ocean will move in
- Changes in lifestyle
- Population increase
- Conversion of farmland to residential/commercial uses
- Fragmented forest/coastal lands
- Production will decrease due to land/water pollution
- Increasing amount of arable land owned by agribusiness
- Loss of open space, rural life, biodiversity
- Reduction in quality of drinking water
- Forestry and agriculture will diversify and intensify
- Increase in impervious surface, decrease in water quality
- Agriculture becoming more friendly
- Loss of forestry market
- More efficient use of farmland/poultry industry
- Government will streamline regulations for conservation planning
- Increase in nonpoint source pollution
- Too many people/birth control
- Pollution decreasing through technology/BMPs
- Negative impacts on wetlands
- Create more wetlands through new techniques

Ideal Future

- Government with common sense (17 dots: 5 agriculture, 4 government, 3 citizen, 2 academia, 2 public interest group, 1 recreation and tourism)
- Development prohibited along shorelines and wetlands (9 dots: 5 government, 3 public interest group, 1 agriculture)
- Effective public/private partnership to maintain productive and environmentally compatible farming (7 dots: 3 public interest group, 2 government, 1 business and industry, 1 citizen)

- Inclusion of agricultural community in watershed planning (7 dots: 5 government, 2 public interest group)
- More open space, less density around inland bays (6 dots: 2 public interest group, 1 agriculture, 1 government, 1 academia, 1 citizen)
- Leave wetlands alone and protect forest (6 dots: 4 government, 1 fisheries, 1 citizen)
- Grocery stores agreeing to sell locally grown products (6 dots: 4 government, 2 public interest)
- Forest buffers on all streams and shoreline (4 dots: 3 government, 1 public interest group)
- Development of more organically growing farms (4 dots: 2 government, 1 fisheries, 1 academia)
- "Better" chicken (4 dots: 3 agriculture, 1 government)
- Prosperous and environmentally friendly
- Farms increase productivity through technology using less damaging chemicals and buffers to prevent runoff (1 dot: recreation and tourism)
- Improve balance between farming and development (2 dots: both agriculture)
- Extend high profits for agriculture and forestry while enhancing environmental quality (2 dots: both agriculture)
- No net loss of farm acreage, increase in family farms and use of best available technology to reduce pollution
- Produce wetlands as a cash crop (2 dots: 1 government, 1 public interest group)
- Realistic, comprehensive land use planning fully implemented (2 dots: both government)
- Less supply-side intervention (1 dot: government)
- More vegetable farming, fewer chickens (2 dots: both citizen)
- People with attitudes of conserving rather than consuming (3 dots: 1 government, 1 business and industry, 1 fisheries)
- Balance between development and conservation (1 dot: government)
- Fully-funded conservation reserve program
- Zoning to limit housing development for open land and parks (2 dots: both government)
- Technology of farming more in harmony with nature values
- Reforestation of large tracts of land (1 dot: government)
- Protection of prime agricultural land and directed growth (1 dot: public interest group)
- End of the plague of greed (2 dots: both public interest group)

STATE OF MARYLAND REMARKS

Verna Harrison
Maryland Department of Natural Resources

Verna Harrison is an Assistant Secretary at the Maryland Department of Natural Resources, and is responsible for the Chesapeake Bay and watershed programs.

Good morning. Very briefly I would just like to say on behalf of the Maryland Department of Natural Resources and Governor Glendening and the members of his Cabinet, that the Governor is strongly committed to the preservation, protection, and restoration of the coastal bays. We want to assure you of our support in working with the very many partners that are here in making this a reality.

One of the things that struck me last night as I listened to the speaker from the President's Council on Sustainable Development was that the Council members noted a couple of things associated with successful actions. These are among the lessons that we have learned from the Chesapeake Bay restoration program. And they are obviously embodied in what we are seeing today in that people are gathered here to cooperate and collaborate, and in the process, listen. It is a long road, but with the kind of enthusiasm and energy that we have seen, it can absolutely happen.

Yesterday we gave thought to what the future might hold, and this morning we are going to hear about science and assessment — the findings of today. My purpose in speaking to you is to commit Maryland's full support to work with Delaware and Virginia, the various federal partners, our very important local government partners, citizen interests, and Congress, towards the development and implementation of actions that can make our visions a reality. So I want to commend you for taking your time on a Friday and Saturday to work together. Thank you.

ENVIRONMENTAL HEALTH OF THE DELMARVA COASTAL BAYS AND THEIR WETLANDS

Dr. Frederick Kutz
EPA Region III

Dr. Rick Kutz received a Ph.D. from Purdue University with a concentration in Medical Entymology, Physiology, and Ecology. Dr. Kutz has worked for EPA for the past 20 years, including 12 years with the Office of Prevention, Pesticides and Toxic Substances where he worked on studies involving environmental epidemiology and human exposure to pesticides and other toxic substances. He joined EPA's Office of Research and Development in 1985, and is currently a Regional Scientist for EPA's Region III.

Slide No. 1 – Title and Cooperators

- Good morning! I am pleased to be here.
- The objective of my presentation today is to share with you some findings about the condition of the Delaware and Maryland coastal bays. In order to gain a more detailed understanding of our study, you are invited to see the exhibit on display here at the conference. If you are particularly interested in the entire scientific report, please leave your name and address, and a copy will be sent to you when it is available in a few months. A two-page summary is provided at the exhibit booth.
- This study was designed to provide a "report card" on the condition of the coastal bays. It was intended as a snap shot to characterize the major problems.
- We found a wealth of new information about the bays and also confirmed on a system-wide basis some older existing findings. On behalf of the Delmarva Coastal Bays Assessment Group who planned and implemented the study, I am pleased to briefly describe our findings.
- This was a truly cooperative effort among the State and Federal agencies listed here. All phases of the study - planning, sampling and examining results - were accomplished together over about a four year period.

Slide No. 2 - Picture of Benthic Sampler (Not Included)

- This study emphasized the condition of the living resources of the coastal bays -- the fish, the submerged aquatic plants and the bottom-dwelling organisms. This slide shows the scientific equipment (Young-modified Van Veen sampler) used to sample bottom-dwelling organisms. As you will note, it's not as simple as reaching down to the bottom and grabbing a handful of muck.
- All of these living creatures represent crucial elements of a healthy bay. We also measured other important parameters - water quality, chemical contaminants in the bottom sediment. We studied most of the important stresses affecting the bays.

Slide No. 3 – Significant Findings

- This slide summarizes the major scientific findings of the study.

- Major portions of the coastal bays were found to have degraded environmental conditions due largely to excessive nutrients from human activities. Twenty-eight percent of the area in the coastal bays had degraded communities of bottom-dwelling organisms (worms, insects and clams). These bottom-dwelling or benthic communities are important because they represent a critical level in the food chain, serving as food to many types of fish and crabs. They also serve as good indicators of water quality.

  - Within the coastal bays, Chincoteague Bay at the southern boundary was in the best condition of the four major subsystems, while Indian River at the northern part was in the worst. This seems to form a gradient of the best condition in the South and the worst in the north. Only 11% of the area in Chincoteague Bay had degraded communities of bottom-dwelling worms and insects compared to 77% in Indian River. Less than 10% of the area in Indian River was suitable for the growth of submerged aquatic vegetation (SAV). In comparison, almost 45% of the area in Chincoteague Bay was shown to support SAV. In fact, the most abundant growth of SAV is found in Chincoteague Bay.

  - Tidal streams (tributaries to the bay) were in poorer condition than the main bodies of the coastal bays.

- Eutrophication (nutrient enrichment) threatens recolonization of submerged aquatic vegetation. More than 75% of the area in the coastal bays was found to have water quality unsuitable for the growth of SAV. Vegetation beneath the surface of the water provides crucial habitat for spawning and development of fish, crabs and other estuarine animals. This hostile habitat for SAV is caused by elevated nutrient levels which stimulate algal blooms and decrease water clarity, thus reducing light required for the growth of submerged plants.

- Traces of pesticides and other toxic compounds were detected, probably a remnant of historic inputs. Most frequently detected pesticides were DDT, dieldrin and chlordane; most frequently detected other toxic compounds were nickel and arsenic.

- Man-made dead-end canals were profoundly degraded. About 57% of their area had dissolved oxygen concentrations less than state standards of 5 ppm. Man-made, dead-end canals were also biologically barren, averaging only 4 bottom-dwelling (benthic) species per sample compared to 26 species per sample in the remaining portions of the coastal bays. Traces of pesticides were also found more frequently in these canals.

- The scientific approach used in this study allowed comparison of conditions in the coastal bays with that in other major estuarine systems in EPA Region III. The coastal bays were found to be in about the same condition as Chesapeake Bay or Delaware Bay with respect to water quality and condition of bottom-dwelling communities. Of course, the actual size of the Chesapeake and Delaware Bays far exceed the area of these coastal bays and must be considered when making these comparisons. There are many other differences as well.

- The variety and abundance of fish in Maryland's coastal bays were found to have remained relatively unchanged during the past twenty years, while that of similar systems in Delaware have changed substantially. The kinds of fish found in the Maryland coastal bays are dominated by Atlantic silversides, bay anchovy, Atlantic menhaden, and spot, which is similar to those measured in the Delaware coastal bays 35 years ago. The fish fauna in Delaware's coastal bays today has shifted markedly toward killifish and sheepshead minnows which are more tolerant to adverse environmental stress. While silversides, anchovy, menhaden and spot have a broad range which includes both bay and ocean waters, the killifish and sheepshead minnows have a much more restricted range and usually stay within several hundred feet of their hatching ground. This means that the food chain has been weakened because they are less available to predator birds and fish feeding on them.

Slide No. 4 – Potential Management Implications

- A number of potential management implications logically follow the results of this study.

- Nutrients appear to be the major stress affecting this system. The sources of these nutrients need to be identified, and strategies to reduce them need to be implemented. Eutrophication is affecting the plants and animals so important to restoring the health of these estuaries.

- When these results are examined on a system-wide basis, it becomes apparent that relationships exists among the bays in the three-state area. For example, much of the stress associated with these bodies of water comes from non-point sources. Many of the non-point sources affecting the northern part of Maryland bays are actually within the State of Delaware. This is because some of the area which drains into Maryland bays fall within Delaware. Looking at a map, the State Line separating Maryland from Virginia falls across Chincoteague Bay. Obviously, the movement of pollutants across this line would be unobstructed. Therefore, a Delmarva-wide watershed management approach is imperative.

- Related to a Delmarva-wide approach to the management of these areas, we need to know what is happening in the Virginia coastal bays. A powerful advantage of the approach used to examine the Delaware and Maryland coastal bays is having the environmental information to tell whether the actions that are taken are doing the right things in the right way. Therefore, a real priority in this Delmarva-wide approach is gathering similar data for the Virginia coastal bays.

- The construction of additional dead-end canals needs careful study. These canals are defined as being at least 200 feet in length with engineered side walls. These canals are for practical purposes devoid of living organisms, and thus, contribute little to the ecological health of the bays as a whole.

- Decisions to dredge new channels and to redredge existing ones need thorough consideration because of the unexpected detection of traces of pesticides and other toxic chemicals. The actual operation of dredging exposes the organisms living in the bay to these chemicals. With the data that we have now, it is difficult to predict whether any kind of biological effect will occur. Additionally, the bottom sediment removed during dredging operations may need to be placed in areas where it will not drain back into the bays.

Slide 6 – Summary (picture of bay - not included)

- This study shows that major parts of the Delaware and Maryland coastal bays are degraded resulting from man-induced stresses. Plants and animals living in the bays are showing indications of decline and change. Nutrients appear to be the most important problem; however, other potential problems also have been detected.

- A frequently-asked question of audiences after hearing this presentation is "What happens if no changes are made?" That is a difficult prediction to make. The stressful conditions that we found will certainly not change without our intervention. If nutrients continue to increase in these systems, certainly algal problems will become more prominent. Episodes of algal blooms and other related effects will become more common.

Delaware - Maryland Coastal Bays Joint Assessment

A Collaborative Effort of

Delaware Department of Natural Resources and Environmental Control

Maryland Department of the Environment

Maryland Department of Natural Resources

Region III

Delaware Inland Bays Estuary Program

Office of Research and Development (EMAP)

Significant Findings

- Degraded Environmental Quality Found in Major Areas
- Eutrophication Threatens Living Resources in Bays
- Traces of Pesticides and other Toxic Chemicals in Sediments
- Man-made, Dead-End Canals are the Most Severely Degraded Areas
- Coastal Bays are as Degraded as Delaware Bay or Chesapeake Bay
- Changes in Fish Communities in Delaware Over Past 35 Years. No Change in Fish Communities in Maryland Over Past 20 Years.

Potential Management Implications

- Eutrophication Appears to Be Major Stress; Need to Identify and Reduce Nutrient Inputs Into Bays
- Delmarva-Wide Watershed Management Approach Recommended Because of Interrelations of Bays
- Coastal Bays in Virginia Need Assessment
- Additional Dead-End Canals Require Careful Study; Detrimental to Ecological Health of Bays
- Dredging Decisions Need Consideration Due to Pesticides and other Toxic Chemicals in Sediments

ECONOMIC STATUS OF FISHERIES AND AQUACULTURE

John Dunnigan
Atlantic States Marine Fisheries Commission

John Dunnigan is the Executive Director of the Atlantic States Marine Fisheries Commission, which was formed over 50 years ago to improve inter-state cooperation and coordination to protect the public's interest in coastal fishing resources. The Commission is best known for its inter-state fisheries management program, which coordinates regulatory planning among states with coastal fisheries. Prior to joining the Commission, Mr. Dunnigan had an extensive career with the National Oceanic and Atmospheric Administration, and the National Marine Service, serving in a variety of legal and programmatic positions in the field as well as headquarters.

What we do at the Atlantic States Marine Fisheries Commission is something that all of you will be focusing on over this period of study — find ways of bringing people together. The Commission recognizes that none of the 15 coastal states can adequately protect their long-term interests without working together. This whole concept of working together is both critical and exciting, based on the Commission's experience of bringing 15 sovereign states together to mutually define their common interests and then agreeing to move forward by taking steps that are in everyone's best interests.

At the outset, I want to thank some of the people who helped in the development of this presentation, particularly Dianne Stephan from the staff of the Commission. Dianne is the Director of our Habitat Program and did most of the legwork in putting this information together. I would also like to thank all of our resource specialists who are listed in the conference program. In addition, I want to recognize Tim Goodyear from the National Marine Fisheries Service, Jeff Tinsman from the State of Delaware, and Mark Homer and Jim Casey from the Maryland Department of Natural Resources.

It is interesting that fisheries seem to always receive such a specific focus. The fact that it gets highlighted is a testament to the enduring and intrinsic values that we all place in fish and fisheries when we start to think of coastal areas. Fisheries are a good indicator; they are one of the ways that you know whether or not a good job is being done in husbanding the coastal environment. It's one of the ways that we first see the results of what we are doing, or the pain of what we are not doing.

The Delmarva Bays are a microcosm of a lot of the issues that play out up and down the Atlantic coast. However, there are also certain issues that tend to make this area unique and this conference will probably want to focus on these. This presentation will cover resources and habitat, commercial and recreational fisheries, aquaculture, and conflicts. The information, however, will be very qualitative, which should provide a certain indication of the direction you will want to take. There is a lot of primary information that is being collected, but we had difficulty finding a lot of that information collated in such a way that people who are considering and determining policy can fully utilize it. There is a lot of work yet to be done in this area of trying to provide some structure to the information that is available about these fisheries. It is also important to note that fisheries must be examined on a system-wide basis, and not as a single issue, because they are tied to many of the other economic and social issues that are attendant in these Delmarva coastal bays. We can't even really look at individual fish species, because the way that they are prosecuted ties everything together.

Commercial fisheries in this area are predominantly small family operations, relatively few in number, and very much tied to being able to respond to whatever fish are available at any given time. These small vessel operations are similar to those found in many areas up and down the Atlantic Coast, and must be able to target and switch their catch depending on the availability of the resources from season to season and from year to year. A wide variety of species are caught, many of which are the same as those caught along other areas of the coast.

The economic values of these fisheries are not well-documented. Many of the statistics are there, but they do not always distinguish between what happens in the bays and what happens in the oceans. In order to address concerns over the coastal bays, we have to be able to develop a system that will capture that information for us. But in general, the whole panoply of species that are important along the Atlantic Coast are important in the Coastal Bays (e.g., flounder, weakfish, shad, striped bass, and many others).

A much larger fishery in the Delmarva Coastal Bays exists for the recreational fisheries. Currently, there are both good and bad signs concerning the state of this resource. Some of the species that the recreational fishery is dependent upon are doing fairly well right now, for example, the success in bringing back the striped bass resource along the Atlantic Coast.

Some seem to be improving, such as summer flounder fishing, which was almost closed a few years ago, and weakfish fishing, which appears to be beginning a recovery according to the most recent stock assessment.

There are very few charter boats that operate in this area. The fishery is dominated by private, individually-owned craft. This creates interesting opportunities and interesting problems. The opportunities for local businesses and for tourism are closely linked. But the opportunity creates problems when you have large numbers of tourist recreational fishermen who are only in the area for short periods of time. They are a diverse community and it is extremely difficult to get in touch with them concerning the status of the resources and good fishing practices. They are also very hard to sample to determine impacts on the fishery resources. The major recreational fisheries sampling mechanism along the Atlantic Coast is the National Marine Fisheries Services and Marine Recreational Fisheries Statistics Survey, which is not designed to yield information and data on a scale that is relevant to inland bays or even on a state level. This survey was designed 15 years ago to provide broad coastal information. In a number of instances, states, including Maryland, have tried to supplement this survey data. But often there are not enough resources to capture all of the data that is needed.

Aquaculture is, perhaps, a large area of opportunity still to be explored in the inland coastal bays. There are operations underway in Delaware, Maryland, and Virginia for clams and scallops. Governments have not yet figured out how to respond completely to this opportunity of using coastal waters for aquaculture. This is true all along the Atlantic Coast. There are a number of businessmen who have tried to make investments in aquaculture for some species that we have been aware of for some time (e.g., rock fish), as well as others (e.g., summer flounder). Governments have not yet learned how to deal effectively and efficiently with these businesses, resulting in complaints regarding the labyrinth of regulations and procedures at all levels of government. The situation is further complicated by technologies that are still under development and businessmen that are trying to break into traditional markets. Therefore, aquaculture has to undergo much more development before it is a major factor influencing the fisheries in the area.

The Delmarva Inland Bays are distinguished from other regional and sub-regional fisheries by the small size of the area, both in terms of miles and the size of the watershed. In addition to being a relatively contained area, barrier islands make this a very fragile environment. Development has consumed much of the buffer zones. Nonpoint source pollution and stormwater management still need to be addressed, and public education needs to be increased. A small area also means less diversity and therefore less buffering between different interests. However, a small area facilitates bringing people together and identifying what their interests are, resulting in more participative decision-making and more locally-controlled public policy decisions.

Let me close with the following conclusions:

1) There is a lot of work that needs to be done in terms of studying what is going on in these fisheries. Much primary information has been collected but has not been collated in a format that is useable for public policy decision-making.

2) Find ways to capture non-scientific information. By the time scientific information is collected, analyzed and made usable, it is somewhat dated. The small size of this area creates opportunities to collect real-time information and make it useable to public policy decision-makers.

3) Focus on education. There is a great opportunity here to raise people's consciousness concerning the critical nexus between habitat, fisheries, and economics.

4) Working together can break down the barriers of communication and overcome the rhetoric that clouds public policy decision-making and fisheries conservation and management decision-making.

DELMARVA'S TOURISM INDUSTRY

Lisa Challenger
Worcester County Tourism

Lisa Challenger is a graduate of Penn State University and moved to Worcester County in 1987. She worked in the hospitality industry in Ocean City before taking her current position as Tourism Coordinator for Worcester County six years ago. Ms. Challenger serves on the Board of the Maryland Downtown Development Association and the Lower Eastern Shore Heritage Commission, and is a member of the Maryland Tourism Council.

I. Past Tourism Trends

1. Beaches, beaches, beaches
2. Long vacations

II. Present Tourism Trends

1. Heritage Tourism
   Educational oriented experiences (Visitation to historic sites, trails, parks with an emphasis on interpretation)

2. Eco Tourism
   Comprising 10-20% of all travel; birdwatching, nature cruises, hiking & canoeing, cycling, etc.

3. Conservation and outdoor recreation as tools for economic development

   - Tourism can justify conservation and subsidize conservation efforts. This is because an environment of scenic beauty & interesting features, vegetation, wildlife, clean air and water offers many of the resources that attract tourists

Statistics:

40.4% walk for health
32.8% pursue physical fitness/exercise
14.9% bicycle
13.75% boat or sail
12.4% run or jog

9.2 million people are involved in wildlife related recreation, 71% pursued wildlife viewing

$13/day spent by typical birdwatcher
$22-$60/day spent by cyclists

Over 1,000 rail-trails in U.S. today

III. Pressing Issues Facing Tourism on Delmarva

1. Balance of built environment vs natural environment

2. Jobs - High unemployment rate in Worcester County and a higher than national average across Delmarva

IV. What's Being Done Today

1. Forming partnerships with local, state and federal government

2. Forming grass roots organizations to address our individual needs/concerns, with particular attention to land use issues. Organizations include:

   Lower Shore Land Trust
   Eastern Shore Land Conservancy
   Lower Eastern Shore Heritage Committee
   Pocomoke River Alliance
   Nanticoke River Alliance

3. The visions of the 1992 Planning Act which have been or are being incorporated into local plans throughout the state:

   a. Development is concentrated in suitable areas
   b. Sensitive areas are protected
   c. In rural areas, growth is directed to existing population centers and resource areas are protected
   d. Stewardship of the Chesapeake Bay and the land is a universal ethic
   e. Conservation of resources, including a reduction in resource consumption, is practiced

4. GIS Mapping Project

   A visual illustration of correlations between resources and resource uses

Source:

Statistics - Rivers, Trails & Conservation Assistance Program of the National Park Service

AGRICULTURE AND FORESTRY

John Tarburton
Delaware Department of Agriculture

John Tarburton was appointed Delaware's Secretary of Agriculture in 1993. He graduated from the Virginia Polytechnic Institute with a Bachelor's degree in Agronomy. For the last 23 years, he has owned and operated a 315-acre potato and grain farm. His involvement in agricultural policy began well before his current position. He served for eight years as President of the Delaware Farm Bureau, and also served as President of the Delaware Association of Conservation Districts and Chairman of the County Conservation District. He was a member of the Delaware and Maryland Governor's Wetlands Roundtable and Co-Chairman of the Water Committee of the Governor's Environmental Legacy Commission.

Before I get started, I want to give you a few "teasers." We have not talked much about the Delaware Center for the Inland Bays, which is a model of how to get something done. The Center is a child of 10 years of work concerning the problems of the inland bays in Delaware. The process takes several years; the development of the Comprehensive Conservation and Management Plan (CCMP) almost got into trouble after five years, but was saved by strong leadership and the involvement of other interested groups that did not feel they had been part of the planning process. It is important to involve all stakeholders at the outset. The process of consensus-building means leaving your agenda at home and understanding, not necessarily accepting, other points of view.

Delaware also has the Governor's planning committee. I am convinced that most people are enthused about geographic information systems (GIS), but do not necessarily understands what the acronym stands for, and even less know what it can do. We are at the point where we have overlaid 17 GIS maps together, 10 of which are priorities and the rest are ancillary. The State of Delaware can no longer put water lines, sewer lines, schools, and roads in "west Podunk." We just don't have the cash. As we overlay the population distribution with the school districts and infrastructure, the old geometry formula for the circumference of a circle (radius squared) shows that it will cost significant amounts of money to incrementally extend services to the next area. This is what is driving planning in the State of Delaware.

Now on to my topic. The best place to begin is with some education and discuss agriculture on a generation basis; what was it like when your parents were the decision makers and what is it like now? In 1975, there were 3,700 farms; in 1995, there are 2,500 farms. I am not sure whether this is good or bad. Always question the statistics; don't make a snap judgment. Average acreage in 1975 was 186; today the average is 228 (a +22.5% change). Delaware has a total of roughly 1.2 million acres; in 1975, about 690,000 acres were productive (in field or vegetable crops) and in 1995, about 570,000 acres were in production (a -17% change). As expected, however, the value of the operating unit has gone up. In 1975, the value was about $181,000 (including infrastructure and equipment); today, it's $581,000 (a +221% change). This far exceeds the Consumer Price Index. A key point is that agriculture is a highly capital intensive business and is not capable of accommodating snap decisions (e.g., planters cost $60,000).

The value of the poultry industry alone along the Delmarva Peninsula is $1.5 billion. On top of this, poultry processing has one of the highest multiplier effects, not only in dollars but also in terms of labor (both are over 5). So when you consider regulations on various aspects of input for the poultry industry, keep in mind the ripple effect that occurs over the allied industries. This came home when there was a threat to cut off all poultry imports into Russia. This was a $700 million threat, which would have resulted in dumping on the domestic market to the detriment of the beef and pork industries, and, in general, have had a severe impact on the entire corn-soybean-meat complex.

Forestry acreage has increased in Delaware since 1909, from 330,000 acres to 376,000 acres today (these are acres that are actively farmed). 231,000 of those acres are in Sussex County and 81 percent are privately owned. The industry employs about 3,700 people and gross sales of products are evaluated at $97 million. In terms of environmental impacts, the larger fields have pushed aside smaller fields due to changes in equipment. Lots of small plots have been abandoned.

We have made several conversions; the State of Delaware led the nation for years in the percentage of acreage converted to no-till. While this reduces the erosion, more chemicals are used. A lot of capital has also been used to put in water retention systems in dairy and poultry farms. Because it costs $50,000 to put in a waste lagoon on a dairy farm, the State has been involved in cost sharing programs; similarly, the State helps share the cost of manure sheds for poultry farms. Again, good science may make us wonder, however, if this is good or bad. I would suggest that government be allowed to experiment. Manure in a field develops a crust that may result in less nutrients in run-off than previously assumed. Manure sheds, on the other hand, present a fire hazard due to spontaneous combustion.

Farms are by far the largest habitat for wildlife. I think many "green" groups now understand that whatever form agriculture takes, they would rather see land in agriculture rather than 1 housing unit per acre. Subdivisions do not have wildlife. Forestry is a renewable resource and a great habitat for quail. The problem is that forestry has an image problem. Trees are only cut down every 30-40 years, and it disturbs some people when they see a forest being cut down. But I would suggest that some image building is needed; maybe a few bus trips to show people what the land will look like 3, 5, or 7 years later.

QUESTION AND ANSWER SESSION

Facilitator:
Gwynne Schultz
Director, Coastal Zone Management Division,
Maryland Department of Natural Resources

Introduction

Following the panel discussion on the environmental and economic status of the coastal bays and their watersheds, conference participants were provided with a 15-minute break in which to develop questions for any of the panelists or resource experts. For the remainder of the hour, the panelists and resource experts addressed several questions, which are presented below. Due to the overwhelming number of questions and limited time, however, the majority could not be discussed. Appendix C lists these other questions that remain for future discussion.

Question 1. Why are the dead end canals so dead?

Response: Dead end canals go against natural forces in estuary systems — estuaries are wider and deeper at the mouth, while dead end canals are uniformly deep (or deeper inside the canal than at the mouth) and do not become wider. Therefore, dead end canals do not have flushing and have a dead zone. Also, because these canals are engineered, they have a linear shoreline. In addition, land uses that cause problems (e.g., contaminated ground water and runoff) are in much closer proximity to the canal.

Question 2. How can we incorporate the effects on fishery resources into the decision-making process for human activities on land? Apply this to small permitting decisions and local and regional land planning.

Response: Some of the laws currently focus on fishing activities. Other activities, however, affect fisheries health. This is a basic structural problem. The best action available now is to provide information to citizens and public policy makers concerning land use and water quality. We also need to coordinate fisheries management decisions made by different agencies (e.g., land use and water-quality).

Question 3. What is the definition of a tourist? The main negative impacts on DE inland bays are from what we call "summer people" who come for two months and then either go home or to Florida to avoid paying DE income tax. They do not attend environmental conferences so how do you reach them?

Response: A tourist is someone who drives here and spends any amount of time and money. One action is to try to market certain types of tourists who will appreciate the resources this area has. How to reach tourists is a challenge to all of us here, and any input is appreciated.

Question 4. If farmers were in a room together to discuss where they would like farming to go, what would their vision be (more intensive or incentives for preserving wildlife and biodiversity)?

Response: Tax law is probably the single biggest tool that changes small business. The 1985 law in particular, caused radical changes by removing the investment tax credit and taking away the opportunity for private enterprise to participate in passive losses. Regarding production and environmental issues, there is a fair amount of agreement; farmers are the foremost stewards of the soil and are as concerned about the environment as anyone. Farmers also work primarily by example; e.g., what is successful for neighbors, the Cooperative Extension, and the USDA. In general, voluntary measures will be much more effective than regulation. Finally, if an action is economically profitable, farmers will ultimately take it (some time may be required to change equipment).

Question 5. Is it feasible to renew the headwaters of our estuaries by recycling the soils into top soil? Headwaters of the St. Martins River were 25 ft. deep and supported the lumber industry's barge and ships, but are now 1.5 ft. deep and spreading out to the larger bays.

Response: Dredging is very expensive. Dredging also raises concerns about spreading historic contaminants that have been found in the sediments. Therefore it may be better to leave the soils in place.

Question 6. As a field researcher, you have the first access to primary data. In your years of experience, how do you feel is the best way to collate this primary information into a "real time" useable tool for policy members?

Response: The data is being used right now as part of a process to comment on 15 management plans for different species. The data is also used for long-term monitoring.

Question 7. Could you speak more as to how, while providing appropriate environmental protection and "sustainable development" to keep tourism in the inland bays area affordable to most citizens? Many places are already out of reach to lower income brackets, which is approximately 35% of the population. I am concerned that close to 2 of every 5 citizens can no longer afford to see and learn from heritage tourism and other valuable resources and thus many citizens do not understand the need or benefits of conservation and preservation. This is a big part of society out of this loop.

Response: Heritage tourism is not expensive. For example the Beach to Bay Indian Trail is a national recreation trail that stops at all of our museums and parks. The museums do have a nominal fee most of the time, but other activities are free. Also, the National Park Service is in the process of developing models for sustainable, affordable ecotourism in St. John. While the process will take several years, the findings can be transferred to bay localities.

Question 8. Agriculture is our most important industry on the Peninsula. It is also a major source of water contamination. With the sandy soils over much of the Peninsula, some degree of ground-water contamination from fertilizers and manures is unavoidable. How much more than what we have done (or are doing presently) with best management practices (BMPs) can we expect to improve this situation?

Response: Agricultural improvements are continuous. For example, in Sussex County, the "We Care" program brought poultry farmers and environmental representatives together, and Delaware was among the first to calibrate manure spreaders in the 1970's. However, as noted in the question, contamination is not only limited to nonpoint sources, but also ground water, and improvements take a long time to see. Nitrate has begun to level off (shallow flow paths have been determined to be approximately 10 years long), but it would take several years to measure improvements if all activities were stopped today. Ongoing activities include research into manure spreaders, assigning one nutrient manager per county in Maryland, and implementation of BMPs on a lot of land. Manure use is likely to increase (e.g., on vegetable crops) because it is less expensive than other fertilizers. Generally, there is a lot of awareness in the industry and incentive to protect ground water because farmers also use it for drinking water.

REGIONAL PERSPECTIVES ON COASTAL BAYS ISSUES

W. Michael McCabe
Regional Administrator, U.S. EPA Region III

The previous speakers talked about many different values — social, economic, environmental. All of these contribute to the complexity of the issues we are trying to address concerning the Delaware Coastal Bays. Their impact on the watershed is critically important.

As we have heard today, we have a lot of important information on the conditions and impact of development on the bays. What we need to do now is use this information to mold the decisions on the future of this area. We need to construct models that are constructive and useful enough to allow policy-makers to use this information. The assumption that "if we build it, the infrastructure will come," is no longer the case, and this presents us with an opportunity to develop information and to show that the end product of development does have consequences. Some of these impacts can be alleviated if we plan properly and manage growth in the proper way.

Therefore, considerations for the future must incorporate all of these outlooks — social, economic, and environmental. Our thinking must be on a Delaware Bays watershed level, not on a county- or state-specific level. There is a role for all of us in developing the information and models. EPA, state government, local government, citizens and business all must be part of a process to help policy-makers gain some control over the future of growth in this area. Our approach must be consistent with the environmental information that has already been collected and is under development. We need to use this information to determine whether the approach we take has the desired outcome.

The current Environmental Protection Agency Administration has a very strong commitment and orientation towards community-based environmental protection. This area, Region III, has some of the strongest programs in the entire country. The Chesapeake Bay Program is a model not only for the rest of the country, but for the world, in how to bring together a regional approach to address a major environmental resource issue. We haven't solved all the problems nor been able to always implement what we believe to be the most effective and efficient approach of managing growth, but we are certainly further along in understanding the issue and providing policy-makers with information to set objectives. We are also working very closely with people in the mid-Atlantic highlands in Maryland and West Virginia. The approach there brought together all levels of the community to help develop priorities for how they want to grow. For this project, EPA provided technical support and information for them to use in charting their future for protecting the environment and creating sustainable development. The EPA is also involved in the Delaware and Maryland Estuary Programs that have already been discussed. An important aspect of this conference is hopefully that we will be able to coordinate the resources that are operating in Delaware and Maryland already, and bring in Virginia to create a new synergy.

We need to leave this conference with several major commitments among ourselves:

- We need to form a partnership to characterize the Virginia coastal bays to understand them better and in a way that is compatible with Delaware and Maryland activities

- We need to work with officials from all three states and the interested stakeholders

- We need to draw in local government more directly because they need the information and incentive to move forward in a way that protects the area

- We need to continually support the implementation of recommendations in the Delaware Inland Bays Comprehensive Conservation and Management Plan (CCMP)

- We need to develop a solid CCMP for the Maryland coastal bays that reflects all three states' support and participation.

To summarize, it is a total regional effort, the model is as nearby as the Chesapeake Bay, and we can draw on the many experiences and technical support available from EPA Region III. EPA is not the only actor; the strength of EPA lies in our scientific information, technical support, and by virtue of our position, the ability to bring together so many different people. Hopefully, if we ever get a budget, we can free up financial resources to further the development of a very important project and process that will determine the future of this incredibly sensitive natural area.

NATIONAL ESTUARY PROGRAM IN MARYLAND

Gwynne Schultz
Director, Coastal Zone Management Division,
Maryland Department of Natural Resources

Gwynne Schultz is Director of the Coastal Zone Management Division in the Maryland Department of Natural Resources. She is currently serving as the Interim Chair of the Management Committee for the Maryland Coastal Bay Program.

Last July, the Environmental Protection Agency accepted the Maryland coastal bays into its National Estuary Program. This is a national program to encourage long-term planning and management of nationally significant estuaries that are currently threatened by pollution, development or overuse. The overall goals of the program are:

1) Protection and improvement of water quality
2) Enhancement of living resources

There are a total of 28 estuaries in the program nationwide.

Maryland's "new program" will build on existing programs - strengthen them and give them more focus. We need to decide what will come out of this planning process and your input is essential. Success depends on realistic, cost-effective, equitable, and fair recommendations. Therefore, we need all input.

The geographic scope of the area extends from the Delaware state line to the Virginia state line and includes the coastal bays and their watersheds.

The process we'll be following has four key elements:

1) Establish management framework
2) Characterize estuary and define problems
3) Create management plan - Comprehensive Conservation and Management Plan (CCMP)
4) Implement plan

Key problems and issues identified in the initial nomination package are:

1) Eutrophication
2) Loss of wetlands
3) Decline in finfish populations
4) Toxics contamination
5) Areas closed to shellfish harvesting
6) Water-based activities

We have set up four committees to ensure all constituents are able to participate:

- Policy Committee - elected and appointed policymaking officials
- Management Committee - environmental managers from federal, state, and local governments
- Scientific/Technical Committee - peer review/identify data gaps
- Citizen's Advisory Committee - provide input

Some of the key activities we'll be undertaking in the near future include:

1) Developing public participation strategy (e.g., how to get tourists involved)
2) Developing an environmental characterization - look at all information, put in usable format, and identify gaps
3) Looking at all existing programs - environmental regulations and education
4) Setting up a water quality monitoring program and tracking BMPs.

DELAWARE CENTER FOR THE INLAND BAYS

Dr. Bruce Richards
Dr. Kent Price
Delaware Center for the Inland Bays

Dr. Kent Price is the Chair of the Delaware Center for Inland Bays. Dr. Bruce Richards is the new Executive Director for the Center. Prior to his new position, Dr. Richards worked for Penn State University in the Philadelphia area where he focused on training science teachers, small animal science, and invertebrate zoology. Previously, he spent two years as an agricultural teacher in Lancaster County, PA. He holds a Bachelor of Science degree in Animal Science from the University of Delaware, and his Master's and Ph.D. are in Agricultural Science Education and Administrative Studies.

Overview

The Delaware Center for the Inland Bays was established as a nonprofit organization in 1994 under the Inland Bays Watershed Enhancement Act (Chapter 76 or Del. C. S7603). The mission of the Center for the Inland Bays is to oversee the implementation of the Inland Bays Comprehensive Conservation and Management Plan and to facilitate a long-term approach for the wise use and enhancement of the inland bays' watershed by conducting public outreach and education, developing and implementing conservation projects, and establishing a long-term process for the preservation of the inland bays' watershed.

The goals of the Center for the Inland Bays are:

1. To sponsor and support educational activities, restoration efforts, and land acquisition programs that lead to the present and future preservation and enhancement of the inland bays' watershed.
2. To build, maintain, and foster the partnership among the general public; the private sector; and local, state, and federal governments, which is essential for establishing and sustaining policy, programs, and the political will to preserve and restore the resources of the inland bays' watershed.
3. To serve as a neutral forum where inland bays' watershed issues may be analyzed and considered for the purposes of providing responsible officials and the public with a basis for making informed decisions concerning the management of the resources of the inland bays' watershed.

The establishment of the Center was the culmination of more than 20 years of active public participation and investigation into the decline of the inland bays and the remedies for the restoration and preservation of the watershed. A key element of this progression was the publication of a <u>Decisions for Delaware: Sea Grant Looks at the Inland Bays</u> (1983) and the participation by Sea Grant researchers and outreach personnel in the problem-solving process. The last six years of this work were accomplished as part of the National Estuary Program.

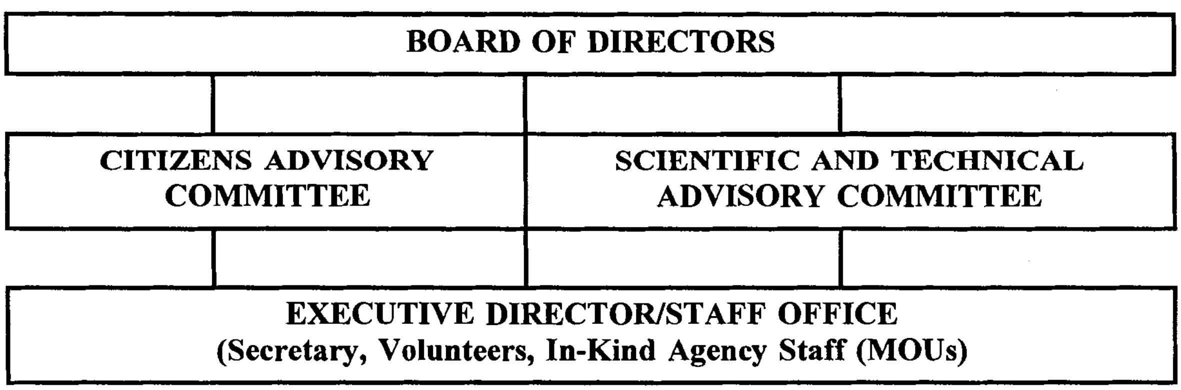
The National Estuary Program, established under the Clean Water Act and administered by the U.S. Environmental Protection Agency (EPA), provided approximately $2 million to study the inland bays, characterize and set priorities for addressing the environmental problems in the watershed, and develop a Comprehensive Conservation and Management Plan (CCMP) to protect and restore the bays. The underlying theme of the program is that a collaborative, consensus-building effort involving citizens; private interests; organized groups; and federal, state, and local governments is essential to the successful development and implementation of the CCMP. Recently completed through a highly successful participatory effort, the Inland Bays CCMP has now been approved by Governor Thomas Carper and the EPA.

Accomplishments: 2/1/94-1/31/96

The Director of the Delaware Sea Grant Marine Advisory Service (MAS), Dr. Kent Price, continues to serve as chair of the Delaware Inland Bays Scientific and Technical Advisory Committee (STAC) and was also reelected chair of the legislatively-created Center for the Inland Bays. He also serves as a member of the Advisory Committee for the Delaware/Maryland Coastal Bays Joint Assessment Program.

Progress to date has included filing and obtaining non-profit status for the Center; requesting and receiving a one-time $50,000 start-up line from the state of Delaware; assisting in the proposal preparation, submission, and acquiring a grant from the U.S. EPA for $257,000 to conduct demonstration projects relating to the Delaware Inland Bays Comprehensive Conservation and Management Plan (CCMP); presiding at the ceremony where Governor Thomas Carper and U.S. EPA Administrator Carol Browner ratified the CCMP; designing the recruitment strategy; coordinating the hiring of an executive director for the Center, Dr. Bruce Richards; establishing basic operating procedures for the Center through the University and local vendors; and assisting in grants management for the Center, including acquiring a $25,000 grant from the Crystal Foundation to enhance the outreach capabilities of the Center.

CENTER FOR THE INLAND BAYS
Organization Chart



Board Members and Alternates

Scientific and Technical Advisory Committee:
Kent Price, Chair
James Falk, Vice-Chair

Citizens Advisory Committee:
James Alderman, Chair
Grace Pierce-Beck, Vice-Chair

Department of Agriculture:
Jack Tarburton, Secretary
Ed Ralph, Alternate

Department of Natural Resources and Environmental Control:
Christopher Tulou, Secretary
Gerard Esposito, Alternate

Sussex Conservation District:
Greg McCabe, Representative
Eric Buehl, Alternate

Sussex County Association of Towns:
John Johnson, Representative
Matthew Falls, Alternate

Sussex County Council:
Robert Stickels, Administrator
Lawrence Lank, Alternate

Ex-Officio Members:
Danny Magee, Appointee of President Pro-Tempore of Delaware State Senate
Pat Campbell-White, Appointee of Speaker of Delaware State House of Representatives
Richard Pepino, Representative, Environmental Protection Agency
Charles App, Alternate, Environmental Protection Agency

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VIRGINIA'S REGIONAL APPROACH TO SUSTAINABILITY: BALANCING ENVIRONMENT AND ECONOMY

Dr. R. Warren Flint
The Eastern Shore Institute
Exmore, VA 23350

Dr. Warren Flint is Executive Director of the Eastern Shore Institute in Virginia.

What Is Sustainable Development?

Communities face enormous challenges world-wide as their social, economic, and environmental resources are depleted and destroyed. **Sustainable development** represents a way to achieve recovery, improve public health, and seek a better quality of life in these communities by limiting waste, minimizing pollution, maximizing conservation, promoting cooperation and efficiency, and developing local resources to revitalize the economy. This is an approach that the two counties on Virginia's Eastern Shore (Accomack and Northampton) are beginning to embrace with respect to revitalizing their local economies while also protecting their wealth of natural resources associated with the coastal bay systems.

Sustainable development recognizes that all resources - human, natural, and economic - are interrelated, and therefore they must be addressed in concert with one another. In practicing sustainable development over the long-term one will:

1) not diminish the quality of the present environment;
2) not critically reduce the availability of renewable resources;
3) take into consideration the value of non-renewable resources to future generations; and
4) not compromise the ability of other species or future generations to meet their needs.

The idea of sustainable development not only implies wisdom and stewardship in resource management for the future, but also includes equal fulfillment in the present for basic human needs, such as food, shelter, clothing, health, and the economic means to achieve these.

In practicing sustainability, one attempts to balance economic development programs with environmental quality. This can be accomplished through both ecological (environmental) and socio-economic (community) assessments that take into consideration and try to balance issues such as quantity vs. quality, value of non-renewable resources, efforts that meet societal needs, extent of natural habitats, status of environmental degradation, and critical numbers of plants and animals to support functional ecosystems. If a balance is not struck among many of these economic-environmental characteristics than a region can be judged as potentially acting unsustainable.

An equally important issue of sustainability is the equitable distribution of resources and benefits among all sectors of society. If the quality of life for the most disadvantaged segment of a community is not improved, sustainability will not happen. Thus, sustainability also translates into community solidarity, equal access to resources, and equal access to opportunities. But in dealing with wide-spread poverty, often the perceived solution is to grow economies. Can we realistically grow out of poverty? The economy is build upon a foundation of natural resources, human-made capital, and human resources. All of these elements that support rural economies are extremely limited. If we want to grow our economy to expand benefits, this growth will be built upon a limited foundation, and sooner or later the economy will falter. Alternatives to the philosophy of uncontrolled economic growth are strategies that **(1)** consider enhancing quality of goods and services (development) rather then their quantity (growth) and **(2)** the transformation of economic flows of capital, materials, and human resources.

Virginia Coastal Bays and Sustainability

Features which distinguish Virginia's Eastern Shore, such as natural areas, landscapes, towns, and local culture, are increasingly valuable assets on a national and global scale, luring increasing numbers of people from cities for outdoor recreation and the experience of this unique region. But change is occurring rapidly, as it is along the entire Eastern Shore of Delaware, Maryland, and Virginia. The health of the estuaries, bays and forests has declined, and along with them the resources, livelihoods and social fabric upon which rural communities and local economies depend. Degradation and alteration of critical ecological components and processes have occurred due to the magnitude and distribution of land uses in this region.

Maintenance of the area's natural resources and social capital is the foundation of, and essential to, a sustainable economy important far beyond the boundaries of the Eastern Shore. Thus, focus upon Virginia's Eastern Shore provides the opportunity to demonstrate sustainable development as a world class model. Many people are seeking ways to manage economic change and to retain and restore the environments from which the region derives its character and value.

Changes on Virginia's Eastern Shore landscape have raised a number of issues of concern for this region that focus around:

agriculture	aquaculture
groundwater	treatment of wastes
transportation	recreation
environment	tourism
public services	economic development
affordable housing	education
land-use	forestry
regional governing approaches	historic and rural character

The Virginia Coastal Resources Management Program, a part of the Virginia Department of Environmental Quality, has devoted significant energy and resources to assisting the two counties on the Eastern Shore, Accomack and Northampton, in addressing many of these issues, especially as they relate to a more sustainable future for the region. The Virginia Coastal Program works with the Marine Resources Commission, Department of Game and Inland Fisheries, Department of Conservation and Recreation, and Department of Health in Virginia to carry out its programs on the Eastern Shore.

Cape Charles Sustainable Park: A World Class Model

An example of how the Eastern Shore of Virginia and its local governments, in this case Northampton County, have begun to take charge of their own destiny in moving towards a more sustainable future is represented by the fine work on the Cape Charles Sustainable Technologies Industrial Park. A large number of stakeholders came together and created a vision, design, and strategies to implement the creation of an industrial park that sits at the cutting edge of sustainability with regards to its connections between economic development, environmental protection and enhancement, and social ethics.

The design of this sustainable, industrial park has been the result of work by local governments, state and federal agencies, non-profit groups, businesses, and individual citizens. The design principles and business approach for the eventual park embrace many characteristics that are now considered important in achieving sustainable communities, such as:

self sufficiency	adequate tax base
nature-based business	family-wage jobs
not <u>what</u> business does, <u>how</u> it does it	environment a forethought
industrial ecology	environmental design
alternative energy	local priorities met
businesses sensitive to economic importance of natural resources	equal access by all societal sectors

Coastal Bay Watersheds

Tidal wetlands and coastal bay lagoons, featuring productive salt marshes and shallow bay bottoms behind a chain of 18 barrier islands stretching 60 miles, dominate the Atlantic seaside coastal bay area of Virginia's Eastern Shore. This area of approximately 362 square miles of open water and emergent wetlands provides habitat to fish and wildlife, including varieties and numbers of bird populations unequaled on the Atlantic coast. These Virginia coastal bays are a tide-dominated estuarine area with a complete replacement of water from oceanic flux in as little as 2-3 days. The principal land uses of the watersheds in this coastal region include agriculture, forestry, and recreational tourism. The population within these watersheds is approximately 47,000.

As noted above, through time the coastal region of Virginia's Eastern Shore has experienced major changes. These impacts are compounded by the fact that watersheds in this coastal region have a land to water surface ratio that approaches 1, meaning that landscape alterations have a more immediate impact on the contiguous bay waters. These alterations have resulted in declines in water quality and certain components of biological diversity which in turn have caused the decline in health of Atlantic coastal bay fisheries, devastating traditional industries of fishing and shellfishing.

Agriculture is important to Virginia's Eastern Shore rural economy but there are perceived conflicts between its impacts on the environment and the traditional seafood and aquaculture industries. Contaminant input to coastal bays has been suggested as the agent responsible for eutrophication in these mid-Atlantic estuaries, potentially affecting fisheries and habitats. The understanding of watershed function is important in being able to predict the relationships among agricultural practices, aquatic-transport agents, lagoon water quality, and associated biological responses. An ecosystem approach is needed to simulate the physical and biological balances that sustain the ecology of these important coastal bay watersheds in relation to their land-use patterns.

For example in one Virginia Eastern Shore watershed study, results to-date illustrate a pattern of nitrate build-up in shallow agricultural soil layers during the fall. These high concentrations of soil nitrate shift from 15-30 cm depth in November, to 45 cm depth by March, and to 60 cm depth by April, coinciding with spring rains and associated leaching, suggesting that there is significant residual of crop-applied fertilizer nitrogen occurring on this watershed from agriculture activities. Groundwater quality measured at selected wells also exhibits a pattern of nitrogen enrichment underlying the agricultural portions of the watershed. For example, total dissolved inorganic nitrogen in the groundwater coming from under agriculture fields showed an average of 228.0 *u*mol/L while these same measures in groundwater derived from areas of forest in the watershed showed an average of 5 *u*mol/L.

Stream discharge and nutrient flux measurements in this watershed indicate quality of the creek surface water is impacted by surrounding land use as dissolved inorganic nitrogen increases during its passage through agricultural dominated regions. Creek dissolved inorganic nitrogen fluxes show increases during passage through the watershed several fold (up to 10 times) greater than estimated fluxes based on background nitrogen levels over the extent of the creek. Likewise, measures of nitrate and chlorophyll collected in the tidal creek and adjacent lagoon areas are indicative of the dynamic nature of the groundwater flow of nutrients to the coastal lagoons, and impacts of these nutrients on water quality. Nitrate is high near the terrestrial confluence (7 *u*M/L) and decreases readily (0.7 - 1.8 *u*M/L) as one moves away from this influence and as the creek waters are further diluted with tidal seawater. Chlorophyll levels ranged from 80-100 ug/L in March 1994, during low tide (time of greatest impact from groundwater), in contrast to only 40 ug/L at high tide. Chlorophyll levels decrease drastically with distance from land, further emphasizing the potential impact of terrestrial nitrogen. These preliminary data suggest that seaside watersheds can represent a constant but widely variable nitrogen source to the coastal bay systems.

Socio-economic Systems

Other areas of focus in Virginia with regards to sustainable land-use and coastal bay environmental quality, include the evaluation of social vitality in this region and how that is impacted by changing environments as well as serving as a source of impact to the quality of the coastal environment. In recent years, as fish stocks have dwindled and agricultural processing has become regionalized closer to metropolitan centers, the Virginia Eastern Shore region has suffered serious economic decline, resulting in the loss of hundreds of jobs. These poor economic conditions have resulted in ripple effects throughout this region's society in that more than 20% of the households live below the poverty level as compared with 10.2% for the State of Virginia as a whole. Many households (greater than 15%) do not even possess in-door plumbing.

The citizens of the region are hungry for new business opportunities that will increase economic development and jobs. The challenge will be to balance desires for economic prosperity and improved social well-being with continued maintenance of environmental quality and important natural resources in the region. Nature-based tourism is being promoted as an up and coming business opportunity for Eastern Shore communities. It is important that we fully evaluate the positive and negative impacts of this potential industry to a region so dependent on its natural resources as the Eastern Shore is. Economic impact analyses performed for three years on the Eastern Shore Annual Birding Festival have shown significant positive impact to local business over the three-day period of this event. The southern end of Northampton County for example, has regularly experience a gross industrial output from this festival of more than $60,000 since 1993 with a peak in income of $112,000 in 1994.

In working towards a sustainable future for Virginia's Eastern Shore, as stated previously, it is also important to guarantee the social well-being of the different communities. Part of this social well-being relates to the development of affordable housing that also takes into consideration the preservation of natural resources on the shore. Work is presently underway to explore possibilities for linking together affordable housing concepts with sustainable, resource efficient building designs. The outcome of this work is expected to further enhance the affordability of housing on the Shore while also adding measures in residential development designed to protect our limited water supplies, shortage of building materials, and enhance the homeowner's energy savings.

Delmarva Regional Approach

Implementation of sound management strategies in coastal regions like the Eastern Shore requires the coupling of coastal environmental quality with sound land-use decisions, supported by improved scientific knowledge. The challenge is to design and carry out interdisciplinary programs of integrated assessment, focusing on the interactions of external forces and associated responses in the coastal zone, that will more soundly guide landscape sustainable development in these regions. This requires an "ecosystem approach" to management and decisionmaking. It also implies that there is often a direct linkage among events that happen respectively in Delaware, Maryland, or Virginia and the outcomes from these events being realized in any other of these states. In other words, the different regions (states) of the Delmarva Peninsula are truly interconnected. Delaware watersheds impact Maryland coastal bays. Likewise, Virginia coastal bays, because of their significant oceanic influence, affect the quality of Maryland bays.

The Delmarva Peninsula represents a coastal compartment. This coastal compartment exemplifies a geomorphologically and physically structured coastal unit repeated around the U.S. and the world, and thus serves as an organizing principle and a model to direct the comparative assessment of the many forces acting on the Delmarva Peninsula's coastal ecosystems. Using this organizing focus and taking a holistic assessment approach can more effectively guide development of the management strategies ultimately required to protect the long-term sustainability of coastal resources in a regional context.

The Eastern Shore Institute

The Eastern Shore Institute (TESI) is a non-profit organization founded in 1994 to address sustainable development on Virginia's Eastern Shore. TESI's **mission** is to study and demonstrate ways for rural coastal communities to promote economic prosperity and social development through methods that will also preserve and enhance their natural ecosystems. The Institute carries out its mission related to environmental integrity, economic viability, social well-being, and cultural uniqueness by pursuing two programmatic tracks: [1] linking land-use development with conservation and protection of economically valuable coastal watersheds and [2] providing assistance in developing rural, sustainable communities through grassroots empowerment, enhancement of local economies, and equitable improvement in quality of life.

The Eastern Shore Institute has become a respected, independent organization sensitive and fully responsive to regional needs. Because its constituency is all sectors of Eastern Shore society, while serving no special interest group, the Institute can truly facilitate the application of objective and sound information in assisting others to meet their goals. It serves as a catalyst in assisting communities to improve human well-being without degrading environmental health.

Measuring Success

The next level of effectiveness for work in Virginia will include the development of tools for measuring progress of projects, programs, and campaigns intended to advance sustainability in this region. The challenge in developing new and different efforts for improving the region's quality of life will be to balance desires for economic prosperity and improved social well-being with continued maintenance of environmental quality and important coastal resources. Several governmental-driven programs and projects, viewed as ways of improving economic conditions in a sustainable way for the region, are either being implemented or in the planning stages. For example, in the development of the Northampton County Comprehensive Plan citizens defined a desired future for the County and strategies to reach their goals. The goals specified in the plan are to conserve the County's natural resources and rural character, as well as to pursue economic self-sufficiency for all citizens. Citizen leaders also developed a *Blue Print for Economic Growth* which further articulates goals and development strategies that preserve and capitalize on the County's natural and cultural heritage. Accomack County has defined similar goals through its comprehensive planning process, and with Northampton County, has cooperated in the Countryside Stewardship Exchange Program.

At present there is no way of determining (measuring) the success of these various programs and projects. In other words, how will we know we are getting where we want to go, or whether we have arrived? Benchmarks are the indicators that tell us whether elements of a plan are being achieved over time or if we are losing ground. An appropriately designed benchmark program for measuring Eastern Shore progress toward achieving sustainable goals will provide this region with an excellent set of coastal management policy tools. These tools will offer managers new approaches for evaluating the effectiveness of current policies and management strategies designed to link coastal resources with economic development. Positive trends can be highlighted, recognized, and actively maintained. The beginnings of negative trends can be detected and action taken to ameliorate problems. A benchmarks program will also promote community awareness about important issues of sustainability and guide future policy and decision making for the region regarding development that is done in harmony with the important natural resources of the area.

With the assistance of *The Eastern Shore Institute*, governments and public special interest groups in this region of the Delmarva Peninsula are working to bridge the gaps among environment, economy, and society in their programs designed and intended to improve economic conditions within the region. I hope that I have been able to accurately present to you some of the new and innovative approaches that are being taken in Virginia and at the same time demonstrated to you how these approaches fall within the realm of a region focusing in a systematic way to achieve sustainable development for its many diverse communities that emphasizes simultaneous focus on environment, economy and social well-being.

REPORT ON BREAKOUT GROUPS TO DISCUSS MODELS AND THEIR APPLICATIONS TO STATE AND LOCAL STRATEGIES

Introduction

At lunchtime on the second day of the conference, all participants were directed to select one of three breakout groups, Delaware, Maryland, or Virginia, based on their own interests. For approximately one hour, each breakout group was directed to discuss the issues and findings raised during the conference in the context of their particular state as well as Delmarva-wide. At the conclusion of the breakout sessions, the full conference reconvened to discuss the findings of each group, which are summarized below. Reports focused on Delmarva-wide strategies, with the exception of Maryland, which used the time to further discuss the National Estuary Program (NEP).

Virginia

The facilitator for the Virginia breakout group was Dr. Warren Flint, Executive Director of the Eastern Shore Institute. Findings from the breakout session were recorded on flip charts in terms of issues and obstacles, and presented to all conference participants.

The first key finding is that, given all of the activity in Delaware and Maryland, Virginia wants to be included. Very little of the process to date has crossed the state line. Models have been developed, organizations are in place, and state boundaries are artificial. What Virginia offers the process is serving as a model for what the other bays would like to achieve in their restoration efforts. These bays are to a large degree, with the exception of agricultural runoff, untouched by human activity. Defining what exists is not complete and additional good science needs to be undertaken to define what is achievable. Also, while lack of coordination among local jurisdictions is another issued faced by Virginia, a planning district commission has been formed to address cross-county issues.

Therefore, a mechanism is in place and needs to be activated with respect to coastal bay issues.

Among the areas where they would like to receive help are:

- Support from the State of Virginia for eastern shore issues — Unlike Maryland and Delaware, the rest of the State pays little heed to the eastern shore. No commissions or coastal bay programs exist. The focus on the Chesapeake Bay is almost total. Also, there is a lack of constituency/voting block.

- Development of an overarching purpose/mission to bring the people of the eastern shore together — Virginia should immediately take advantage of the models offered by Delaware and Maryland to begin motivating people.

Delaware

Dr. Bruce Richards, Executive Director of the Delaware Center for Inland Bays, facilitated the breakout session. Findings were presented on flip charts, beginning with the key factors that contribute to tourism, development, fisheries/shellfisheries/aquaculture, and agriculture.

Factors that influence tourism include:

- No sales tax
- Two bridges with access
- Stock car races
- Birding/ecotourism activities
- Coastal state parks
- Outlets
- Boating/jet skis

Factors that influence development include:

- No sales tax, good economy, job base
- Infrastructure
- Proximity to water
- Profit/developer
- Quality of life
- Retirement area
- Clean beaches
- Recreational opportunities
- Pro-development atmosphere (politicians)
- Availability of housing
- Colleges and universities
- Public schools

Factors that influence fisheries/ shellfisheries/aquaculture include:

- Lack of submerged aquatic vegetation (SAV)
- Political environment
- Water quality
- Nonpoint source pollution
- Loss of habitat
- Lack of education
- Agricultural impacts
- Neighboring jurisdictions (PA, MD, VA, NJ)
- Overharvesting
- Loss of wetlands
- Increase in technology
- Recreational boating/jet skis
- Commercial development
- Benthic food systems
- Septic system impacts on habitat
- Shoreline stabilization
- Point source pollution
- Storm/waste water impacts
- Laws and regulations

Factors that influence agriculture include:

- Jack Tarburton/Frank Perdue
- Russian exports
- Profit/costs/equipment
- Need to eat
- Commodity markets
- Weather
- Proximity to markets/infrastructure
- Consumer demand
- BMPs
- Land availability
- Uncontrolled development
- Laws and regulation
- Drainage/irrigation
- Availability of labor
- Urban encroachment
- Buffer zone/tax ditches
- Pest/weed control
- Technology
- Government subsidies
- Changing demographics (family farm preservation)

The other key area focused on by the breakout group was Delaware's connection to Delmarva-wide issues. Issues that were identified included:

- Over/underplanned uses of the landscape
- Population growth
- Changes in age/demographics
- Transportation
- Loss of habitat
- Water quality
- Quality of life
- Dredging Assawoman canal
- Rural/urban conflict
- "User" conflicts
- Natural disasters and planning
- Collective planning and education
- Increased cost for infrastructure
- Loss of federal funds

- Political "will" regionally (county and state)
- Loss of farmland
- Environmental data collection, use

In summary, key areas were access and infrastructure, changing demographics, unplanned growth, coordination at all levels of government, education and outreach, and regulations and laws.

Maryland

The facilitator for this breakout group, Gwynne Schultz, Director of the Coastal Zone Management Division, Maryland Department of Natural Resources identified four topics for discussion:

1) upcoming activities; 2) the process; 3) confirmation of the problems and goals; and, time permitting, 4) Delmarva-wide strategies.

Regarding National Estuary Program (NEP) activities, a committee structure is under development. The management committee recently met, while the remaining committees (policy, scientific/technical, and citizen's advisory) have yet to meet. Candidates for the Program Director's position will be interviewed this week. Conference participants interested in learning more about the program and its committees should call Kathy Ellet at 410/974-3382.

Strategic activities underway include development of a public participation strategy to reach all stakeholders, development of a data management strategy, preparation of a first-year work plan, and signing of a partnership agreement among key players. Other activities include an environmental characterization study, review of environmental programs, identification of priority problems, development of a monitoring program, and preparation of a management plan.

The following comments/questions were received concerning the NEP process (responses are noted where applicable):

Comment: Please elaborate on development of the public participation strategy.
Response: The Maryland NEP will review and evaluate strategies that were developed for the Chesapeake Bay Program and for other NEPs. A draft strategy will be developed based on these experiences. We will look at what groups have been involved in past issues and determine which interests we need to reach to make this new program a success.

Comment: Americorp requires goal-orientation, while we keep hearing about the process. There are numerous Americorp people on the eastern shore who have been trained in databases, environmental assessment, etc. Citizens need to know what is expected of them and what the goals will be. We also need to develop a list of community groups with contact names that can help.
Response: Maryland has used the Conservation Corps in the past to identify problems. In general, volunteer assistance is essential.

Comment: We need to make sure that different agencies do not have barriers that exclude cooperation (e.g., years ago a bridge was built that now restricts flushing, dredging actions may bring up contamination, and barrier islands were created that are now preserved). Different issues will require agencies to work synergistically.
Response: The NEP will be looking at linkages over the next year.

Comment: What connection is there between the NEP and the Corps of Engineers?
Response: The Corps of Engineers recently completed a 1 1/2-year long study that used a holistic approach to examine water resources (e.g., navigation, water quality, and infrastructure). This study set the groundwork for the NEP, which will elaborate on it.

Comment: Is there a process for getting citizen input?
Response: The NEP will have two focuses: getting input from all stakeholders and getting information out to everyone. Mechanisms are under development.

Comment: Instead of population control, we should recognize that everyone is a "re-creation" artist and capable of re-thinking things. Limiting creativity, in general, is a bad idea. Also, why not try to develop other areas of the state and bring the whole state into the process, since all resources come from the same pot of money?
Response: This leads into the next part of the discussion, priority problems.

The breakout/group next discussed the following priority problems identified by the NEP:

Eutrophication
Habitat modification and loss
Decline in living resources
Toxic contamination
Shellfish closures
Water-based activities

The following comments/questions were received concerning the identification of problems:

Comment: Flooding and standing water problems due to population pressures should be added. We need better stormwater management. We also need to consider land subsidence due to ground-water withdrawal, as well as sea level rise (the minimum estimates indicate that it will affect this area).

Comment: Environmental education is one of the most significant actions to take.

Comment: We need to start demonstration projects on sustainable economic development.

Comment: None of the studies have shown a lot of toxic contamination. Why is this problem listed and not sedimentation (like eutrophication, this affects drainage patterns)? [Note: a resource expert responded that toxics are listed because of findings pertaining to historical practices and implications for dredging; sedimentation is a valid issue and should be covered as a separate problem or as a subset of another.]

Comment: Fishing is very poor in the back bays and the flounder are gone. Clam dredges flatten out the floor of the bay and create large flows of material. In addition, a speed limit should be established for all vessels to control wakes. The MD DNR says concerns are an over-reaction, but the commenter has seen these changes over a 45-year period.

The final discussion focused on the four main goals for the MD NEP that were identified in the original submittal package:

- Reduce water and habitat quality impacts where they are most severe and maintain quality of areas not degraded

- Protect existing high-quality habitat, and where possible, restore degraded habitat

- Control input of pathogens and toxic chemicals for human health and recreation purposes

- Plan for sustainable development and population growth.

The following comments/questions were received on these goals (responses are noted where applicable):

Comment: No one has recommended looking at the Chesapeake Bay and what has been done there. Rumor says it has improved. We also have not heard anyone talking about critical areas. Is there any movement to push this legislation?

Response: The MD NEP is not aware of any legislation, but does have plans to look at the Chesapeake Bay program. Furthermore, EPA noted that there are 28 NEPs in the country and a technology transfer program exists to exchange information. There are several good examples, beginning with the Delaware Inland Bays.

Comment: Anything that happens needs to go through the Maryland State legislature; therefore, we need to push for what we want.

Comment: A lot comes down to money and development. We are not going to be able to keep people out. Ultimately, county regulations are most important and critical areas are a good place to start. We need to figure out how to live with these conditions. For example, we may want to consider opening up areas that are restricted in exchange for controls on harmful types of development. Also, we need to communicate within groups (e.g., via a computer bulletin board or e-mail).
Response: Besides regulatory programs, we need to look at offering incentives to the development community. In addition, the MD NEP has flyers available on becoming involved with the Citizen's Advisory Committee.

FULL CONFERENCE DISCUSSION ON ISSUES AND STRATEGIES BEST ADDRESSED BY A DELMARVA-WIDE APPROACH

Following reports from the state breakout groups, Rick Johnstone, Supervisor of Forestry for Delmarva Power and Light, opened the discussion to all participants on Delmarva-wide issues. In doing so, he noted that reduced federal funds increase opportunities for partnerships. Specifically, his experience in developing new Endangered Species Regulations emphasized the importance of involvement with respect to non-regulatory approaches. To elaborate on these approaches, Mr. Johnstone showed a videotape that outlined the voluntary pesticide environmental stewardship program between the U.S. EPA and Delmarva Power and Light, and other utilities. The videotape provided an example of a partnership between private industry and regulators to resolve environmental concerns through best management practices instead of regulations or legislation. These approaches constitute a paradigm shift, are economical, and have proven successful in farming and the Chesapeake Bay.

The following Delmarva-wide issues were then identified by conference participants:

- The scientific and technical communities are very aware of what the problems are and some of the solutions, but the public at large needs to be educated. A series of public service announcements in the tri-state area needs to be undertaken regarding the problems, programs, and objectives.

- As revealed by the Chesapeake Bay studies, the significance of air emissions needs to be taken into account, including auto emissions.

- Do not underestimate the fondness of the American public for some of the regulations that have protected and improved our environment far more than any other nation in the world. Environmental regulations are not harmful and were not developed to be bothersome; they were developed because they are necessary. People do not write unnecessary regulations.

- Perhaps the bays should be federalized. The states will not get together with enough clout, and this approach was successful for the Grand Canyon. It should be used here because this resource feeds people.

- Regarding how to reach the people who did not attend, every person here has the ability to contact other people; everyone here is a carrier of the disease called "bay-saving". It doesn't matter if it's your Rotary Club, Kiwanis Club, Lion's Club, sorority, board of realtor's, farming organization, or other groups. Everyone has jobs that are dependent on the health of the economy in this area. We cannot point fingers and expect others to act; we have to do it.

- The structure of the conference will be kept together for a while; i.e., the Agenda Planning Committee will meet again. Your input is needed as to what would be most helpful. Ideas can be sent to Marsha Ramsay, Rick Kutz, Warren Flint, Rick Johnstone, Bruce Richards, Kent Price, and others if you are not comfortable speaking in front of a large audience. Also, please fill out the evaluation forms.

- Can the state representatives get together a few times per year to share information on what works and what doesn't work?

- There are many youth in the area that can get involved; e.g., Americorp and Conservation Corps. These people are trained in environmental assessments and environmental restoration. This involvement will improve the environment, provide hands-on training, and help these youth to be of service to their community and become worthy citizens of tomorrow.

- Everyone should visit and snorkel in Virginia's inland bays with elected officials and citizens to see pristine bays and develop goals for Delaware and Maryland.

- Lack of involvement by the biggest stakeholder, Ocean City, is a concern. We will have a difficult time achieving goals without them.

- As a direct consequence of this conference, the Worcester County Planning Department has received tentative commitments from the four other planning staffs to begin meeting on a regular basis.

CONFERENCE FOLLOW UP

W. Michael McCabe
Regional Administrator, U.S. EPA

Marsha Ramsay, President of Assateague Coastal Trust (ACT), began the Follow Up session by stating ACT's commitment to advancing the work of the conference. She expects ACT to facilitate communications among conference sponsors and participants, to build on this coalition to reach others, to reach out to and educate all Delmarva stakeholders, and to facilitate involvement of local governments. She invited all conference sponsors to work with ACT. ACT will seek public and private funding to carry out this commitment. Ms. Ramsay then turned the podium over to Michael McCabe for closing remarks.

I just want to thank everybody for coming, and in particular, thank all of the members of the Planning Committee, especially Marsha Ramsay and the people at the Assateague Coastal Trust. When they first started talking about putting this conference together, I think they were envisioning 60 or 70 people coming, and obviously with 275 involved, this has been beyond the planners' wildest expectations. This says great things about the level of involvement in this region.

I am not about to provide a summary or synthesis of what went on; I think everybody can take away different things from this conference. But I think it's pretty clear that we need to build on the success of this conference in order to accomplish some of the goals and objectives that have been set forth here. I was really pleased to hear that the four counties will be getting together and that the agenda committee is staying together. I think we ought to make this conference an annual event and EPA would certainly be willing to help if that is the desire of the stakeholders.

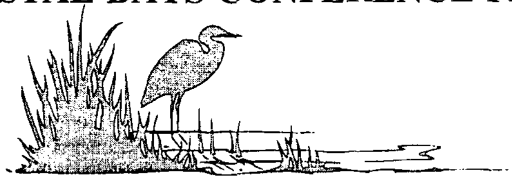
We need to reach out and pull in more people. One disappointment, I think, with this conference is that there were not more development representatives. These people are having a tremendous impact on this area and we need to bring them in, talk to them, and educate them. We also need to involve local government; I was pleased to see the level of local government participation but I think it can be better. We are lucky that with the Chesapeake Bay Program in such close proximity, we can have a lot of overlapping benefits. One of the exciting new things in the Chesapeake Bay Program is our local government initiative. It's being put together this year, including an action plan scheduled for completion by this October. This action plan can be applied to several other communities as well, including the coastal bays. As has been discussed, EPA can tap into the community at every level, and this is what we need to do. Everyday new people move into this community because of the quality of life and they do not want to see that jeopardized. To the extent that we can involve these new residents as stakeholders, they will be a potent force in making sure that we have the kind of sustainable future that we all care about and are looking for.

If you are not involved, get involved with the Delaware and Maryland Estuary Programs.

Also, as discussed, Virginia has a number of new initiatives in the coastal area that need our involvement and a broader stakeholder base. With that kind of involvement, we can make some changes. To my knowledge, there has been no natural tidal wave that has hit the Delmarva Peninsula, but we are experiencing a tidal wave approach to development in this part of the country. Unlike the natural phenomenon, we can plan for the impacts of the man-made kind. If we don't, however, the destruction to the quality of life and to the environment could be no less severe, although a lot more prolonged. We are looking for ways to deal with the impact of that tidal wave. Your commitment and participation indicates that you care about how we manage that, and I think that the future looks hopeful. I am glad that I was part of this process, and I certainly plan on being a part of future events of this kind, whether I am in a politically appointed position or as a private citizen. Thank you and I look forward to the next meeting of this group.

APPENDIX A

DELMARVA COASTAL BAYS CONFERENCE PARTICIPANTS



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APPENDIX B

CONFERENCE EVALUATION FORM

Please turn in this completed form at the end of the conference.

1. Did the conference meet your expectations? 73 Yes 10 No

2. The conference was

Well organized	75 Yes 4 No
Informative	76 Yes 1 No
Good presentations	68 Yes 6 No

How could the conference have been improved?

Comments: Audio-visuals should have been suitable for large audience and large room so all could see. Some presentations not effective. More local officials, developers, local citizens should have attended. Subject matter too general. More breaks needed.

3. How were the conference accommodations?

Meeting rooms	34 Good 36 Fair 11 Poor
Food	35 Good 40 Fair 6 Poor

Comments: Too cold and noisy in breakout groups.

4. Should this conference set the stage for followup actions?

81 Yes 0 No

Future Conferences	70 Yes 5 No
Newsletters	69 Yes 5 No
Committees	62 Yes 3 No

If YES, what issues should be addressed?

Comments: Most respondents stressed need for public education and involvement and cited issues raised at conference (agricultural practices, development, tourism, fishing) as well as good land planning, preservation of fragile areas, and updates on three-state efforts as being most important issues for future focus.

If YES, at what governmental level?

49 Local (County) 34 State 59 Delmarva-wide

5. Are you willing to commit your time and/or money to ensure follow up actions are successful? 71 Yes 5 No

6. What is your personal vision for the future of Delmarva's Coastal Bays?

   Comments: There was considerable agreement that nature and human needs be in harmony: affordable and good quality of life; clean environment; open space; reasonable growth; protection of sensitive areas such as wetlands and shorelines; good fishing; clean bays throughout Delmarva.

7. How can this vision best be achieved?

   Comments: There was considerable support for education of all citizens, visitors and political leaders; for better planning for growth, involving all stakeholders and including reduction of waterside development and putting sensitive lands in conservation; for local zoning ordinances to protect sensitive areas and guide development to already developed areas and away from wetlands and shorelines. Everyone working together: cooperate, build consensus, stop finger-pointing.

8. What role do you envision for elected and appointed officials?

   Comments: There was almost unanimous agreement that officials need to listen to stakeholders' concerns and lead an effort toward sensible growth in the region that considers responses summarized in 6 & 7 above. Elected officials, most believe, should lead public education and involvement efforts and fund projects that protect and restore fragile and sensitive areas. Other suggestions include creating incentives to businesses that operate in environmentally protective ways and establishing user fees to pay for restoration. There was considerable criticism of local elected officials who chose not to attend the conference. There was additional criticism that these officials tend to make decisions that favor special, rather than public, interests. Most agreed, however, that it's time to move forward together.

Total attendance at the conference was 269. The summary above is based on the 83 Evaluation Forms that were turned in at the end of the conference, representing 31 percent of conference attendees.

APPENDIX C

REMAINING QUESTIONS

Following the panel discussion on the environmental and economic status of the coastal bays and their watersheds, conference participants were provided with a 15-minute break in which to develop questions for any of the panelists or resource experts. For the remainder of the hour, the panelists and resource experts addressed several questions, which are presented on page 60. Due to the overwhelming number of questions and limited time, however, the majority could not be discussed. This Appendix lists these other questions that remain for future discussion.

1. How can overuse/abuse of resources be prevented or curtailed?

2. Discussions of this conference have all emphasized sustainable development practices as a means of assuring good quality of life and healthy ecosystems for the future. If this approach is adopted, we will need a means to persuade the public to adopt this idealogy. Will there be any focus on the economic benefits of sustainable development approaches that can be translated to pocketbook savings meaningful to the individual taxpayers?

3. We keep talking about growth management and control. This issue has even been addressed in comprehensive management plans. So, why are growth limits/boundaries not drawn and implemented by co-governments? Why don't we do what Portland has done?

4. How much of the original wetlands have been lost to development over the years?

5. The majority of attendees are either from the government or are involved in grass roots efforts. How do we involve in the planning process those people in the middle?

6. What efforts are underway to enact better land use planning mechanisms such as: transfer of development rights and cluster zoning to create open space, etc.?

7. The perception among citizens is that their input is not truly desired because they may not be qualified or have a different agenda that is contrary to the environmental protection. This is not true! They offer real time, on-site data. However, they may need more information. What efforts will be made to inform and involve the public?

8. Why not set up a "Tributary Strategies" type process for the Coastal Bays involving DE, MD and VA? Since nutrients are the major problem, a "Coastal Bays Strategies" would involve citizens, local, state and federal governments, businesses and environmental groups, and could concentrate on specific issues that are unique to each state's coastal bays.

9. We have heard about limited resources, but have not tapped our most available - volunteers. The governmental agencies do not seem to have had, as a part of their process, harnessing this resource for gathering data, interviewing people and in general creating an army of extra help. Can you do more to integrate public groups into your teams? Example: Ocean Pines has several groups to help: Boat Club, Fishing Club (Anglers), Power Squadron, and individuals.

10. It was mentioned that the benthic community in southern Chincoteague Bay was in good shape and that northern Indian River Bay was in poor shape. Does this indicate a general north to south trend in degradation which may correspond with numbers of individual septic systems going north to south? Were the northern Indian River Bay sites and the southern Chincoteague Bay sites sampled simultaneously?

11. Do manmade canals act as a sump keeping runoff pollutants from entering the main bodies of water in the bays?

12. What are the largest sources of nutrient pollution into the bays? What causes the oxygen and toxic chemicals? What two to three things would have the most impact on reduction?

13. Are county economic development and tourism staff talking to planning and zoning staff to ensure that natural resource amenities that serve as attractions to companies to locate in this area are protected? If so, how is the planning process affected?

14. Functionally, a stand of trees does not make a forest. What is Delaware doing to foster a sustainable forestry ethic among its forest industry?

15. Hasn't Delaware put the cart before the horse by creating major access routes between its bays and beaches and the metropolitan areas to the north before establishing, fully, management plans relating to the coastal area?

16. What about the loss of biodiversity associated with Loblolly Pine Plantations; i.e., less of mixed hardwoods and old growth forest? How will this highly potential problem be addressed?

17. Is the environmental degradation in the north, i.e., Delaware Bay, reversible?

18. How will the new Farm Bill affect Delmarva agriculture ("Freedom to Farm")?

19. Are the tree farms monoculture? If so, is there any effort to change this?

20. Has the amount of eutrophication caused by agriculture and human habitation been quantified?

21. What needs to be done to stop eutrophication? If implemented, how long to see an improvement?

22. What has caused the decrease in spot and mullets in Indian River?

23. Who is benefitting from the poultry industry on the shore?

24. How would life change if the poultry industry was not here?

25. For the benefit of the eastern shore, agriculture should diversify!

26. Is it true that intensive farming (use of pesticides, fertilizers, manure, etc.) is indicated in the nonpoint source of pollution? What role does the poultry industry play? Please discuss the economic and environmental bad buys; how it got that way and what needs to be done.

27. Ecotourism is a developing concept globally. Where is Delmarva going with this concept, or have they even considered marketing this concept?

28. Is it feasible to promote (or require) trapping of storm runoff from farms and elsewhere into ponds? These could serve as sediment traps, sources of irrigation water, recreational fishing etc. and help lessen bay pollution.

29. Do you know of any way to "garner" the numbers of individual farmers who are implementing BMPs on their own but aren't being "captured" in existing reporting systems? This would be a valuable information/education source for the general public to realize farmers, on a whole, are good stewards.

30. What is the adverse impact of tree farms on the ecosystems (include use of toxics, pesticides, fertilizers, etc.)?

31. Do the fish that we find in the ocean spawn in the coastal bays, and if so, what percentage?

32. Offering incentives to recreational fishermen for filling out a simplified survey before a fishing license is issued.

33. How can you reconcile your studies showing no fisheries stock change in MD waters over the past 20 years with the undoubted severe decline in the flounder fishery?

34. For discussions of water quality, no one has mentioned the trends in sediment loads in the bays or the actual effects of sediments on SAV; etc. What are the trends and effects?

35. Rick Kutz stated that species in Chincoteague Bay "haven't changed in 20 years." Does that mean that healthy populations of fish and shellfish exist?

36. Dredging of clams during winter months disturbs crab beds and also creates serious silting conditions in the shallow water bays. Please comment on whether it may be desirable to modify the practice of dredging.

37. Recently proposed crab regulations are geared to conditions in the Chesapeake Bay and do not adequately address the problems of over-crabbing in the coastal bays. Please comment on the need for additional conservation measures such as establishing sanctuary areas where commercial crabbing would be prohibited and also placing greater restriction on the taking of sooks.

38. If dredging brings up toxic chemicals and is considered bad and submerged vegetation is so important, why are hydraulic clam dredges allowed to operate in our beleaguered bays?

39. In the species changes that have occurred in Delaware Coastal Bays, has there been biomass shifts as well? In the Maryland Bays has there been number changes; i.e., have numbers and age classes shown declines while species composition may be insignificantly changed?

40. What is ASMFC doing about the decline of the horseshoe crab population and its impact on shorebirds and fin fish?

41. Secretary of Agriculture DE brought this home: in other words, economics controls everything including conservation, which is unfortunate for the planet! For me, I am in a quandary since my employment is dependent upon agriculture yet it is clear that how things are done are controlled first by economics not conservation. We find ourselves educating how to conserve based on economics, which is not always the correct way.

42. Why not require a salt water recreational fishing license (like hunting) that requires "catch" information to help assess the resource "taken" and enhance knowledge of scientists? (Should be done statewide)

43. Is recreational water usage and aquaculture compatible in populated areas such as that surrounding Ocean City?

44. Isle of Wright Bay's filling with sand in its interior sections, probably due to the severe channeling of its two (east and west) sides and due to the addition of rock pilings by the Route 50 bridges. What environmental impacts will the continued reshaping of the bay have? Is anyone doing anything to combat those manmade changes?

45. Studies show that industrial tourism coupled with corporate farming practices are a major contributor to loss and degradation of critical finfish nursery and spawning habitat in the Delmarva Bays. The ASMFC manage both weakfish and winter flounder which occur here and are in serious decline. What is the ASMFC doing to address this matter?

46. Can a resort community like Ocean City be made to stop - by overbuilding, overcrowding, and overstressing utilities and water supplies - the destruction of the natural features tourists come to enjoy?

47. Where was the Army Corps of Engineers, the EPA, Assateague Coastal Trust, etc. when the last remaining shoreline of West Ocean City (including Captain's Point) were allowed to be developed by a few very wealthy people, thus excluding all of the mostly working class people of West Ocean City from their beaches that they have used for generations. The only people I noticed at the local hearings were worried "summer people" and lawyers for wealthy property owners. "Locals" say "oh, the EPA was bought off."

48. Seems to be an absence of those involved in tourism; perhaps having them as the tourism experts would have been wiser than using the government employees. What efforts are being made to involve the general public and to educate them in this conference so they could participate with some "real time" information?

49. What is your organization doing, or what can it do to support ecotourism ventures? Is there financial or logistical support? Can you advise of grant monies that may be available?

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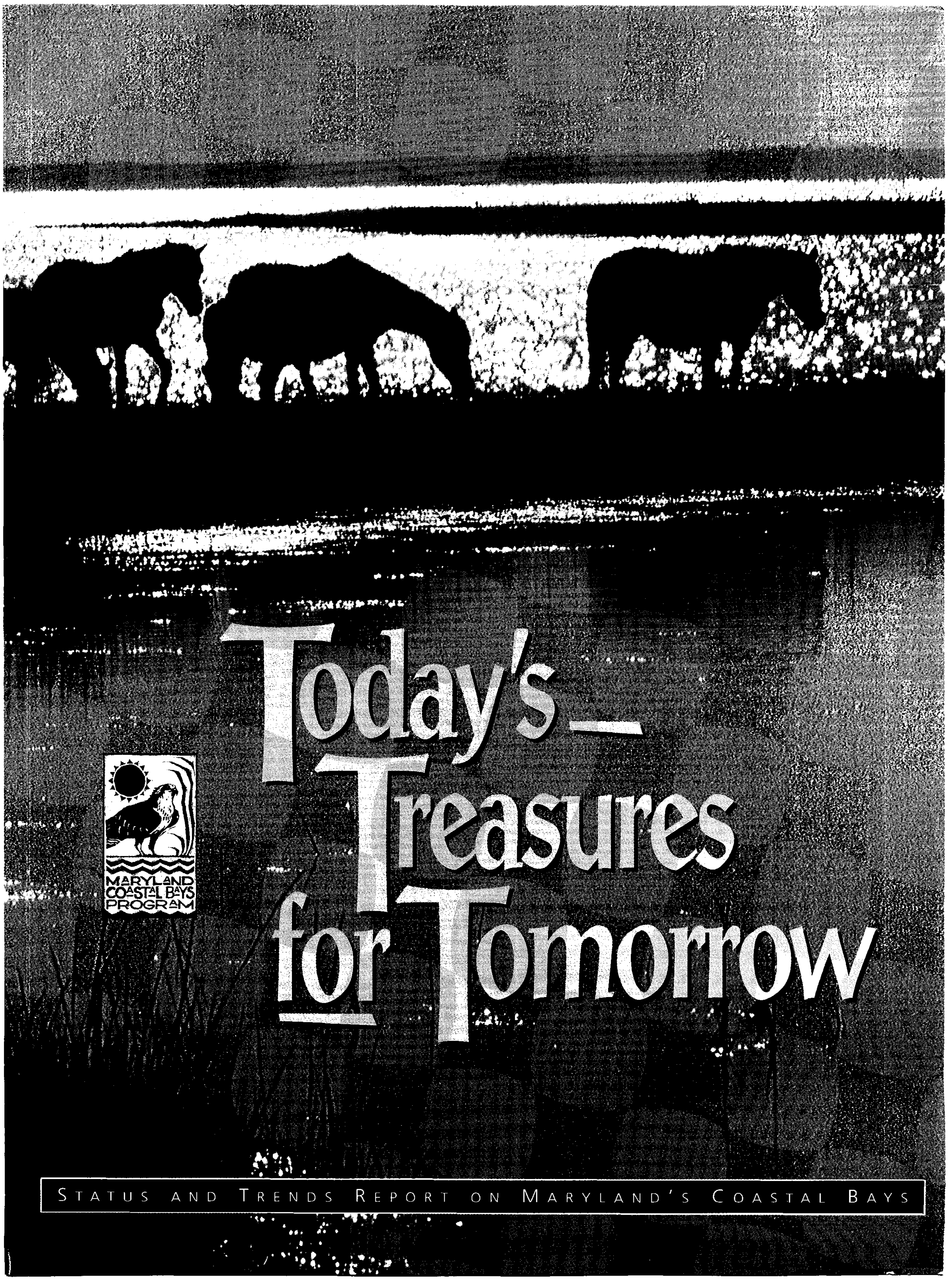

Today's Treasures for Tomorrow

MARYLAND COASTAL BAYS PROGRAM

STATUS AND TRENDS REPORT ON MARYLAND'S COASTAL BAYS

Status and Trends of Eutrophication, Chemical Contamination, Habitat Loss/Modification, Pathogens and Living Resources in the Maryland Coastal Bays

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Table of Contents

List of Figures ....

List of Tables ....

Executive Summary .... -i-

Maryland Coastal Bays and Their Surroundings 1
- Introduction 1
- The Coastal Bays 2
- Changing Land Use 6
- Comparison To Delaware's Inland Bays 7

Eutrophication 9
- The Process of Eutrophication 9
- Nutrient Sources 9
- Loading Rates 14
- Water Quality In the Coastal Bays 16
- Long-term Trends in Water Quality 20
- Comparison With Water Quality in Delaware's Bays 22

Chemcial Contamination 25
- Chemicals in the Marine Environment 25
- Sources of Chemical Contaminants 25
- Bay-wide Chemical Distribution 26
- Dead-end Canals 28
- Chemical Contamination in Living Tissue 29
- Evaluation 30

Habitat Loss and Disturbance 31
- Habitat Loss 31
- Causes of Habitat Loss 32
- Terrestrial Habitats 32
- Marine Environments 36

Living Resources 39
- Living Resources of Maryland's Coastal Bays 39
- Submerged Aquatic Vegetation 39
- Benthos 43
- Endangered and Threatened Species 45
- Colonial Nesting Birds 45
- Fish Communities 45
- Finfish Harvests 46
- Shellfish Harvests 49
- Shellfish Area Closures 50

Conclusions 53

Bibliography 57

Appendix A: GIS Maps (figure A-1 through A-7)

Appendix B: List of Data Sources

Appendix C: Data Source Records

Appendix D: Threatened and Endangered Species List

Appendix E: List of Finfish species caught in DNR fish trawl sampling.

Appendix F: List of Invertebrate and Reptilian species found in DNR trawl sampling.

List of Figures

Figure 1: Worcester County Economics 2

Figure 2: Coastal bays watershed to surface area ratios 5

Figure 3: Coastal bays land use change (1973-1990) 6

Figure 4: Nutrient sources to the coastal bays 10

Figure 5: Chicken and hog production, Worcester County 13

Figure 6: Percentage of bay area failing Chesapeake Bay SAV water quality standards 18

Figure 7: Frequency of mid-day low dissolved oxygen conditions 19

Figure 8: Daily fluctuations in dissolved oxygen related to algal abundance 20

Figure 9: Contaminants with higher concentrations in the artificial canals. 29

Figure 10: Seasonal patterns of water quality in the coastal bays 41

Figure 11: Changes in SAV acreage in the coastal bays (1986-1995) 42

Figure 12: Percent of area of coastal bays with benthic index scores indicative of degraded conditions 44

Figure 13: Coastal bay finfish harvests (1960 - 1990) 48

Figure 14: Coastal bays shellfish harvests (1940 - 1990) 49

Figure A-1: Coastal bays locator map .... Appendix A

Figure A-2: Sediment distribution map .... Appendix A

Figure A-3: The coastal bays watershed .... Appendix A

Figure A-4: Land use in the coastal bays watershed .... Appendix A

Figure A-5: Distribution of submerged aquatic vegetation in the coastal bays .... Appendix A

Figure A-6: Shellfish closure areas .... Appendix A

List of Tables

Table 1: System dimensions 3

Table 2: Estimated annual system-wide nutrient loads in runoff 12

Table 3: Nitrogen loadings 15

Table 4: Phosphorus loadings 17

Table 5: Comparison of nitrogen loading rates to loadings in other estuaries 18

Table 6: Sources of major toxic chemicals 22

Table 7: Sources of major toxic chemicals 26

Table 8: Existing wetlands in the coastal bays watershed 34

Table 9: Tidal wetland losses since the 1930s 34

Table 10: Permitted non-tidal wetlands losses and gains in coastal bays watersheds, 1991-1995 35

Table 11: Chesapeake Bay SAV habitat requirements 40

Table 12: Fish species of the coastal bays showing trends in abundance since the mid 1970s 47

Executive Summary

The Maryland coastal bays are shallow coastal lagoons located behind Assateague and Fenwick Islands, on the Atlantic coast of Worcester county, Maryland. The Maryland coastal bay system enclosed by the two islands consists of five major bays: Chincoteague, Newport, and Sinepuxent Bays to the south (the "lower bays") and Isle of Wight and Assawoman Bays to the north ("upper bays"). Several large tidal tributaries are associated with the bays including the St. Martin River, Turville and Herring Creek in the upper bays and Trappe Creek in the lower bays. Smaller but significant tributaries include Manklin Creek, Greys Creek and Roy Creek. "The Ditch", a canal that connects Little Assawoman Bay in Delaware to Assawoman Bay in Maryland is also hydrologically significant. The coastal bays themselves are shallow, with average depths of 1.2 meters or less.

The total area of the coastal bays watershed is 452 km^2 (Maryland portion), less than twice the area of the coastal bays themselves. As a result, freshwater inputs to the coastal bays are small, and a substantial portion are derived from groundwater flow. The small size of the watershed reduces the susceptibility of the bays to pollutants derived from diffuse sources such as agriculture or suburban development. The tidal tributaries, however, have higher watershed area to surface area ratios and are therefore more sensitive to pollutants derived from these sources. Except in areas adjacent to Ocean City inlet, flushing in the tidal bays (and especially in the tidal tributaries) is inefficient. Limited flushing makes the bays more susceptible to inputs of sediments, nutrients, pathogens and toxic materials because these materials will tend to be retained within the bay systems.

Maryland's lower bays are generally in better ecological condition than are the upper bays, and the upper bays are, in turn, generally in better condition than Delaware bays to the north. The better environmental quality of the coastal bays as you move south along the coast reflects the lower human populations and less intensely developed landscape in the watersheds of the southern bays. The greater environmental problems found in the north and in Delaware, however, also reflects the greater susceptibility to human impacts caused by their larger watersheds, finer sediments and less vigorous tidal mixing.

Eutrophication, Nutrient Dynamics and Water Quality

Existing estimates of nutrient flows to the coastal bays are preliminary. The relative significance of groundwater and surface water as pathways for nutrient delivery to the coastal bays is especially uncertain, as are the contributions to nutrient concentrations in the groundwater and to the coastal bays of septic tanks, land application of manure, and

fertilizer applications in agricultural and suburban lands. Considerable work will be needed to work out the exact inputs from major nutrient sources and the major pathways of nutrient transport in the coastal bays.

Nutrient inputs to the coastal bays are derived primarily from diffuse sources such as atmospheric deposition, agriculture and urban runoff. Only 4% of the nitrogen and 4% of the phosphorus entering the coastal bays come from point sources. Direct atmospheric deposition of nutrients to the bays via rainfall supplies a substantial portion of the nutrients that enter the bays (16% of phosphorus and 32% of nitrogen). Runoff from all land uses accounts for 67% of phosphorus and 55% of nitrogen. Most of the nutrients in runoff are from agricultural sources; under current land use patterns, developed lands account for a relatively small proportion of nutrients (only 1% of phosphorus and 1% of nitrogen).

Total nutrient loading rates to the coastal bays as a whole are low to moderate in comparison to loading rates in other estuaries. But loading rates to several of the tidal tributaries are high, reflecting their relatively large watersheds, as well as local concentrations of poultry production facilities and suburban lands. These high loading rates, combined with the tributaries' poor flushing characteristics make them especially susceptible to eutrophication.

Over-enrichment by nutrients has not resulted in the persistently low dissolved oxygen conditions that have plagued the Chesapeake. The shallow, well-mixed nature of the coastal bays provides a measure of protection against severe or chronic anoxia. However, low dissolved oxygen conditions have been observed on a regular basis only in the artificial canals and in the St. Martin River during the day. Daylight measurements of dissolved oxygen levels give a limited picture of oxygen dynamics since the lowest dissolved oxygen conditions in the coastal bays generally are observed in the early morning. The frequency and extent of early morning low-dissolved oxygen conditions is largely unknown. Future monitoring efforts need to emphasize collection of continuous dissolved oxygen data, rather than just biweekly or monthly measurements taken during daylight hours.

The most widespread water quality problem in the coastal bays appears to be poor water clarity. Turbid conditions in the bays, however, reflect natural conditions as well as human impacts to the ecosystem. The extent to which turbidity can be reduced by management actions is unclear.

Chemical Contaminants

Chemical contaminants of concern in marine environments like the coastal bays include a variety of metals (such as copper and mercury) and organic chemicals (like pesticides and PCBs). Within the Maryland bays, contamination is more widespread and more likely to be severe in the upper bays and in the artificial canals associated with developed

shorelines than in the less intensively developed lower bays. The extent of toxic contamination in the sediments of Assawoman and Isle of Wight Bays is comparable to those observed in other nearby estuaries such as Chesapeake Bay and Delaware Bay.

Existing evidence suggests that sediment concentrations of most persistent organic chemicals (many of which are now banned for use in the U.S.) are declining in the coastal bays, while levels of contamination with metals (especially copper and zinc) are increasing. Copper and zinc have a number of anthropogenic sources, including several associated with recreational and commercial boating activities (anti-fouling paints, wood preservatives, metal coatings and sacrificial anodes used to limit corrosion). Elevated levels of zinc and copper have been observed primarily in the St. Martin River, at marina sites, along developed shorelines, and near stormwater outfalls.

The level of chemical contamination is much greater within the artificial canals compared to other areas of the coastal bays. One study indicated that 75% of the canal areas contained six or more contaminants in the sediments at concentrations high enough to be of concern (exceeded ER-L concentration). Almost all areas within the canals show elevated levels of at least one contaminant. The magnitude of contamination also tends to be higher in canals. Fourteen of the 45 contaminants measured showed higher mean concentrations in artificial canals than elsewhere in the coastal bays. The accumulation of chemicals in the dead-end canals is a cause for concern, and deserves further examination.

Habitat Loss

Historical wetland and forest losses within the coastal bays watershed have been substantial. As much as three quarters of the region's original forested wetlands and almost half its forests have been drained and cleared for agriculture and development. Modification and loss of wetlands and forests have slowed in the last several decades, but the present landscape is substantially altered from it's condition prior to European colonization of the region.

Modification of aquatic habitats also appears to have slowed in the last 20 years as the significance of tidal wetlands and near-shore habitats has been recognized by planners and regulatory agencies. If development projections for Worcester county prove true, however, substantial areas of shoreline and shallow near-shore habitats are likely to be altered to provide for navigation and water-based recreation. Impacts on shallow water habitats of commercial clam harvesting and of increasing recreational boating deserve more careful evaluation. Propeller wash, groundings, and boat wakes can also disturb the bay bottom and resuspend sediments in the water column. Boat wakes can also uproot aquatic plants and accelerate shoreline erosion. Better information is needed on the extent and severity of impacts to coastal bay habitats from recreational boaters.

Living Resources

Commercial catches of finfish have been increasing in the coastal bays for decades. Unfortunately, data on fishing effort in the coastal bays is sparse, and troublesome to interpret. As a result, it is difficult to be certain whether important commercial and recreational fish stocks are being overexploited, although several species are showing signs of stress. While abundance of most fish species has fluctuated over the last twenty years, the numerically most abundant species in the coastal bays of twenty years ago (bay anchovy, Atlantic silverside, spot, Atlantic menhaden) remain the most abundant species in both Chincoteague Bay and the northern bays today. This contrasts markedly with what has occurred in Delaware's bays over the same period. There, fish communities have become increasingly dominated by pollution-tolerant species.

Oyster harvests in the coastal bays have declined precipitously during this century, reflecting harvesting, disease, and predation. Harvests of hard clams increased for most of this century, but have declined since the 1970s. Current crab harvests are robust, but substantially below peak levels of the 1940s and 50s. It appears likely that, if harvests continue at current levels and environmental conditions do not significantly deteriorate, the crab population should remain stable.

SAV beds within the coastal bays are increasing, creating habitat for fish and other aquatic creatures, and helping to improve water quality conditions. The total area of submerged aquatic vegetation beds in Maryland's coastal bays has nearly doubled in the last decade to approximately 1620 hectares. Impacts to SAV from boating (increased turbidity, prop scarring) are severe in the northern bays.

Fish communities show few signs of stress, other than preliminary suggestions of over-exploitation of some fish stocks. However benthic communities covering approximately 40% of the area of the coastal bays show signs of impact from deteriorating environmental conditions. Areas showing degraded conditions are most common in artificial canals and in the tidal tributaries, especially the St. Martin River.

Chapter 1:

Maryland Coastal Bays and Their Surroundings

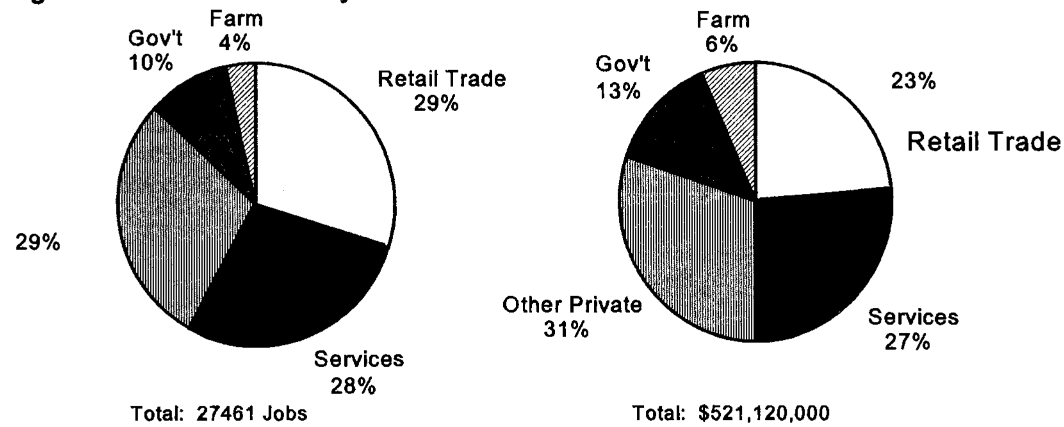
Introduction

Maryland's coastal bays are significant environmental and recreational resources for the state of Maryland and the nation. The bays offer sheltered waters for recreational boating, thousands of hectares of salt marsh and other habitat for waterfowl, shorebirds, other wildlife and populations of shellfish and finfish of both recreational and commercial importance. Their location within a few hours drive of Norfolk, Washington, Baltimore, Wilmington, and Philadelphia, places these environmental resources within easy reach of millions of Americans for weekend visits and vacations. The coastal bays area receives millions of visitors a year. Annually, approximately eight million people visit Ocean City alone (Ocean City Department of Planning and Community Development 1994). Improved regional road networks and the rapid growth of Ocean City over the last several decades have resulted in increased recreational use of the coastal bays and increased development of the bays' shoreline and watershed for recreation and second-home development.

Worcester county's environmental and marine resources have become a major force shaping the local economy. Tourism, second home development, and a growing retired population now drive much of the regional economy. About half of the county's economic activity is in the retail and service sectors, which are heavily oriented towards visitors from outside the county (figure 1) who are attracted by the healthy condition of the local environment and the high quality of life it affords. Therefore, protecting the health of the coastal bays will have economic, as well as environmental benefits.

The Worcester County, Maryland comprehensive plan (Redman/Johnston Associates 1989) envisions continued expansion of the recreation and tourism industries throughout the county. Changes in land use to accommodate this expansion are likely to increase flows of certain pollutants to the coastal bays, while expected increases in ecotourism, boating, fishing and other recreational uses of the bays will place additional direct stresses on the coastal bays ecosystem. A central challenge for the next decade will be to find ways to protect the ecological health of the coastal bays despite increases in environmental stressors.

Figure 1: Worcester County Economics



Source: Maryland Office of Planning 1995

The Coastal Bays

The Maryland coastal bays are shallow coastal lagoons located behind two barrier islands, Assateague, the more southerly of the two, and Fenwick (figure A-1 and table 1). The coastal bay system, enclosed by the two islands, consists of five major bays: Chincoteague, Newport, and Sinepuxent Bays to the south (the "lower bays") and Isle of Wight and Assawoman Bays to the north ("upper bays"). Several large tidal tributaries are associated with the bays including the St. Martin River, Turville/Herring Creeks in the upper bays and Trappe Creek in the lower bays. Smaller but significant tributaries include Manklin Creek, Greys Creek and Roy Creek. "The Ditch", a canal that connects Little Assawoman Bay in Delaware to Assawoman Bay in Maryland is also hydrologically significant (Boynton et al. 1993; Cerco et al. 1977).

Natural barrier island processes such as overwash events, the cutting of inlets across the barrier islands during hurricanes and other violent storms, and the formation of tidal shoals help create and maintain habitat and control circulation patterns within the bays and between the bays and the Atlantic. Barrier island overwash events provide a sediment source for the creation of shoals, salt marshes and seagrass beds within the coastal bays. Tidal shoals have also formed because of tidal circulation patterns adjacent to existing inlets and within the northern portion of Sinepuxent Bay. Several inlets have existed across what we now call Fenwick and Assateague Islands over the past 400 years; formation of another connection between the bays and the Atlantic would dramatically alter circulation patterns, salinity, and tidal flushing of the bays.

The coastal bays are shallow, with average depths of 1.2 meters or less (Boynton et al. 1993). The shallow waters are readily mixed by wind, waves and tidal currents. Throughout most of the open portions of the bays there is little difference in water quality conditions between surface and bottom waters. Unlike the Chesapeake Bay, the main

Table 1: System dimensions

Coastal Bay Location	Surface Area ($m^2 \cdot 10^6$)	Average Depth (m)	Volume ($m^3 \cdot 10^6$)	Drainage Area ($m^2 \cdot 10^6$)
Assawoman Bay	22.5	1.20	27.0	24.7
Isle of Wight Bay	15.8	1.22	19.3	17.5
St. Martin River	8.40	0.67	5.63	95.5
Turville/Herring Creek	5.30	0.67	3.55	34.3
Sinepuxent Bay	24.6	0.67	16.5	26.7
Newport Bay	15.9	1.22	19.4	113
Chincoteague Bay (Maryland portion)	189	1.22	231	141
Totals	282		322	452

Source: Boynton et al 1996

bodies of the coastal bays seldom stratify, and long periods of hypoxic or anoxic conditions near the bottom are unusual. Stratification and anoxia are generally confined to sheltered bays and canals, where sediments are finer, nutrient loads greater, and wind-driven mixing more limited (Boynton et al. 1993; Boynton et al. 1996; Chaillou et al. 1996).

The bottom sediments of the coastal bays reflect the nature of underlying geologic formations and the dynamics of lagoons and barrier islands. The sediments in Maryland's coastal bays are sandier towards the ocean islands, and finer near the mainland to the west (figure A-2). The finer textured western sediments are derived from finer underlying deposits, supplemented by deposition and redeposition of silts and clays eroded from adjacent uplands. The sandier sediments behind the barrier islands reflect sand inputs that occur during overwash events (Bartberger and Biggs 1970; Wells et al. 1994a; Wells et al. 1994b).

This east-west gradient in sediment texture broadly influences ecological conditions within the coastal bays. Organic matter, nutrients, and toxic pollutants associate with fine sediments. Benthic communities on fine sediments support different species than do communities that develop on sand. Fine sediments also are readily suspended and resuspended in shallow waters by wind-driven currents. Suspended sediments increase turbidity, reduce light penetration, and thereby reduce both benthic and planktonic primary production.

Net surface water inputs to the coastal bays are small (Cerco et al. 1977; Boynton et al. 1993). River gauging stations on the St. Martin River indicate low flows (0.02-0.03 $m^3 s^{-1}$ or 32-48 gal per minute) even for this major tributary (Cushing et al. 1973). Much of the

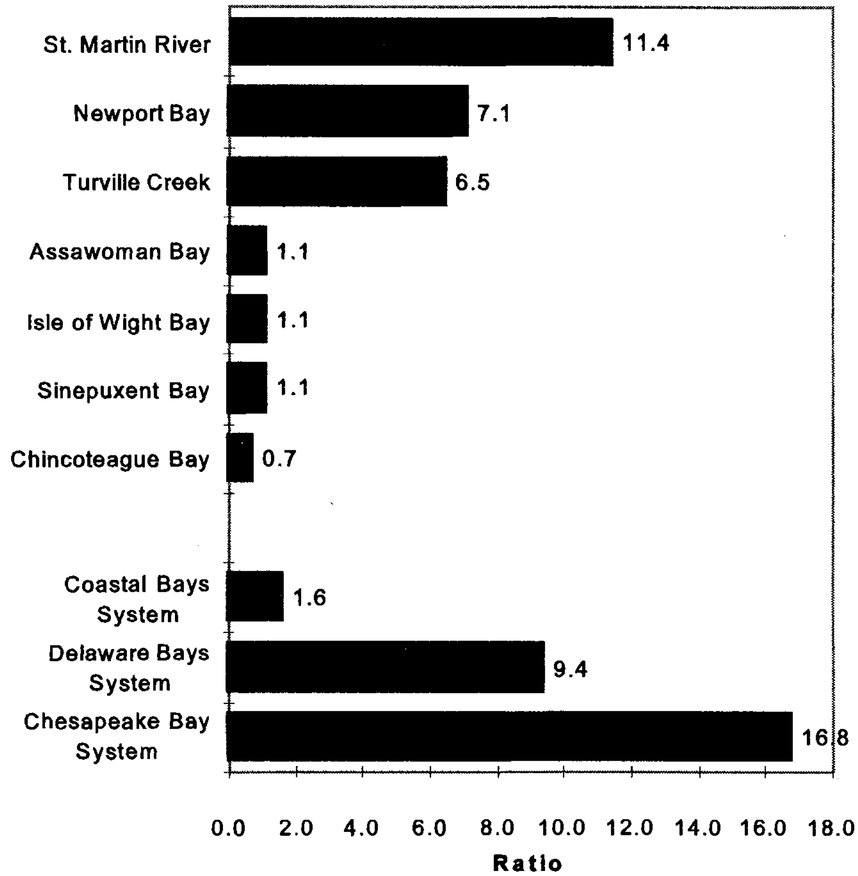
local precipitation evaporates or percolates to groundwater. Upon entering the groundwater system, water may take several years to decades to reach the coastal bays (Hamilton et al. 1991).

The total area of the coastal bays watershed is 452 km^2 or 175 mi^2 (Maryland portion), less than twice the area of the coastal bays themselves (Jacobs et al. 1993). In comparison, the Chesapeake Bay watershed has approximately 28 times the surface area of the Chesapeake Bay (Lipson 1973), while the catchment that drains to Delaware's inland bays is almost 10 times as large as the actual bays (Delaware Inland Bays Estuary Program 1995). The small size of the watershed means that quantities of water and nutrients entering the coastal bays via surface waters are comparatively small relative to quantities entering the bays from other sources. Within the coastal bay system, however, several tidal tributaries, including St. Martin River, Newport Bay/Trappe Creek and Turville/Herring Creek, have high watershed area to surface area ratios (figure 2). These tidal tributaries are more sensitive than the coastal bay system as a whole to increases in pollutant loading from diffuse sources such as agriculture or suburban development.

Most of the coastal bays watershed (figure A-3 is on the mainland of the Delmarva Peninsula (with the rest on Assateague and Fenwick Islands—Jacobs et al. 1993). The area is characterized by low topographic relief, high water tables, poor surface drainage, sandy soils, and an abundance of wetlands. Groundwater hydrology is complex, including both confined and unconfined aquifers (Hamilton et al. 1993). Shallow, unconfined groundwater generally flows over a period of years from topographic highs near the watershed drainage divides toward discharge areas along local streams, tidal shorelines, and the wetlands that fringe the bays.

Freshwater input into the coastal bays is substantially derived from ground-water flow and tends to be small throughout most of the watershed because of the low ratio of total watershed area to the surface area of the bays (Shedlock et al. 1993; Böhlke and Denver 1995). For Chincoteague Bay, the only bay for which a detailed water budget has been developed, freshwater inflows average less than 1/1000 of the volume of the bay per day, or about 1/3 of the volume of the bay per year (Pritchard 1960). In the central portions of the coastal bays, freshwater inputs (from runoff, direct discharge of groundwater and precipitation) have only a small effect on salinity. Thus salinity in the main body of the coastal bays tends to be near that of ocean water (from about 26 to about 31 parts per thousand). Salinity in the bays follows a seasonal cycle and tends to be lowest in the winter and early spring, when freshwater inflow is the greatest and evaporation is at its annual minimum.

Figure 2: Coastal bays watershed to surface area ratios.



Sources: Lipson 1973, Delaware Inland Bays Program 1995 , Boynton et al. 1993 , Jacobs et al. 1993.

During the summer months salinities in Chincoteague and Assawoman Bays may exceed that of normal sea water due to evaporation. Freshwater inputs, however, reduce salinity significantly within the tidal tributaries, the headwaters of which generally remain fresh (Pritchard 1960; Cerco et al. 1977; Boynton et al. 1993).

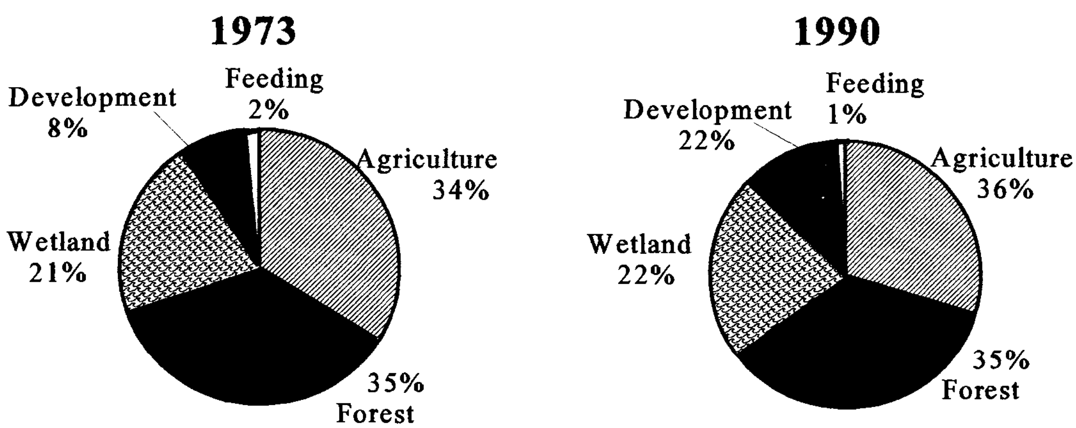
Tidal exchange with the Atlantic plays a key role in the ecology of the coastal bays. Tidal ranges and tidal currents are strongest near Ocean City and Chincoteague inlets, and drop off with distance from them. Within Maryland's coastal bays, Sinepuxent Bay and Isle of Wight Bay near the Ocean City Inlet have greater tidal ranges and higher tidal currents. The tidal range near the Ocean City inlet is over one meter, while it drops to 0.1 meter in the center of Chincoteague Bay (ACOE 1994). The other bays and the tidal tributaries have more limited tidal exchange. It has been estimated that it takes about 63 days for 99% of the water in Chincoteague Bay to be replaced by tidal exchange (Pritchard 1960). Sediments, nutrients, pathogens and toxic materials appear to be

effectively retained within the bay systems because of this limited flushing (Quinn et al. 1989; Boynton et al. 1996).

Changing Land Use

The watershed of Maryland's coastal bays is dominated by forest lands and wetlands, with the two categories together accounting for more than half of the land area within the watershed (figures 3 and A-4). Slightly less than a third of the watershed is used for agriculture, while another one to two percent of the watershed supports animal (primarily poultry) feeding operations. Only about 9% of the watershed is currently in developed land. The relative proportion of wetlands and forests within the coastal bays watershed has not changed appreciably in the last two decades (figure 3), but the amount of developed land has increased from 7% to 9% of the watershed area, largely at the expense of agricultural lands. The amount of developed land in the watershed is likely to rise sharply in the future, with increased losses of wetland and forest if anticipated economic growth in the region occurs without adequate planning (Redman/Johnston Associates 1989; Jacobs et al. 1993). The possibility of extensive conversion of lands on Fenwick Island is limited by the small amount of undeveloped land remaining on the island (Ocean City 1989). Conversion of substantial areas of agricultural and forest land for commercial and residential purposes is more likely on the adjacent mainland, especially within the watersheds of Assawoman Bay and its tidal tributaries.

Figure 3: Coastal bays land use change 1973-1990.



Source: Jacobs,1993 from MD Office of Planning data.

Increased suburbanization can be expected to have a number of effects on the coastal bays. First, suburban lands tend to be rich sources of nutrients, sediments, chemicals and pathogens derived from garden chemicals, road runoff, septic tank leachate, and sewage (Schueler 1987, EPA 1991, Olsenholler 1991). Second, suburban development increases impervious surfaces in the watershed, reducing infiltration, and increasing surface runoff, which degrades stream quality and increases transport of pollutants. Third, poorly planned development frequently results in losses of wetland and forest areas which are important wildlife habitat and play important roles in maintaining hydrologic processes and protecting water quality (e.g., Richardson 1994). The detailed effects of suburbanization on the coastal bays ecosystem, however, are difficult to predict. Many existing land uses within the watershed that would be displaced by suburban development can also be significant sources of pollutants (Jacobs et al. 1993). Despite such uncertainties, estimates of pollutant loads to the coastal bays under projected development conditions suggest that loads of chemicals and pathogens to the coastal bays would increase as suburbs replace agricultural lands.

Comparison To Delaware's Inland Bays

It is valuable to compare Maryland's coastal bays with the similar bays in Delaware. Maryland's lower bays, are generally in better ecological condition than are the upper bays, and the upper bays are, in turn, generally in better condition than Delaware bays to the north. The better environmental quality of the coastal bays as you move south along the coast reflects the lower human populations and less intensely developed landscape in the watersheds of the southern bays.

The greater environmental problems found in the Marylands northern bays and in Delaware also reflect the greater susceptibility to human impacts of the more northern bays. The watershed associated with Delaware's bays is much larger, relative to the size of the bays themselves, than are the watersheds associated with Maryland's bays (figure 2). In accord with what one might expect, freshwater inputs are more significant in the Delaware bays. Annual freshwater discharges to the Delaware bays are two to three times the mean low-water volume of the bays, while annual inflows to Chincoteague Bay have been estimated at about a third of the bay's volume. Tidal exchange is less significant in Delaware's bays than it is in Maryland's bays (Pritchard 1960; Delaware Inland Bays Estuary Program 1995). The sediments in the Delaware bays also are generally finer than those in the Maryland bays (Chaillou et al. 1996). These differences in hydrology and sediments will all tend to make Delaware's bays more susceptible to, and Maryland's bays more resilient to, a variety of anthropogenic stresses.

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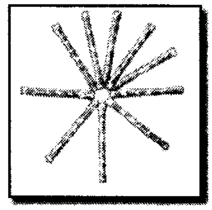
Chapter 2:

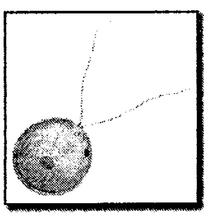
Eutrophication

The Process of Eutrophication



Eutrophication has been defined by Nixon (1995) as "an increase in the rate of supply of organic matter to an ecosystem". The ecological implications of eutrophication can be far-reaching. Coastal ecosystems undergoing eutrophication commonly develop hypoxic (low dissolved oxygen) or anoxic (no dissolved oxygen) bottom waters. Among the impacts of depressed oxygen conditions are reduction in habitat availability for mobile organisms, death of those organisms that can not escape, and reductions in key biogeochemical processes that naturally purge ecosystems of nutrients. In estuaries, eutrophication can cause fish kills, blooms of noxious or toxic algae, declines in biodiversity, reductions in fish populations, decreased submerged aquatic vegetation (SAV), and shifts in species composition of fish and invertebrate communities.

Anthropogenic eutrophication is a serious problem in certain parts of the coastal bays, especially in the northern bays where human activity is more concentrated. Problems are most severe in the tidal tributaries like St. Martin River, and within the dead-end canals along developed shorelines. Many of the canals and tidal tributaries trap nutrients and other pollutants, have limited water circulation to export locally-produced organic matter and are sheltered from wind-driven and tidal mixing. Canals (and to a lesser extent the tidal tributaries) are often seasonally anoxic, suffer occasional fish kills and support reduced diversity and abundance of marine organisms. Within the less sheltered parts of the coastal bays, tidal currents and wind-driven mixing keep the bottom waters well oxygenated and ameliorate the most severe effects of eutrophication. However benthic communities (see chapter 5) suggest that anthropogenic eutrophication may be altering ecological relationships throughout the bays.

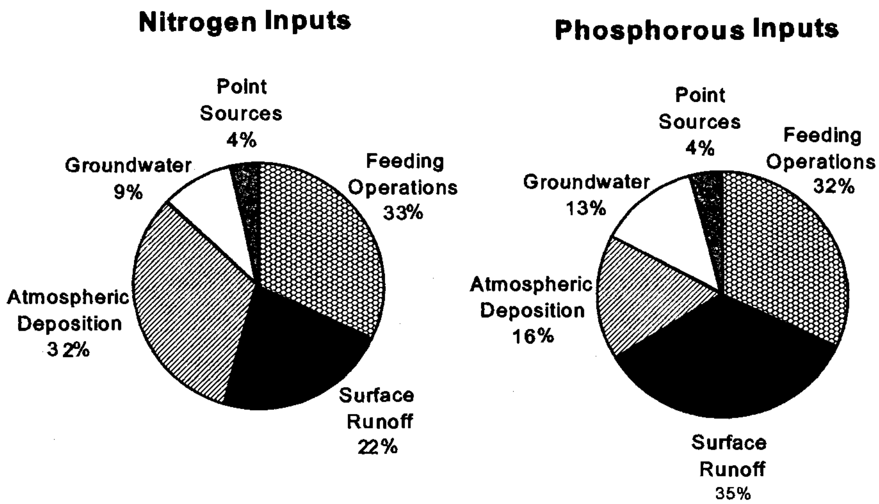


Nutrient Sources

Existing estimates of nutrient loads are indirect, derived not from measurement, but from estimated loading rates that are based on information from other, better-studied estuaries (Jacobs et al. 1993). These estimates are sufficiently accurate to identify major areas of concern, but more work is needed before an exact budget of sources of nutrients entering the bays will be available (Boynton et al. 1993; Jacobs et al. 1993; Boynton et al. 1996). Given the importance of nutrients to the health of the coastal bays, it is surprising that we do not have better information on nutrient inputs.

Non-point sources are the predominate source of nutrients entering the coastal bays (Jacobs et. al 1993). While there are currently four sewage treatment plants and three industrial plants that discharge into Maryland's coastal bays (ACOE 1994), the total amount of nutrients entering the bays from point sources is small. As of 1990, only about 4% of the nitrogen and 4% of the phosphorus entering the coastal bays came from point sources (Jacobs et al. 1993; figure 4).[1]

Figure 4: Nutrient sources to the coastal bays.



Sources: Jacobs et al 1993 , Boynton et al. 1996.

Hydrologic changes accompanying agricultural or suburban development also exacerbate delivery of nutrients to downstream ecosystems. Increases in impervious surfaces and construction of agricultural and flood control ditches speed delivery of nutrients to the coastal bays and reduce the effectiveness of natural filtering systems such as wetlands and forests.

Despite the apparent significance of non-point sources of nutrients to the coastal bays, few studies have explicitly examined them. Jacobs et al. (1993) looked at loadings to Maryland's coastal bays from groundwater, runoff and point sources. Cerco et al. (1977) studied nutrients in runoff to Chincoteague Bay alone. Boynton et al. (1996) relied on Jacobs et al. (1993) for estimates of point source, surface water and groundwater nutrient loads, but considered atmospheric inputs as well.

[1] Estimated percentages of nutrients from each source are calculated from data in Jacobs et al. 1993, and Boynton et al. 1996, except atmospheric deposition of P, calculated on the basis of 111 cm rainfall with an average concentration of 0.064 mg/l phosphorous in rainfall, and following methods used in (Boynton et al. 1996) to calculate N deposition.

We have combined information from several previous studies to develop nutrient budgets for the coastal bays. We have estimated atmospheric inputs following the methods of Boynton et al. (1996), which are based on average annual rainfall and data on average nutrient concentrations in rainfall in the region. We relied on Jacobs et al. (1993) for estimates of pollutant loads in point sources, and for estimates of nutrients delivered to the bays in groundwater and surface runoff. The resulting system-wide nutrient budgets are presented in table 2 and figure 4. Future work is necessary to reduce the uncertainty in these estimates.

The nutrient budget suggests groundwater, atmospheric deposition and agricultural runoff are significant non-point sources of nutrients to the coastal bays. Because the surface area of the coastal bays is large compared to the size of the watershed, direct atmospheric deposition of nutrients to the bays via rainfall supplies a substantial portion of the nutrients that enter the bays (16% of phosphorus and 32% of nitrogen). Runoff from all land uses accounts for 67% of phosphorus and 55% of nitrogen. Under current land use patterns, developed lands account for a relatively small proportion of nutrients (1% of phosphorus and 1% of nitrogen) entering the coastal bays; however, nutrient inputs from this source may be underestimated. Most of the watershed remains in agriculture, forest or wetlands; as the proportion of the coastal bays watershed in urban and suburban lands increases, nutrient and other water quality problems derived from urban runoff will increase. On a per-unit-area basis, runoff from animal feeding operations (predominately poultry production facilities) and high-density urban areas are the most significant sources of nutrients. Because both of these land uses are relatively uncommon within the watershed, however, other more extensive land uses such as croplands and lower-density urban lands are cumulatively more important to the nutrient budget for the coastal bays.

The significance of groundwater as a path for nutrient delivery to the coastal bays is uncertain. Septic tank leachate from residential areas and fertilizers and manure applied to agricultural lands can rapidly leach into the groundwater system. Water in the unconfined aquifers of the central Delmarva Peninsula frequently contains elevated levels of nutrients, especially nitrate (Hamilton et al. 1993; Jacobs et al. 1993). At present, too little is known about (1) concentrations of nitrogen in the groundwater, (2) groundwater flow patterns, and (3) biological processing of groundwater nitrogen in aquifers and discharge zones to permit precise delivery estimates. The only extant estimate of nutrient delivery via groundwater (Jacobs et al. 1993) suggests that it is an important, but not dominant pathway of delivery of nutrients to the coastal bays, (9% of nitrogen, 13% of phosphorus; see figure 4). However, these relatively low values appear inconsistent with the low topographic relief and permeable sediments of the coastal bays watershed. The true proportion of nutrients entering the bays via the groundwater may be substantially greater. Better information is

needed on nutrients entering the groundwater, the importance of groundwater as a medium of nutrient transport to the bays.

Table 2: Estimated annual system-wide nutrient loads in runoff.

Land Use Category	1990 Land Use Hectares	Phosphorus kg/yr	Nitrogen kg/yr
Residential- Low Density	1814	381	2722
Residential - Med Density	304	131	487
Residential- High Density	513	565	2566
Open Urban Land	410	246	4098
Forested Large Lot	13	3	33
Commercial	686	452	2742
Industrial	31	23	200
Institutional	79	52	315
Extractive	35	21	349
Agriculture- Cropland	15898	34976	262322
Agriculture- Row And Garden	73	0	0
Agriculture- Pasture	106	86	550
Agriculture- Orchards	18	4	46
Agricultue- Feeding Operations	655	36822	479620
Agriculture- Other	72	0	0
Forest	18692	3738	46729
Wetlands	8144	-2036	0
Beaches	564	0	0
Bare Ground	0	0	0
Totals	48108	75464	802,781

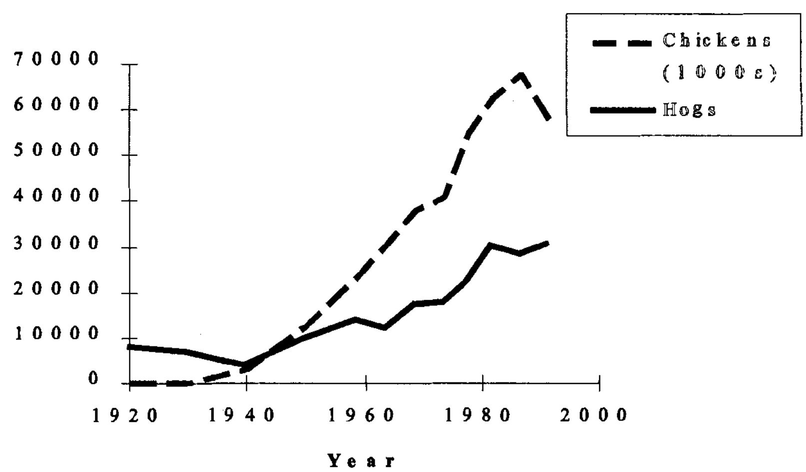
Source: Land use From Maryland Office of Planning, Loadings recalculated from Jacobs et al. 1993.

Five decades ago, there were few chickens produced in Worcester County. Now more than 60 million broilers are produced there annually (figure 5). Hog production in confined feeding operations has also increased. The rise in poultry and hog production represents a substantial increase in imports of nutrients into the coastal bays watershed in the form of feed for livestock. While some of the nutrients contained in that feed is

exported as poultry and pork, the majority stays within the watershed as manure and other wastes. Releases of nutrients to surface and groundwater can be minimized through the use of a variety of best management practices. Indeed, with appropriate management, some of the nutrients associated with these wastes are offset by reductions in use of inorganic fertilizer on adjacent agricultural lands. Nevertheless, poultry and hog wastes are concentrated sources of both nitrogen and phosphorus, and nutrient releases from poultry and hog facilities can be exacerbated by poor management practices and improper manure handling. Storage of manure in unconfined areas or spreading manure too close to streams and ditches may lead to elevated nutrient concentrations in surface runoff. Land-application of manure in excess of rates at which the nutrients in the manure can be utilized by crops, or during times of year in which plant uptake of nutrients is slow, can increase concentrations of nutrients in groundwater as well. Thus, poultry production may present a significant source of nutrients to the coastal bays that has grown substantially in importance over the last few decades.

Modified loading coefficients were developed by Jacobs et al. (1993) based on estimates of nutrient loadings from poultry production facilities in EPA reports. It appears they based their loading estimates on data on runoff from concentrated animal wastes. Straightforward use of these runoff coefficients, however, resulted in what the authors considered "unrealistic estimates of total nutrient loads from these sources."

Figure 5: Chicken and hog production, Worcester County.

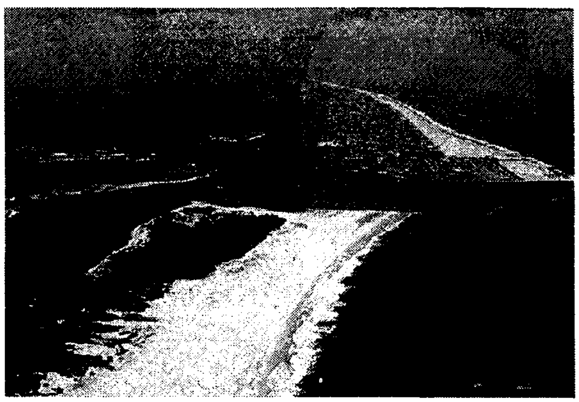


Sources: U.S. Department of Commerce 1956, U.S. Department of Commerce 1994 , U.S. Department of Commerce 1962, U.S. Department of Commerce 1972 , U.S. Department of Commerce 1981, U.S. Department of Commerce 1989; Lessley and Hamilton 1967, Lessley and Beiter 1972, MDA 1994 .

Accordingly, Jacobs et al. (1993) applied the EPA-derived loading coefficients in a

modified way to account for the limited exposure of concentrated animal wastes within the land area occupied by animal feeding operations. Effectively, their method applies loading coefficients to poultry production facilities (56.4 kg•ha^{-1}•yr^{-1} for phosphorus, 733.35 kg•ha^{-1}•yr^{-1} for nitrogen) that are slightly over one quarter of the value from EPA sources for runoff from concentrated animal wastes.

Complete nutrient budgets for the coastal bays would require that we examine all nutrient sources and transport paths, including point sources, surface runoff, groundwater, atmospheric deposition, nutrient regeneration from the sediments and advection of nutrients in tidal exchanges with Delaware's inland bays and the coastal Atlantic. To our knowledge, no study has yet attempted to account for all these sources. The Boynton et al. (1996) study comes closest, by accounting for all these inputs except tidal flows, for which much of the necessary data do not exist. In an intensive one-day study, Welch et al. (1994) observed net nutrient transport out of Maryland's Assawoman Bay and into Delaware's Little Assawoman Bay via "the Ditch", the canal that links the two, but it remains unclear whether Little Assawoman Bay represents a source or a sink of nutrients to the Maryland bays on a longer term basis.



Loading Rates

Nutrient loading rates to the coastal bays as a whole are generally low (5.20 g N m^{-2}yr^{-1} and 0.41 g P m^{-2}yr^{1}; Boynton et al. 1993, Boynton et al. 1993). Higher loading rates (on a nutrients per area basis) are found in the tributaries such as the St. Martin River and Turville/Herring Creek, both of which are major freshwater tributaries to the coastal bays (table 3 and 4). St. Martin River has the highest areal nitrogen loading rates in the coastal bay system, approaching 40 g N m^{-2} yr^{-1}. The nitrogen loads entering the St. Martin River, therefore, approach (on an area by area basis) the loading rates observed in the Patapsco River, in Baltimore (table 5). The high nutrient loading to the St. Martin River (nitrogen loading) and Turville/Herring Creek (phosphorus loadings) are associated with (1) high watershed to surface area ratios, (2) abundant poultry production facilities, and (3) high levels of suburban development.

Table 3: Nitrogen loadings

Coastal Bay Location	Point Sources	Diffuse Sources	Atmospheric Sources	Total Loading	Areal Loading Rate
	(kg N yr^{-1})	(kg N yr^{-1})	(kg N yr^{-1})	(kg N yr^{-1})	(g N m^{-2} yr^{-1})
Assawoman Bay	0	52,091	39,800	91,891	4.1
Isle of Wight Bay	0	12,969	27,949	40,918	6.5
St. Martin River	18,290	302,867	12,382	333,539	39.7
Turville/Herring Creek	0	78,249	4,953	83,202	15.7
Sinepuxent Bay	10	22,566	35,820	58,396	2.4
Newport Bay	36,939	220,842	20,342	278,123	17.5
Chincoteague Bay (Maryland portion)	29	258,038	318,403	576,470	3.1
Coastal Bays System	55,268	947,622	459,649	1,462,539	5.2

Source: Boynton et al. 1996 and Jacobs et al. 1993

Table 4: Phosphorus loadings

Coastal Bay Location	Point Sources	Diffuse Sources	Atmospheric Sources	Total Loading	Areal Loading Rate
	(kg P yr^{-1})	(kg P yr^{-1})	(kg P yr^{-1})	(kg P yr^{-1})	(g P m^{-2} yr^{-1})
Assawoman Bay	0	4,881	1,488	6,369	0.28
Isle of Wight Bay	0	1,459	1,125	2,584	0.16
St. Martin River	0	7,391	199	7,590	0.90
Turville/Herring Creek	1,569	28,896	498	30,963	5.84
Sinepuxent Bay	2	2,038	1,716	3,756	0.15
Newport Bay	3,318	20,980	940	25,238	1.59
Chincoteague Bay (Maryland Portion)	5	26,421	13,457	39,883	0.21
Coastal Bays System	4,894	92,066	19,424	116,384	0.41

Source: Boynton et al. 1993 and Jacobs et al. 1993

Table 5: Comparison of nitrogen loading rates to loadings in other estuaries.

Location	Total Nitrogen Loading Rate ($g\ N\ m^{-2}\ yr^{-1}$)
Kaneohe Bay, HI	2.2
Maryland coastal bays (Lower Bays)	2.4 - 3.1
Choptank River, MD	4.3
Maryland coastal bays (Upper Bays)	4.1 - 6.5
Albermarle Sound, NC	7.1
Pamlico River, NC	12.0
Patuxent River, MD	12.7
Delaware Bay, DE	18.2
Mainstem Chesapeake Bay, MD	20.5
Narragansett Bay, RI	27.6
Maryland coastal bays (Tributaries)	15.7 - 39.7
Potomac River, MD	29.3
Patapsco River, MD	49.0
Tokyo Bay, Japan	89.1

Source: Boynton et al. 1996

Water Quality In the Coastal Bays

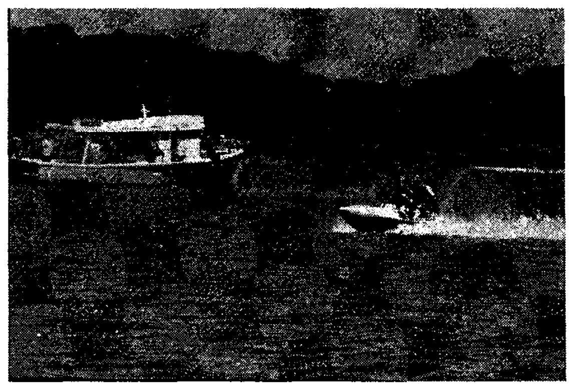
There are several chemical and physical parameters which can describe the quality of a body of water. We follow Chaillou et al. 1996 in reporting water quality conditions in the coastal bays by comparison with levels of biological significance derived from studies of SAV in the Chesapeake Bay. The Chesapeake Bay Program has identified water quality conditions with respect to a number of important water quality parameters that are conducive to the growth and reproduction of SAV in the Chesapeake (see table 10). These conditions describe water quality conditions for SAV in terms of the light attenuation coefficient and concentrations of total suspended solids, chlorophyll a, dissolved inorganic nitrogen and dissolved inorganic phosphorus. Comparing water quality in the coastal bays

with these targets provide an ecologically relevant benchmark against which to compare water quality conditions within the coastal bays, especially with reference to those water quality parameters most directly linked with anthropogenic eutrophication.

While these targets are useful as benchmarks, it is important to realize that the way the data from Chaillou et al. (1996) were collected precludes drawing conclusions about whether water quality conditions in the coastal bays are suitable for growth of SAV (see chapter 5). Instead, the data presented here are valuable because they provide a way of assessing the relative frequency of conditions in the range at which negative biological consequences begin to appear.

In comparison to these biologically relevant water quality conditions, over enrichment with nitrogen (dissolved inorganic nitrogen >10 M) occurs during the summer in 13% of the area of the coastal bays as a whole, and is especially common in Assawoman Bay. Over-enrichment with phosphorus (dissolved inorganic phosphorus >0.67 M) occurs less often (in 9% of the area of the bays), but is most abundant in the tributaries and in the artificial canals. An excess of phytoplankton, as measured by the amount of chlorophyll-a in the water (chlorophyll-a >15 g/l) occurs in an estimated 16% of the area of Maryland's coastal bays. However, excess chlorophyll-a concentrations occurred in 30% of the area of Assawoman Bay, 40% of Trappe Creek/Newport Bay, and 80% of St. Martin River (figure 6; Benyi et al. 1996).

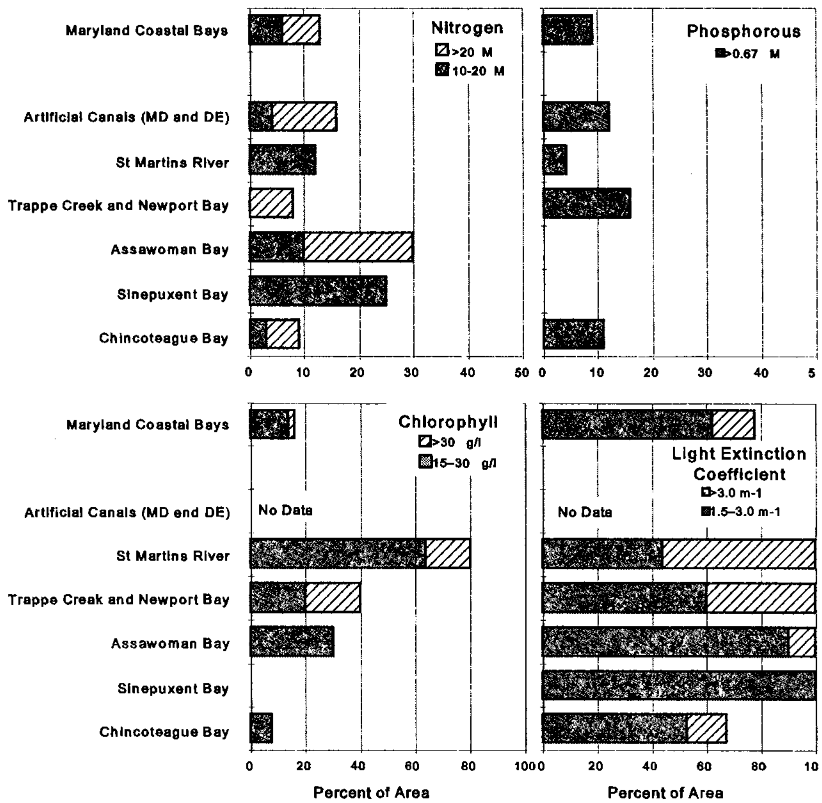
The most widespread water quality problem identified by comparing existing conditions with conditions thought to be needed to permit the growth of submerged aquatic vegetation is poor water clarity. Whole sections of the coastal bays, including Trappe Creek/Newport Bay, St. Martin River and Assawoman Bay have water clarity insufficient (light attenuation coefficient, $K > 1.5\ m^{-1}$) to meet the SAV restoration goals used in the Chesapeake Bay. Only 22% of the area of the coastal bays as a whole has water that satisfies these targets, and that area is almost entirely in Chincoteague Bay.



Human activities contribute to, but alone do not cause, the high-turbidity conditions often observed in the coastal bays. Much of the bottom of the northern and western portions of the bays are covered with fine sediments. Because local waters are so shallow, currents driven by wind and tide and turbulence associated with surface waves can be strong enough to pick sediments off the bottom and resuspend them in the water column. A dynamic equilibrium between settling and suspension processes determines suspended sediment load and influences water clarity. While it is true that these processes are especially important in the shallow coastal bays, human activities influence water clarity by altering the balance between suspension and

settling processes. Boating activities increase turbidity because wakes and propeller wash suspend and slow resettlement of sediments. Erosion of adjacent uplands and the resulting transport of fine sediments to the bays can alter the abundance of fine sediments on the bay bottom, again shifting the suspended sediment equilibrium. Existing information on present and historic anthropogenic inputs of fine sediments to the coastal bays and their effects on the sediment equilibrium are limited.

Figure 6: Percentage of bay area failing SAV -based standards.

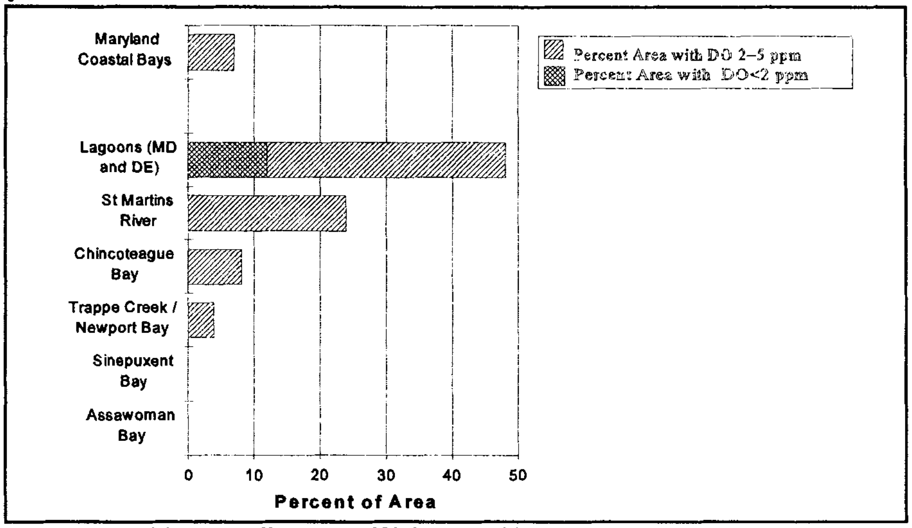


Sources: Benyi et al. 1996, Chaillou, and Weisberg 1996

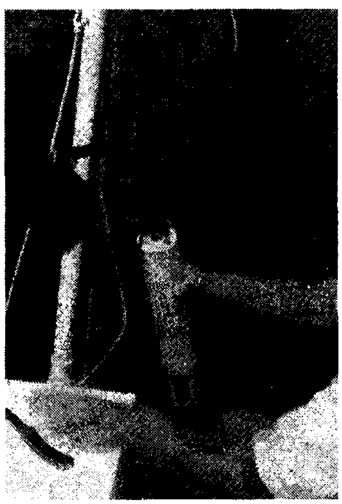
While Maryland's coastal bays are showing some signs of over enrichment by nutrients, enrichment has so far not resulted in chronic low dissolved oxygen conditions like those that have plagued the Chesapeake. This is due to mixing processes which appear to efficiently re-oxygenate the shallow waters, limiting stratification and the potential for persistent low dissolved oxygen. Nonetheless, dissolved oxygen levels low enough to be cause for concern (DO < 5 mg/l) have been found in 7% of the coastal bays during summer daylight hours (Benyi et al. 1996; figure 7). Only in the artificial canals and in the St. Martin River are daytime low dissolved oxygen conditions frequent (occurring in 48% and

24% of these areas, respectively). Even infrequent observations of low D.O. is cause for concern; it shows that the natural resistance of these shallow-water systems to low-oxygen conditions has been overcome (Boynton et al. 1996; Chaillou et al. 1996).

Figure 7: Frequency of mid-day low dissolved oxygen conditions within the coastal bays.



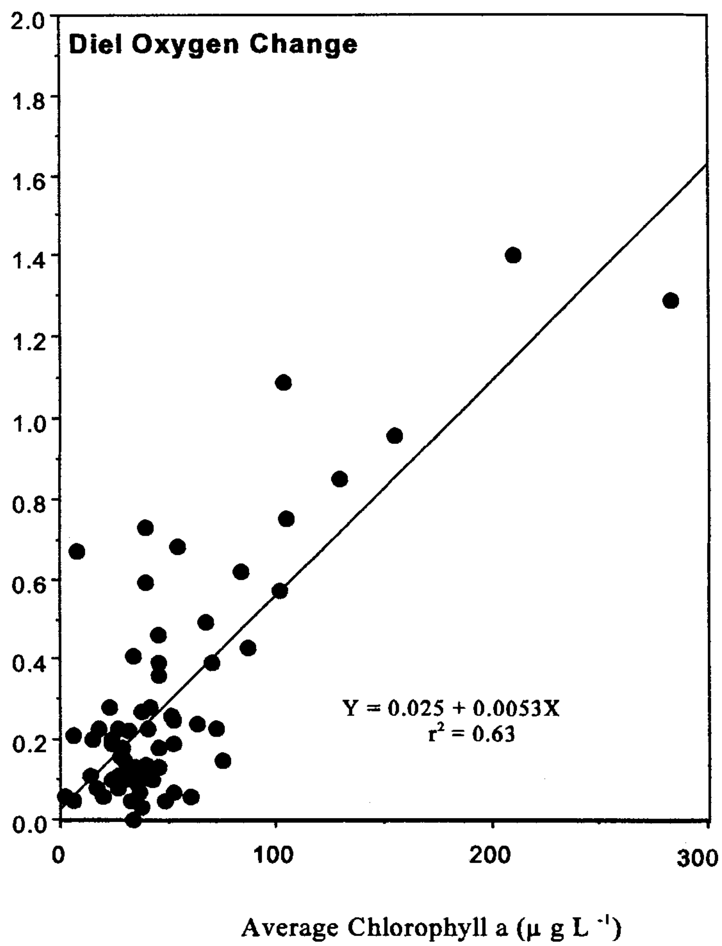
Source: Benyi et al. 1996, Chaillou, and Weisberg 1996



Daylight measurements of dissolved oxygen levels give only a partial picture of oxygen dynamics within the coastal bays. Low-dissolved oxygen conditions within the bays are likely to be more widespread than is suggested by the mid-day measurements alone since the lowest dissolved oxygen conditions occur early in the morning. Few 24 hour studies of dissolved oxygen conditions within the coastal bays have been carried out, so the frequency and extent of early morning low-oxygen conditions remains uncertain.

It is known, however, that the magnitude of daily fluctuations in dissolved oxygen levels in the coastal bays are related to the abundance of algae in the water, as measured by chlorophyll-a concentrations (figure 8—Boynton et al. 1996). Thus the artificial canals and tidal tributaries, where wind-driven mixing processes are attenuated, and chlorophyll-a levels are often high, are likely to be susceptible to early morning hypoxia. Further studies are needed to determine the extent, frequency and ecological effects of diurnal hypoxia within the coastal bays.

Figure 8: Daily fluctuations in dissolved oxygen are related to algal abundance



Source: Boynton et al. 1996.

Long-term Trends in Water Quality

Long-term patterns in water quality conditions within the coastal bays are difficult to determine. Water quality in the coastal bays has been measured by several groups since the 1970s. Nevertheless, those data are difficult to use to identify long-term trends. Until recently, water quality samples were collected at sites not representative of the coastal bays as a whole. In fact, sampling locations for several studies were chosen explicitly because they represented sites at which deteriorating water quality conditions were feared. Data collection at different times of year further complicate the picture.

Some analyses are possible if we restrict attention solely to the southern bays, where the data record is longest and where several studies have measured water quality parameters throughout the year. Data are available going back to the 1970s for both dissolved oxygen and chlorophyll-a (data from Chaillou et al. 1996, NPS 1996, Boynton 1970, and Fang et al. 1977).

A simple comparison is possible by looking only at the southern-bays data from the summer months (June through September), and using a linear regression to examine whether water quality conditions have changed with calendar year. The analysis suggests that water quality conditions have changed ($p<<0.0001$), although very slowly. This analysis suggests that summer dissolved oxygen levels in the southern bays have declined at an annual rate of -0.0552 (±0.01014) $mg \cdot l^{-1} \cdot yr^{-1}$. (The regression equation is $DO = -0.0552 * YR + 116.2909$, $R^2= 0.047$, $F=29.5788$ on 591 observations). The natural log of chlorophyll-a concentrations has also declined at a rate of -0.07331 (±0.006347) G•l-1•yr-1. (The regression equation is $Ln(CHL\_A) = -0.0733 *YR + 147.999$, $R^2= 0.192$, $F=133.408$ on 564 observations).

This simple analysis, however, is not entirely satisfactory, since there remains considerable variability from month to month in water quality parameters even within the summer months. A somewhat better approach to analyzing the southern bay data is to use statistical techniques to estimate seasonal effects, and examine long term trends once such effects have been taken into account. Results of an analysis of covariance (which provides one approach to adjusting water quality information for time of year) suggests that dissolved oxygen levels have slightly declined over time. The estimated annual decline in dissolved oxygen levels is -0.0313 (±0.00661) $mg \cdot l^{-1} \cdot yr^{-1}$. Chlorophyll-a levels in the coastal bays also appear to have declined. The estimated annual decline in Ln(CHL_A) is -0.0755 (±0.004589) $g \cdot l^{-1} \cdot yr^{-1}$ (table 6).

It is difficult to know what to conclude from these analyses. The estimated changes in water quality parameters are very small, and while they are statistically significant, it is likely that they have little biological meaning. Such small changes, when balanced against often profound unexplained variability (as revealed by the low R squared values) also suggests that while detected trends may be statistically significant (meaning it is unlikely to merely reflect a chance occurrence), it probably has little biological meaning. Moreover, not only are the estimated rates of change small, but it is also unclear the extent to which they reflect changes in water quality as opposed to differences in methods and sampling locations between studies carried out over a 30 year period. For the moment it appears best to conclude that existing data are insufficient to support the idea that substantial long-term trends in water quality in the southern bays have occurred over the past 30 years.

Table 6: ANOVA Tables and Regression Statistics for Analyses of Covariance on Water Quality Parameters

Ln(CHL-A)

Regression Statistics	
Multiple R	0.54299253
R Square	0.29484089
Adjusted R Square	0.28482829
Standard Error	0.93287094
Observations	958

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	13	343.855153	26.4503964	30.3940835	4.8757E-63
Residual	945	822.384546	0.8702482		
Total	958	1166.2397			

Dissolved Oxygen

Regression Statistics	
Multiple R	0.68473865
R Square	0.46886702
Adjusted R Square	0.46144891
Standard Error	1.22130156
Observations	1007

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	13	1308.81607	100.67816	67.4977734	1.104E-126
Residual	994	1482.62803	1.49157749		
Total	1007	2791.4441			

Comparison With Water Quality in Delaware's Bays

Nutrient enrichment is more widespread in Delaware than in Maryland. As gauged by the Chesapeake's SAV restoration targets, enrichment with nitrogen occurred in 20% of the area of Delaware's inland bays, and overenrichment with phosphorus occurred in 29% of the area (compared to 13% and 9% in Maryland, respectively). The consequences of

elevated nutrient levels are also more widespread in Delaware. Almost half the area of Delaware's bays (46%) fail the chlorophyll-a concentration targets, compared with only 16% of the area in Maryland. An estimated 13% of the area of Delaware's inland bays show low dissolved oxygen conditions (DO < 5 mg/l) during daylight hours, nearly double the area in Maryland (Benyi et al. 1996).

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Chapter 3:

Chemical Contamination

Chemicals in the Marine Environment

Chemicals include a variety of substances that are dangerous, "toxic," to living organisms at certain levels. Chemicals of concern in marine environments include a variety of metals (such as copper and mercury), organic chemicals (like pesticides and PCBs) and tributyl tin (an ingredient in certain anti-fouling paints). Most chemicals of concern tend to bind to fine sediments and accumulate in plant and animal tissues. Bottom-dwelling organisms therefore, are often exposed to higher levels of chemical contaminants than other organisms, since they are in frequent contact with the sediments. Animals exposed to toxics ingest tiny amounts of the contaminants with each feeding. When organisms can not clear the contaminants from their tissues, the contaminants accumulate within their bodies, producing higher concentrations of contaminants in their tissues than in the surrounding environment (bioaccumulation). Predatory animals are also more likely to be at risk from toxic contaminants due to a process called biomagnification. When this process is repeated several times as predator becomes prey, contaminants can accumulate to hundreds or thousands of times their ambient concentration, leading to environmental and health risks, despite low total concentrations in the environment.

Sources of Chemical Contaminants

Metals in the marine environment come from a variety of sources (table 7). Zinc is used to prevent corrosion of metal parts on boats and marine hardware (as galvanizing coatings and as sacrificial anodes); it is also sometimes used as a pigment in paints and other coatings. Copper is widely used in antifouling paints, wood preservatives and pesticides, and is released through wear of brake parts in automobiles. Lead enters the environment from batteries that are improperly disposed of, through the combustion of leaded fuels and from use in paints. Chromium is used to produce chrome-plated parts for automobiles and other products. Arsenic is a component of some pesticides and is found in the most commonly used wood preservative for marine applications.

Organic toxins include a diverse group of chemicals that derive from a wide variety of sources. PCBs (polychlorinated biphenyls) are highly persistent compounds, which tend to bioaccumulate. PCBs were widely used in electrical equipment and for other industrial purposes into the 1970s. Their use in new products has now been banned, but they are still found in some existing electrical equipment. PAHs (polycyclic aromatic hydrocarbons) are

a large and diverse group of chemicals. Many are produced as byproducts of combustion (for example, in power plants, incinerators and automobile engines). Others are found in petroleum-based products such as lubricants and fuels. Persistent pesticides include chlorinated hydrocarbons like DDT, chlordane and dieldrin. Their use is now generally restricted in the U.S. Tributyl tin is a component of antifouling paints; its use is now restricted in small boats, but it is still used on larger vessels.

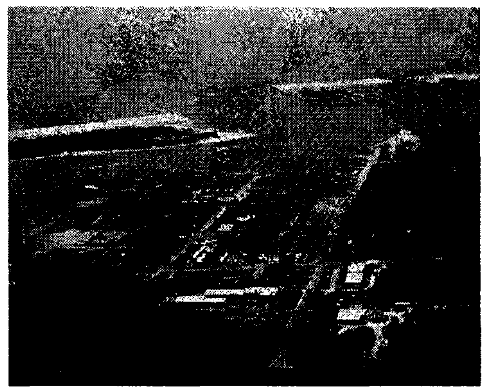
Table 7: Sources of major toxic chemicals.

Toxic Chemical or Chemicals	Type of Toxic Chemical	Primary Uses or Sources	Comments
DDT, DDE, DDD	Chlorinated Hydrocarbon	Insecticide and its breakdown products	Banned in the USA.
Chlordane	Chlorinated Hydrocarbon	Mix of several chlorinated insecticides	Use on crops banned in USA in the 1970s. Use for termite control stopped in the 1980s.
PAH	Polycyclic Aromatic Hydrocarbons	Oil spills, by-products of combustion, creosotes, tars, natural sources	Naturally occurring substances but abundance has been greatly increased by human activity.
PCBs	Polychlorinated Biphenyls	Used in electrical transformers and capacitors	Banned for use in new equipment in the 1970s. Still found in some older equipment.
Tributyl tin, dibutyl tin, monobutyl tin	Organo-metalic Compounds	Antifouling paint and its breakdown products	Banned for use on vessels under 70 feet long.
Copper	Metal	Antifouling paints, wood preservatives, auto part wear, pesticides, plumbing	
Arsenic	Metal	Wood preservatives, pesticides	
Nickel	Metal	Paints and finishes	
Zinc	Metal	Galvanized metals, sacrificial anodes to prevent corrosion of metals in seawater, pigments and paints	
Lead	Metal	Paints, leaded fuels, batteries, plumbing	Ban of its use in auto fuels sharply reduced releases
Chromium	Metal	Chrome plating of metals	
Cadmium	Metal	Batteries, paints, pesticides	

Bay-wide Chemical Distribution

Data on chemical contamination of the coastal bays remains scarce. Recent studies (Wells et al. 1994b, Chaillou et al. 1996) have examined levels of various contaminants in the sediments on the basis of threshold values identified by Long and Morgan (1990) and Long et al. (1995). The lower, or ER-L concentration threshold corresponds to a sediment concentration of the contaminant above which biological effects begin to appear. The higher, or ER-M threshold corresponds to a concentration above which biological effects are probable. These studies have shown that contamination of sediments with one or more chemicals at or above their ER-L thresholds is common throughout the coastal bays. Severe contamination (either contamination above the ER-M threshold, or lower-level contamination by several toxic chemicals) is less common.

While many contaminants can be transported over long distances by atmos-pheric and other processes, the most severe contamination tends to be found in areas with heavy human activity. Within the Maryland bays, contamination is more widespread and more likely to be severe in the upper bays and in the artificial canals associated with developed shorelines than in the less intensively developed lower bays. Contamination is even more widespread in Delaware's coastal bays (Chaillou et al. 1996).

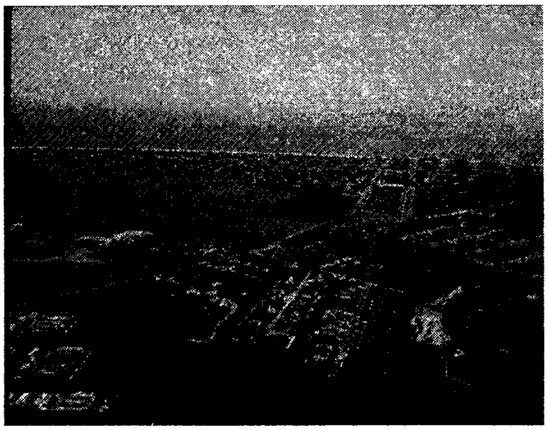


The Maryland Geological Survey carried out extensive sampling of sediments in Assawoman and Isle of Wight bays looking for five metals including chromium, copper, magnesium, nickel and zinc. They found no sites with excessively high concentrations of metals. While approximately a quarter of the sites sampled had concentrations of one or more of these metals (especially nickel) above the ER-L threshold, no sites showed levels above the ER-M level (Wells et al. 1994b).

Comparisons of concentrations of metals in the recently deposited surface sediments with concentrations in deeper sediments suggested that levels of copper and zinc have increased in the recent past, while concentrations of other metals have not. Elevated levels of zinc and copper were found primarily in the St. Martin River, at marina sites, along developed shorelines and near stormwater outfalls. This pattern suggests that elevated levels are associated both with fine sediments and with high levels of human activity (Wells et al. 1994b).

A recent study of the Maryland and Delaware coastal bays also examined sediments for signs of chemical contamination (Chaillou et al. 1996). The study examined sediments for abundance of persistent toxic chemicals, including metals, organic pesticides, PAHs and PCBs. They estimated that 68% of the area of the Maryland and Delaware coastal bays

combined had concentrations of at least one contaminant that exceeded ER-L thresholds. That figure probably over-estimates the extent of contamination in Maryland's coastal bays, because Maryland's bays are sandier and have less intensively developed watersheds than those in Delaware. Nevertheless, the study's results suggest that areas in Assawoman and Isle of Wight Bays with concentrations of at least one chemical at or above ER-L thresholds are about as common as similar sites in other nearby estuaries such as Chesapeake Bay (46%) or Delaware Bay (34%—Chaillou et al. 1996).



Dead-end Canals

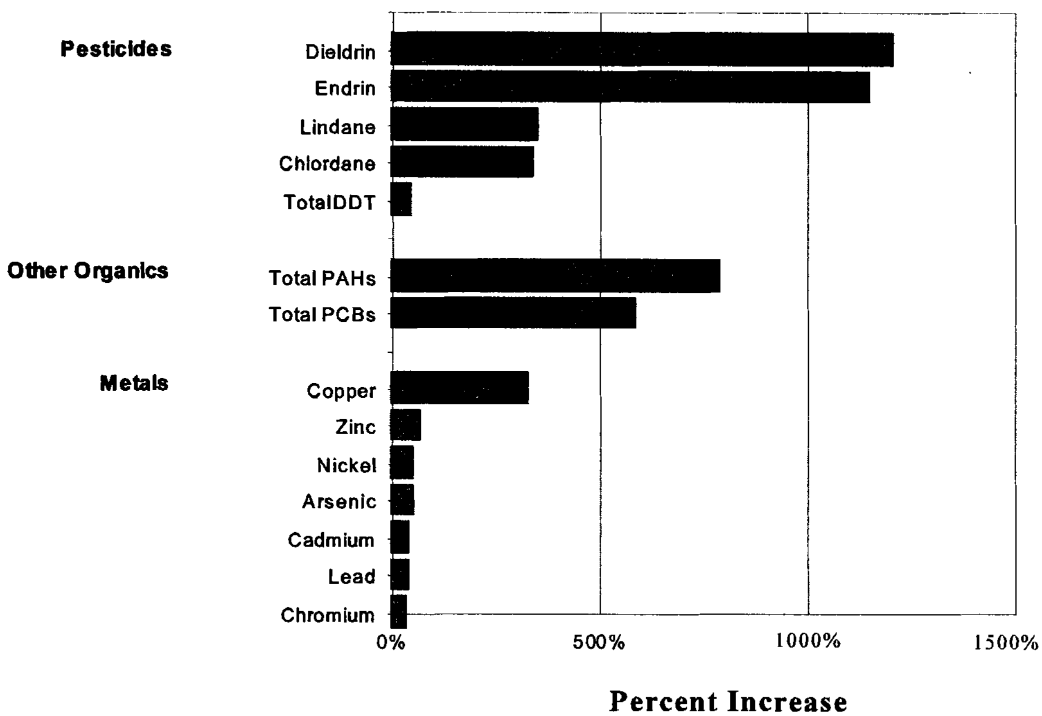
The report by Chaillou et al. (1996) also revealed that contaminants were especially prevalent within artificial dead-end canals. Dead-end canals, which represent 4% of the total area of the coastal bays, are basins constructed to permit or improve navigational access to the water. They are typically long, narrow basins or channels associated with marinas or shoreline housing developments. The flushing characteristics of the canals are often poor because (1) most are long and narrow and (2) the bottoms of the canals are sometimes dredged to be deeper than adjacent parts of the bays. Stormwater outfalls are often located within these canals. A number of characteristics of dead-end canals make them especially vulnerable to toxic contamination. First, even the finest sediments tend to settle out in the still waters of the narrow canals. Since toxic contaminants often bind to fine silt and clay particles, chemicals tend to become concentrated anywhere fine sediments settle out of the water column. Second, boats and bulkheading are themselves sources of several important toxic chemicals including zinc (used for corrosion protection), copper (antifouling paint and wood preservatives), arsenic (a component of wood preservatives) and PAHs (oil). Third, many dead-end canals receive direct runoff from marinas, roads and parking lots which act as sources of metals and PAHs.

The areal extent of low-level toxic contamination in the canals is much greater than in other areas of the coastal bays. Approximately 75% of the area of the canals showed levels of at least six contaminants above the ER-L threshold. Almost all areas within the canals show elevated levels of at least one contaminant (Chaillou et al. 1996).

Fourteen of 45 contaminants measured show higher concentrations in artificial canals than elsewhere in the coastal bays (figure 9). Mean concentrations of arsenic, copper, nickel, chlordane, DDT, endrin and dieldrin within the canals are above ER-L levels. Chemicals that are elevated in the sediments of the canals include contaminants for which

boating activities and urbanization provide likely sources of contamination (copper, zinc and PAHs), as well as contaminants for which no obvious local sources exist (DDT, other pesticides and PCBs).

Figure 9: Contaminants with higher concentrations in the artificial canals.



Source: Based on data in Chaillou and Weisberg 1996. Figures shown are area-weighted mean concentrations observed in Maryland and Delaware artificial canals, expressed as a percentage of area-weighted mean concentrations observed in the coastal bays.

Chemical Contamination in Living Tissue

Only one site in the coastal bays has been sampled repeatedly for the presence of chemical contaminants over the past decade. Samples of oyster tissue have been collected and analyzed every year since 1986 at Chincoteague Inlet, Virginia (NOS 1989; O'Connor and Baliaeff 1996). Oysters are filter-feeders; they are exposed to chemical contaminants in the water they filter, and concentrate certain chemicals in their tissue. Between 1986 and 1993, there have been significant downward trends in the tissue concentrations of chlordane, dieldrin and PAHs (O'Connor and Baliaeff 1996).

Evaluation

Chemicals in the coastal bays are widespread, but outside of the artificial canals they are seldom found at concentrations of biological concern. The persistent organic pesticides such as DDT and chlordane are unlikely to present significant management problems in the coastal bays. Their current concentra-tions are generally below levels that pose environmental risks. All have been banned or their use has been severely restricted within the United States. Thus it is likely that their concentrations within the coastal bays will continue to decline (Boynton et al. 1993).

The accumulation of chemical contaminants (especially metals and PAHs) in the dead-end canals presents the most serious long term management concern with respect to chemicals in the coastal bays. As the boating industry continues to grow within the coastal bays, increased amounts of copper, zinc, arsenic and PAHs can be expected to find their way into the ecosystem. Many of these contaminants will be released from boats moored within artificial canals or from pilings and bulkheads. Runoff from roads and parking lots also contributes both metals and PAHs to the canals, which are often adjacent to developed lands. Road runoff may become a more important source of contaminants to the coastal bays as shoreline areas are more extensively developed.

Chapter 4:

Habitat Loss and Disturbance

Habitat Loss

Habitat loss and modification have been occurring in the coastal bays watershed since before European settlement of the region. Simultaneously, natural processes of recovery such as succession of vegetation in wetlands, regrowth of forests after timber harvesting and re-establishment of SAV in disturbed bay bottom sediments have reduced the environmental consequences of some habitat loss. Given sufficient time, many forms of habitat loss or alteration are at least partially reversible. The time scale of recovery of habitats from disturbance, however, varies tremendously. Recovery of some bay bottom habitats from disturbance takes only a year or two, while recovery of forested wetlands takes many decades. Other habitat losses are essentially permanent. Once constructed, an urban neighborhood built on the bay side of Fenwick Island is unlikely to revert to healthy salt marsh on any timescale relevant for environmental planning. Similarly, oyster bars and reefs that have all but disappeared from the coastal bays are unlikely to recover so long as oyster populations are repressed by disease and predation.

Habitat loss and alteration have both direct and indirect effects on the ecology of the coastal bays. Loss of habitat directly reduces space, food and other resources available to support fish and wildlife. Destruction of certain habitats, such as forests, wetlands and beds of SAV, will have effects disproportionate to their area. Destruction of wetlands and salt marshes both deprives resident and migratory waterfowl and shorebirds of important foraging and resting areas, and also alters hydrological conditions and increases nutrient flows to downstream ecosystems, exacerbating eutrophication. Destruction of even small areas of forest can fragment remaining forests, reducing their value as habitat for forest-interior dwelling birds. Beds of submerged aquatic vegetation not only provide habitat for many marine species, but also play a role in limiting suspension and resuspension of sediments.

A full understanding of habitat loss and alteration therefore requires some understanding not only of processes of habitat loss, but also processes of habitat recovery and the secondary consequences of habitat disruption. The most significant habitat losses therefore are those that (1) occur at high rates, (2) are essentially permanent or for which recovery occur slowly and (3) have significant secondary effects on the ecological condition of the coastal bays and their watershed.

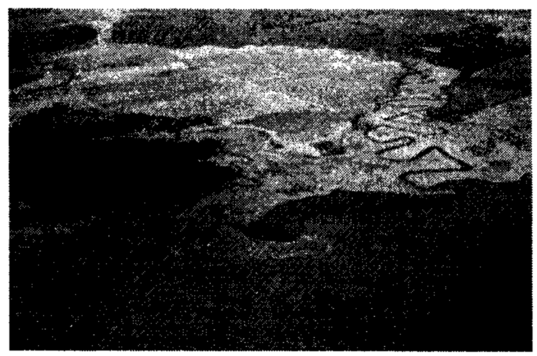
Causes of Habitat Loss

Many activities, from forestry and agriculture to urbanization and marina construction, alter or destroy wetlands, forests and other habitats. Changes in land use alter hydrologic properties or add sediments and pollution to adjacent aquatic environments. Boating, shellfish harvesting activities and dredging disrupt shallow water marine environments. Beach, dune and salt marsh habitats on Assateague Island have been lost due to accelerated erosion of the north end of the island triggered by the engineering works that keep the Ocean City inlet open (ACOE 1994). Even the populations of feral horses on Assateague Island have an effect on wetland habitats. The horses graze salt marshes on Assateague Island, changing their vegetation composition and affecting their value as habitat for other wildlife species (Furbish 1994).

Major recent sources of habit loss and alteration include (ACOE 1994):

- **Urbanization**
- **Construction of marinas, boat slips, navigation channels and canals**
- **Dredging for fill material**
- **Draining of wetlands for agriculture**
- **Erosion of the north end of Assateague Island**
- **Overwash of the north end of Assateague Island**
- **Disappearance of bay islands.**

Terrestrial Habitats



Forests

At the time of European settlement, the coastal bays watershed was dominated by forest. Presently approximately 43% of the coastal bays watershed is agricultural or developed lands. Forests (now mostly second or third growth and often growing on lands that were in agricultural production a few generations ago) have been reduced to slightly less than half of their original abundance. While forests and wetlands still comprise a majority of the landscape, today's forests are fragmented, intermixed with agricultural and urban lands and are often intensively managed for production of wood or fiber. Land use surveys in the coastal bays watershed (Jacobs et al. 1993) show little reduction in the area of forest in the last two decades. Changes in forest quality and in the spatial distribution of forest patches over the same period, however, have not been studied.

Loss of forests has a variety of ecological consequences; loss of forest often increases nutrient losses from forest soils and accelerates soil erosion and topsoil loss. Clearing also

profoundly affects local and downstream aquatic ecosystems. Disappearance of forest alters the thermal and hydrological environment of streams and eliminates a source of energy—leaf-litter-derived detritus—of significance to many aquatic systems. Since forest lands have among the lowest per-acre yields of nutrients, sediments and other pollutants, replacement of forests by other land uses tends to increase flows of pollutants to the coastal bays.

Forest habitats associated with the coastal bays are significant reservoirs of biological diversity and provide important habitat for nesting and migration of neotropical migrant birds. While neotropical migrants are associated with particular habitats on a species-specific basis, overall density of neotropical migrants has been shown to be higher (1) on barrier islands than on adjacent mainland areas, (2) on bay-associated areas than on either inland areas or on seaside coastal regions and (3) close to the water (within 1.6 km) than further from the water (Mabey et al. 1993). Furthermore, as neotropical songbirds from northern North America migrate along the coastal bays, they rely on the naturally vegetated areas along the coastal bay shorelines as primary travel route, foraging and resting locations. The loss of native vegetation from these areas degrades or destroys the corridor necessary for these birds to reach their wintering grounds.

Wetlands

Wetlands provide a variety of environmental and natural resource functions, including improvement of water quality, reduction in the frequency and severity of flooding, the provision of habitat for waterfowl and other wildlife and support of a disproportionate share of endangered species. Wetlands influence regional hydrology by storing and regulating surface flows and acting as discharge or recharge areas for groundwater. Wetlands can also trap sediments and nutrients, reducing flow of these pollutants to downstream ecosystems (Richardson 1994).

At the present time, estuarine emergent wetands (salt marshes) are the most abundant wetland type in the coastal bays watershed, followed by forested freshwater wetlands (table 8). The extent of forested wetlands in the region, however, are likely to be underestimated because of the difficulty of recognizing seasonally saturated forested wetlands in the aerial photographs on which these estimates are based (Tiner and Burke 1995). Forested wetlands within the region have been extensively drained and cleared for agriculture and development (table 9). An unpublished Army Corps of Engineers estimate suggests that 8500 hectares of forested wetlands have been drained for agriculture and an

additional 1620 hectares drained for development within the coastal bays watershed[2]. These figures suggest that three quarters or more of the watershed's original forested wetlands have been

Table 8: Existing wetlands in the coastal bays watershed

Wetlands In the Coastal Bays Watershed (Hectares)	
Freshwater Wetlands	
Forested	2082
Emergent	182
Open Water	153
Scrub-shrub	61
Estuarine Wetlands	
Emergent	6693
Scrub-Shrub	135
Non-vegetated	439

Source: Tiner and Burke 1995

Table 9: Tidal wetland losses since the 1930s

Estimated Tidal Wetland Losses in the Coastal Bays		
Area	*Hectares*	*Cause*
Northern Assateague Island	10-26	Overwash and Erosion
Fenwick Island	163-364	Development
Coastal Bay Mainland	465	Development
Total	637-856	

Source: ACOE 1994

[2] These estimates are contained in a fact sheet describing an Army Corps of Engineers study of environmental restoration opportunities in the coastal bays watershed. The study will appear in a report to be published by the Corps of Engineers in 1997 as Ocean City, Maryland, and Vicinity, Water Resources Feasibility Study; MD-1.

drained, and that at one time, forested wetlands were the most abundant wetland type in the region.

Substantial losses of tidal wetlands occurred within the coastal bays watershed earlier in this century (table 9). The U.S. Army Corps of Engineers has estimated that between 637 ha and 856 ha of tidal wetlands have been lost in the coastal bays watershed since the 1930s. Conversion of salt marshes and other tidal wetlands to upland has been restricted under state law since the early 1970s, by Maryland's Tidal Wetlands Protection Act and under Section 404 of the Federal Clean Water Act since the late 1970s. Losses of tidal wetlands in the recent past have slowed as a result of regulatory programs.

Maryland's Department of Natural Resources and more recently Maryland's Department of the Environment have issued permits and letters of authorization for activities in non-tidal wetlands that result in impacts to 8.3 hectares of wetlands in the coastal bays watershed since 1991 (table 10). Most of these impacts were associated with suburban development, especially in the Ocean Pines subdivision, which was platted prior to current wetlands protection laws. Wetland mitigation and other permitted activities reduce the net loss of wetlands since 1991 to 1.6 ha.

Data on wetland losses are based on permitted wetland impacts. Thus, estimates of wetland impacts do not take into account any undiscovered illegal or unregulated wetland impacts. On the other hand, the data also do not account for wetland restoration not carried out within a regulatory context. Non-regulatory programs such as the USDA's Wetlands Reserve Program are becoming increasingly important in wetland management. These non-regulatory programs, however, tend to focus on provision of wildlife habitat rather than the restoration of wetland functions vital to water quality, and they can not compensate for losses of wetland functions that have resulted from the documented long-term historical losses of thousands of hectares of wetlands.

Table 10: Permitted non-tidal wetlands losses and gains in coastal bay watersheds, 1991-1995.

Watershed	Permanent Impacts	Permitee Mitigation	Programatic Gains	Other Gains	Net Change
	Hectares	*Hectares*	*Hectares*	*Hectares*	*Hectares*
Assawoman Bay	0.06	0.0	0.0	0.0	0.06
Isle of Wight Bay	5.6	0.7	2.0	0.1	2.7
Sinepuxent Bay	0.6	0.8	0.2	0.04	0.3
Newport Bay	1.3	1.1	0.0	0.00	0.06
Chincoteague Bay	0.8	0.0	0.0	1.59	0.77
Coastal Bays Total	8.3	2.7	2.2	1.75	1.62

Source: MDE 1996

Marine Environments

Shallow Subtidal Habitat

Large-scale impacts to shallow subtidal habitats are most significant in the northern bays, where extensive navigation improvements have been made. The U.S. Army Corps of Engineers estimates that 134 ha of bottom have been dredged for navigation, while 74 ha were dredged to acquire fill material to restore Fenwick and Assateague Island beaches. An additional area of approximately 186 ha has been filled by accelerated overwash of sediments into Sinepuxent Bay resulting from stabilization of the Ocean City Inlet (ACOE 1994).

The significance of these habitat alterations remains unclear. Benthic organisms colonize newly available bottom habitat quickly. However, qualitative changes in habitat condition associated with a change in water depth will have longer-lasting effects on both shellfish and fish communities. Since a majority of benthic habitat changes have been concentrated near the Ocean City inlet, cumulative local effects are likely to be significant.

Concern has been expressed about the possible impacts of two other sources of habitat disturbance, (1) disruption of SAV beds and other shallow water habitats by recreational boats and (2) the impacts of shellfish harvesting on bay bottom habitats.

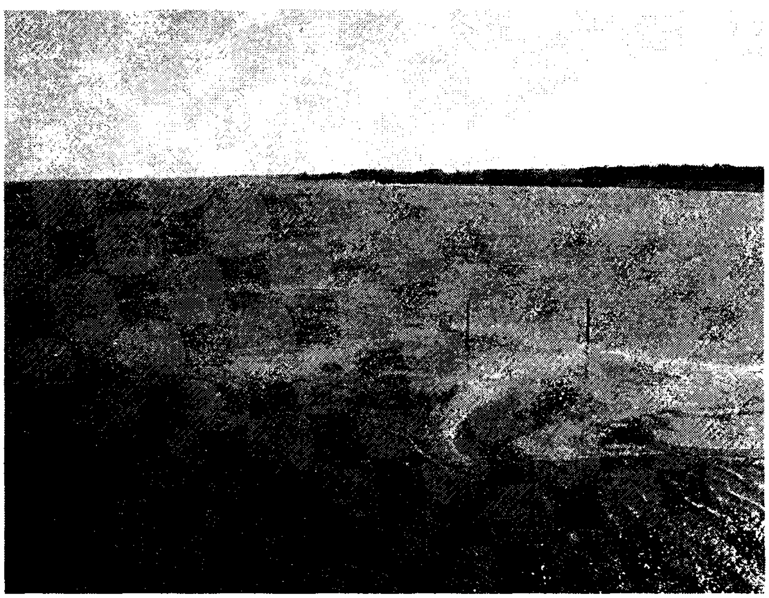
The following example offers calculations to estimate the approximate scale of impact occurring because of commercial clam dredging operations. Assuming about ten active commercial clammers, each dredging about one half hectare of bottom a day for five days a week for four months, the total area disturbed would amount to something on the order of 430 hectares of bay bottom disturbed each year. That area represents about 1% of the total area of the coastal bays, or about the same area of bay bottom as the Army Corps of Engineers estimates has been disturbed by navigation improvements and beach replenishment operations over the last 50 years (ACOE 1994). More information is clearly needed on both the recovery of bay bottom animal communities from disturbance by dredging and on the detailed harvesting practices of commercial clammers; clammers do not harvest all parts of the bays with equal frequency and clamming activity is concentrated in areas in which clams are most abundant. As a result, local impacts may be significant, even if overall impacts are minor. If the areas favored by clammers also contain other significant environmental resources such as submerged aquatic vegetation, the impacts of harvesting may be more important to the ecology of the bays than is suggested by the low proportion of the bottom disturbed annually.

The extent to which recreational boating disturbs aquatic habitat is also difficult to quantify. Both the population of recreational boaters and the proportion of those boaters using watercraft like jet skis that are able to operate in very shallow water are increasing.

Propeller wash, groundings and boat wakes all disturb the bay bottom and resuspend sediments in the water column. Boat wakes can uproot aquatic plants and accelerate shoreline erosion. The noise of recreational boats disturbs wildlife and reduces habitat value of salt marshes and other coastal habitats. Prop scars in SAV beds in Isle of Wight Bay are the worst ever seen in either the Chesapeake or coastal bays[4]. Yet, better information is needed to document the extent and severity of environmental impacts from recreational boaters.

Nearshore Habitats

Efforts to protect shorelines from erosion and to provide access for recreational and commercial boating have resulted in construction of many miles of bulkhead and stone revetments (rip-rap) along the shores of the northern bays. Future development in the coastal bays is likely to be associated with continued demand to protect shorelines from erosion, yet different approaches to protecting shorelines have different effects on the coastal bays ecosystem. Bulkheads protect local shorelines from erosion, but because they tend to reflect rather than absorb waves, bulkheads can exacerbate erosion and sediment suspension in nearby areas. Bulkheads also provide little cover for fish and shellfish. Stone revetments (rip-rap) are an alternative method of protecting high-energy shorelines from erosion. The energy of waves striking a revetment is dissipated on the gradual slope or among the rocks of which revetments are constructed. Crevices and cracks in the rocks also provide hiding places for marine life. Additionally, in moderate to low-energy applications, salt marsh planting techniques can be used to create small fringing marshes. A salt marsh planting not only limits erosion, it also provides valuable habitat for fish, wading birds and invertebrates.



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Chapter 5:

Living Resources

Living Resources of Maryland's Coastal Bays

The coastal bays harbor significant living resources, including but not limited to submerged aquatic vegetation, diverse communities of fishes and benthic organisms, important commercial and recreational fish and shellfish stocks, shorebirds, and threatened and endangered species. Monitoring the condition of these living resources is important to improving living resource management, but an understanding of the condition of the coastal bays' living resources also provides significant insight into the ecological health of the coastal bays ecosystem.

Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) is both a living resource in its own right and also a primary habitat for other marine organisms. SAV also support an amazing diversity of organisms in the "aufwuchs", a thin layer of mostly microscopic organisms living on their leaves, which includes algae, bacteria, protists and many other marine organisms. SAV are highly productive, producing organic matter important to estuarine food webs. For example, SAV beds provide food and shelter for vulnerable life stages of many marine organisms, from peeler crabs to juvenile fishes.

Submerged aquatic vegetation not only plays an important role within estuarine ecosystems, it is also a sensitive indicator of environmental condition. Underwater plants depend on the light that reaches their leaves to support photosynthesis. With insufficient light, the plants eventually die. The intensity of light penetrating the water depends both on water depth and clarity, which is largely determined by the amount of algae and suspended material in the water. Algae and other organisms living on the leaves of aquatic plants also reduce the light the plants receive. If the water is too deep, is not clear, or if nutrients in the water encourage excess growth of algae on SAV leaves, aquatic plants will not survive.

Water quality-based habitat requirements for SAV growth have been examined for eelgrass in the polyhaline (higher-salinity) parts of the nearby Chesapeake Bay (table 11). These habitat requirements may be applicable in the coastal bays, since eelgrass is the dominant species of SAV and habitat requirements are likely to be broadly similar in the two environments. Differences in nutrient dynamics, sedimentary processes and seasonal patterns in salinity and temperature, however, may mean that Chesapeake-derived water quality targets for growth of SAV do not apply directly in the coastal bays. Some scientists

believe that the five parameter approach used to assess habitat quality for SAV in the Chesapeake (based on light attenuation coefficient and concentrations of total suspended solids, chlorophyll a, dissolved inorganic nitrogen and dissolved inorganic phosphorus) is inappropriate for the shallow coastal bays where sediment suspension and resuspension plays a strong role in determining water clarity. These scientists believe that a more accurate representation of habitat suitability for SAV in the coastal bays can be acquired by reliance on a three parameter approach based on nitrogen, phosphorus and chlorophyll-a alone. Other changes in Chesapeake-derived water quality requirements for SAV have also been suggested for application in the coastal bays but the necessary research to identify coastal-bays-specific water quality conditions for SAV has not yet been studied.

Table 11: Chesapeake Bay SAV habitat requirements

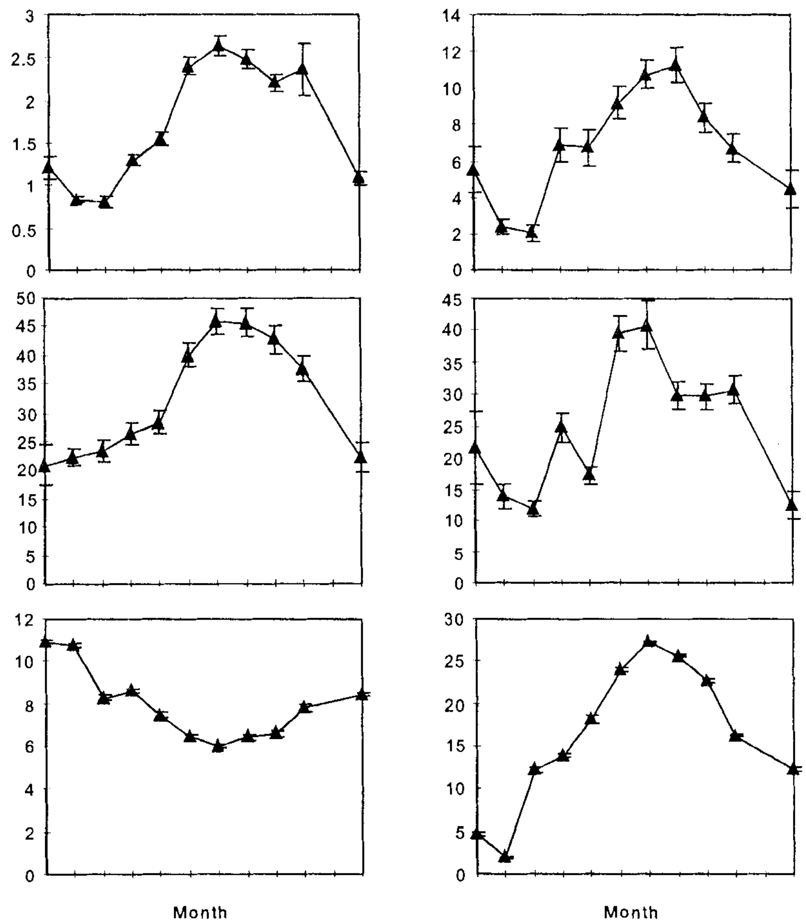
	Total Suspended Solids [1]	Chlorophyll A [2]	Dissolved Inorganic Nitrogen	Dissolved Inorganic Phosphorus	Light Attenuation Coefficient [3] (Plants at a depth of 1 m)
SAV Habitat Requirements [4]	<15 mg/l	<15 g/l	<0.15 mg/l	<0.02 mg/l	$<1.5\ m^{-1}$
Percent of area of Assawoman and Isle of Wight Bays failing to meet standards during summer[5]	70%	45%	10%	<5%	100%
Percent of area of Chincoteague Bay failing to meet standards during summer[5]	45%	10%	25%	10%	60%

1. Total Suspended Solids is a measure of algae, sediments and other particles in the water.
2. Chlorophyll-a is a measure of the abundance of algae in the water
3. Light attenuation coefficient is a measure of the turbidity of water
4. Source: Batiuk et al. 1992
5. Sources: Chaillou et al. 1996, Benyi et al. 1996

Little water quality data, currently available, have been collected in a manner suitable for determining whether the Chesapeake-derived habitat requirements are met within the coastal bays. Recent water quality surveys carried out during the summer months (MDE 1983; MDE 1992; ACOE 1994; Chaillou et al. 1996) have found that conditions throughout much of the coastal bays at that time of year fail to meet the Chesapeake-derived requirements for growth of submerged aquatic vegetation (table 11) because light attenuation coefficients and concentrations of total suspended solids exceed target values (see Chapter 2). Summer water quality measurements, however, may not be appropriate for evaluation of SAV habitat suitability because the dominant species within the coastal bays, eelgrass (*Zostera marina*), shows reduced growth during the summer. Therefore,

but are restricted to data from a small number of sites within the lower bays. Examination of these data confirms the existence of strong seasonal patterns in many water quality parameters that could influence success of SAV (figure 10). Nutrient levels, chlorophyll-a concentrations, and measures of total suspended solids are all higher during the summer, when the system-wide water quality data were taken, than during the spring and fall growing seasons for SAV. Because of insufficient water quality data and the lack of coastal-bays specific information on habitat requirements for SAV, therefore, the extent to which water quality limits growth of SAV within the coastal bays remains uncertain.

Figure 10: Seasonal patterns of water quality in Chincoteague Bay.

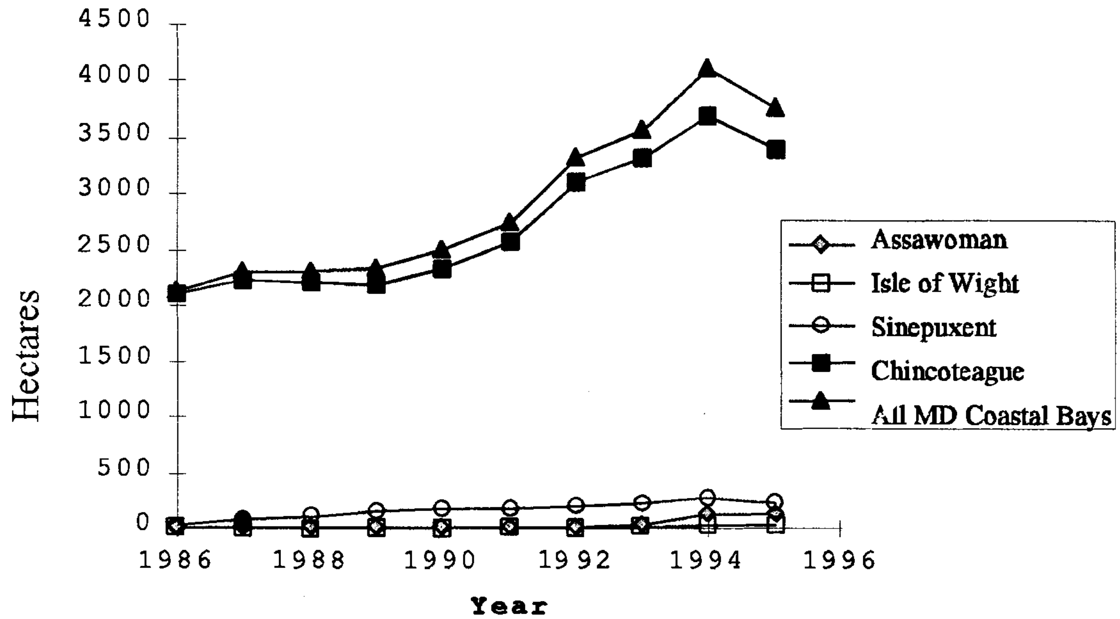


Source: Measure and standard errors calculated from data in NPS 1996.

The total area of submerged aquatic vegetation beds in Maryland's coastal bays has nearly doubled in the last decade to approximately 4,117.5 hectares (figures A-5 and 11). The dominant SAV species include eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*). While SAV is now found in all of Maryland's coastal bays the majority of SAV beds are found in Chincoteague Bay. Populations are largely restricted to the eastern

portions of the bays, in areas with sandy sediments behind the barrier islands. However, there are some beds on the western side of bays. The reasons for the resurgence in SAV are not entirely clear. There is no strong evidence that water quality conditions within the coastal bays have changed in the past decades in ways that would encourage SAV growth. In the 1930s, eelgrass populations throughout the mid-Atlantic region were decimated by eelgrass blight. Populations in the coastal bays, as in other mid-Atlantic estuaries, have been slowly recovering for much of this century. Perhaps recent increases in SAV represent the recovery of populations depleted by disease. Because SAV has been absent from Maryland's bays for so long (and is still absent from Delaware's inland bays) seed banks are depleted, and re-establishment of SAV in areas with suitable habitat may have been delayed by the absence of suitable propagules.

Figure 11: Area of SAV beds in the coastal bays 1986-1995.



Sources: Orth et al. 1986, Orth et al. 1987, Orth et al. 1989, Orth et al. 1990, Orth et al. 1993.

Efforts to expand the extent of SAV in the coastal bays will have to explore different strategies than those used in Chesapeake Bay. In the Chesapeake, restoration effort has been focused on reducing nutrient loadings to the point that SAV can again thrive. Since nutrient concentrations and algal abundance in the coastal bays are generally within the Chesapeake Bay habitat requirements for SAV, similar reductions in nutrient loadings are likely to offer limited benefits in terms of increasing SAV establishment in the coastal bays. Instead, restoration efforts may have to focus on strategies to reduce suspended sediment loads and on ensuring the availability of plants and seed in areas with appropriate habitat conditions.

likely to offer limited benefits in terms of increasing SAV establishment in the coastal bays. Instead, restoration efforts may have to focus on strategies to reduce suspended sediment loads and on ensuring the availability of plants and seed in areas with appropriate habitat conditions.

Benthos

The benthic community of estuaries like the coastal bays consists of a diverse collection of clams, snails, worms, crustaceans, fish and other marine animals, collectively known as the benthos. Many benthic organisms live in burrows or buried in the sediments. Others rest on the sediment surface and retreat into burrows only for protection from predators and other hazards. Life buried in the sediments has its challenges. The sediments, and the waters immediately overlying them often lack oxygen. Decomposition in the sediments produce organic acids, hydrogen sulfide, and other toxic compounds, and toxic chemicals derived from human activities also tend to concentrate in the sediments.

The benthic community supports organisms with a wide variety of lifestyles. Filter feeders (which feed on suspended plankton and organic matter in the water) can be abundant. Other benthic species feed on detritus lying on or buried in the sediments. Still others, including many snails and some worms, are voracious predators, hunting and feeding on the other residents. The benthos provides a key link in estuarine food webs, feeding on phytoplankton and on detritus derived largely from macroscopic plants and algae. The benthos, in turn, provide food for larger, free-ranging organisms, including many commercial and recreational fishes. The constant, slow stirring of bottom sediments caused by bottom-dwelling animals helps recycle nutrients, and accelerates processes that remove excess nitrogen from the bay ecosystem.

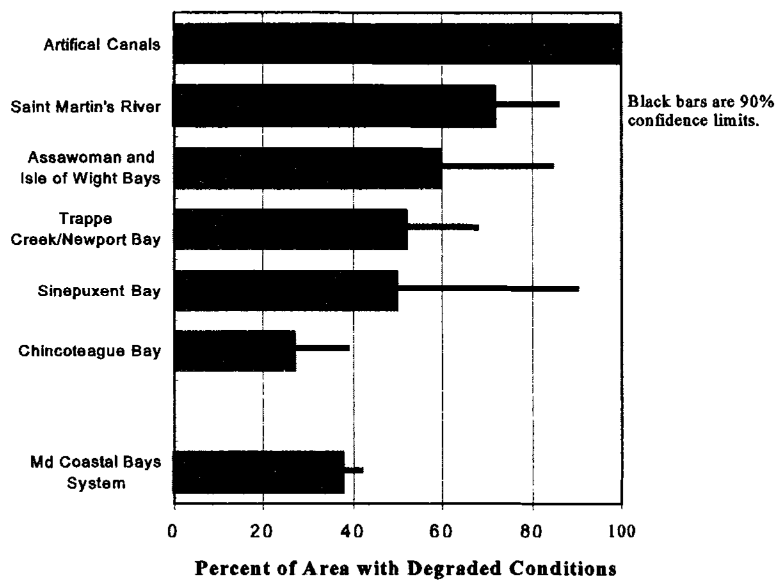
The benthos offers a way to assess the ecological condition of estuarine environments. Benthic organisms live in the sediments in contact with contaminants and at especially high risk for exposure to low dissolved oxygen conditions. Benthic organisms are frequently small and entirely or largely immobile. Unlike the larger fish and crabs, they can not swim away if conditions are not to their liking, so they tend to be exposed to pollutants and disturbances that more mobile organisms evade.

Over 157 species of benthic invertebrates from five phyla were collected from bay sediments in 1981 (Casey and Wesche 1982). The benthic community consists of a wide variety of organisms, with a broad range of tolerances to disturbance and pollution. As a result, the structure and composition of the benthic community can be a sensitive indicator of recent ecological condition. Typically, areas that harbor few individuals, or individuals from just a few stress-tolerant species suggest environmental degradation while sites with more abundant or more diverse benthic communities are considered healthy. Some care is required in assessing environmental condition in this way, as both diversity of benthic

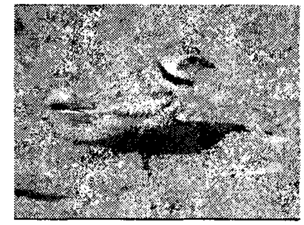
invertebrates and density of invertebrates vary east to west within the coastal bays and according to substrate type, salinity, and other environmental factors.

The Benthic Index is a number calculated from data on the composition of the benthic community. It was designed so that negative values of the benthic index indicate poor environmental condition, while positive values suggest a healthy situation. The benthic index is calculated based on information on salinity, overall species richness, and the abundance of pollution-tolerant species (Strobel et al. 1995). Examination of benthic communities of the coastal bays and calculation of the Benthic Index show that approximately 40% of the area of Maryland's coastal bays have bottom communities that suggest degraded conditions (Figure 12; Chaillou et al. 1996, Benyi et al. 1996). Degraded conditions are most common in artificial canals and in the St. Martin River. Degraded conditions are least abundant in Chincoteague Bay. Only about a quarter of the area of Chincoteague Bay has benthic communities that suggest degraded conditions. All sites sampled within artificial dead-end canals had benthic communities suggestive of poor conditions

Figure 12: Percent of area of coastal bays with benthic index scores indicative of degraded conditions



Source: Chaillou, and Weisberg 1996



Endangered and Threatened Species

A total of 16 species of animals and 60 plants on the State of Maryland's list of state rare, threatened, endangered species are currently found within the coastal bays watershed (see Appendix C). In addition, 3 species of animal and 14 species of plants now extirpated from the state of Maryland were once found in the coastal bays watershed. Two federally listed endangered species, the Atlantic loggerhead turtle and bald eagle, and one threatened species, the piping plover are found in the area (See Natural Heritage Program data, cited in ACE 1994). Personnel from Maryland's Coastal Bays Fisheries Project report encounters within the coastal bays with another threatened species, the Atlantic Leatherback Turtle[3]. Several other plants and animals found within the region are candidates for federal endangered or threatened status.

Colonial Nesting Birds

The coastal bays area contains 36 active (used in the last 5 years) nesting colonies for colonial breeding birds. The species nesting at these sites include gulls, terns, herons, night herons, egrets, glossy ibis and black skimmer. Twelve other breeding colonies are known to have been used in the past, but have not been used within the past 5 years. Three breeding colonies have been either destroyed by development, or lost as the island on which they stood were eroded away (Brinker 1993 as cited in ACOE 1994).

Fish Communities

A variety of studies over the last 100 years have examined the species composition of the fish community in the coastal bays. Unfortunately, direct comparisons of present and past fish surveys are difficult because sampling has often been carried out at different locations, at different times of year, and using different collecting methods.

A single long-term study exists that examines characteristics of the fish community over time (Linder et al. 1996a; Linder et al. 1996b). While the fish community of the coastal bays has changed over the past two decades, the observed changes provide little evidence for systematic declines in environmental quality.

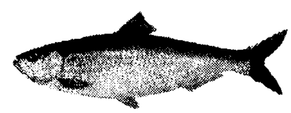
[3] Jim Casey, Maryland Department of Natural Resources, Tidewater Administration, Fisheries Service. Personal communication, October 31 1996.

Although abundance of most fish species has fluctuated, the numerically most abundant species in the coastal bays of twenty years ago (bay anchovy, Atlantic silverside, spot, Atlantic menhaden) remain the most abundant species in both Chincoteague Bay and the northern bays today. This contrasts markedly with the results observed in the Delaware bays, where the dominance of the fish community has shifted over the past 36 years. A few decades ago, fish communities were dominated by juvenile menhaden, tidewater silversides, and bay anchovy have been replaced by a communities dominated by more pollution-tolerant species, especially killifish and the sheepshead minnow (Price 1996).

The Index of Biotic Integrity (IBI) is an index of ecosystem condition based on characteristics of the fish community (Fausch et al. 1984, Karr 1981). Linder et al. (1996a) developed an IBI metric of ecosystem condition for application in the coastal bays and applied it to the long-term data on coastal bays fish community. They detected no trends in the Index of Biotic Integrity (IBI) over the last twenty years. One component of the Index of Biotic Integrity, species richness (often interpreted as indicative of healthy environmental conditions) has actually increased over that time.

Looking at individual species and how they have changed in abundance over time (table 12), scientists have noted increases in some species and decreases in others. Year-to-year fluctuations in abundance of fish species is a prominent feature of the fish community of the coastal bays. If there is a pattern to be picked out of the long-term data on the fish community, it is that many commercially and recreationally significant fish species are declining in abundance (Linder et al. 1996a; Linder et al. 1996b).

Finfish Harvests



Little data is available on which to base a comprehensive assessment of fisheries in the coastal bays. Records of recent commercial catches show variable but significant increases in finfish harvests over the last several decades, especially for menhaden, gray sea trout, and bluefish (figure 13). Without commensurate data on fishing effort it is impossible to determine whether present-day catches reflect sustainable harvesting. Increased harvests could reflect growing fish populations or increasing effort on the part of fishermen to capture fish. Unfortunately, effort data from sources such as the Marine Recreational Fishery Statistics Survey (Osborn et al. 1996; U.S. Department of Commerce 1984, 1985a, 1985b, 1986, 1987,1990) and Federal Fishing Vessel Trip Reports do not differentiate consistently between fishing effort that occurs within the coastal bays and effort that occurs offshore in other nearby marine environ-ments. More in-depth review of catch and effort data for the coastal bays region may provide a better understanding of the current status of finfish populations within the coastal bays.

Long-term seine and trawl data (Linder et al. 1996a) show several important fish species (including summer flounder, bluefish, Atlantic croaker, spot and American eel)

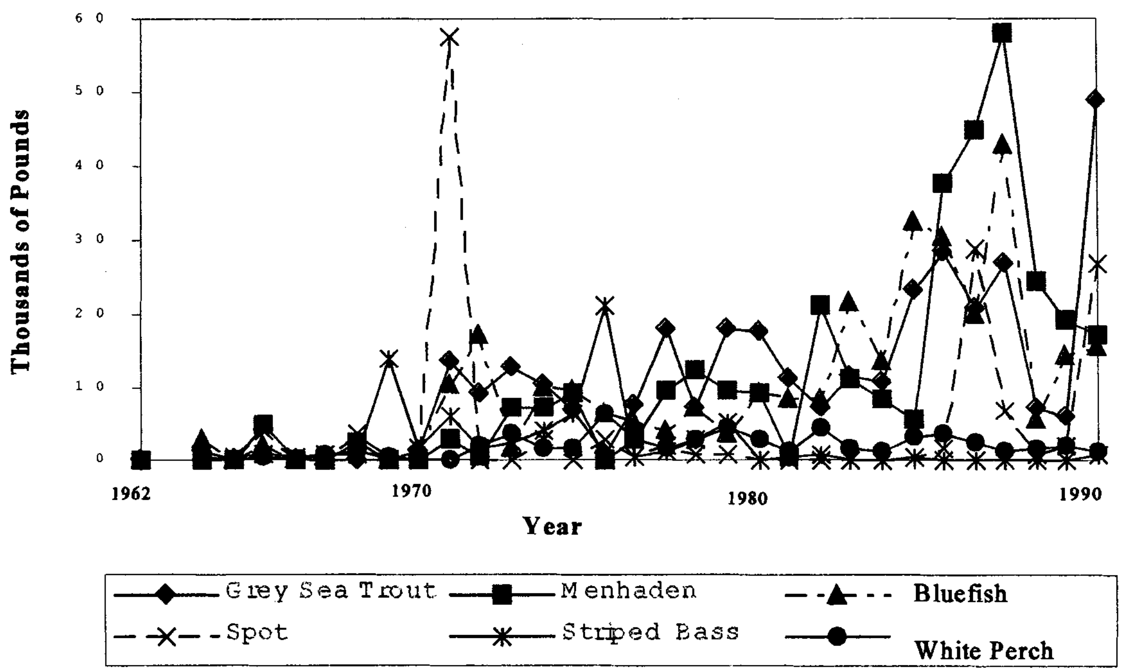
have declined in the coastal bays. None of these species spawn within the coastal bays, and so declines in the seine and trawl data reflect more regional population trends. Declines in summer flounder populations appear to have reversed since harvesting restriction were imposed (Linder et al. 1996a).

Table 12: Coastal bays trends in fish abundance since the mid 1970s.

	Increasing Species	Decreasing Species	No Trend, or Changing Trends
Planktivores	Banded Killifish	Atlantic Menhaden	Atlantic Silverside
	Spotted Hake		Bay Anchovy
			Mummichog
			Striped Killifish
			Striped Mullet
SAV-Associated Species	Fourspine Stickleback	Atlantic Needlefish	
	Northern Pipefish		
Bottom Dwellers and Bottom Feeders	Northern Puffer		Northern Searobin
	Inshore Lizardfish		Oyster Toadfish
			Hogchoaker
Commercial and Recreational Fisheries	Silver Perch	Spot	Winter Flounder
		Atlantic Croaker	
		American Eel	
		Weakfish	
		Black Sea Bass	
		Summer Flounder	
		Bluefish	

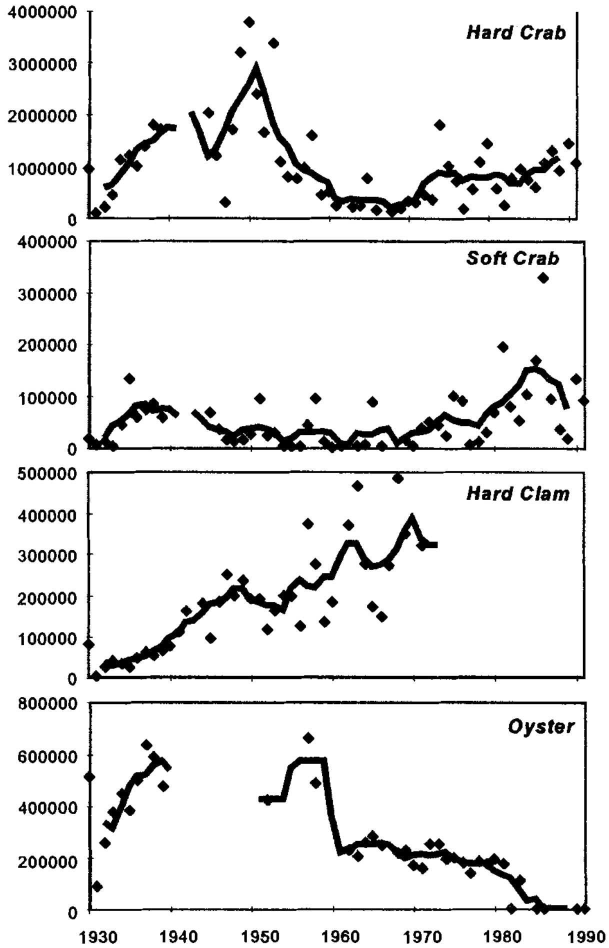
Source: Linder et al. 1995

Figure 13: Coastal bay commercial finfish catches.



Source: Maryland Department of Natural Resources Data

Figure 14: Coastal bays shellfish harvests.

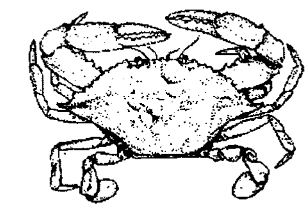


Source: MD DNR data . Oyster harvests represent Chesapeake oysters transplanted to the coastal bays for short periods to aquire a desirable salty taste. Native oyster harvests have been insignificant since the the 1940s (MD DNR Tidewater Administration Fisheries Service personal communication).

Shellfish Harvests

Oyster harvests have declined precipitously during this century, to the point that there now is essentially no commercial fishery for wild oysters (figure 14). That decline reflects decimation of oyster populations by harvesting, disease, and predation (Homer et al. 1994). Harvests of hard clams, on the other hand increased for much of this century. Available harvest data, however, stops prior to significant changes in the hard clam fishery

that occurred in the late 1960s and early 1970s with the introduction of the hydraulic escalator dredge (Homer et al. 1994). Following introduction of the more efficient harvesting gear, clam harvests declined to low levels suggestive of over-harvesting and limited recruit-ment. Current clam populations are less than 25% of estimates from the late 1960s and early 1970s (Homer et al. 1994).



Crab harvests, after peaking around 1950 declined sharply, but then gradually increased again in the 1970s and 1980s to moderate levels of both hard and soft crabs. Much of the current hard crab harvest is taken in a short period early in the season to take advantage of high crab prices that develop before the Chesapeake Bay crab fishery is in full swing. Current crab harvests are substantially below peak levels of the 1940s and 50s, and it appears likely that if harvests continue at current levels, and environmental conditions do not significantly deteriorate, the crab population should remain stable.

Shellfish Area Closures

Clams, oysters, and similar shellfish are filter feeders. They feed by straining algae, bacteria, and other particulate materials from the surrounding waters. Occasionally, these filtering organisms are exposed to disease-causing organisms, and concentrate those pathogens in their tissues. Under these circumstances, anyone consuming the shellfish could be exposed to dangerous levels of pathogenic organisms.

Untreated or improperly treated sewage, released from failing septic tanks, and a variety of animal wastes can introduce dangerous pathogens into marine waters. The state of Maryland has an aggressive water sampling program in place to test for contamination of state waters by looking for bacteria that indicate contamination. The particular test used, the "fecal coliform" test, does not test for pathogens directly, but tests only for bacteria (usually harmless themselves), that are typically found within the gastrointestinal tracts of warm blooded animals. Fecal coliform bacteria do not persist in the marine environment, and so elevated levels of these bacteria are a good indicator of recent contamination. While there is no practical way to know whether such contamination was from a source that harbored pathogens, indications of fecal contamination are considered sufficient reason to close areas to shellfish harvesting.

The primary sources of fecal contamination in the coastal bays are sewage treatment plant outfalls and stormwater runoff. Bacteria and pathogens are supposed to be killed by sewage treatment, but occasional glitches in the treatment process allow pathogens to escape. Stormwater runoff from urban and suburban areas carry high bacterial loads from a variety of natural sources, and also can be contaminated with human and pet wastes. Because stormwater runoff can be an important source of fecal coliform bacteria, water samples taken soon after rainfall events tend to have elevated levels of fecal coliform.

Long term records of fecal coliform tests at selected sites in the coastal bays show no trends in either the frequency or severity of high fecal coliform counts. In fact, no area in the coastal bays have been closed to shellfish harvesting because of anomalously high coliform levels since the mid 1970s, when the method used to test for the bacteria was changed to make the test more accurate. Existing closures of waters to shellfish harvesting are precautionary. The closures have been implemented because of the proximity of a known source or potential source of pathogens (usually a wastewater treatment plant) nearby (figure A-6). As a result, the areas in the coastal bays closed to shellfish harvesting have been extremely stable over time[4].

[4] Personal communications, Mary Jo Garreis, Environmental Program Manager, Environmental Risk Assessment Program, Maryland Department of the Environment.

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Chapter 6:

Conclusions

Six issues were identified at the start of this study as being of primary interest to policy makers and the public. Those six issues were eutrophication, toxic contamination, habitat modification and loss, the growing prevalence of water based activities, changes in the living resources of the coastal bays, and closure of areas to shellfish harvesting. This study provides insight into current status of each of these issues within the coastal bays.

Eutrophication

Eutrophication presents a significant problem for the coastal bays. High nutrient loadings from urban and agricultural runoff, atmospheric sources and poultry production fuel algal growth that produces episodic low dissolved oxygen conditions in sheltered areas such as the tidal tributaries and artificial canals. To date, the effects of eutrophication and other water quality problems have had mostly localized effects on the living resources of the bays because the shallow, well mixed nature of the main bays helps protect them from chronic or severe anoxia.

The greatest management challenge with respect to reducing the effects of eutrophication on the coastal bays arises from the limited information currently available on loading of nutrients to the bay from different sources. Current estimates have substantial uncertainty. Without better information on transport of nutrients, especially nitrogen to the coastal bays in ground water, and more precise estimates of nutrient loadings from poultry and hog production activities, it will be difficult to identify priority areas for management effort, and even more difficult to come to consensus on the need for action.

The earliest manifestations of environmental decline in response to nutrient enrichment in the coastal bays is likely to be increasing prevalence and severity of early-morning low-oxygen conditions. It is essential therefore that environmental monitoring efforts be targeted on detecting early morning drops in oxygen availability. Monitoring efforts should increasingly emphasize continuous (24 hour) and early morning measurements of oxygen concentrations, rather than infrequent (biweekly or monthly) daytime measurements.

Chemical Contamination

Chemicals are finding their way into the coastal bays in moderate quantities from a

variety of diffuse sources. The most widespread toxics reflect contamination with organic pesticides and other organic chemicals that are now banned for most uses in the U.S. Levels of contamination with these persistent chemicals should continue to decline slowly over time. More serious concerns are raised by the occurrence of moderate levels of contamination by metals, especially metals associated with road runoff and the marine industries. These metals are likely to continue to accumulate within the coastal bays especially in the artificial canals and other sheltered areas associated with marinas and developed shorelines. Careful monitoring of these toxics is needed, along with more detailed examination of the extent to which the low and moderate levels of toxics found in the coastal bays have biological effects.

Habitat Modification and Loss

Historical wetland and forest losses, within the coastal bays watershed have been substantial, with as much as three quarters of the region's original forested wetlands, and almost half its forests drained and cleared for agriculture and development. Habitat modification and loss within the coastal bays watersheds has slowed in the last several decades as awareness of the consequences of indiscriminate destruction of forests and wetlands has become more widespread. Low-level losses of wetlands and forests continue, but at least in the near term, wetland area in the coastal bays has apparently stabilized, and may increase if cooperative wetland creation and restoration programs become more active in the region. Projections for future development in Worcester county suggest that significant changes in land use can be expected, especially in the watersheds of the northern bays. If new development is accompanied by wetland and forest losses, water quality in the coastal bays will suffer and populations of wildlife that rely on these habitats will decline.

Modification of aquatic habitats also appears to have slowed, although impacts of commercial clam harvesting and of increasing recreational boating in the coastal bays deserve more careful evaluation. As with terrestrial habitats, if development projections for Worcester county prove true, substantial areas of shoreline and shallow near-shore habitats are likely to be altered to provide for navigation and water-based recreation.

Water-based Activities

The shallow water coastal bays ecosystem may be especially susceptible to environmental effects of recreational boating and dredging for clams. Personal watercraft and other motor boats running in shallow water disturb SAV beds, disrupt other benthic habitats, resuspend bottom sediments, and erode shorelines. Clam dredging activities further disturb benthic habitat. Development of the personal watercraft industry, and the

widespread availability of boats able to operate in shallow waters are likely to exacerbate such problems in the future. Yet little is known about the environmental effects shallow-water recreational boating and clam dredging are having on the ecology of the coastal bays. Better information is sorely needed to help manage potential conflicts between growing demand for shallow-water recreation and the health of the coastal bay ecosystem.

Changes/ Declines in Living Resources

Commercial catches of finfish have been increasing in the coastal bays for decades, but fish community data and other information suggests that at least some commercial and recreational species are overexploited. Oysters have all but disappeared from the bays, primarily as a result of predation and disease. Clam populations are also well below historic levels. SAV beds within the coastal bays are increasing, creating habitat for fish and other aquatic creatures, and helping to improve water quality conditions. Fish communities and benthic communities show few signs of stress, other than indications of over-exploitation of some fish and shellfish stocks.

Shellfish Area Closures

Shellfish area closures do not appear to be a problem in the coastal bays at this time. No closures have been ordered because of contamination in over a decade. Existing closed areas have been closed as a precautionary measure because of the proximity of sewage treatment plants or other potential sources of contamination.

Ecological Health of Maryland's Coastal Bays

In many respects, the health of the coastal bays is good. Submerged aquatic vegetation is returning to the bays after a decades-long absence. Fish and benthic communities within the coastal bays remain diverse. And large areas of the coastal bays seldom suffer from the worst effects of cultural eutrophication such as hypoxia. Yet signs of stress on the bays exist as well. The tidal tributaries and the artificial canals regularly suffer from poor water quality. Commercially important fish and shellfish stock are showing signs of overexploitation. And contamination of sediments with copper and zinc is frequent in waters affected by road runoff and marine development. Existing human activities in the watershed are stretching the bays' natural resilience to its limits. The challenge to be addressed in the future will be to prevent deterioration in the health of the coastal bays despite projected regional increases in development and human population.

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Bibliography

(ACE), U.S. Army Corps of Engineers (1994). Ocean City, Maryland and Vicinity Water Resources Study Reconnaissance Report. U.S. Army Corps of Engineers, Baltimore District.

(EPA), U. S. Environmental Protection Agency (1991). Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. U. S. Environmental Protection Agency, Washington, D. C.

(MDA), Maryland Department of Agriculture (1994). Maryland Agricultural Statistics Summary for 1994. Maryland Department of Agriculture.

(MDE), Maryland Department of the Environment (1992). Intensive Water Quality Survey of Maryland's Coastal Bays--1992. Baltimore, MD, Maryland Department of the Environment.

(MDE), Maryland Department of the Environment. (1983). Maryland Department of the Environment Intensive Water Quality Survey of Maryland's Coastal Bays-- 1983. Baltimore, MD, Maryland Department of the Environment.

(NOS), National Ocean Service (1989). A summary of data on tissue contamination from the first three years (1986-1989) of the Mussel Watch Project. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Status and Trends Program.

(NPS), National Park Service (1996). Assateague Island National Seashore water quality monitoring data 1987-1995. Assateague Island National Seashore, National Park Service, U.S. Department of the Interior.

Anderson. 1970. The submerged vegetation of Chincoteague Bay. Page 136-155 in Assateague Ecological Studies, Part I: Environmental Information. Natural Resources Institute, University of Maryland Contribution Number 446. Chesapeake Biological Laboratory, Solomons, MD.

Bartberger, C. E., and R.B. Biggs (1970). Sedimentation in Chincoteague Bay. Assateague Ecological Studies, Part II: Environmental Threats. Solomons, MD, Contribution #446, Chesapeake Biological Laboratory.

Batiuk, R. A., Robert J. Orth, Kenneth A. Moore, William C. Dennison, J. Court Stevenson, Lorie W. Staver, Virginia Carter, Nancy Rybicki, R. Edward Hickman, Stan Kollar, Stephen Bieber, and Patsy Heasly (1992). Chesapeake bay submerged aquatic vegetation habitat requirements and restoration targets: a technical synthesis. Annapolis, MD, United States Environmental Protection Agency.

Benyi, S., S. Rego, R. Johnson, and J. Paul (1996) Draft Summary Information prepared for Delmarva Coastal Bays Assessment Group. Status Report. 26 June, 1996. National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency, Narragansett, RI.

Böhlke, J. K. and J. M. Denver (1995). "Combined use of Groundwater dating, chemical and isotopic analysis to resolve the history and fate of nitrate contamination in two agricultural watersheds, Atlantic coastal plain, Maryland." Water Resources Research 31(9): 2319-2339.

Boynton, W. (1970). Phytoplanktonic Primary Production in Chincoteague Bay. Assateague Ecological Studies, Part I: Environmental Information. Solomons, MD, Natural Resources Institute, University of Maryland Contribution Number 446. Chesapeake Biological Laboratory. 91-133.

Boynton, W. R., L. Murray , J.D. Hagy, C. Stokes and W.M. Kemp (1996). "A Comparative Analysis of Eutrophication Patterns in a Temperate Coastal Lagoon." Estuaries : 19(2B):408-421.

Boynton, W. R., L. Murray, W.M. Kemp, J.D. Hagy, C. Stokes, F. Jacobs, J. Browers, S. Souza, B. Krinsky, and J. Seibel (1993). Maryland's Coastal Bays: An assessment of Aquatic Ecosystems, Pollutant Loadings, and Management Options. Maryland Department of the Environment Chesapeake Bay and Special Projects Branch, Baltimore, MD.

Casey, J. F. and A. E. Wesche (1982). Results of a Marine and Benthic Survey of Maryland's Coastal Bays. Maryland Department of Natural Resources, Tidewater Administration.

Cerco et al., C. F., C.S. Fang and A. Rosenbaum (1977). Intensive hydrographical and Water Quality Survey of the Chincoteague/Sinepuxent/Assawoman Bay Systems. Volume III. Nonpoint source pollution studies in the Chincoteague Bay System. Virginia Institute of Marine Sciences, Glocester Point, Virginia.

Chaillou, J.C., S.B. Weisberg, F.W. Kutz, T.E. DeMoss, L. Mangiaracina, R. Magnien, R. Eskin, J.Maxted, K. Price, and J.K. Summers. 1996. Assessment of the ecological condition of the Delaware and Maryland coastal bays. U.S. Environmental Protection Agency, National Human and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-96/004.

Cushing et al., E. M., I.M. Kantrowitz, and K.R. Taylor (1973). Water resources of the Delmarva Peninsula. United States Geological Survey, Reston, VA.

Delaware Inland Bays Estuary Program. (1995). Chapters 1-5 of the Delaware Inland Bays Comprehensive Conservation and Management Plan. Delaware Inland Bays Estuary Program.

Drobeck, K.G., H. Hidu, J.M. Odell, and W. Boynton. 1970. Chincoteague Bay benthos. Page 175-241 in Assateague Ecological Studies, Part I: Environmental Information. Natural Resources Institute, University of Maryland Contribution Number 446. Chesapeake Biological Laboratory, Solomons, MD.

Fang, C. S., J.P. Jacobson, A. Rosenbaum, and P.V. Hyer (1977). Intensive hydrographical and Water Quality Survey of the Chincoteague/ Sinepuxent/ Assawoman Bay Systems. Volume II. Data Report. A report for the Maryland Water Resources Administration. Virginia Institute of Marine Sciences, Glocester Point, Virginia.

Fausch, J. D., James R. Karr, and Philip R. Yant (1984). Regional Application of an Index of Biotic Integrity Based on Stream Fish Communities. Transactions of the American Fisheries Society, 113, 39-55.

Furbish, C.E. 1994. Wetlands Assessment - Assateague Island, Maryland. Final Report. Division of Natural Resources Management, Assateague Island National Seashore, Berlin, MD.

Hamilton et al., P. A., J.M. Denver, P.J. Phillips and R.J. Shedlock (1993). Water Quality assessment of the Delmarva Peninsula, Delaware, Maryland, and Virginia--Effects of agricultural activities on, and distribution of nitrate and other inorganic constituents in the surficial aquifer. U.S. Geological Survey.

Hamilton et al., P. A., R.J. Shedlock, and P.J. Phillips (1991). Ground-water quality assessment of the Delmarva Peninsula, Delaware, Maryland, and Virginia-- Analysis of available water quality data through 1987. U.S. Geological Survey.

Homer, M.L., M. Tarnowski, and L. Baylis (1994). A Shellfish Inventory of Chincoteague Bay, Maryland. Final Report to Coastal and Watershed Resources Division, Coastal Zone Management Program, Maryland Department of Natural Resources December 1994. Maryland Department of Natural Resources, Tidewater Administration, Fisheries Division, Shellfish Program.

Jacobs, F., J. Bowers, S. Souza, B. Krinsky and J. Seibel. (1993). Part 2. Diagnostic assessments of terrestrial pollutant loadings. <u>Maryland's Coastal Bays: An Assessment of Aquatic Ecosystems, Pollutant Loadings and Management Options</u>. Solomons, MD, Chesapeake Biological Laboratory Ref. No. [UMCEES] CBL 93-053. 2-1 through 3-16.

Karr, J. R. (1981). Assessment of Biotic Integrity Using Fish Communities. Fisheries, 6(6), 21-27.

Lessley, B. V., and A.B. Hamilton et al. (1967). Maryland Agricultural Trends by Counties 1920-1264. Cooperative Extension Service, Department of Agricultural Economics, University of Maryland, College Park, MD.

Lessley, B. V., and R.J. Beiter (1972). Maryland Agricultural Census Data. Maryland Extension Service, Department of Agricultural and Resource Economics, University of Maryland, College Park, MD.

Linder, C. C., J. Casey, and S.J. Jordan (1996a). Ecological Integrity of Maryland's Coastal Bays: Effects of Water Quality, Physical Habitat, and Land Use Characteristics. Maryland Department of Natural Resources, Tidewater Administration, Chesapeake Bay Research and Monitoring Division.

Linder, C. C., J. Casey, S. Doctor, and A. Wesche (1996b). Maryland's coastal bays shore zone fish communities. In Chaillou, J.C., S.B. Weisberg, F.W. Kutz, T.E. DeMoss, L. Mangiaracina, R. Magnien, R. Eskin, J.Maxted, K. Price, and J.K. Summers. 1996. Assessment of the ecological condition of the Delaware and Maryland coastal bays. U.S. Environmental Protection Agency, National Human and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-96/004. (Appendix A).

Lipson, A. J. (1973). <u>The Chesapeake Bay In Maryland, An Atlas of Natural Resources</u>. Baltimore, Johns Hopkins University Press.

Long, E.R. and L.G. Morgan (1990). The potential for biological effects of sediment-sorbed contaminants tested in the National Status an Trends Program. NOAA Technical Memorandum NOS OMA 52. U.S. Department of Commerce, National

Oceanic and Atmospheric Administration, National Ocean Service, Rockville, MD.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1):81-97.

Mabey, S.E., J. McCann, L.J. Niles, C. Bartlett, P. K. Linger. 1993. The Neotropical Migratory Song Bird Coastal Corridor Study. Final Report. August 1993. A Report to NOAA by the Virginia Department of Environmental Quality. 72 pp

Maryland Office of Planning (1995). Data extracts prepared by the Maryland Office of Planning, Planning Data Services, from BEA table CA-25. May 1995. Maryland Office Of Planning, Planning Data Services, Annapolis, MD.

Nixon, Scott W. (1994) "Coastal marine eutrophication: A definition, social causes, and future concerns." Ophelia 41: 199-219.

O'Connor, T. P. and B. Beliaeff (1996). Recent trends in coastal environmental quality: results from the mussel watch project. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Status and Trends Program.

Ocean City (1989). The Comprehensive Plan for Ocean City, Maryland. Town of Ocean City.

Ocean City (1996). O.C. 2010–The Comprehensive Plan for Ocean City. Town of Ocean City. Ocean City, Maryland.

Ocean City Department of Planning and Community Development (1994). Town of Ocean City Socio-Economic Profile 1994. Town of Ocean City Department of Planning and Community Development.

Olsenholler, S. M. (1991). Annual Loading Estimates of Urban Toxic Pollutants in the Chesapeake Bay Basin. Department of Environmental Programs, Metropolitan Washington Council of Governments, Washington, D.C.

Orth, R. and J. F. Nowak. (1990). Distribution of submerged aquatic vegetation in the Chesapeake Bay and Tributaries, and Chincoteague Bay. U.S. Environmental Protection Agency, Washington, DC.

Orth, R.J., J.F. Nowak, G.F. Anderson, and J.R. Whiting (1993). Distribution of submerged aquatic vegetation in the Chesapeake Bay and Tributaries, and Chincoteague Bay - 1992. U.S. Environmental Protection Agency, Washington, DC.

Orth, R.J., J.F. Nowak, G.F. Anderson, D.J. Wilcox, J.R. Whiting, and L.S. Nagey (1995). Distribution of submerged aquatic vegetation in the Chesapeake Bay and tributaries and Chincoteague Bay - 1994. Final Report U.S. EPA. 290 pp.

Orth, R.J., J.F. Nowak, G.F. Anderson and J.R. Whiting (1994). Distribution of submerged aquatic vegetation in the Chesapeake Bay and tributaries and Chincoteague Bay - 1993. Final Report U.S. EPA 1994. 262 pp.

Orth, R.J., A.A. Frisch, J.F. Nowak and K.A. Moore (1989). Distribution of submerged aquatic vegetation in the Chesapeake Bay and Tributaries, and Chincoteague Bay-1987. Final Report to U.S. Environmental Protection Agency, Washington, DC.

Orth, R.J., A.A. Frisch, J.F. Nowak and K.A. Moore (1989). Distribution of submerged aquatic vegetation in the Chesapeake Bay and Tributaries, and Chincoteague Bay-1989. U.S. Environmental Protection Agency, Washington, DC.

Orth, R.J., J.J. Simmons, J. Capelli, V. Carter, A.A. Frisch, L. Hindman, S. Hodges, K.A. Moore, and N. Rybicki (1987). Distribution of submerged aquatic vegetation in the Chesapeake Bay and Tributaries, and Chincoteague Bay-1986. U.S. Final Report to Environmental Protection Agency, Washington, DC.

Orth, R.J., J.J. Simmons, J. Capelli, V. Carter, L. Hindman, S. Hodges, K.A. Moore, and N. Rybicki (1986). Distribution of submerged aquatic vegetation in the Chesapeake Bay and Tributaries -- 1985. Final Report to U.S. Environmental Protection Agency, Washington, DC.

Osborn, M.F., D.A. Van Voorhees, G. Gray, R. Salz, E. Pritchard, and M. C. Holliday (1996). National Marine Fisheries Service Marine Recreational Fishery Statistics Survey. World Wide Web Version. Accessed January 1997. http://remora.ssp.nmfs.gov/mrfss/info/mrf_overview.html. U.S Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Fisheries Statistics and Economics Division.

Price, K. S., M. Timmons, and J. Chaillou (1996). Delaware Coastal Bays Shore Zone Fish Community Trends. In Chaillou, J.C., S.B. Weisberg, F.W. Kutz, T.E. DeMoss, L. Mangiaracina, R. Magnien, R. Eskin, J.Maxted, K. Price, and J.K. Summers. 1996.

Assessment of the ecological condition of the Delaware and Maryland coastal bays. U.S. Environmental Protection Agency, National Human and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-96/004. Appendix A.

Pritchard (1960). "Salt balance and exchange rate for Chincoteague Bay." Chesapeake Science 1(1): 48-57.

Quinn, H., J.P. Tolson, C.J. Klein, S.P. Orlando, and C. Alexander (1989). Strategic assessment of near coastal waters—Susceptibility of east coast estuaries to nutrient discharges: Passamaquoddy Bay to Chesapeake Bay. Summary Report. Strategic Assessment Branch, Ocean Assessments Division, Office of Oceanography and Marine Assessment, National Ocean Service, National Oceanic and Atmospheric Administration, Rockville, Maryland.

Redman/Johnston Associates, L. (1989). Comprehensive Development Plan, Worcester County, Maryland. Worcester County, Maryland.

Richardson, C. J. (1994). "Ecological Functions and Human Values in Wetlands: A Framework for Assessing Forestry Impacts." Wetlands 14(1): 1-9.

Schueler, T. R. (1987). Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Metropolitan Washington Council of Governments, Washington D. C.

Schwartz, F.J. (1961). Fishes of Chincoteague and Sinepuxent Bays. American Midland Naturalist 65 (2): 384-408.

Schwartz, F.J. (1964). Fishes of Isle of Wight and Assawoman Bays near Ocean City, Maryland. Chesapeake Science 5 (4): 172-193.

Scott, L., J.B. Frithsen, and J.A. Ranasinghe (1995). Final Report: Analysis of Delaware/Maryland Coastal Bays Benthic Samples. A Report to U.S. Environmental Protection Agency -- Region III. Versar, Inc., Columbia, MD.

Shedlock, R. J., P.A. Hamilton et al., J.M. Denver, and P.J. Phillips (1993). Multiscale approach to regional ground-water-quality assessment of the Delmarva Peninsula. Regional Groundwater Quality. New York, Van Nostrand Reinhold. 563-587.

Strobel, C. J., H.W. Buffum, S.J. Benyi, E.A. Petrocelli, D.R. Reifsteck, and D.J. Keith (1995). Statistical Summary: EMAP-Estuaries Virginia Province - 1990 to 1993. United States Environmental Protection Agency National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division. Narragansett, RI.

Tarnowski, M.L., R. Bussell, L. Baylis, and M.L. Homer (1996). A Shelfish Inventory of Maryland's Coastal Bays. Final Report to Coastal Zone Management Division, Maryland Department of Natural Resources For the Period October 1994 to September 1995. Maryland Department of Natural Resources Fisheries Service, Shellfish Program.

Tiner, R. W. and D. G. Burke (1995). Wetlands of Maryland. U.S. Fish and Wildlife Services, Ecological Services, Region 5, Hadley MA and Maryland Department of Natural Resources, Annapolis, MD.

U.S. Department of Commerce (1956). 1954 Census of Agriculture—Volume 1: Area Reports. Maryland. U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census.

U.S. Department of Commerce (1962). 1959 Census of Agriculture—Volume 1: Area Reports. Maryland. U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census.

U.S. Department of Commerce (1972). 1969 Census of Agriculture—Volume 1: Area Reports. Part 23 Maryland. U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census.

U.S. Department of Commerce (1981). 1978 Census of Agriculture—Volume 1: Geographic Area Series. Part 20 Maryland. U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census.

U.S. Department of Commerce (1989). 1987 Census of Agriculture—Volume 1: Geographic Area Series. Part 20 Maryland state and county data. U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census.

U.S. Department of Commerce (1994). 1992 Census of Agriculture—Volume 1: Geographic Area Series. Part 20 Maryland state and county data. U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census.

U.S. Department of Commerce (1984). Marine Recreational Fishery Statistics Survey, Atlantic and Gulf coasts, 1979 (revised) - 1980. Current Fishery Statistics No. 8322. Washington, DC. 239 pp.

U.S. Department of Commerce (1985a). Marine Recreational Fishery Statistics Survey, Atlantic and Gulf coasts, 1981 - 1982. Current Fishery Statistics No. 8324. Washington, DC. 215 pp.

U.S. Department of Commerce (1985b). Marine Recreational Fishery Statistics Survey, Atlantic and Gulf coasts, 1983 - 1984. Current Fishery Statistics No. 8326. Washington, DC. 222 pp.

U.S. Department of Commerce (1986). Marine Recreational Fishery Statistics Survey, Atlantic and Gulf coasts, 1985. Current Fishery Statistics No. 8327. Washington, DC. 130 pp.

U.S. Department of Commerce (1987). Marine Recreational Fishery Statistics Survey, Atlantic and Gulf coasts, 1986. Current Fishery Statistics No. 8392. Washington, DC. 127 pp.

U.S. Department of Commerce (1990). Marine Recreational Fishery Statistics Survey, Atlantic and Gulf coasts, 1987 - 1989. Current Fishery Statistics No. 8904. Washington, DC. 363 pp.

Wells, D. V., R.D. Conkwright, and J. Park (1994). Geochemistry and geophysical framework of the shallow sediments of Assawoman Bay and Isle of Wight Bay in Maryland. Maryland Geological Survey Open File Report No. 15,State of Maryland, Department of Natural Resources, Maryland Geological Survey.

Wells, D. V., R.D. Conkwright, J.M. Hill, and M.J. Park (1994). The Surficial sediments of Assawoman Bay and Isle of Wight Bay in Maryland: physical and chemical characteristics. Coastal and Estuarine Geology File Report No. 94-2, State of Maryland, Department of Natural Resources, Maryland Geological Survey.

Wells, D. V., R.D. Conkwright, R. Gast, J.M. Hill, and M.J. Park (1996). The shallow sediments of Newport Bay and Sinepuxent Bay in Maryland: physical and chemical characteristics. Coastal and Estuarine Geology File Report No. 96-2, State of Maryland, Department of Natural Resources, Maryland Geological Survey. Baltimore, Md.

Wells, D. V., S.M. Harris, J.M. Hill, and M.J. Park, and C.P. Williams (1996). The shallow sediments of the upper Chincoteague area in Maryland: physical and chemical characteristics. Coastal and Estuarine Geology File Report No. 97-2, State of Maryland, Department of Natural Resources, Maryland Geological Survey. Baltimore, Md.

Welch, S., L. Graziano, B. Overman, T. Purnell, and W. Ullman (1994). Nutrient Survey of Little Assawoman Bay. Page 9 in William Ullman (ed.) A Day in The Life of Delaware's Forgotten Bay: A Scientific Survey of Little Assawoman Bay: 12 June 1991. Report of Delaware Inland Bays Estuary Program.

Wiley, M.L., J.P. Chandler, and R. Hartman (1970). The finfish of Chincoteague Bay. Page 296-355 in Assateague Ecological Studies, Part I: Environmental Information. Natural Resources Institute, University of Maryland Contribution Number 446. Chesapeake Biological Laboratory, Solomons, MD.

Appendix A

Figure A-1: Coastal Bays Locator Map

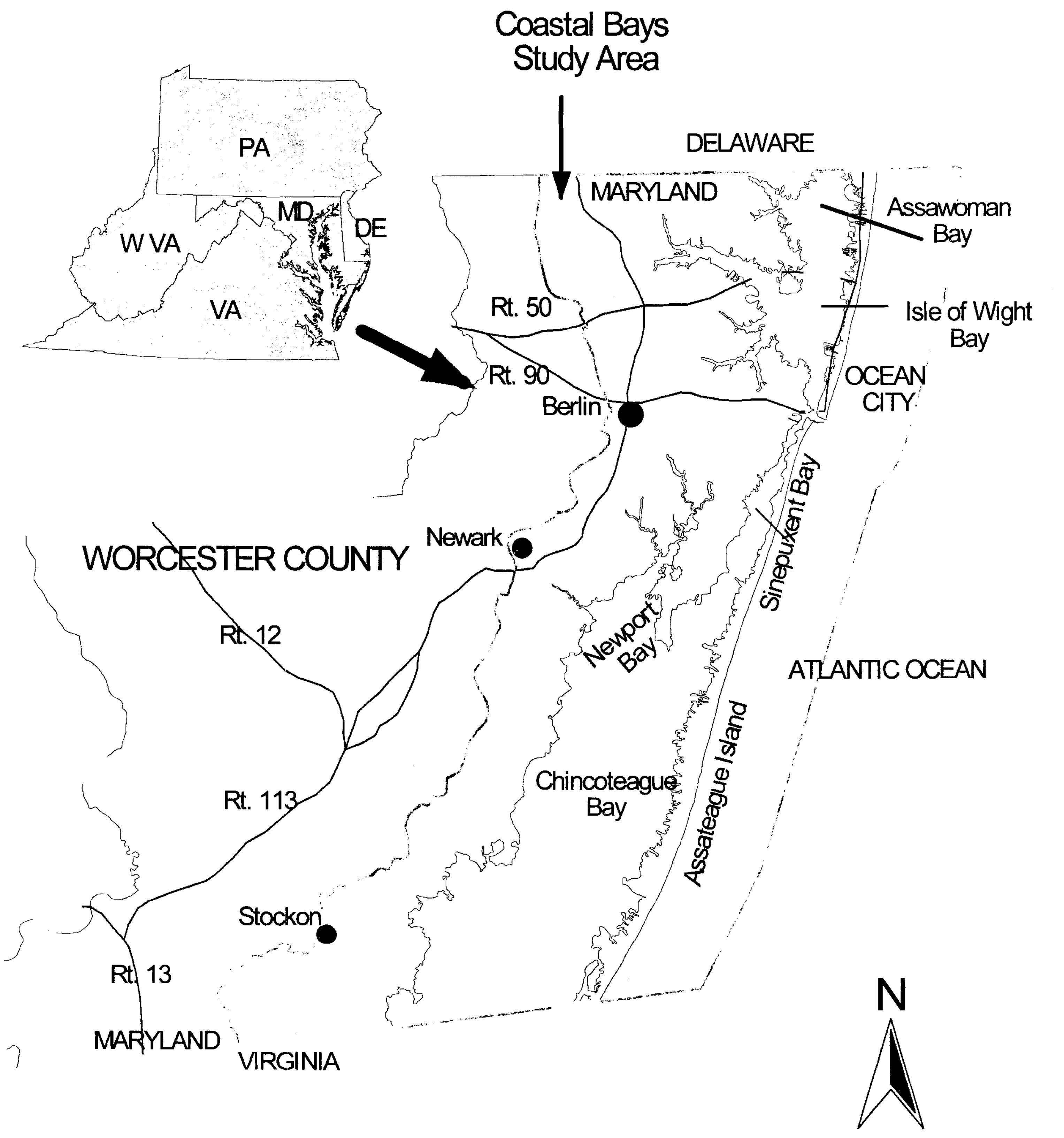


Figure A-2: Sediment Distribution in the Maryland Coastal Bays

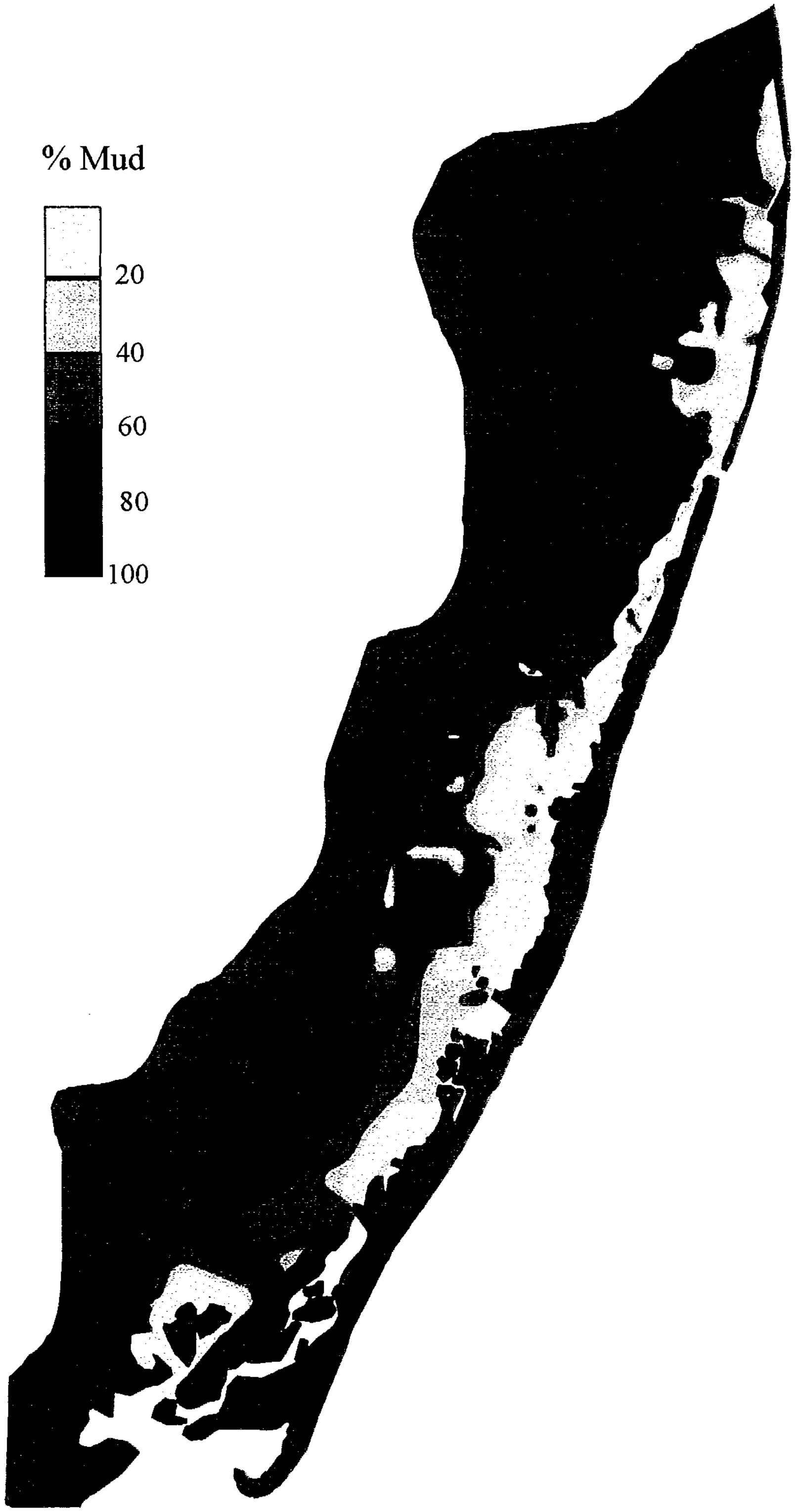
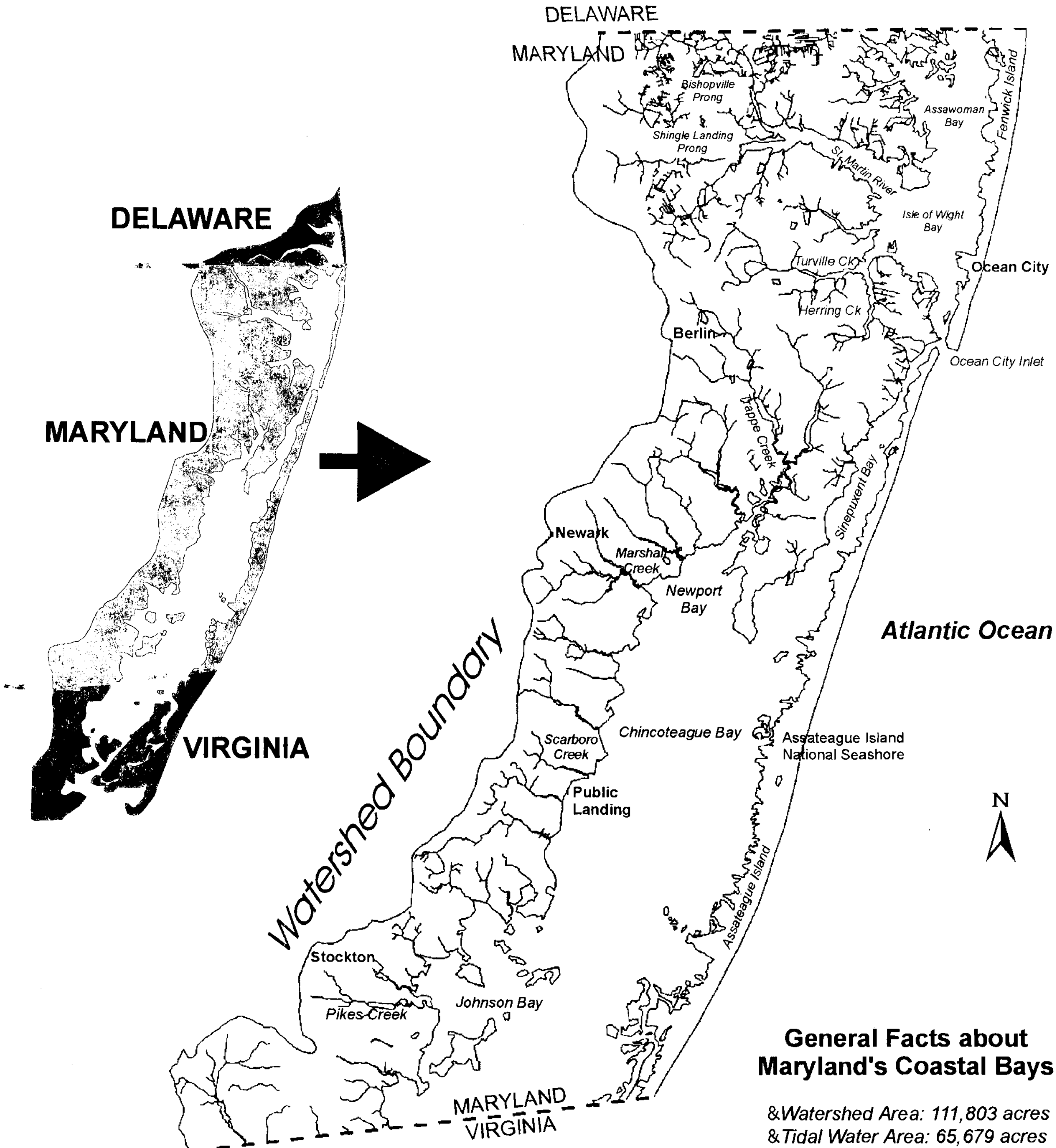


Figure A-3 Watershed Map



General Facts about Maryland's Coastal Bays

&*Watershed Area: 111,803 acres*
&*Tidal Water Area: 65,679 acres*
&*Average Water Depth: 3.9 feet*
&*Resident Population: 21,781*

Figure A- 4: 1994 Land Use in the Coastal Bays Watershed

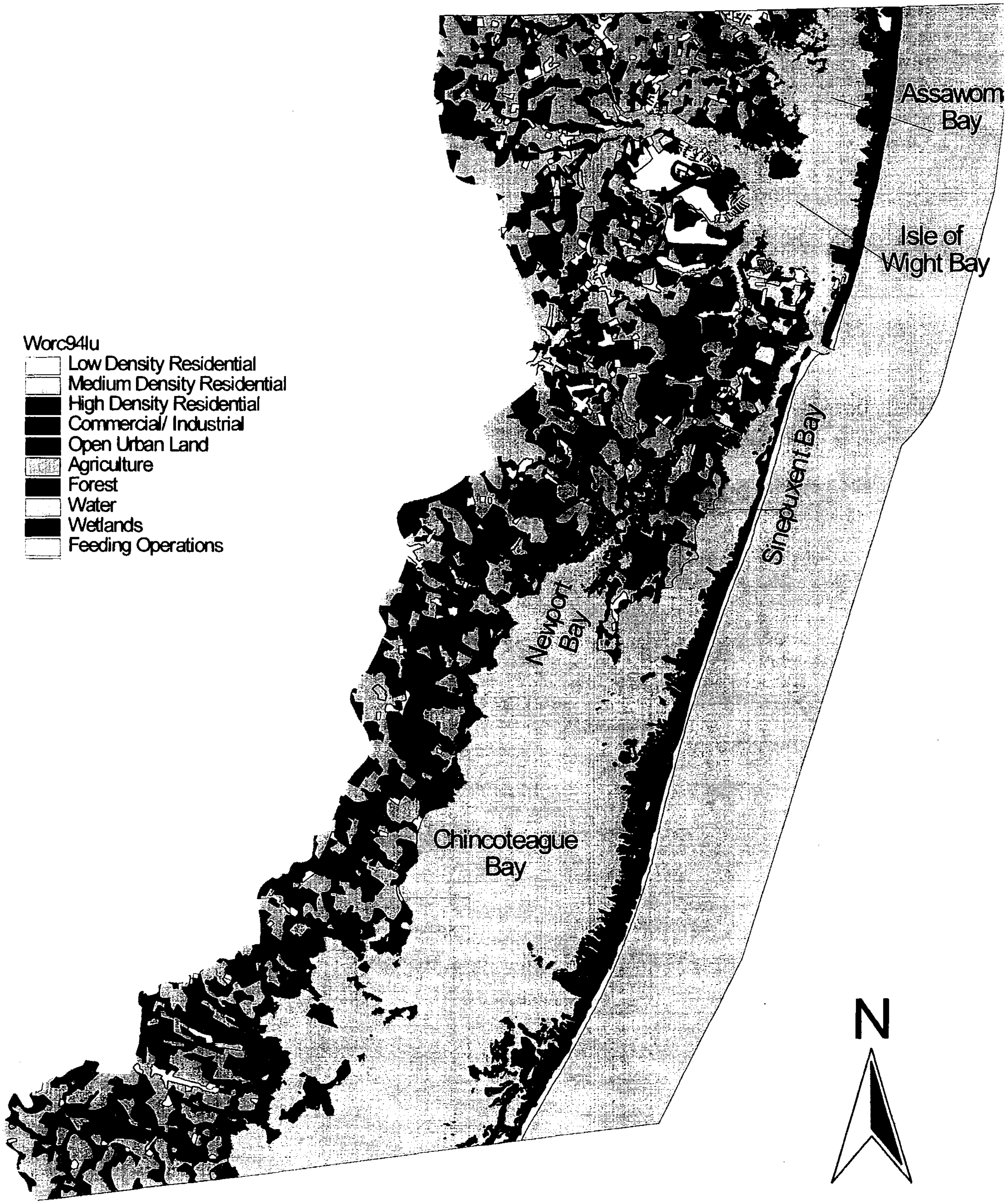


Figure A - 5: SAV in the Coastal Bays (1995 Distribution)

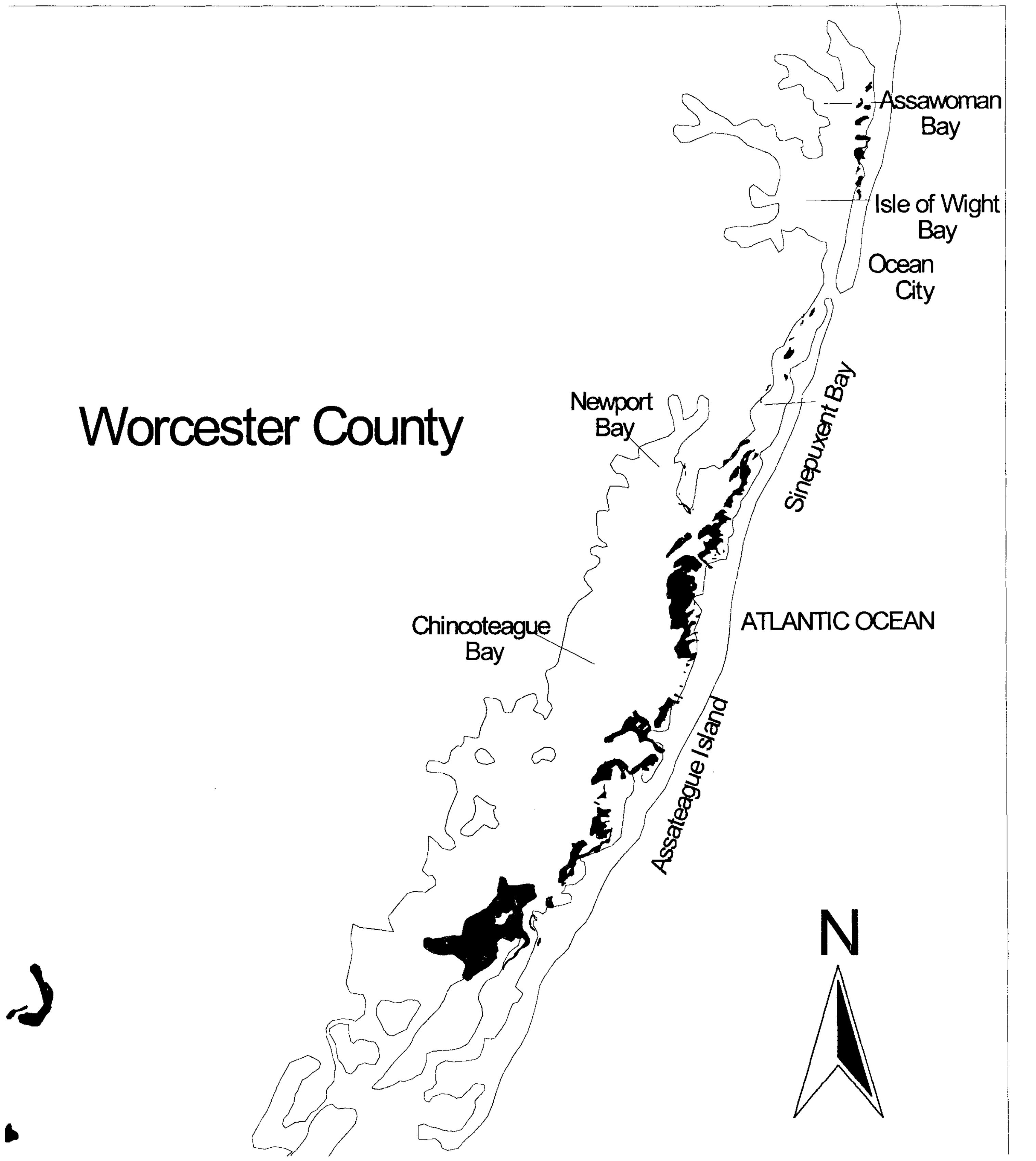
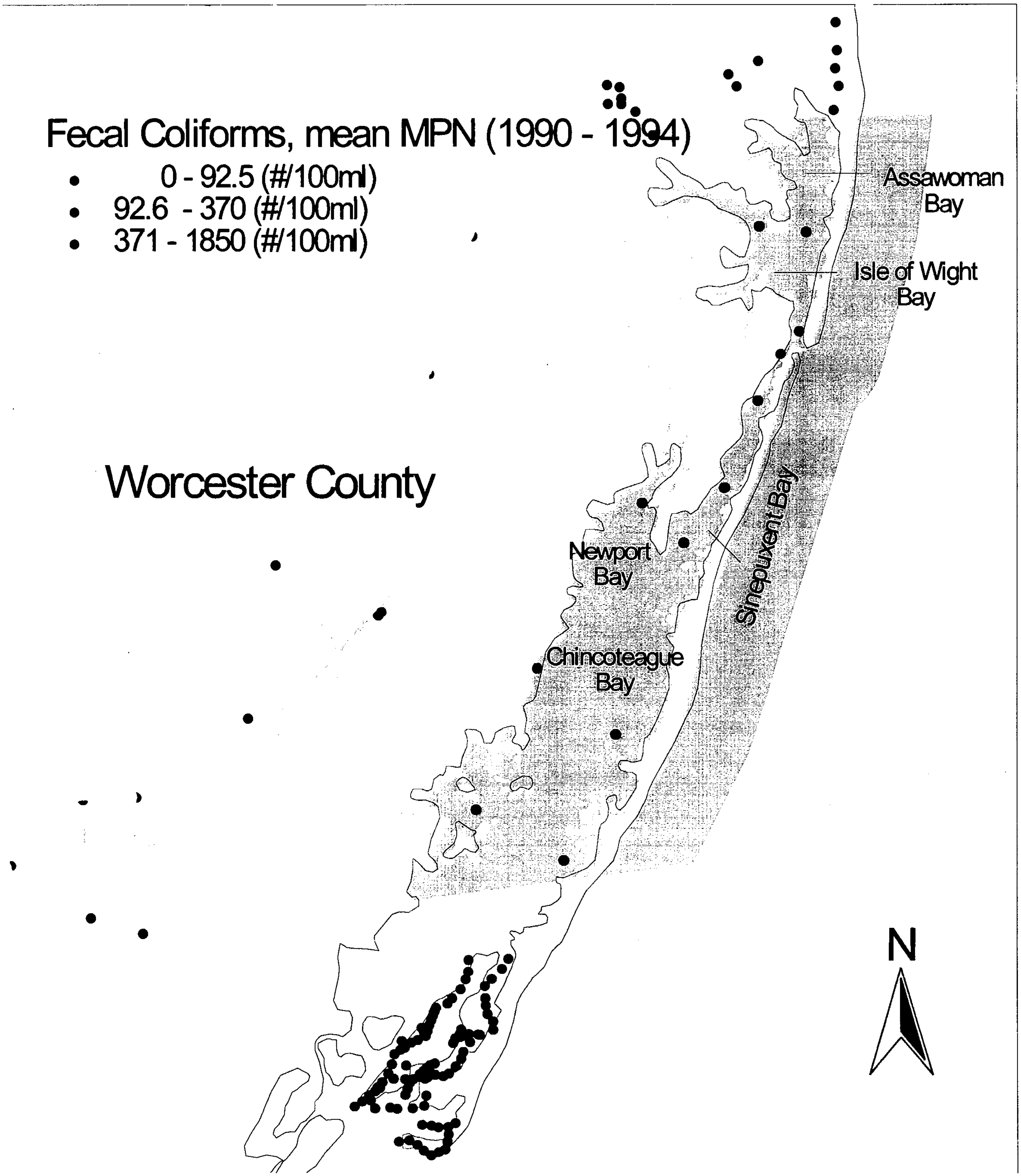


Figure A - 6: Bacteria Levels in the Coastal Bays



Appendix B

Appendix B: Maryland Coastal Bays Data Sources

Data Set Name	Data Category
Casey and Wesche 1982 Benthic Survey	Benthos
Delaware-Maryland Joint Assessment Water Quality Data sets--Benthic Benthos	Benthos
Delaware-Maryland Joint Assessment Water Quality Data sets--Benthic Chlorophyll	Benthos
Droebeck et al. 1970 Benthic Data	Benthos
DNR Hard Clam Survey Data	Benthos, Fisheries
NPS Assateague National Seashore Beach Bird	Birds
Demoflush	Economic and Social
Ocean City Building Permits and Certificates of Occupancy	Economic and Social
U.S. Bureau of Economic Affairs Economic Data	Economic and Social
U.S. Census Data	Economic and Social
United States Census of Agriculture Surveys	Economic and Social, Land Use
DNR Seine and Trawl Data	Fish Community
Wiley, Chandler and Hartman Seine and Trawl Study	Fish Community
DNR Commercial Catch Data	Fisheries Data
ACOE Reconnaissance Report and Feasibility Study	Hydrology and Geology, Wetlands
Coastal Change Analysis Package (C-CAP)	Land Use
E-Map land use coverage	Land Use
Intensive hydrographic and water quality survey of the Chincoteague/Sinepuxent/Assawoman Bay systems, Volume III	Land Use
MD Office of Planning Land Use Data	Land Use

Appendix B: Maryland Coastal Bays Data Sources (Continued)

Data Set Name	Data Category
Anderson SAV data	SAV
Orth SAV Distribution data	SAV
MDGS sediment data 1	Sediments
MDGS sediment data 2	Sediments
NOAA National Status and Trends Program. Mussel Watch Data	Toxic Chemicals
Delaware-Maryland Joint Assessment Data sets--Sediments	Toxic Chemicals, Sediments
NOAA National Status and Trends Program Sediment Contaminant Data	Toxic Chemicals, Sediments
Boynton 1973 Water Quality and Algae Data	Water Quality
Delaware-Maryland Joint Assessment Data sets--Water Quality	Water Quality
Intensive hydrographic and water Quality Survey of the Chicoteague/Sinepuxent/Assawoman Bay systems, Volume II.	Water Quality
MDE Intensive Water Quality Surveys	Water Quality
NPS Chincoteague Bay Water Quality Data	Water Quality
National Wetlands Inventory Wetlands Status Data	Wetlands
Permitted Nontidal Wetlands Losses	Wetlands

Appendix C

Maryland Coastal Bays Status and Trends
Data Source Record

Data Set Name	Casey and Wesche 1982 Benthic Survey
Data Category	Benthos
Description	Eight sampling locations (one in Assowoman bay, five in Isle of Wight Bay, two in Chincoteague bay) were sampled with a Ponar grab for sediment particle size distribution. Sample sites selected non-randomly, includes one dead-end canal site. Benthos sampled with an epibenthic sled and Ponar Grab. Data were also collected on tidal amplitude, current velocity, salinity, temperature and wind. Since many of these measurements were not repeated, their significance is difficult to estimate.
Purpose of Data Set	Assess potential impacts of dredging activities on coastal bay biota, especially regionally important commercial and recreational fisheries
Time Period of Data	1981
Spatial Domain	Mostly Isle of Wight Bay. Some also in Chincoteague Bay and Assawoman Bay.
Update Information	No updates.
Related Publications	Casey and Wesche 1982
Comments	Small number of sites, and biased selection of sites may make interpretation of data difficult.

Who to Contact For More Information

Jim Casey
(410) 643-4601
Maryland Department of NAtural Resources
Mattapeake Laboratory

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name Delaware-Maryland Joint Assessment Water Quality Data--Benthos

Data Category Benthos

Description Data from VERSAR on the condition of Maryland and Delaware's Coastal Bays were based on a comprehensive stratified random spatial sampling based on EMAP-Estuaries methods. The study was based on 200 sites, sampled once each. The composition of the benthic community (numbers and biomass) at each site was assessed.

Purpose of Data Set Characterization of environmental condition in the Coastal Bays. Intended to be the beginning of a monitoring program

Time Period of Data 1993

Spatial Domain Samples drawn from Upper Indian River, St. Martin River, Trappe Creek/Newport Bay, Remaining Delaware coastal Bays, Remaining MD

Update Information No direct update planned, but methods are widely published, and are likely

Related Publications Scott et al. 1995, Chaillou and Weisberg 1996, Benyi et al. 1996

Comments

Who to Contact For More Information

Rick Kutz
(410) 573-6842
EPA Region III
Annapolis, MD

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Delaware-Maryland Joint Assessment Water Quality Data--Benthic Chlorophyll
Data Category	Benthos
Description	Data from VERSAR on the condition of Maryland and Delaware's Coastal Bays were based on a comprehensive stratified random spatial sampling based on EMAP-Estuaries methods. The study was based on 200 sites, sampled at least once each. 20 sites were sampled four times each. Concentrations of benthic chlorophyll were assessed both flourometrically and via HPLC. Some data from both the 200 one-time samples and the 20 intensively sampled are missing.
Purpose of Data Set	Characterization of environmental condition in the Coastal Bays. Intended to be the beginning of a monitoring program
Time Period of Data	1993
Spatial Domain	Samples drawn from Upper Indian River, St. Martin River, Trappe Creek/Newport Bay, Remaining Delaware coastal Bays, Remaining MD
Update Information	No direct update planned, but methods are widely published, and are likely
Related Publications	Scott et al. 1995, Chaillou and Weisberg 1996, Benyi et al. 1996
Comments	

Who to Contact For More Information

Rick Kutz
(410) 573-6842
EPA Region III
Annapolis, MD

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	DNR Shellfish Inventory of Chincoteague Bay
Data Category	Benthos
Description	A total of 661 stations were sampled using five different sampling techniques. Almost 15,000 individuals of 51 moluscan species were collected. Data was used to estimate population levels and examine spatial distributions of major taxa. Hard Clam abundance data collected with commercial harvesting gear, more detailed benthic data collected with a Ponar Grab. Bottom sediments were characterized in terms of percent sand. Sample were collected based on stratified random sampling regimes, with additional strata added each year.
Purpose of Data Set	Assessment of mollusk populations in Chincoteague bay
Time Period of Data	1993-1994
Spatial Domain	Chincoteague bay
Update Information	Unlikely without additional funding
Related Publications	Homer et al. 1994, Tarnowski et al. 1996
Comments	Homer at al. 1994 report that hard clams are most abundant on sand substrates, and thus on the eastern side of the Bay. A slight tendency for elevated abundance toward the south end of the bays was also detected.

Who to Contact For More Information

Mark Homer	Mitch Tarnowski
(301) 994-0241	(410)974-3733
Maryland DNR	

Maryland Coastal Bays Status and Trends
Data Source Record

Data Set Name	Droebeck et al. 1970 Benthic Data
Data Category	Benthos
Description	A quantitative benthic survey was carried out in the Maryland portion of Chincoteague bay. Samples were taken within 3 proposed borrow areas adjacent to Assateague island, and scattered throughout the bay. At each site, triplicate 1 m^2 samples were collected with the "CBL shallow-water escalator harvester". This device retains organisms over approximately 1 cm in length. This database includes abundances for 64 species of invertebrates collected in the course of the survey, size data for hard clams collected as well as various sediment characteristics.
Purpose of Data Set	Assessment of benthic community to advise on policies associated with the Assateague Island National Seashore
Time Period of Data	1969
Spatial Domain	Chincoteague Bay
Update Information	None
Related Publications	Droebeck et al. 1970
Comments	Data is potentially comparable to more modern benthic surveys, but methods retained fewer small organisms. Quantitative comparisons, therefore, would be difficult.

Who to Contact For More Information

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name NOAA National Status and Trends Program. Mussel Watch Data

Data Category Benthos, Toxic Chemicals

Description Data on tissue concentrations of a variety of organic contaminants and trace elements in oysters. Samples have been collected annually at Chincoteague Inlet since 1986.

Purpose of Data Set Monitoring of environmental condition and change

Time Period of Data 1986 to the present.

Spatial Domain Nationwide, 200 or so sites sampled. Only 1 site in the coastal bays, at Chincoteague Inlet (actually in Virginia, not MD)

Update Information Annual (or nearly annual) samples should continue

Related Publications O'Connor and Beliaeff 1995
NOS 1989

Comments Tissue concentrations of dieldrin, chlordane, and polycyclic aromatic hydrocarbons have all been declining over time at the Chincoteague Inlet site. Data available over the internet at
http://www-orca.nos.noaa.gov/projects/nsandt/nsandt.html

Who to Contact For More Information

Tom O'Connor
(301) 713-3028 x151
NOAA National Oceans Service
tom.oconnor@noaa.gov

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name Coastal Corridor Study

Data Category Birds

Description Results of a study of use of coastal forest and scrub areas by neotropical migrants.

Purpose of Data Set Determine the significance of coastal habitats to regional populations of neotropical migrant songbirds

Time Period of Data 1990s

Spatial Domain Mid Atlantic Coastal region, especially Maryland and Delmarva peninsula

Update Information Unknown

Related Publications Mabey et al. 1993.

Comments

Who to Contact For More Information

Maryland Coastal Bays Status and Trends
Data Source Record

Data Set Name	DNR Colonial Water birds Data
Data Category	Birds
Description	DNR has been conducting state-wide surveys of water bird colonies for several years. List of colonies in coastal bays region is available in ACOE 1994.
Purpose of Data Set	Monitoring of colonial nesting bird populations
Time Period of Data	Uncertain. Minimum of 1988 to the present.
Spatial Domain	State of MD
Update Information	Updated annually
Related Publications	Summarized in ACOE 1994
Comments	

Who to Contact For More Information

David Brinker
(410) 974-3195
MD Department of Natural Resources

Data Set Name NPS Assateague National Seashore Beach Bird Surveys

Data Category Birds

Description Assateague National Seashore carries out shorebird surveys along the ocean side of the seashore every two weeks, year-round. Census is carried out by driving the length of the seashore and recording all birds observed.

Purpose of Data Set Long term characterization and monitoring of local bird communities and migration patterns.

Time Period of Data 1980s to 1996

Spatial Domain Assateague National Seashore 200m offshore to the dune vegetaiton line.

Update Information Every two weeks.

Related Publications

Comments These data refer to the birds observed on the ocean side of Assateague island. They provide a general indication of migratory patterns and breeding activity for birds in the coastal bays vacinity. Survey methodology and lack of control of ORV access to areas studied may limit value of these data for more detailed analyses.

Who to Contact For More Information

Carl Zimmerman
(410) 641-1443
NPS Assateague National Seashore

Data Set Name Demoflush Data

Data Category Economic and Social

Description Ocean City has no direct way of estimating the population of visitors they get, so each weekend they record sewage volumes, and use that to generate an estimate of Ocean City's weekend population. Jesse Huston, the ocean city town planner,says the original regression relationship was worked out in the 1970s. He also believes current estimates are about 15-20% over actual numbers. Nevertheless, Demoflush represents the only consistent, long-term estimates of visitor numbers to ocean city.

Purpose of Data Set Estimation of visitor numbers for planning and development purposes

Time Period of Data 1977 (approximately) to the present.

Spatial Domain Ocean City sewage treatment plant service area

Update Information Updated weekly

Related Publications Ocean City 1989
Department of Planning and Urban Development 1994

Comments Methodology of deriving population estimates from sewage flow is unknown. Partial data from 1977 to the present is available in Ocean City comprehensive plan and City Development Profiles.

Who to Contact For More Information

Jesse Huston
(410) 289-8941
Ocean City Department of Planning and Community
Mayor and City Council, Town of Ocean City
P.O. Box 158
Ocean City, MD 21842

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name Ocean City Building Permits and Certificates of Occupancy

Data Category Economic and Social

Description Ocean city has recorded data on certificates of occupancy and building permits issued for at least 15 years. Building permits can be seen as an indicator of the beginning of the process of building or modifying a structure, while certificates of occupancy are a bureaucratic marker of the the end of construction.

Purpose of Data Set Data collected as part of municipal government practice

Time Period of Data Late 1970s to the present.

Spatial Domain Ocean City

Update Information Permits and certificates are still issued by the city. Annual Reports are

Related Publications Ocean City 1989
Department of Planning and Urban Development 1994

Comments These data are not very well maintained, as they are generally incidental to the actual decisions of issuing permits and certificates of occupancy. Graphs can be found in Ocean City comprehensive plan. Numbers available back to mid 1980s are in the Ocean City Demographic Profile.

Who to Contact For More Information

Jesse Houston

(410) 289-8855

Ocean City Planning Office

Mayor and City Council, Town of Ocean City
P.O. Box 158
Ocean City, MD 21842

Maryland Coastal Bays Status and Trends
Data Source Record

Data Set Name	U.S. Bureau of Economic Affairs Economic Data
Data Category	Economic and Social
Description	The U.S. Department of Commerce Bureau of Economic Affairs collects a great deal of economic data on a county by county basis. These data are published annually in a variety of formats. The data we have available at this time were compiled by the Maryland Office of Planning from primary sources
Purpose of Data Set	Economic profiles for policy making planning purposes
Time Period of Data	1940s to the present.
Spatial Domain	Nationwide, on a county-by-county basis
Update Information	Updated annually
Related Publications	Data published annually in a variety of formats
Comments	

Who to Contact For More Information

Phil Hager
(410)632-1200
Worcester County Office of Planning

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name U.S. Census Data

Data Category Economic and Social

Description Census data by census block numbers. Includes data on population, housing units, occupancy of housing units, and so forth.

Purpose of Data Set National Census

Time Period of Data 1800s (early) to the present.

Spatial Domain Entire USA

Update Information Updated every 10 years

Related Publications

Comments Data is developed by the Bureau of the Census, of the Department of Comerce. Much of it is now available in CD-ROM formats and via internet. A variety of Maryland-specific extracts and summaries of census data are prepared by MD Office of Planning. Some historical census data is reported in county and city comprehensive plans.

Who to Contact For More Information

State, county and local planners

Data Set Name United States Census of Agriculture

Data Category Economic and Social, Land Use

Description Census Of Agriculture includes data on agricultural land use, animal populations and sales, acres planted to various crops, crop production, pesticide use, farm size, and a large variety of farm economic statistics.

Purpose of Data Set Periodic survey of agriculture carried out approximately 10 years with less intensive updates occurring every 5 years.

Time Period of Data 1800s to the present. Available from 1920s.

Spatial Domain Whole U.S. Data presented on county-by-county basis. Most recent data available on a zip code basis on CD-ROM

Update Information Updates normally every 5 years. Data is now available on CD

Related Publications Maryland Department of Agriculture 1994, Lessley and Hamilton 1967, Lessley and Beiter 1972, Bureau of the Census 1956, 1962, 1972, 1981,

Comments Data used in this study back to 1950 were extracted directly from Census of Agriculture. Data back to 1920 were drawn from a summary of Maryland agricultural trends in Lessley and Hamilton 1967

Who to Contact For More Information

Bureau of the Census

U.S Department of Commerce

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	DNR Seine and Trawl Data
Data Category	Fish Community
Description	Seine and trawl data characterizing the fish community of the Coastal Bays. Trawls at 20 fixed sites, on a monthly basis April-October Seine at 18 fixed points, twice a year (July and September). Data includes number of fishes by species, some size and biomass data.
Purpose of Data Set	Long-term monitoring. Data characterizes fish communities and changes in fish communities over time.
Time Period of Data	1972 to the present. Standardized since 1989.
Spatial Domain	Trawl and seine locations in Chincoteague, Assawoman, Isle of Wight, Sinepuxent, and Newport bays, and St. Martin River.
Update Information	Expect continued collection of similar data.
Related Publications	Linder, Casey and Jordan 1996 Linder, Casey, Doctor and Wesche 1996
Comments	

Who to Contact For More Information

Jim Casey
(410)643-4601
Maryland Department of Natural Resources
Mattapeake Laboratory

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Schwarz Fish Surveys
Data Category	Fish Community
Description	Lists of fish species found in the coastal bays. Data based on a variety of sampling techniques, without any quantitative data on abundance, biomass, or distribution
Purpose of Data Set	Characterization of fish community
Time Period of Data	Late 1950s, early 1960s
Spatial Domain	Coastal Bays
Update Information	No updates
Related Publications	Schwartz 1960, 1964
Comments	Cites earlier work from the early part of the century, and lists which species were observed in those earlier studies. Without knowing anything about methods of those earlier studies, however, implications are difficult to identify.

Who to Contact For More Information

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Wiley, Chandler and Hartman Seine and Trawl Study
Data Category	Fish Community
Description	Seining was carried out at eight stations once each season for a year (1969-1970). A variety of other seining stations were sampled once. Trawls were run once at each location. Samples were not collected in a quantitative manner, but were intended to indicate the species composition of the finfish community without regard to absolute numbers. Seine Samples were collected with a 50 foot bag seine with 1/4 inch mesh. trawl samples were collected with a variety of trawls, all with mesh 1/4 inch or smaller.
Purpose of Data Set	Characterize fish community
Time Period of Data	1969-1970
Spatial Domain	Chincoteague bay and a few freshwater marsh ponds on Assateague island
Update Information	No Updates
Related Publications	Wiley et al. 1973
Comments	Lack of quantitative sampling makes interpretation of these data difficult. Will probably have to use species-accumulation curves to be able to use these data at all.

Who to Contact For More Information

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name DNR Commercial Catch Data

Data Category Fisheries Data

Description DNR has maintained, and continues to maintain data on catches of fish and shellfish for a variety of purposes. Data on catches from the coastal bays alone are problematic, as data were not collected originally for purposes of assessing catch from specific aquatic ecosystems. Most data comes from port-based landing statistics and surveys of watermen. Both sources of data are potentially influenced by reporting errors. Data is likely to be useful mostly for showing large-scale changes in catch and value of catch, but of little use for detailed trend analysis.

Purpose of Data Set Analysis of fisheries landings to guide policy with respect to fisheries management.

Time Period of Data 1950s to the present.

Spatial Domain Uncertain.

Update Information Unknown. Does DNR publish annual summaries?

Related Publications Boynton 1970 cites early versions of this data. Boynton et al. 1993 and Boynton et al. 1996 include an update to 1992.

Comments Data primarily collected by location of landings, not by where fish and shellfish were caught. Many years with missing data. Substantial annual variation and anecdotal information suggests small fishery makes tracking difficult. A single fisherman failing to report data can significantly alter numbers for a year. Related data, including Federal Fishing Vessel Trip Reports are maintained by the National Marine Fisheries Service.

Who to Contact For More Information

Jim Casey

(410) 643-4601

Department of Natural Resources

Mattapeake Laboratory

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Marine Recreational Fishery Statistics Survey
Data Category	Fisheries Data
Description	Data on recreational fish catches and effort derived from telephone surveys and on-site interviews of recreational fishers. Collected annually by NMFS. Maryland Department of Natural Resources collaborated to produce more in-depth surveys in 1983, 1988 and 1990. Because of methods, it may be difficult to relate some results to the coastal bays
Purpose of Data Set	Characterization of recreational fishing.
Time Period of Data	Late 1970s to the present.
Spatial Domain	Nationwide
Update Information	Updated annually, more detailed surveys as resources permit
Related Publications	U.S. Department of Commerce 1984, 1985a,1985b, 1986, 1987, 1990. Some data available via the internet.
Comments	

Who to Contact For More Information

Fisheries Economics and Statistics Service

National Marine Fisheries Service

National Oceanic and Atmospheric Administration, U.S. Department of Commerce

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name MD Office of Planning Land Use Data

Data Category Land Use

Description MD Office of Planning digitized (Arc-Info) land use maps and associated estimates of land use in different watersheds. Original data includes more than thirty land use classifications.

Purpose of Data Set State's basic land use database for planning purposes.

Time Period of Data 1973, 1990, 1994

Spatial Domain State of MD

Update Information 1994 dataset not yet available for Worcester County

Related Publications Cerco Fang and Rosenboum 1978, Jacobs et al. 1993, Boynton et al. 1996

Comments Data exists in GIS format. Data reduction to land use summaries based on these data were done based on the 1973 data (Cerco Fang and Rosenboum 1978), the 1990 data (Jacobs et al. 1993) and the 1994 data by DNR in work to be published soon. Other land use data may be availabe from NOAA's Coastwatch or EPA's EMAP programs.

Who to Contact For More Information

Rich Hall

Maryland Office of Planning

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Intensive hydrographic and water quality survey Vol III (Cerco et al. 1978)
Data Category	Land Use, Water Quality
Description	Data on runoff and land use within the watershed. Runoff data is record of pollutant runoff from a number of different land uses throughout the watershed. Land use data was generated by examining land uses under grid points to estimate percent land in various land uses. Many land uses identified in MD Office of Planning data were consolidated.
Purpose of Data Set	Was developed to provide first-cut estimates of pollutant loadings to Maryland's Coastal bays
Time Period of Data	1976 (runoff data) and 1973 (land use data)
Spatial Domain	Coastal bay watersheds. Data on DE and VA portions of watershed were assumed to be the same as for MD portions of sub-basins.
Update Information	Boynton et al. 1993 (part 2) includes more recent similar data.
Related Publications	Cerco, Fang and Rosenbaum, 1978, Boynton et al. 1993, Boynton et al. 1996
Comments	

Who to Contact For More Information

Virginia Institute of Marine Science
Gloucester Point, VA 23062

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Nonpoint Pollution Estimates from Jacobs et al. 1993
Data Category	Land Use, Water Quality
Description	Estimates of pollutant loadings from nonpoint spources in the coastal bays watershed are based on Maryland Office of Planning Data combined with per-acre pollutant yields derived from literature sources. Data on groundwater transport of nutrients is based on limited measurements of concentration of polutants in groundwater, and various models of groudwater flow in major aquifers in the coastal bays region.
Purpose of Data Set	Estimate pollutant loadings to Maryland's Coastal bays
Time Period of Data	Based on 1990 land use data.
Spatial Domain	Coastal bay watersheds.
Update Information	No updates planned
Related Publications	Jacobs et al. 1993 Boynton et al. 1996
Comments	

Who to Contact For More Information

Fred Jacobs
(410) 684-3324

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name Natural Heritage Inventory

Data Category Rare and Endangered Species

Description MD Heritage and Biodiversity Conservation Programs have data on occurrences of state and federal endangered and threatened species. Data was sorted for rare species in and around the coastal bays region for ACOE 1994.

Purpose of Data Set Tracking of rare and endangered plant and animal species

Time Period of Data 1600s to the present

Spatial Domain Coastal Bays area (available)

Update Information Updated continuously.

Related Publications

Comments HBCP data are based on numerous sources, including museum and herbarium collections, journal articles, reports from local naturalists, and surveys performed by staff biologists. Levels of locational precision and accuracy are indicated for database records.

Who to Contact For More Information

Lynn Davidson, Glenn Therres

MD Heritage and Biodiversity Conservation Programs

Maryland Department of Natural Resources

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Anderson SAV data
Data Category	SAV
Description	Anderson studied the distribution and primary production of Zostera and Ruppia within Chincoteague Bay. Data as reported in his report, however, are limited. Biomass and production results are presented as means and ranges, but without estimates of standard deviation or standard error, making interpretation of the data difficult.
Purpose of Data Set	Characterization of biomass and growth of SAV
Time Period of Data	1970
Spatial Domain	
Update Information	
Related Publications	Anderson, 1970
Comments	Anderson used aerial photography to estimate total aerial extent of SAV, and estimates that 10 million square meters of Chincoteague bay were covered with SAV. No SAV was observed along the western shoreline.

Who to Contact For More Information

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Orth SAV Distribution data
Data Category	SAV
Description	SAV distribution and density data for coastal bays. Data based on aerial photography taken specifically to search for SAV. Ground truthing of observations used to confirm species identifications and density estimates. Data available as GIS (Arc-Info) files. Summaries of data are currently being developed for the Coastal Bays themselves.
Purpose of Data Set	Monitoring of SAV abundance as water quality indicator and habitat for estuarine and marine fish and shellfish and food for waterfowl
Time Period of Data	1986 to the present.
Spatial Domain	Coastal bays.
Update Information	Updated annually
Related Publications	Orth et al. 1986, 1987, 1989, 1990, 1993, 1994, 1995, 1996
Comments	Published along with Chesapeake Bay SAV survey numbers. Data and maps can be accessed via the internet at http://www.vims.edu/bio/sav

Who to Contact For More Information

Robert Orth
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Virginia Institute of Marine Sciences
Virginia Institute of Marine Sciences
Gloucester Point, VA
rjorth@vims.edu

Maryland Coastal Bays Status and Trends
Data Source Record

Data Set Name	Bartberger and Biggs Sediment Data
Data Category	Sediments
Description	Map of sediment grain-size composition of Chincoteague bay and a detailed description of sedimentary processes in the bay.
Purpose of Data Set	Characterization of the benthic environment and sedimentary processes near Assateague Island
Time Period of Data	1969-1970
Spatial Domain	Chincoteague Bay
Update Information	No updates
Related Publications	Bartberger and Biggs 1970
Comments	

Who to Contact For More Information

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name Delaware-Maryland Joint Assessment Data-- Sediments

Data Category Sediments, Toxic Chemicals

Description Data from VERSAR on the condition of Maryland and Delaware's Coastal Bays were based on a comprehensive stratified random spatial sampling based on EMAP-Estuaries methods. Only 36 samples were processed for sediment chemistry. These samples were selected so as to focus on the artificial man-made canals and on the condition of the coastal bays as a whole. Data includes measurements of a variety of organic contaminants (PAHs, DDT and metabolites, other chlorinated pesticides, PCBs), tributyl tin, and a variety of metals.

Purpose of Data Set Characterization of environmental condition in the Coastal Bays, establishment of baseline for future monitoring.

Time Period of Data 1993

Spatial Domain Samples drawn Coastal Bays and from man made artificial canals.

Update Information Methods are widely published, and are likely to form the basis for future

Related Publications Scott et al. 1995, Chaillou and Weisberg 1996, Benyi et al. 1996 Maxted et. al. 1997

Comments http://www.epa.gov/emap/html/related/cbay

Who to Contact For More Information

Rick Kutz
(410) 573-6842
EPA Region III
Annapolis, MD

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name MDGS sediment data

Data Category Sediments, Toxic Chemicals

Description This data set consists of several tables (ASCII file) containing location, textural, and chemical parameters for core samples and surficial samples collected in the coastal bays, beginning in 1992. The spatial parameters include latitude and longitude for core locations (and depth interval for core samples). Textural parameters include sand, silt, and clay size components of the sediments as well as percent by weight of water content. Chemical parameters include total nitrogen, carbon, and sulfur content for core and sediment samples (and monosulfide content for selected core samples), and concentrations of six metals: chromium, copper, iron, manganese, nickel, and zinc for core and sediment samples.

Purpose of Data Set Map the geochemical character of the near surface sediments and provide base line data set for future studies of the coastal bays.

Time Period of Data 1992

Spatial Domain Isle of Wight and Assawoman Bays, Maryland

Update Information Continued study in lower Chincoteague Bay to be completed in fall of

Related Publications Wells et al. 1994a
Wells et al. 1994b

Comments

Spatial Domain	Time Period of Data	Cores Collected (Samples Analyzed)	Surficial Samples
Isle of Wight and Assawoman Bays	1992-1993	14 (94)	172
Sinepuxent and Newport Bays	1995	10(114)	175
Upper Chincoteague Bay	1996	6 (71)	298

Who to Contact For More Information

Darlene Wells
(410) 554-5518
dwells@mgs.dnr.md.gov

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	NOAA National Status and Trends Program. Sediment Contaminant Data
Data Category	Sediments, Toxic Chemicals
Description	Data was collected at National Status and Trends sites on contamination of sediments with a variety of organic contaminants and trace metals. Data is available over the internet. Sediments were sampled in 1984 through 1987. Since then, sediment samples have only been taken if the site had not been visited in earlier years.
Purpose of Data Set	Monitoring of environmental quality trends. These data support the mussel watch data.
Time Period of Data	1984 to the present.
Spatial Domain	Nationwide, some 200 sample sites. Only 1 in Coastal bays, data available only for 1986
Update Information	Uncertain
Related Publications	O'Connor and Beliaeff 1995 NOS 1989
Comments	Data available over the internet at http://www-orca.nos.noaa.gov/projects/nsandt/nsandt.html

Who to Contact For More Information

Tom O'Connor
(301) 713-3028 x151
NOAA National Status and Trends
tom.oconnor@noaa.gov

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Boynton 1973 Water Quality and Phytoplankton Data
Data Category	Water Quality
Description	Algal production, nutrient concentrations, dissolved oxygen, salinity, Secci disk, and other environmental parameters related to algal production were collected at three sites at approximately monthly intervals over a six month period. Sites were not randomly located.
Purpose of Data Set	Examination of algal productivity in the Coastal Bays
Time Period of Data	1970
Spatial Domain	Three field sites
Update Information	No Updates
Related Publications	Boynton 1970
Comments	

Who to Contact For More Information

Walter Boynton
(410) 326-7275
Chesapeake Biological Laboratory
P.O. Box 38
Solomons, MD 20688

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Delaware-Maryland Joint Assessment Data-- Water Quality
Data Category	Water Quality
Description	Data from VERSAR on the condition of Maryland and Delaware's Coastal Bays were based on a comprehensive stratified random spatial sampling based on EMAP-Estuaries methods. 200 sites were sampled once each. Hydrolabs were placed at 20 locations, giving full diel DO measures, etc. Data includes DO, Chl-a, ammonium, nitrate and nitrite, total particulate carbon, nitrogen and phosphorous, total dissolved nitrogen and phosphorous, phaeophytin, orthophosphate, Secci depth, TSS, turbidity, and presence of trash.
Purpose of Data Set	Characterization of environmental condition in the Coastal Bays
Time Period of Data	1993
Spatial Domain	Samples drawn from Upper Indian River, St. Martin River, Trappe Creek/Newport Bay, Remaining Delaware coastal Bays, Remaining MD
Update Information	No direct update planned, methods may form the basis for future studies
Related Publications	Scott et al. 1995, Chaillou and Weisberg 1996, Benyi et al. 1996
Comments	http://www.epa.gov/emap/html/related/cbay

Who to Contact For More Information

Rick Kutz
(410) 573-6842
EPA Region III
Annapolis, MD

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name	Intensive hydrographic and water quality survey Vol. II. (Fang et al. 1976)
Data Category	Water Quality
Description	Data sets, on paper, relating to water quality in the coastal bays. Includes data on DO, Chl-a, N, P. Boynton suspects that some of the N and P data may be inaccurate. Additional data on physical conditions and currents also presented.
Purpose of Data Set	This was an early MDE intensive water quality survey, and was the forerunner of more recent MDE Intensive Surveys.
Time Period of Data	1976
Spatial Domain	MD Coastal Bays
Update Information	MDE has repeated intensive water quality surveys in 1983 and 1992.
Related Publications	Fang et al. 1977a,b Boynton et al. 1993 and 1996 reanalyzed some of this data
Comments	Data quality is uncertain. In reviewing the data, Boynton et al. (1993) decided that some nutrient data may be unreliable.

Who to Contact For More Information

Virginia Institute of Marine Sciences

Virginia Institute of Marine Sciences
Gloucester Point, VA

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name MDE Intensive Water Quality Surveys

Data Category Water Quality

Description Data includes nutrients, Chlorophyll, dissolved oxygen, and related water quality parameters.

Purpose of Data Set Assessment of water quality in the Coastal Bays, for purposes of assisting MDE with permitting and other responsibilities.

Time Period of Data 1983 and 1992

Spatial Domain Coastal Bays

Update Information Unknown

Related Publications

Comments Tom Parham at DNR worked on these datasets. He has located the 1983 dataset on tape, and the 1992 data set on PC SAS files.

Who to Contact For More Information

Tom Parham
(410) 260-8630
Maryland Department of Natural Resources

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name NPS Chincoteague Bay Water Quality Data

Data Category Water Quality

Description Park Service WQ Data. Regular sampling since 1987. Samples were taken approximately monthly during the summer (approximately May through October) up to 1994. A few winter samples were added in 1995. Data includes temperature, salinity, pH, dissolved oxygen, chlorophylls A, B, C, phaeophytin, ammonium, nitrate and nitrite, orthophosphate, total nitrogen, total phosphorous, total suspended solids, and silicate. Several of these data fields were not collected when the monitoring program was initiated, but have been added over time.

Purpose of Data Set Monitor water quality in and around the park and Chincoteague Bay to assist park management.

Time Period of Data 1987 to the present.

Spatial Domain Chincoteague Bay, including Sinepuxent and Newport Bays

Update Information Data gathering continues, so updates are expected.

Related Publications

Comments Sample sites were selected to highlight areas with existing or anticipated water quality problems. Extrapolation to the entire bay would be questionable, but analysis of trends within sites will be robust. Other data on tides, weather, and physical environment are also available.

Who to Contact For More Information

Carl Zimmerman

(410) 641-1443

National Park Service, Assateague Island National Seashore

7206 National Seashore Lane
Berlin, MD 21811

Data Set Name ACOE Tidal Wetlands Loss Estimates

Data Category Wetlands

Description Information on tidal weltands loss used in ACOE 1994. Wetlands loss in Sinepuxent and northern coastal bays estimated based on USGS topographic maps, and NWI maps. A coarse estimate of wetlands losses on the northern 2.6 miles of assateague island was estimated based on comparisons of 1933 aerial photographs to 1983 NWI maps.

Purpose of Data Set Estimates of marsh loss are to be used to set potential targets for environmental restoration efforts.

Time Period of Data Approximately 1930s to the present.

Spatial Domain Northern Assateague Island, Sinepuxent Bay, and northern coastal bays

Update Information No updates

Related Publications ACOE 1994

Comments Methods used to derive wetland loss estimates are unclear from the Reconnaissance Report. A range of loss estimates is given, based on conservative and generous estimates of the original wetland acreages.

Who to Contact For More Information

Christopher Spaur
(410) 962-6134
Army Corps of Engineers
Baltimore District Office
Baltimore, MD

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name National Wetlands Inventory Wetlands Status Data

Data Category Wetlands

Description NWI maps, based on aerial photography have been used to estimate the area of various wetland types across the state of Maryland. Results were reported in Tiner and Burke 1995.

Purpose of Data Set Wetland Status Description, establishment of a baseline

Time Period of Data Based on 1980s aerial photography.

Spatial Domain State of Maryland, much of the United States.

Update Information

Related Publications Tiner and Burke 1995

Comments Data on wetlands trends derived from National Wetlands Inventory data and related trends analysis (e.g. Tiner 1994) are not statistically valid for the Coastal Bays region. New studies would have to be commissioned to derive accurate estimates of wetlands loss within the Coastal Bays watersheds.

Who to Contact For More Information

Maryland Coastal Bays Status and Trends
Data Source Record

Data Set Name	Permitted Nontidal Wetlands Losses
Data Category	Wetlands
Description	Maryland's Nontidal Wetlands Program has maintained extensive data by watershed of permitted nontidal wetland losses and required wetland mitigation. These data are maintained in a database that can be queried in a variety of ways for information on permitted activities by watershed or year. Data represents activity permitted. In some cases, permitted activities have not yet been, or may never be carried out.
Purpose of Data Set	Tracking performance of Maryland's wetlands protection programs
Time Period of Data	1991 to the present.
Spatial Domain	State of Maryland, queriable by watershed
Update Information	Updated continuously
Related Publications	
Comments	

Who to Contact For More Information

Dave Walbeck
(410) 974-3841
Maryland Department of the Environment --Nontidal Wetlands

Maryland Coastal Bays Status and Trends

Data Source Record

Data Set Name Tidal Wetlands Status Data

Data Category Wetlands

Description These data are derived from Maryland's Coastal Wetlands maps, which were drawn up for regulatory purposes in the early 1970s. Tidal wetlands are categorized according to vegetation type. Data does not coincide well with NWI county wetlands data. For example, total saltmarsh area is about 20% lower from this source than from NWI. It is unclear whether that is because of different methodologies, or different study areas.

Purpose of Data Set Maps developed for regulatory purposes.

Time Period of Data Based on 1970s maps.

Spatial Domain ACOE "Study Area", presumably the coastal bays area and perhaps the barrier islands.

Update Information No updates likely.

Related Publications ACOE 1994, Citing McCormick and Somes 1982

Comments These data present a bit more useful data on the mix of vegetation types found in tidal wetlands in the coastal bays region. The basic picture does not change very much. Forested tidal wetlands are rare, scrub-shrub wetlands fairly abundant, and various emergent tidal wetlands are highly abundant throughout the region.

Who to Contact For More Information

Maryland Coastal Bays Status and Trends
Data Source Record

Data Set Name	ACOE Reconnaissance Report and Feasibility Study
Data Category	Wetlands, Hydrology and Geology
Description	ACOE Water Resources Reconnaissance Report. This report includes some in-bay tidal current measurements, wave field data, and wetlands loss data. Feasibility Study is still underway, and will include more information. Until publication, raw data may have to be collected from individual Corps scientists involved. Dat includes 1-D hydrodynamic model of area near the Ocean City Inlet, Bathymetry, limited tide and current data, aerial photography, and limited coring and grab samples of sediments.
Purpose of Data Set	Reconnaissance report undertaken to examine a variety of potential engineering projects in the coastal bays and along the Ocean City inlet
Time Period of Data	Various.
Spatial Domain	Various. Emphasis on the area near the Ocean City Inlet.
Update Information	Feasibility study is being developed now. Final Report scheduled to be
Related Publications	ACOE 1994
Comments	Study primarily aimed at engineering issues related to four projects, including restoration of Assateague Island, long-term sand placement around the inlet, habitat restoration in the coastal bays, and navigation improvements. These data include good data on important resources in the region and on historic habitat loss.

Who to Contact For More Information

Stacey Underwood
(410)962-4977
U.S. Army Corps of Engineers
Baltimore District

Appendix D

Appendix D: Current and historical rare, threatened and endangered species of Maryland's coastal bays.

Scientific Name	Common Name	State Status
ANIMALS:		
Acantharchus pomotis	Mud sunfish	
Caretta caretta	Atlantic loggerhead turtle	Threatened
Charadrius melodus	Piping plover	Endangered
Charadrius wilsonia	Wilson's plover	Endangered
Cicindela dorsalis media	White tiger beetle	Endangered
Cicindela lepida	Little white tiger beetle	Endangered
Circus cyaneus	Northern harrier	
Cistothorus platensis	Sedge wren	Threatened
Fundulus luciae	Spotfin killifish	
Haliaeetus leucocephalus	Bald eagle	Endangered
Ixobrychus exilis	Least bittern	In Need of Conservation
Podilymbus podiceps	Pied-billed grebe	
Rana virgatipes	Carpenter frog	In Need of Conservation
Rynchops niger	Black skimmer	Threatened
Sterna antillarum	Least tern	Threatened
Sterna dougallii	Roseate tern	Extirpirated
Sterna maxima	Royal tern	Endangered
Sterna nilotica	Gull-billed tern	Threatened
Sterna sandvicensis	Sandwich tern	
Plants:		
Agalinis fasciculata	Fascicled gerardia	Endangered
Alnus maritima	Seaside alder	

Amaranthus pumilus	Seabeach amaranth	Extirpirated*
Ammannia latifolia	Koehne's ammannia	
Antennaria solitaria	Single-headed pussytoes	Threatened
Aristida lanosa	Woolly three-awn	Endangered
Aster concolor	Silvery aster	Extirpirated
Axonopus furcatus	Big carpet grass	Extirpirated
Bidens discoidea	Swamp beggar-ticks	
Borrichia frutescens	Sea ox-eye	Extirpirated
Buchnera americana	Blue-hearts	Extirpirated
Carex barrattii	Barratt's sedge	Threatened
Carex gigantea	Giant sedge	Endangered
Carex glaucescens	A sedge	Endangered
Carex joorii	Cypress-swamp sedge	Threatened
Carex silicea	Sea-beach sedge	Endangered
Carex striatula	Lined sedge	Extirpirated
Carex tenera	Slender sedge	Extirpirated
Centella erecta	Coinleaf	Endangered
Cleistes divaricata	Spreading pogonia	Endangered
Coelorachis rugosa	Wrinkled jointgrass	Endangered
Cyperus retrofractus	Rough cyperus	
Desmodium rigidum	Rigid tick-trefoil	Endangered
Desmodium sessilifolium	Sessile-leaved tick-trefoil	Extirpated
Desmodium strictum	Stiff tick-trefoil	Endangered
Drosera capillaris	Pink sundew	Endangered
Dryopteris celsa	Log fern	Threatened
Eleocharis albida	White spikerush	Endangered
Eleocharis rostellata	Beaked spikerush	Threatened
Eleocharis tortilis	Twisted spikerush	

Epilobium ciliatum	Northern willowherb	Endangered
Eragrostis refracta	Meadow lovegrass	Threatened
Erianthus contortus	Bent-awn plumegrass	Endangered
Eriocaulon decangulare	Ten-angled pipewort	
Eupatorium leucolepis	White-bracted boneset	Endangered
Fimbristylis puberula	Hairy fimbristylis	
Fuirena pumila	Smooth fuirena	Endangered
Galactia volubilis	Downy milk pea	Endangered
Galium hispidulum	Coast bedstraw	Endangered
Gymnopogon brevifolius	Broad-leaved beardgrass	Endangered
Honckenya peploides	Sea-beach sandwort	Extirpated
Hypericum denticulatum	Coppery St. John's-wort	Endangered
Juncus megacephalus	Big-headed rush	Extirpated
Juncus polycephalus	Many-headed rush	
Juncus torreyi	Torrey's rush	Endangered
Leptochloa fascicularis	Long-awned diplachne	Endangered
Limonium nashii	Nash's sea lavender	
Linum intercursum	Sandplain flax	Endangered
Ludwigia hirtella	Hairy ludwigia	Endangered
Lycopodiella caroliniana	Carolina clubmoss	Extirpated
Myriophyllum heterophyllum	Broadleaf water-milfoil	
Myriophyllum humile	Low water-milfoil	Endangered
Oldenlandia uniflora	Clustered bluets	
Panicum commonsianum	Commons' panicgrass	
Panicum flexile	Wiry witch-grass	Endangered
Panicum oligosanthes	Few-flowered panicgrass	Endangered
Panicum scabriusculum	Tall swamp panicgrass	Endangered
Paspalum dissectum	Walter's paspalum	Endangered

Persea borbonia	Red bay	Endangered
Platanthera blephariglottis	White fringed orchid	Threatened
Platanthera cristata	Crested yellow orchid	Threatened
Pluchea camphorata	Marsh fleabane	Endangered
Polygala cruciata	Cross-leaved milkwort	Threatened
Polygonum glaucum	Seaside knotweed	Endangered
Potamogeton pusillus	Slender pondweed	
Prunus maritima	Beach plum	Endangered
Pycnanthemum setosum	Awned mountain-mint	Threatened
Rhynchospora globularis	Grass-like beakrush	Endangered
Rhynchospora glomerata	Clustered beakrush	Endangered
Rhynchospora microcephala	Tiny-headed beakrush	Extirpated
Rhynchospora torreyana	Torrey's beakrush	Endangered
Sacciolepis striata	Sacciolepis	Endangered
Sagittaria longirostra	Long-beaked arrowhead	
Sagittaria rigida	Sessile-fruited arrowhead	Endangered
Schwalbea americana	Chaffseed	Extirpated*
Scleria reticularis	Reticulated nutrush	
Scleria verticillata	Whorled nutrush	Endangered

Source: Maryland Department of Natural Resources Wildlife and Heritage Division, October 9, 1996

Sesuvium maritimum	Sea-purslane	E
Sphenopholis pensylvanica	Swamp-oats	T
Spiranthes odorata	Sweet-scented ladys' tresses	X
Spiranthes praecox	Grass-leaved ladys' tresses	
Trachelospermum difforme	Climbing dogbane	E
Triglochin striatum	Three-ribbed arrow-grass	E
Trillium pusillum var virginianum	Dwarf trillium	T
Utricularia biflora	Two-flowered bladderwort	E
Utricularia inflata	Swollen bladderwort	E
Xyris difformis	Variable yelloweyed-grass	
Xyris smalliana	Small's yelloweyed-grass	E
Zephyranthes atamasca	Atamasco lily	E
Zizaniopsis miliacea	Southern wildrice	E

Appendix E

Appendix E: Fish Species Caught in MD DNR Seine and Trawl Surveys from 1972 to 1994

COMMON NAME	SCIENTIFIC NAME
ALEWIFE	*Alosa pseudoharengus*
AMERICAN EEL	*Anguilla rostrata*
AMERICAN SAND LANCE	*Ammodytes americanus*
ATLANTIC CROAKER	*Micropogonias undulatus*
ATLANTIC HERRING	*Clupea harengus harengus*
ATLANTIC MENHADEN	*Brevoortia tyrannus*
ATLANTIC MOONFISH	*Selene setapinnus*
ATLANTIC NEEDLEFISH	*Strongylura marina*
ATLANTIC POLLOCK	*Pollachius virens*
ATLANTIC SILVERSIDE	*Menidia menidia*
ATLANTIC SPADEFISH	*Chaetodipterus faber*
ATLANTIC THREAD HERRING	*Opisthonema oglinum*
BANDED KILLIFISH	*Fundulus diaphanus*
BAY ANCHOVY	*Anchoa mitchilli*
BLACK DRUM	*Pogonias cromis*
BLACK SEA BASS	*Centropristis striata*
BLACKCHEEK TONGUEFISH	*Symphurus plagiusa*
BLUEBACK HERRING	*Alosa aestivalis*
BLUEFISH	*Pomatomus saltatrix*
BLUESPOTTED CORNETFISH	*Fistularia tabacaria*
BULLNOSE RAY	*Myliobatis freminvillei*
BUTTERFISH	*Peprilus triacanthus*
CLEARNOSE SKATE	*Raja eglanteria*
COBIA	*Rachycentron canadum*
COMMON TRUNK FISH	*Lactophrys trigonus*

CONGER EEL	*Conger oceanicus*
COWNOSE RAY	*Rhinoptera bonassus*
CREVALLE JACK	*Caranx hippos*
CUNNER	*Tautogolabrus adspersus*
DUSKY PIPEFISH	*Syngnathus floridae*
DWARF GOATFISH	*Upeneus parvus*
FEATHER BLENNY	*Hypsoblennius hentzi*
FOURSPINE STICKLEBACK	*Apeltes quadracus*
FOURSPOT FLOUNDER	*Paralichthys oblongus*
GAG	*Mycteroperca microleptis*
GIZZARD SHAD	*Dorosoma cepedianum*
GRAY TRIGGERFISH	*Balistes capriscus*
GREAT BARRACUDA	*Sphyraena barracuda*
GREEN GOBY	*Microbius thalassinus*
HALFBEAK	*Hyporhamphus unifasciatus*
HARVESTFISH	*Peprilus alepidotus*
HOGCHOKER	*Trinectes maculatus*
HORSE-EYE JACK	*Caranx latus*
INLAND SILVERSIDE	*Manidia beryllina*
INSHORE LIZARDFISH	*Synodus foetens*
KING MACKEREL	*Scomberomorus cavalla*
LADYFISH	*Elops saurus*
LINED SEA HORSE	*Hippocampus erectus*
LOOKDOWN	*Selene vomer*
MOSQUITOFISH	*Gambusia affinis*
MUMMICHOG	*Fundulus heteroclitus*
NAKED GOBY	*Gobiosoma bosci*
NORTHERN KINGFISH	*Menticirrhus saxatilis*

NORTHERN PIPEFISH	*Syngnathus fuscus*
NORTHERN PUFFER	*Sphoeroides maculatus*
NORTHERN SEAROBIN	*Prionotus carolinus*
NORTHERN SENNET	*Sphyraena borealis*
NORTHERN STARGAZER	*Astroscopus gutttatus*
ORANGE FILEFISH	*Aluteras schoepfi*
OYSTER TOADFISH	*Opsanus tau*
PERMIT	*Trachinotus falcatus*
PIGFISH	*Orthopristis chrysoptera*
PINFISH	*Lagodon rhomboides*
PLANEHEAD FILEFISH	*Monacanthus hispidus*
RAINWATER KILLIFISH	*Lucania parva*
RED DRUM	*Sciaenops ocellata*
RED HAKE	*Urophycis chuss*
RED SNAPPER	*Lutjanus campechanus*
ROUGH SCAD	*Trachurus trachurus*
ROUGH SILVERSIDE	*Membras martinica*
ROUND POMPANO	*Trachinotus carolinus*
SAND SHARK	*Odontaspis taurus*
SANDBAR SHARK	*Carcharhinus milberti*
SCUP	*Stenotomus chrysops*
SEABOARD GOBY	*Gobiosoma ginsburgi*
SHEEPSHEAD MINNOW	*Cyprinodon variegatus*
SHORTHEAD REDHORSE	*Moxostoma macrolepidotum*
SILVER PERCH	*Bairdiella chrysura*
SKILLETFISH	*Gobiesox strumosus*
SMALLMOUTH FLOUNDER	*Etropus microstomus*
SMOOTH BUTTERFLY RAY	*Gymnura micrura*

SMOOTH DOGFISH SHARK	*Mustelus canis*
SOUTHERN PUFFER	*Spheroides nephelus*
SOUTHERN STINGRAY	*Dasyatis americana*
SPANISH MACKEREL	*Scomberomorus maculatus*
SPINY DOGFISH	*Squalus acanthias*
SPOT	*Leiostomus xanthurus*
SPOTFIN BUTTERFLY FISH	*Chaetodon ocellatus*
SPOTFIN MOJARRA	*Eucinostomus argenteus*
SPOTTED HAKE	*Urophycia regius*
SPOTTED SEA TROUT	*Cynoscion nebulosus*
STRIPED ANCHOVY	*Anchoa helsetus*
STRIPED BASS	*Morone saxatilis*
STRIPED BLENNY	*Chasmodes bosquianus*
STRIPED BURRFISH	*Chilomycterus schoepfi*
STRIPED CUSK EEL	*Ophidion marginatum*
STRIPED KILLIFISH	*Fundulus majalis*
STRIPED MULLET	*Mugil cephalus*
STRIPED SEAROBIN	*Prionotus evolans*
SUMMER FLOUNDER	*Peralichthys dentatus*
TAUTOG	*Tautoga onitis*
THREESPINE STICKLEBACK	*Gasterosteus aculeatus*
WEAKFISH	*Cynoscion regalis*
WHITE CATFISH	*Ictalurus catus*
WHITE MULLET	*Mugil curema*
WHITE PERCH	Morone americana
WINDOWPANE FLOUNDER	Scophthalmus aquosus
WINTER FLOUNDER	Pseudopleuronectes americanus

Source: Maryland Department of Natural Resources

Appendix F

Appendix F: Invertebrate and Reptilian Species Caught in the Seine and Trawl Survey From 1972 - 1994

COMMON NAME	SCIENTIFIC NAME
AMERICAN OYSTER	*Crassostrea virginica*
ATLANTIC SURF CLAM	*Spisula solidissma*
BLOOD ARK	*Anadara ovalis*
BLUE CRAB	*Callinectes sapidus*
BLUE MUSSEL	*Mytilus edulis*
BORING SPONGE	*Clionidae sp.*
BROWN SHRIMP	*Penaeus aztecus*
CHANNELED WHELK	*Busycon canaliculatum*
COMB JELLY 1	*Mnemiopsis leidyi*
COMB JELLY 2	*Ctenophore*
COMMON SEA CUCUMBER	*Cucumaria pulcherrima*
ENSIS DIRECTUS	*Ensis directus*
ENSIS SP.	*Ensis sp.*
EUPLEURA CAUDATA	*Eupleura caudata*
FLAT MUD CRAB	*Eurypanopeus depressus*
FORBES ASTERIAS STAR	*Asterias forbesi*
GRASS SHRIMP	*Palaemonetes sp.*
HAMINOEA SOLITARIA	*Haminoea solitaria*
HARD SHELL CLAM	*Mercinaria mercinaria*
HERMIT CRAB 1	*Pagurus longicarpus*
HERMIT CRAB 2	*Pagurus pollicaris*
HORSESHOE CRAB	*Limulus polyphemus*
HYDROBIIDAE SP.	*Hydrobiidae sp.*
KNOBBY WHELK	*Busycon carica*
LADY CRAB	*Ovalipes ocellatus*

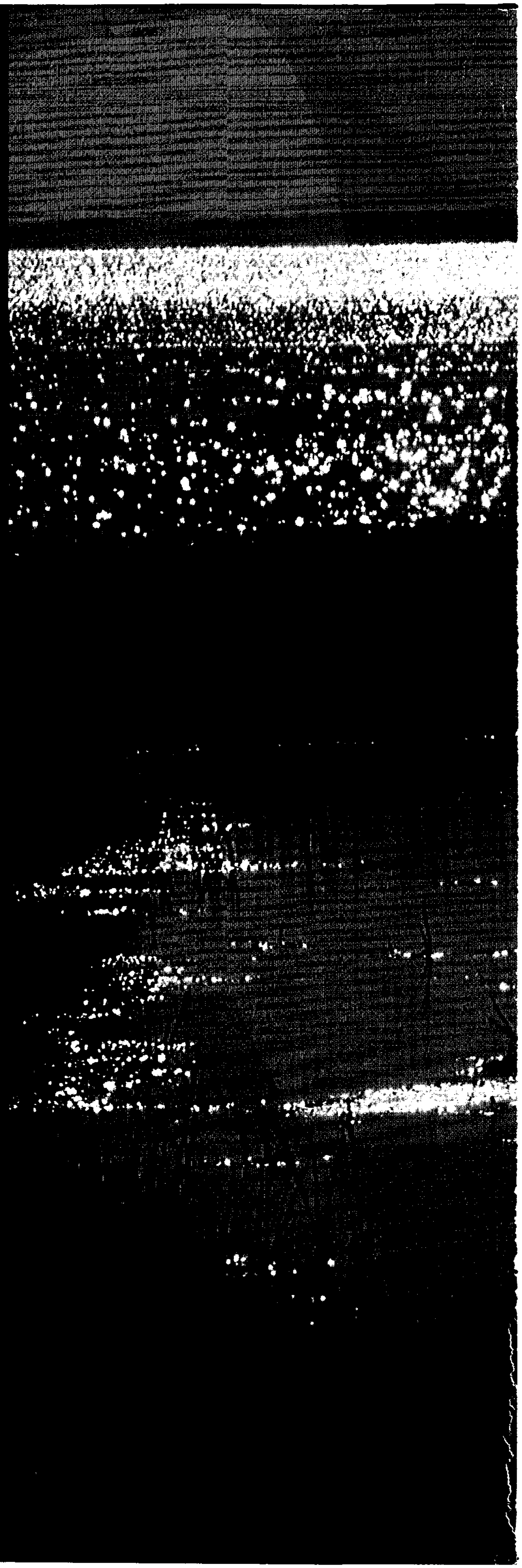
LION'S MANE JELLY	*Cyanea capillata*
LOBED MOON SNAIL	*Polinices duplicatus*
LONG-FINNED SQUID	*Loligo pealei*
MANTIS SHRIMP	*Squilla empusa*
SEA SQUIRT	*Molgula manhattensis*
TUNICATE	*Molgula sp.*
MOON JELLY	*Aurelia aurita*
MUD CRAB 1	*Rhithropanopeus harrisii*
MUD CRAB 2	*Neopanope texana sayi*
MUD CRAB 3	*Panopeus sp.*
MUD FIDDLER	*Uca pugnax*
MUD SNAIL 1	*Nassarius vibex*
MUD SNAIL 2	*Nassaridae sp.*
MULINIA LATERALIS	*Mulinia lateralis*
MYSIDOPSIS ALMYRA	*Mysidopsis almyra*
NARROW MUD CRAB	*Hexapanopeus angustifrons*
OYSTER DRILL	*Urosalpinx cinera*
PANOPEUS	*Panopeus sp.*
PHSYSA SP.	*Phsysa sp.*
PONDEROUS ARK	*Noetia ponderosa*
PORTUNID CRAB	*Portunidae sp.*
PORTUNIDAE	*Portunidae sp.*
ROCK CRAB	*Cancer irroratus*
SAND FIDDLER	*Uca pugilator*
SAND SHRIMP	*Crangon septemspinosa*
SEA NETTLE	*Chrysaora quinquecirrha*
SHORTSPINED BRITTLESTAR	*Ophioderma brevispina*
SNAPPING SHRIMP	*Callianassa atlantica*

SOLEN SP.	*Solen sp.*
SPIDER CRAB 1	*Libinia dubia*
SPIDER CRAB 2	*Libinia emarginata*
TELLLINA AGILIS	*Tellina agilis*
TRANSVERSE ARK	*Auldera transversa*
ATLANTIC LOGGERHEAD TURTLE	*Caretta caretta*
DIAMONDBACK TERRAPIN	*Malaclemys centrata concentrica*

Source: Maryland Department of Natural Resources

Today's Treasures for Tomorrow

An Environmental Report on Maryland's Coastal Bays



Maryland's Coastal Bays Program

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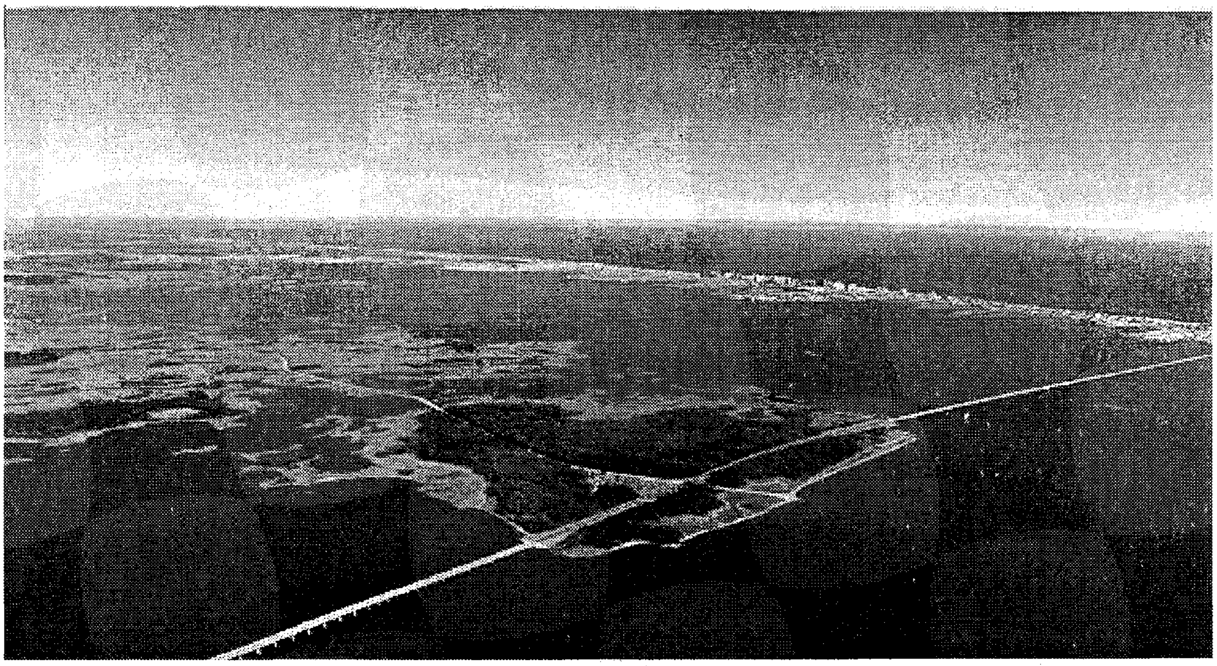
A PRELIMINARY ASSESSMENT OF RECREATIONAL BOATING ON MARYLAND'S COASTAL BAYS, 1999



Maryland Coastal Bays Program
Water-Based Activities Subcommittee

April 2000

A PRELIMINARY ASSESSMENT OF RECREATIONAL BOATING ON MARYLAND'S COASTAL BAYS, 1999

Prepared for

Maryland Coastal Bays Program
Water-Based Activities Subcommittee

Prepared by

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April 2000

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MARYLAND COASTAL BAYS PROGRAM

REPORT SUMMARY

INTRODUCTION

The coastal bays of Maryland were designated as an estuary of national significance in 1996 by the U.S. Environmental Protection Agency under the Clean Water Act. Nationally significant estuaries are identified and targeted for special attention because of their recreational, economic, and ecological significance. Under the leadership of the Maryland Department of Natural Resources, and in cooperation with numerous federal, state, and local government agencies, and a Citizens Advisory Committee (CAC), a Comprehensive Conservation and Management Plan (CCMP) for Maryland's Coastal Bays was developed. To help better understand human activities and their environmental impacts on the bays, the Water-Based Activities Subcommittee, a subcommittee of the Maryland Coastal Bays Program, applied for a grant from the coastal bays program to examine attitudes and perceptions of boaters about the environment and other bay- related uses.

The subcommittee contacted the University of Delaware Sea Grant Marine Advisory Service to assist with the project. Initially the project involved designing two survey instruments, one a field intercept survey and the other developed for mailing. Both surveys would be pre-tested with a small sample of users to gauge how effective and comprehendible the survey instruments were to boaters.

As planning meetings progressed with the Water-Based Activities Subcommittee to develop and refine the surveys, officials from the Maryland Department of Natural Resources, Fisheries Service began attending meetings and providing input. They informed the subcommittee that they needed information from coastal bays' boaters about their fishing practices to assist in developing fisheries management plans for the bays. It was imperative, however, that they begin collecting the information during the summer of 1999. They indicated a willingness to support the boating project by conducting aerial flights during the summer of 1999 to document peak boating uses on the bays. The subcommittee felt that this was a good compromise and agreed to conduct a more extensive field data collection effort in August of 1999.

The on-site field survey instrument was finalized in mid-August and trained volunteers began interviewing boaters at various coastal bays' access sites on August 21, 1999. Additional field interview dates included, August 22, August 28, and August 29. The mail survey instrument was developed and was tested in late-fall of 1999. The results presented in this report include the data collected from the field intercept survey (n=193 boaters) and from respondents who replied to the mail survey (n=78 boaters).

FIELD SURVEY RESULTS

Trained interviewers obtained information from 193 boaters during dockside interviews. The greatest number of interviews were completed at the West Ocean City public launch ramps (39%), followed by the ramps at Ocean Pines--White Horse Park (26%), and Frontier Town (17%). The Ocean Pines Community Marina was the primary marina where interviews were conducted (15%).

Three-quarters of the boaters interviewed were operating powerboats (typically outboard sportfishing boats). Another 10 percent operated pontoon boats and 7 percent were operating personal watercraft (PWC). Eight percent of boaters were in other types of watercraft, from sailboats to inflatables. As expected, Maryland (70%) boat registrations were the most prominent, followed by Delaware (11%), and Pennsylvania (10%).

The predominant boat length operated by responding boaters was between 16 and 25 feet (76%), with only 8 percent of boaters having a vessel 26 feet or greater. Nearly one-half (48%) of the vessel's engines were less than 100 horsepower and 12 percent were greater than 250 horsepower. Thirty percent of boaters keep their boats in the water during the boating season. Marinas (73%) were the primary in-water location for most of the boats, followed by private residences (docks--21% and boat lifts--6%).

Two-thirds of all boaters interviewed were Maryland residents, almost one-quarter were Pennsylvania residents (24%). Eleven percent of the boaters resided in the states of Delaware (5%), Virginia (3%), New Jersey (2%), and New York (1%).

Fifty-nine percent of the boaters had boated on Maryland's Coastal Bays between 1 and 10 years. Nineteen percent had boated between 11 and 20 years and 22 percent had boated on the bays for more than 20 years.

Twenty-two percent of the boaters boated on the bays 10 days, or fewer, in 1999 and about one-third (34%) boated between 11 and 25 days. Thirty one percent boated between 26 and 50 days and 13 percent boated more than 50 days in the bays during 1999. The average number of days spent boating on the bays was 32.

A majority of the boaters indicated they were flexible with their boating time, with 54 percent noting that they boat on both weekdays and weekends equally. Thirty-nine percent indicated they are mostly weekend boaters.

When boaters were asked to rate their skill level, 54 percent mentioned they were advanced (43%) or experts (11%), and 46 percent felt they were novices (7%) or intermediate (39%).

When boaters were asked if they had taken a boating safety course, 65 percent indicated that they had. When asked when they took their last course, two-thirds noted that they had completed a safety course in the 1990's.

Ninety-four percent of all boaters engaged in their trip with other family members or friends. The average group size was 3.2. Sixty-one percent boated with 2 or 3 people (including themselves). Eighteen percent boated with groups of 5 or more individuals.

Eighty percent of the boaters who were interviewed started boating before noon, with 43 percent starting before 10 a.m. Twenty-one percent of the boaters indicated that they began their daily boat trip after 12 noon.

Fishing (60%) was the dominant activity engaged in by boaters, followed by pleasure cruising (45%). Boaters also engaged in jetskiing (8%), waterskiing/tubing (7%), and swimming (5%).

Boaters rated crowding in the bays to be 5.1 (based on a 9-point scale, with 1 = Not At All Crowded and 9 = Extremely Crowded). Boaters were most inclined to indicate that crowding was most intense around the Ocean City Inlet (near the Route 50 bridge) and north of the inlet in the Isle of Wight Bay.

Boaters responded to a series of statements that helped to better understand boating trip experiences. They rated the statements on a 5-point scale (1 = Strongly Disagree and 5 = Strongly Agree). Boaters were most likely to respond that they thoroughly enjoyed their boat trip on the bays (4.2) and also felt navigational buoys were adequate to direct them on the bays (4.0). There was also agreement that there were adequate DNR police on the water (3.8), that boating conditions were safe (3.7) and the depth of the water was not a problem for them (3.6). Boaters overall disagreed with the statement that poor water quality affected their boat trip (2.0).

Nearly three-quarters of all boaters indicated that they fish in Maryland's Coastal Bays. It is also interesting to note that 78 percent of those who fish the bays would still visit if fishing was not part of their planned activities.

Boaters fish in the bays at various times and at various frequencies. Forty-two percent of respondents indicated they fish fewer than 10 weekend days annually. Twenty-two percent mentioned that they fish more than 30 weekend days annually. Forty-five percent reported they fished fewer than 10 weekdays annually and 25 percent mentioned that they fish more than 30 days annually on weekdays.

Fishermen overwhelmingly preferred drift fishing (79%) to any other type of fishing. This was followed by anchoring (22%) and trolling (14%). A majority of fishermen (69%) indicated that they target a specific species of fish while fishing in the coastal bays. The predominant species was flounder (71%), followed by croaker (10%), and sea trout (8%).

Boaters were generally pleased with their fishing trip on the bays. Their responses to a series of statements about fishing supported this observation. Their responses were rated on a 5-point scale (1 = Strongly Disagree and 5 = Strongly Agree). Fishermen indicated that they would fish Maryland's Coastal Bays again (4.4) and they reported they thoroughly enjoyed their trip (4.2). Some fishermen wished that they had caught more fish (4.1), but others felt they would have been happy even if they had not caught any fish (3.7). Fishermen thought the Maryland DNR does a good job managing fish (3.6) and they were not too concerned about having too many people fish where they fished (2.6).

When asked to rate their ability as fishermen, 38 percent indicated they were average. Forty-seven percent indicated they were above average (30%) or expert (17%), and 15 percent noted that they were below average (8%) or novice (7%) anglers.

It is noteworthy that 66 percent of respondents felt they understand how saltwater fishing policies and regulations are determined in Maryland, with 34 percent mentioning they were unaware (20%) or unsure (14%).

The majority of all respondents (61%) indicated they would not favor a coastal bays sportfishing license under any circumstances, only 11 percent said that they would favor it under any circumstances, and 28 percent reported they might support it depending on how the monies were used. When asked how they think license money should be used, 44 percent felt it should stay in the bays and support only coastal bays' fisheries efforts, one-third felt it should be used to manage all of Maryland's saltwater fisheries, and 23 percent felt it could best be used to manage fisheries on a region-wide basis.

Fishermen were also asked to indicate an amount they would be willing to pay for a coastal bays' fishing license, even if they did not support the idea of a license. Only 10 percent indicated that they would not be willing to pay anything. The majority of fishermen (57%) indicated a willingness to pay between $6 and $10 to fish in the coastal bays. The average amount fishermen were willing to pay was $8.58.

A series of tools for managing fisheries were presented to fishermen. They were asked to indicate whether they supported or opposed the measures (a 5-point scale was used, 1 = Strongly Oppose and 5 = Strongly Support). Daily bag limits (4.3) and size limits (4.3) received the most support. These are also the types of tools that are typically used to manage sport fisheries and fishermen have a fairly good understanding of them. There was also strong support for stricter enforcement of fisheries regulations (3.8).

MAIL SURVEY RESULTS

Approximately, 150 questionnaires were distributed to boaters primarily affiliated with local boating and fishing organizations. The individuals were mostly year-round residents with substantial boating experience in the coastal bays. The completed questionnaires were returned via first class postage-paid mail. Seventy-eight questionnaires were completed and returned, and this number proved to be an adequate number to assess the validity of the questions as well as to analyze information from this select group of boaters.

The majority of the respondents were male (96%), with more than one-half (52%) indicating they were between the ages of 60 and 69. Another 29 percent noted they were between the ages of 70 and 79. The group was fairly well-educated, with 55% mentioning that they had college degrees, another one-third (32%) indicated they had some college training. Consistent with the age of the respondents, 75% of boaters indicated that they were retired; only 19% mentioned that they had full-time jobs. Two-thirds of all respondents noted that their annual family incomes were greater than $50,000, with 22% mentioning incomes greater than $100,000. Eighty-one percent mentioned that they belonged to a sportfishing club or recreational boating organization.

When boaters were asked how long they owned the boat they used most often on the bays, 62 percent mentioned between 2 and 5 years and 20 percent mentioned between 6 and 10 years. Almost one-half (48%) of the respondents noted that they had participated in recreational boating as a boatowner for more than 20 years. About one-quarter (26%) participated for ten years or less.

Two-thirds (67%) of responding boatowners consider themselves fairly experienced boaters. When asked to rate their skill level, 56 percent indicated they were advanced in their skills, and 11 percent felt they were experts. This segment of boaters appears to have considerable flexibility with their boating time. Forty percent indicated they do most of their boating on weekdays and 48 percent mentioned they boated mostly on weekdays and weekends equally.

Two-thirds of all boats used most often on Maryland's Coastal Bays were sportfishing boats, followed by pontoon boats (13%) and kayaks/canoes (3%). Most boats (82%) were between 16 and 25 feet in length. Fifty-eight percent of all engines were under 150 horsepower and 17 percent were greater than 250 horsepower. Nearly three-quarters of all boaters carried the following equipment on their boats: depth finder (75%), compass (74%), and VHF radio (70%). Fifty-six percent had a cell phone that they carried onboard and 47 percent had Global Positioning Systems (GPS).

Eighty-four percent of respondents indicated that they kept their boat in the water on the coastal bays during the boating season. Eighty percent of those who keep their boat in the water kept it on a boat lift (41%) or at a private dock (39%). Another 16 percent kept their boat at a marina.

Eighty-five percent indicated that they familiarize themselves with new Coast Guard regulations each year. More than one-half (51%) receive a Coast Guard Auxiliary courtesy safety inspection. Eighty-nine percent of respondents felt that all boaters should be required to take a boating safety course. Eighty-four percent of responding boaters indicated that they had taken a course and 66 percent took their safety training during the 1990's. Two-thirds of all respondents noted that their insurance companies offered discounts on their boat insurance if they completed a safety course or received a safety inspection.

As expected, peak boating times in Maryland's Coastal Bays occurs during the summer months, however, "fringe season" boating is also significant. Responding boaters mentioned considerable boating activity in May (86%), September (97%), October (88%), and November (75%).

Ninety-three percent of responding boaters mentioned they participated in fishing and 84 percent mentioned they spent time pleasure cruising during a typical year. Boaters also mentioned crabbing (36%), waterskiing/tubing (22%), and swimming (18%) as activities they engaged in. Other responses included clamming as well as being members of the Coast Guard Auxiliary.

Coastal bays' boaters had an average of 15 years experience boating on the bays. Forty-six percent mentioned having between 1 and 10 years of bays' boating experience, 35 percent had between 11 and 20 years of experience, and 19 percent had more than 20 years of boating experience on the coastal bays.

A vast majority of boaters indicated that they do most of their boating in the bays. Eighty-six percent noted that they spend between 76 and 100 percent of their total boating time on the coastal bays.

Responding boaters were quite avid in their boating frequency. They averaged 49 days boating on the bays in 1999. Almost one-half (48%) spent between 26 and 50 days boating on the bays, and 28 percent spent more than 50 days.

When asked to rate their overall experience boating on Maryland's Coastal Bays, 13 percent indicated it was excellent (12%) or perfect (1%), 64 percent felt it was good (41%) or very good (23%), and 22 percent mentioned that it was poor (3%) or fair (19%).

Boaters were provided with a series of attributes and asked to indicate which specific attributes attracted them to Maryland's Coastal Bays. The reason mentioned most often by boaters was that the bays were close to home or other lodgings (90%). Other attributes that were mentioned by a considerable number of boaters included: good fishing (49%) and the scenic qualities of the bays (43%). When boaters were asked to indicate if they felt the quality of boating had changed in the bays during the past few years, 56 percent felt that it had decreased, 26

ACKNOWLEDGMENTS

The authors of the report wish to thank many individuals for their help on this project. Most importantly, the Water-Based Activities Subcommittee deserve special mention for providing input and comments throughout the entire study. These individuals included: Dave Blazer, Executive Director, Maryland Coastal Bays Program; Carl Zimmerman, Chairman, Maryland Coastal Bays Program, Water-Based Activities Subcommittee; Jack McAllister, Maryland Coastal Bays Program, Water Based Activities Subcommittee; John Laughlin, Maryland Coastal Bays Program, Citizen's Advisory Committee; Tom O'Connell and Eric Schwab, Maryland Department of Natural Resources, Fisheries Service; David Street and Michael Bloxom, Maryland Department of Natural Resources, Natural Resources Police; Will Callihan, Todd Watanabe, and Mark Ogle, U.S. Coast Guard Group Eastern Shore.

In addition numerous individuals assisted in conducting field interviews during the two weekends in August, 1999. They included: David and Doris Lloyd, Fred Heinlen, John Henglein, Don Logan, Walter Boge, Charles and Donna Gentzel, Catherine Kirchner, James Falcon, Joseph O'Hara, William Neubrand, William Killinger, Kenneth MacMullin, William Haag, Bob Abele, and Jack McAllister.

Finally we wish to thank all of the boaters who agreed to be interviewed during the on-site field survey and to those who responded to the mail questionnaires. Their responses were vital to the success of this mini-grant project. By characterizing boating use patterns on Maryland's Coastal Bays and profiling users, we have provided an initial preliminary baseline by which resource managers can monitor changes in the future.

INTRODUCTION

BACKGROUND

The coastal bays of Maryland were designated as an estuary of national significance in 1996 by the U.S. Environmental Protection Agency under the Clean Water Act. Nationally significant estuaries are identified and targeted for special attention because of their recreational, economic, and ecological significance. Under the leadership of the Maryland Department of Natural Resources, and in cooperation with numerous federal, state and local government agencies, and a Citizens Advisory Committee (CAC), a Comprehensive Conservation and Management Plan (CCMP) for Maryland's Coastal Bays was developed. The CAC consisted of a diversity of stakeholders representing over 20 varied interests including, recreational and commercial fishing, boating, farming, forestry, hunting, developers, construction, academia, education, tourism, environmentalists, golfing, private landowners, civic groups and a variety of small businesses and numerous, knowledgeable, and concerned citizens. This collaborative effort, called the Maryland Coastal Bays Program (MCBP), is currently examining the wide range of human influences and activities that are causing ecological change within the coastal bays.

These groups identified, for the CCMP, priorities and actions required to protect the coastal bays as growth and development increases. These include topics such as improving water quality, protecting fish and wildlife resources, and reviewing issues related to human activities, especially those related to recreational use of the bays. To help better understand human activities and their environmental impacts on the bays, the Water-Based Activities Subcommittee (a subcommittee of the MCBP) applied for a mini- grant from the coastal bays program to examine attitudes and perceptions of boaters about the environment and other bay-related uses.

Specifically, the proposed project sought to design a boating survey that could be used to measure public attitudes, perceptions, behaviors, and problems associated with boating on the bays. The survey instrument would be designed to solicit input from recreational boaters (both residents and visitors) and from commercial boaters (watermen and headboat operators). The survey design would address coastal bays' issues and actions defined in the CCMP and by the Water-Based Activities Subcommittee. The issues would focus on safety, user conflicts, public awareness of the environmental impacts of boating, resource limitations, impediments to navigation, lack of public access, educational needs, and knowledge of laws, rules, and regulations and their enforcement. Finally, the survey would be useful to benchmark current public attitudes, perceptions, knowledge, and concerns. It would form the basis for periodic future surveys to determine the effectiveness of CCMP actions in resolving problems and protecting resources. The survey would be designed to be mailed to targeted boaters or be useful as a field intercept tool.

Prior to developing the mini-grant, personnel with the University of Delaware Sea Grant Marine Advisory Service were contacted to inquire whether they could lend assistance on the project. This marine outreach education program has had extensive experience in the design of survey instruments and surveying various recreational user groups. In 1996 they conducted similar work on the Nanticoke River, with support from the Maryland Department of Natural Resources and the Delaware Department of Natural Resources and Environmental Control.

Once the subcommittee was notified its grant application had been approved, a series of meetings began with the University of Delaware Sea Grant Marine Advisory Service personnel to develop a set of tasks associated with the project. The subcommittee was quite diverse and included members of the U.S. Coast Guard, the U.S. Coast Guard Auxiliary, Maryland DNR Police, and several other members of the Water-Based Activities Subcommittee. Initially, it was agreed that two survey instruments were to be designed, one would be designed as a field intercept survey and the other developed for mailing. It was also agreed that both surveys would be pre-tested with a small sample of users to gauge how effective and comprehendible the survey instruments were to boaters.

As planning meetings progressed with the subcommittee to develop and refine the surveys, officials from the Maryland DNR Fisheries Service began attending meetings and providing input. They informed the subcommittee that they needed additional information from boaters in the coastal bays about their fishing practices to help develop fisheries management plans for the bays. It was imperative, however, that they begin to obtain fishing information during the summer of 1999. They indicated a willingness to support the boating project by conducting aerial flights during the summer of 1999 to document peak boating uses on the bays. Aerial flight results can be reviewed in Appendices R and S. The subcommittee felt that this was a good compromise and agreed to conduct a more extensive field data collection effort in August of 1999.

The field intercept survey was finalized in mid-August and, after completing a training program, volunteers began interviewing boaters at various coastal bays' access sites on August 21, 1999. In addition, the development of the mail survey was still underway and it's testing was scheduled for late-fall of 1999. With this more-extensive data collection effort, the original mini-grant project took a major turn. Now, the collected data would have to be entered into a computer data base for analysis and project results would need to be drafted. The University of Delaware Sea Grant personnel agreed to perform these additional assignments, and still meet the objectives of the original mini-grant proposal.

The results presented in this report include the data collected from the field intercept survey (193 boaters) and from respondents who replied to the mail survey (78 boaters). Results from the two surveys are reported independently since there was considerable variation in the way questions were asked of boaters in the field, in contrast to the select boaters who responded to the hand-delivered mail surveys in the privacy of their homes. Copies of the two survey instruments can be reviewed in Appendices C and P.

FIELD SURVEY RESULTS

INTRODUCTION

Seventeen volunteer interviewers were trained to collect interviews from boaters during two weekends in August of 1999. They obtained information from 193 boaters during dockside interviews. The information collected provides insights into boating and fishing experiences from boaters for the day they boated, as well as general attitudes and perceptions on various issues related to boating on Maryland's Coastal Bays. The information presented in the following tables and figures shows overall frequencies reported for all boaters interviewed during two weekends in August.

On the first weekend, 51 interviews were collected on Saturday August 21, the weather was cloudy, gentle winds, calm to light seas, and temperatures around 77 degrees; 56 interviews were collected on Sunday August 22, the weather was partly cloudy, light winds, calm to light seas, and temperatures around 77 degrees. On the second weekend, 47 interviews were collected on Saturday August 28, the weather was sunny, light winds, light seas, and temperatures in the upper 80's; 39 interviews were collected on Sunday August 29, the weather was sunny to partly cloudy, gentle winds, light seas, and temperatures in the upper 80's. Statistical analyses were performed to detect any significant differences among boaters who boated on the different weekends, but none were found.

INTERVIEW LOCATIONS

Interviewers were stationed at various access points throughout the coastal bays' system. This distribution helped ensure that a complete cross-section of boaters were interviewed. The greatest number of interviews were completed at the West Ocean City public launch ramps (39%), followed by the ramps at Ocean Pines--White Horse Park (26%), and Frontier Town (17%). The Ocean Pines Community Marina was the primary marina where interviews were conducted (15%) (Figures 1 and 2).

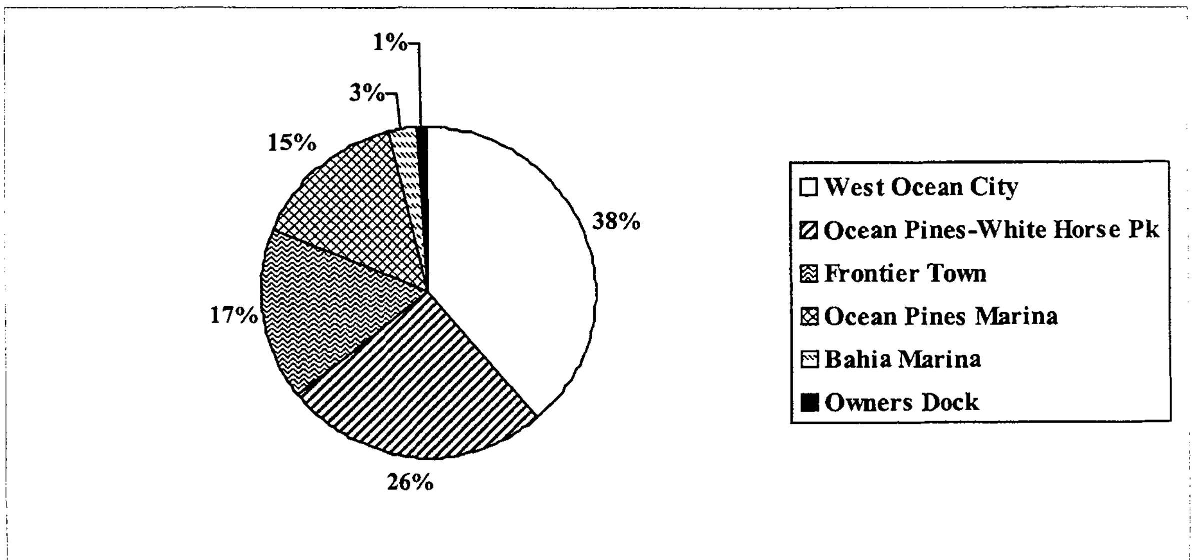


Figure 1. Interview Locations

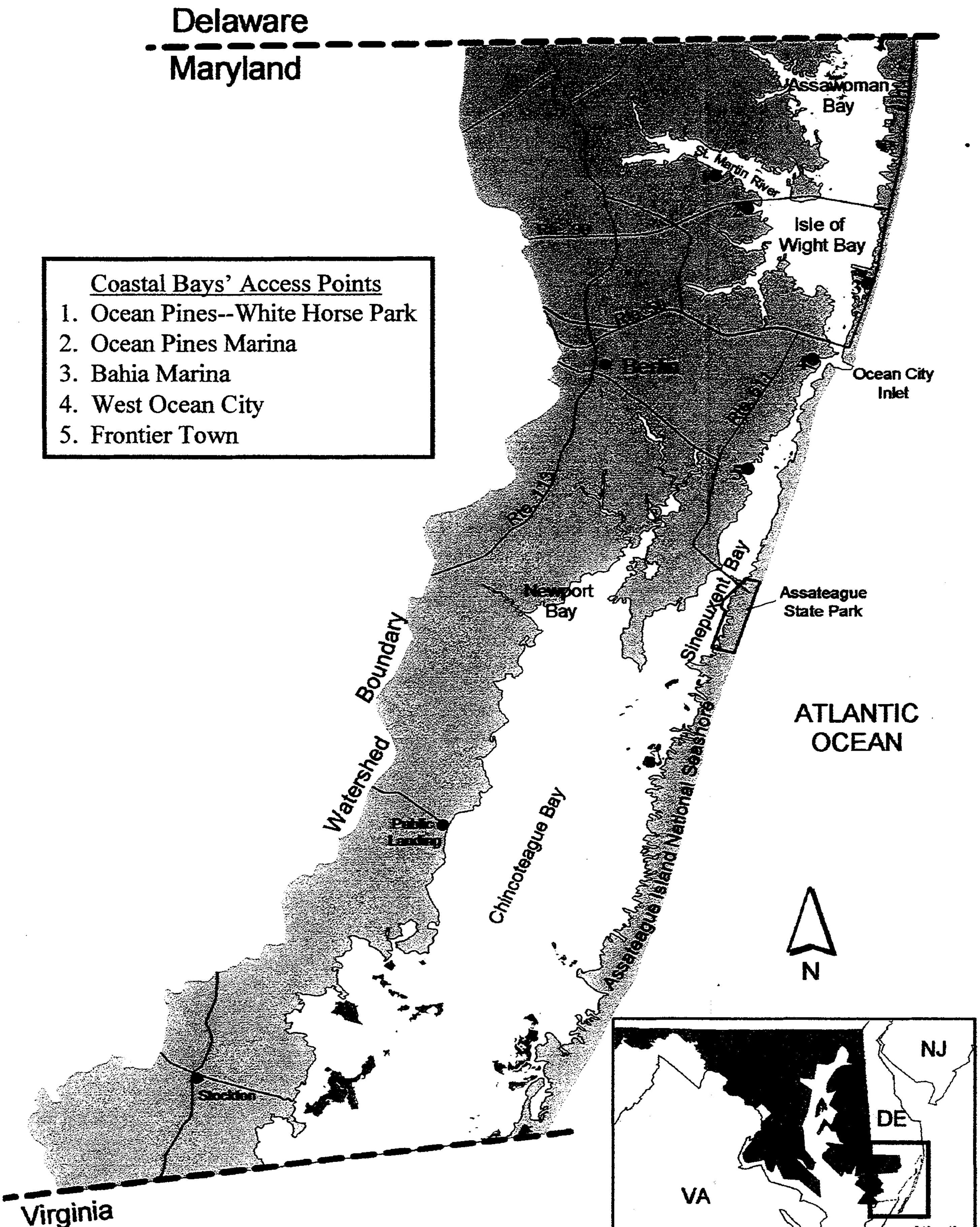


Figure 2. On-site Field Survey Locations

PROFILE OF BOATS USED ON MARYLAND'S COASTAL BAYS

Boat registrations were noted at the time of each interview. As expected, Maryland (70%) boat registrations were the most prominent, followed by Delaware (11%), and Pennsylvania (10%) (Figure 3).

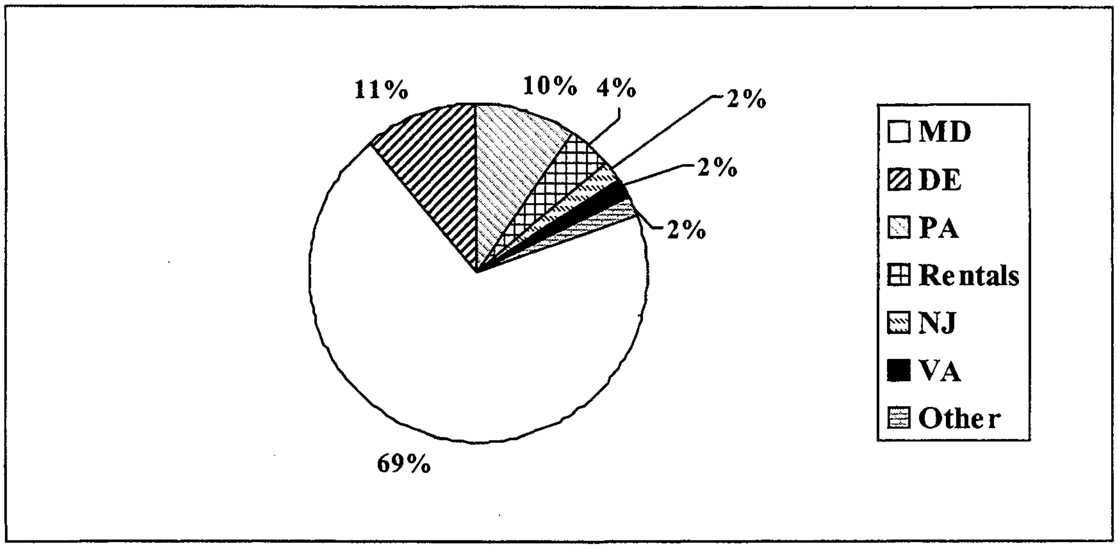


Figure 3. State Boat Registrations

Three-quarters of the boaters interviewed were operating powerboats (typically outboard sportfishing boats). Another 10 percent operated pontoon boats and 7 percent were operating personal watercraft (PWC). Eight percent of boaters were in other types of watercraft, from sailboats to inflatables (Figure 4). To gain a clearer understanding of the multiple activities occurring on the bays on a particular day, see Appendix Table R-2 for the results of aerial flight information collected by Maryland DNR.

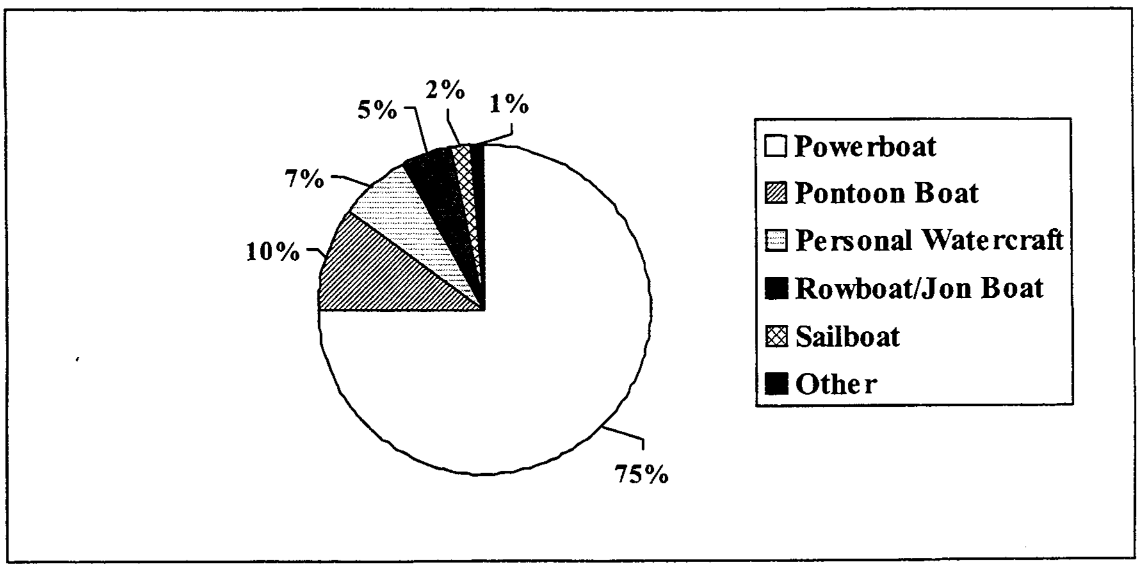


Figure 4. Type of Boat

The predominant size boat operated by responding boaters was between 16 and 25 feet (76%), with only 8 percent of boaters having a vessel 26 feet or greater. Nearly one-half (48%) of the vessel's engines were less than 100 horsepower and 12 percent were greater than 250 horsepower (Table 1).

Table 1. Boat Length and Horsepower	
Length	**Percent**
Less than 16'	15
16' - 20'	54
21' - 25'	22
26' and Greater	8
Horsepower	**Percent**
Less than 50	15
51 - 100	33
101 - 250	40
Greater than 250	12

Thirty percent of boaters interviewed keep their boats in the water during the boating season. Marinas (73%) were the primary in-water location for most of the boats, followed by private residences (docks--21% and boat lifts--6%) (Table 2.).

Table 2. Boat Kept in Water on Maryland's Coastal Bays During Boating Season	
	Percent
Keep In-water	30
Where Keep Boat	**Percent**
Marina	73
Private Residence-Dock	21
Private Residence-Boat Lift	6

PROFILING MARYLAND COASTAL BAY BOATERS

Two-thirds of all boaters interviewed were Maryland residents, almost one-quarter were Pennsylvania residents (24%). Eleven percent of the boaters resided in the states of Delaware (5%), Virginia (3%), New Jersey (2%), and New York (1%) (Figure 5).

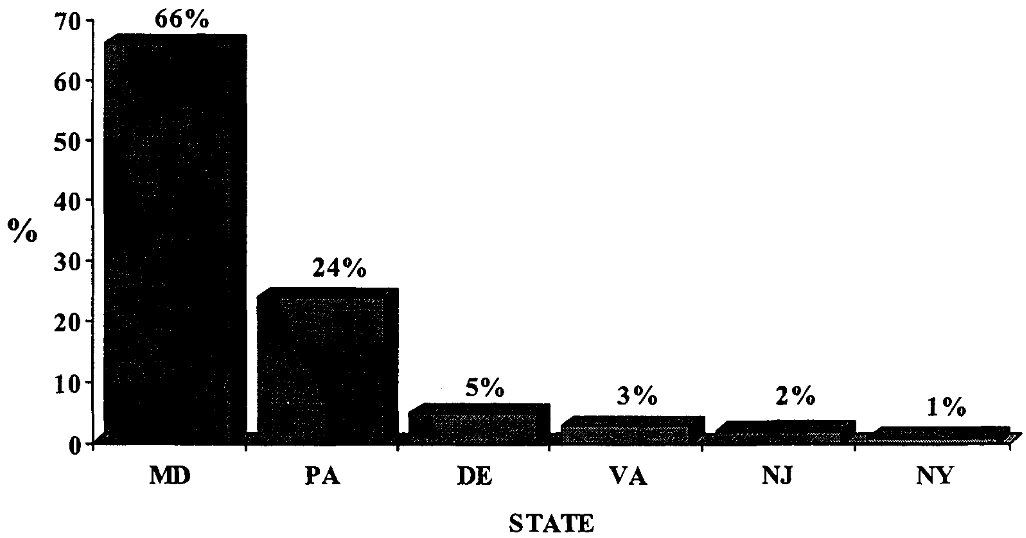


Figure 5. Home Residence of Maryland Coastal Bays' Boaters

Fifty-nine percent of the boaters interviewed had boated on Maryland's Coastal Bays between 1 and 10 years. Nineteen percent had boated between 11 and 20 years and 22 percent had boated on the bays for more than 20 years (Figure 6).

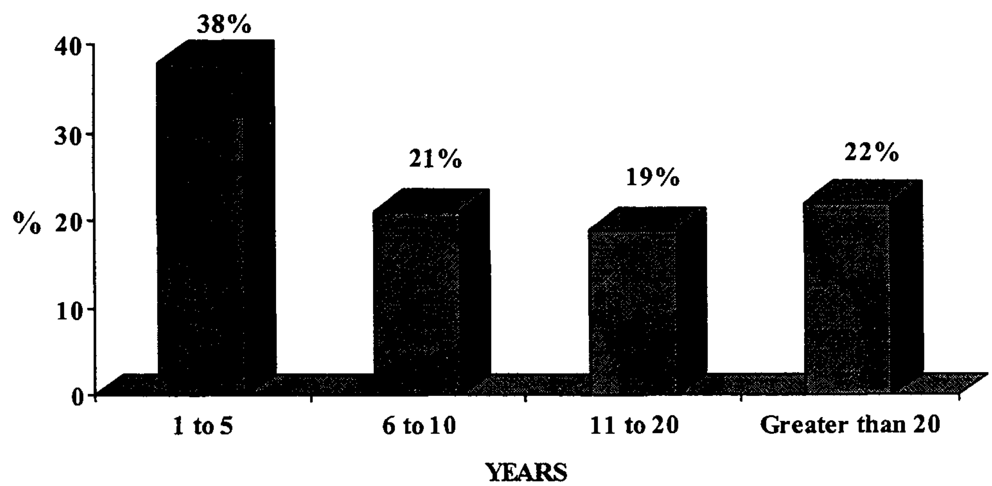


Figure 6. Years of Boating Experience on Maryland's Coastal Bays

Twenty-two percent of the boaters boated on the bays 10 days, or fewer, in 1999 and about one-third (34%) boated between 11 and 25 days. Thirty-one percent boated between 26 and 50 days and 13 percent boated more than 50 days in the bays during 1999. The average number of days spent boating on the bays was 32 (Figure 7).

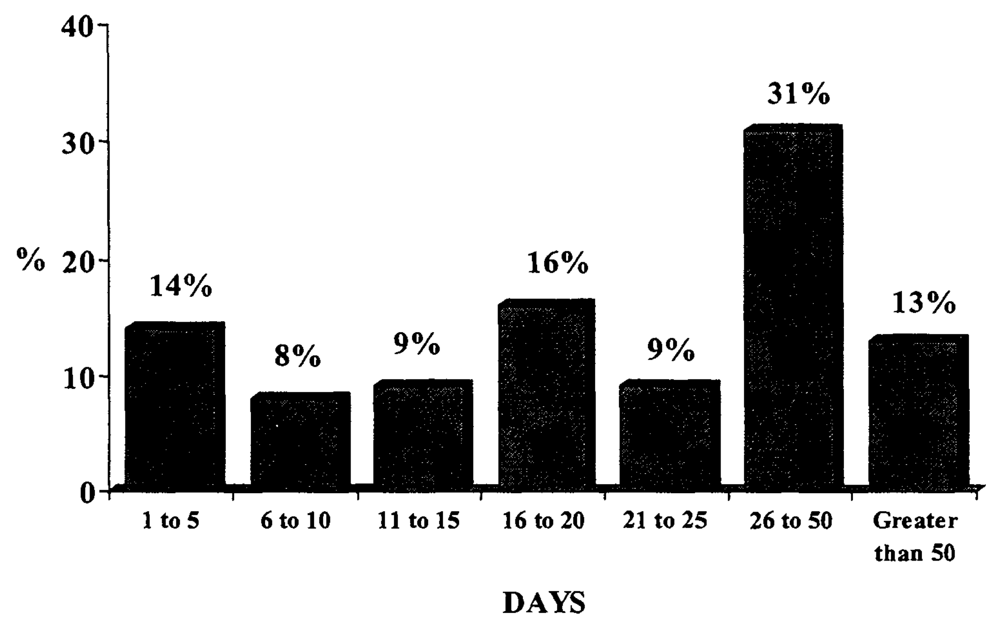


Figure 7. Total Days Boating on Maryland's Coastal Bays in 1999 (Average = 32 Days)

A majority of the boaters indicated they were flexible with their boating time, with 54 percent noting that they boat on both weekdays and weekends equally. Thirty-nine percent indicated they are mostly weekend boaters (Figure 8).

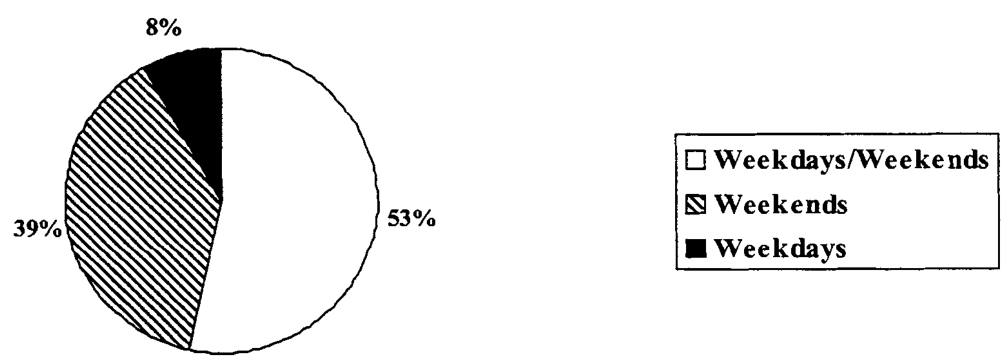


Figure 8. Frequency of Boating in Bays

When boaters were asked to rate their skill level, 54 percent mentioned they were advanced (43%) or experts (11%), and 46 percent felt they were novice (7%) or intermediate (39%) (Figure 9).

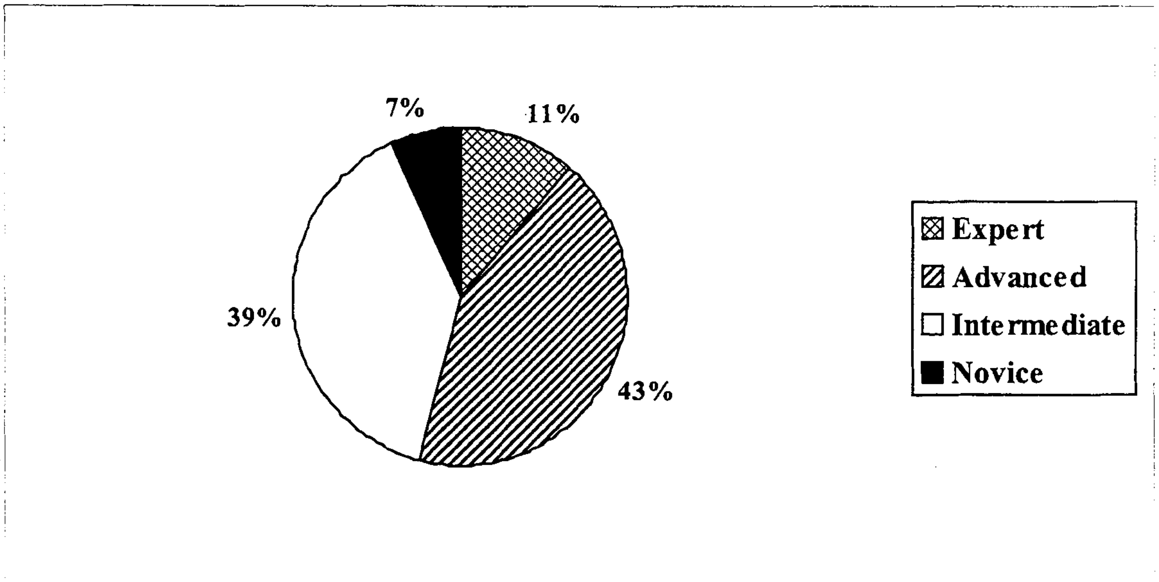


Figure 9. Skill Level of Maryland Coastal Bays' Boaters (Self-Rating)

Safety is always a concern of boaters and properly trained boaters are more inclined to operate boats in a safe and courteous manner. When boaters were asked if they had taken a boating safety training course, 65 percent indicate that they had. When asked when they took their last course, two-thirds noted that they had completed a safety course in the 1990's (Table 3).

Table 3. Safety Concerns of Boaters	
	Percent
Taken Boater Safety Course (% YES)	65
Last Safety Course	**Percent**
1960's	2
1970's	12
1980's	19
1990's	66

DAILY BOAT TRIP EXPERIENCE

Ninety-four percent of all boaters engaged in their trip with other family members or friends. The average group size was 3.2. Sixty-one percent boated with 2 or 3 people (including themselves). Eighteen percent boated with groups of 5 or more people (Figure 10).

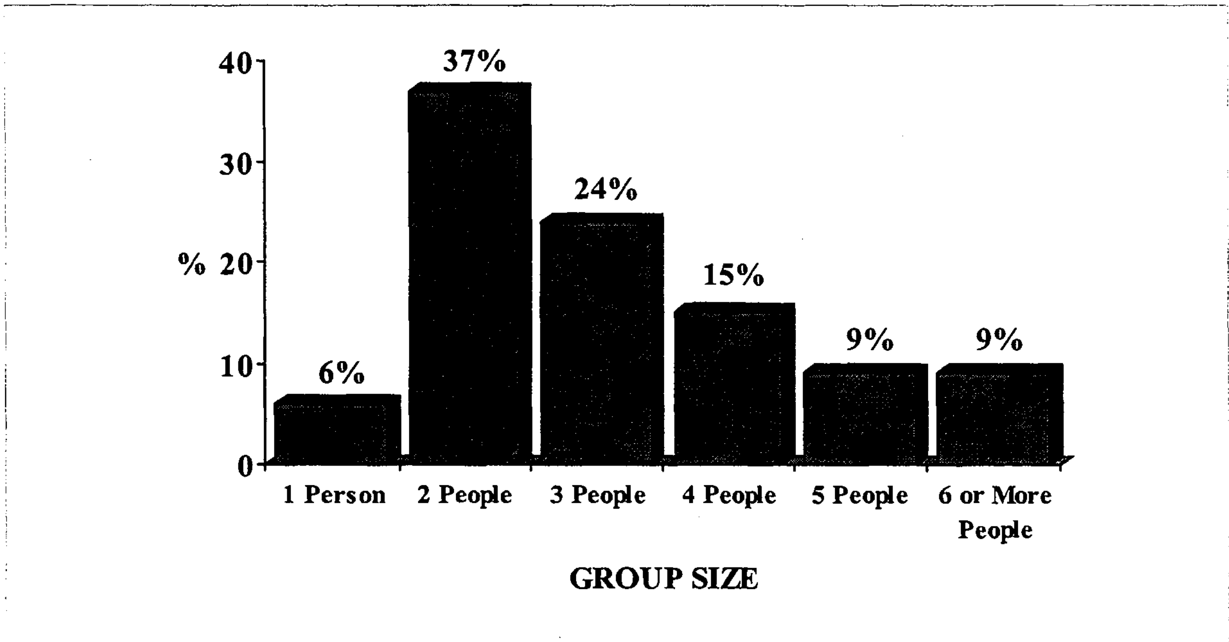


Figure 10. Boating Group Size

Most boaters preferred beginning their boat trips before noon. Eighty percent of the boaters who were interviewed started boating before noon, with 43 percent starting before 10 a.m. Twenty-one percent of the boaters indicated that they began their daily boat trip after 12 noon (Figure 11).

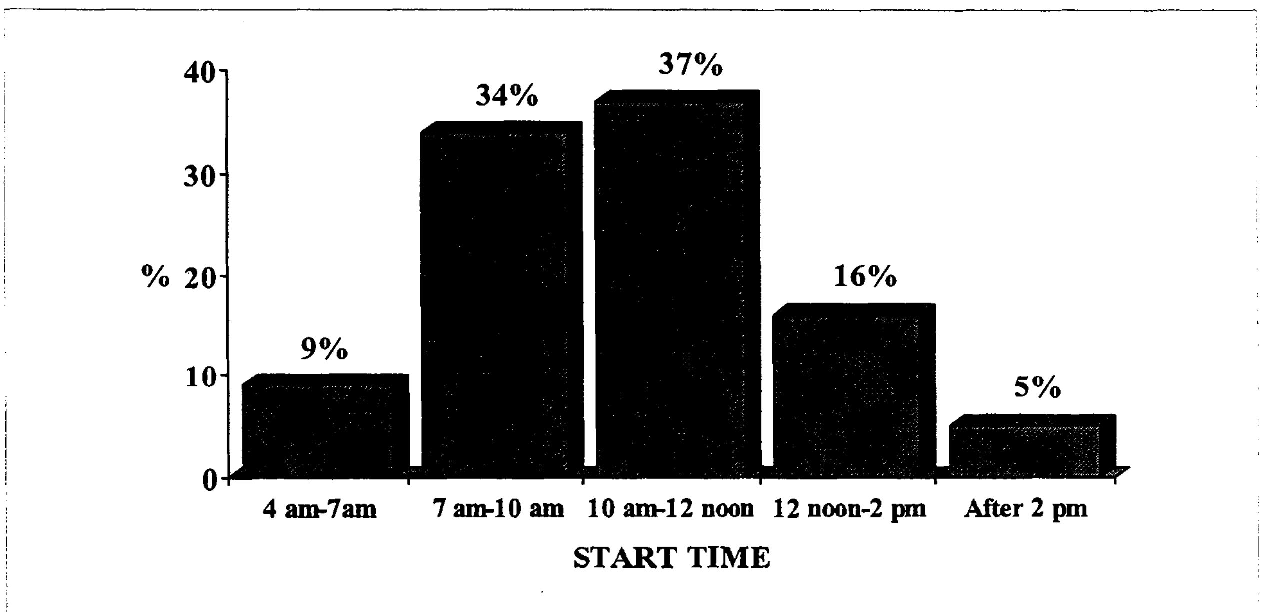


Figure 11. Boating Trip Start Time

Boaters engaged in a number of different activities during their daily boat trip. Fishing (60%) was the dominant activity mentioned, followed by pleasure cruising (45%). Boaters also engaged in jetskiing (8% -- boaters who indicated this activity, did it exclusively), waterskiing/tubing (7%), and swimming (5%) (Figure 12). See Appendix Table R-2 for a clearer understanding of the activities on the bays based on aerial flight data.

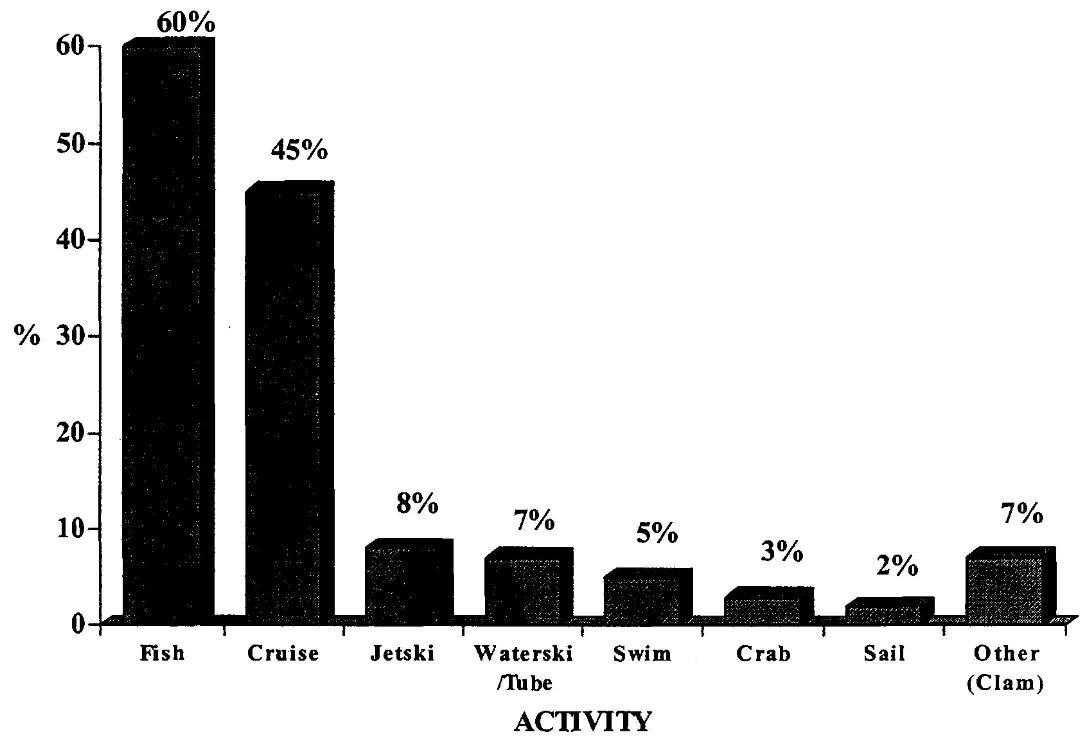


Figure 12. Boat Trip Activities (Percent of Boaters Who Participated on Day of Interview)

Boaters were asked to indicate the level of crowding they perceived on the bays for the day that they boated. They were asked to rate the crowding on a 9-point scale, with 1 = Not at All Crowded and 9 = Extremely Crowded. The overall crowd rating was 5.1 (Table 4). Only 27 percent of all respondents rated crowding at a level 7 or higher. It is difficult to apply these rating scores to the entire bay system since it is so large, but additional map information collected for boaters and data compiled from aerial surveys will be used to augment this mean rating value. (See Appendices Q and R.)

Overall, boaters were most inclined to indicate that crowding was most intense around the Ocean City Inlet (near the Route 50 bridge) and north of the inlet in the Isle of Wight Bay. Aerial observations confirmed their crowding perceptions. (See Appendix S.)

Table 4. Boater's Perception of Crowding on Maryland's Coastal Bays (Based on 9-Point Scale, 1 = Not at All Crowded and 9 = Extremely Crowded)	
Rating	**Percent**
1	4
2	10
3	14
4	11
5	14
6	20
7	15
8	7
9	5

In order to better understand boating trip experiences, a series of statements were presented to boaters and they were instructed to rate the statements on a 5-point scale, with 1 = Strongly Disagree and 5 = Strongly Agree. Boaters were most likely to respond that they thoroughly enjoyed their boat trip on the bays (4.2) and also felt navigational buoys were adequate to direct them on the bays (4.0). There was also agreement that there were adequate DNR police on the water (3.8), that boating conditions were safe (3.7), and the depth of the water was not a problem for them (3.6). Boaters overall disagreed with the statement that poor water quality affected their boat trip (2.0). This response may indicate that coastal bays' boaters sense that water quality conditions on the bays are in fairly good condition (Table 5).

Table 5. Boating Trip Statements (Based on 5-Point Scale, 1 = Strongly Disagree and 5 = Strongly Agree)	
Boating Statement	**Average Rating**
Thoroughly enjoyed trip today	4.2
Navigational buoys were adequate to direct me	4.0
There were adequate DNR police on water	3.8
Boating conditions on bays were safe	3.7
Water depth was not a problem on bays	3.6
I observed boaters operating in an unsafe manner	3.0
Behavior of boaters interfered with my experience	2.8
Poor water quality affected my boating experience	2.0

FISHING ACTIVITY IN MARYLAND'S COASTAL BAYS

As part of the field survey effort, it was important to better understand how bay boaters feel about fishing in the coastal bays. It is the predominant activity undertaken by boaters and there are a number of issues being discussed by state fisheries managers to safeguard the resource. Of the boaters who were interviewed on both weekends, nearly three-quarters indicated that they fish in Maryland's coastal bays. It is also interesting to note that 78 percent of those who fish the bays would still visit if fishing was not part of their planned activities. This is further indication that the bays and surrounding communities are important to visitors and residents for amenities they have, other than fishing (Table 6).

Table 6. Percent of Boaters who Fish Maryland's Coastal Bays	
	Percent
Fish Bays	74
Still Visit Bays If Did Not Fish	**Percent**
Yes	78
No	17
Unsure	6

Boaters fish in the bays at various times and at various frequencies. Forty-two percent of respondents indicated they fish fewer than 10 weekend days annually. Twenty-two percent mentioned that they fish more than 30 weekend days annually. Forty-five percent reported they fished fewer than 10 weekdays annually and 25 percent mentioned that they fish more than 30 days annually on weekdays (Table 7).

Table 7. Days Fishing in Maryland's Coastal Bays (Weekends and Weekdays)

	Percent	
# of Days	**Weekends**	**Weekdays**
5 or less	16	29
6 - 10	26	16
11- 20	19	20
21 -30	17	12
31 - 50	13	9
Greater than 50	9	16

Overall, fishermen overwhelmingly preferred drift fishing (79%) to any other type of fishing they could do in the bays. This was followed by anchoring (22%) and trolling (14%) (Figure 13).

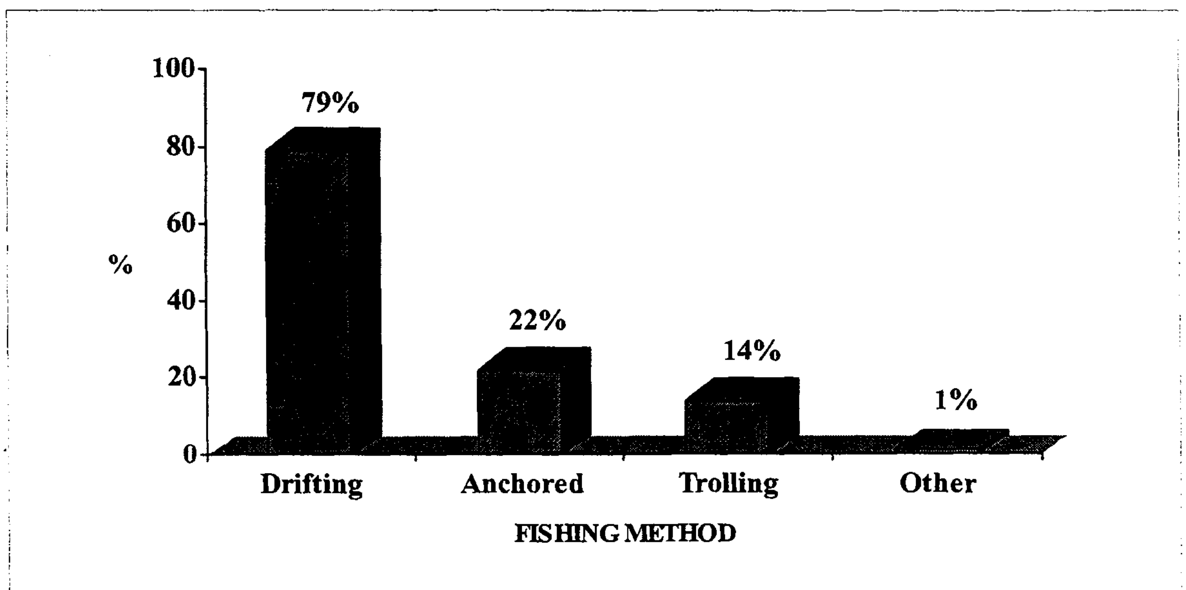


Figure 13. Preferred Bay Fishing Methods

A solid majority of fishermen (69%) indicated that they target a specific species of fish while fishing in the coastal bays. The predominant species was flounder (71%), followed by croaker (10%), and sea trout (8%) (Table 8).

Table 8. Preferred Fish Species	
	Percent
Target Species (% YES)	69
Species Targeted	**Percent**
Flounder	71
Croaker	10
Sea Trout	8
Other (Offshore)	11

Boaters were generally pleased with their fishing trip on the bays. Their responses to a series of statements about fishing support this observation. Their responses to the statements were rated on a 5-point scale, with 1 = Strongly Disagree and 5 = Strongly Agree. Fishermen indicated that they would fish Maryland's Coastal Bays again (4.4) and they indicated they thoroughly enjoyed their trip (4.2). Some fishermen wished that they had caught more fish (4.1), but others felt they would have been happy even if they had not caught any fish (3.7). Fishermen indicated that they think the Maryland DNR does a good job managing fish (3.6) and they were not too concerned about having too many people fish where they also fished (2.6) (Table 9).

Table 9. Fishing Trip Statements (Based on 5-Point Scale, 1 = Strongly Disagree and 5 = Strongly Agree)	
Fishing Statement	**Average Rating**
I will fish MD Coastal Bays again	4.4
I thoroughly enjoyed fishing trip	4.2
I wish I had caught more fish	4.1
The trip was well worth the money	3.9
I would have been happy if I had not caught fish	3.7
MD DNR does good job managing fish	3.6
I did not catch the kinds of fish I wanted	3.5
Noise/wake from other boats interfered with my fishing	3.3
Too many people fished where I was fishing	2.6

When asked to rate their ability as fishermen, 38 percent indicated they were average. Forty-seven percent indicated they were above average (30%) or expert (17%) and 15 percent noted that they were below average (8%) or novice (7%) anglers (Figure 14).

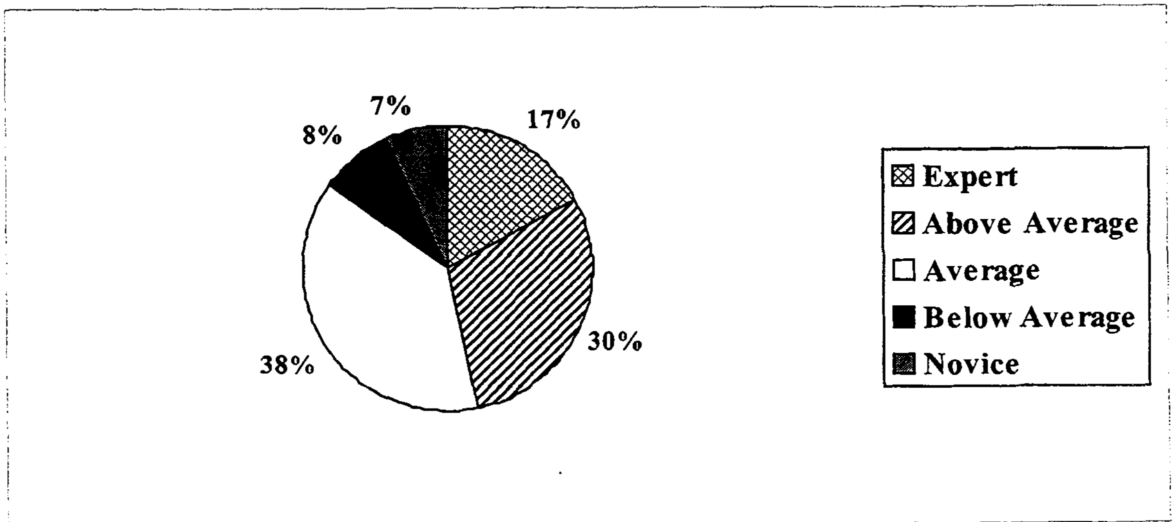


Figure 14. Fishermen's Skill Level (Self-Rating)

It is noteworthy that of this segment of bay boaters who fish, 66 percent felt they understand how saltwater fishing policies and regulations are determined in Maryland. Thirty-four percent mentioned they were unaware (20%) or unsure (14%) (Figure 15).

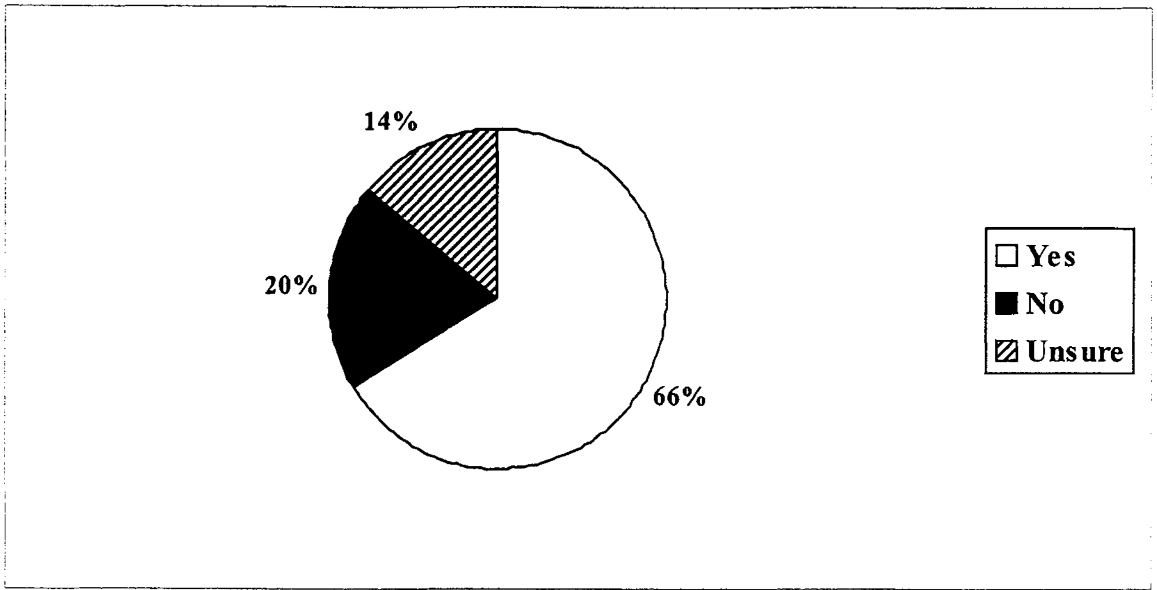


Figure 15. Percent of Boaters Who Understand How Maryland Saltwater Fishing Policies and Regulations are Determined

Although no decisions have been made to institute a fishing license for Maryland's Coastal Bays, fishermen were asked if they would support such a license for the bays. The majority of all respondents indicated they would not favor it under any circumstances (61%), only 11 percent said that they would favor it under any circumstances, and 28 percent reported they might support it depending on how the monies were used. When asked how they think license money should be used, 44 percent felt it should stay in the bays and support only coastal bays' fisheries efforts, one-third felt it should be used to manage all of Maryland's saltwater fisheries, and 23 percent felt it could best be used to manage fisheries on a region-wide basis (Table 10).

Table 10. Support for Maryland Coastal Bays' Fishing License

Favor Coastal Bays Fishing License	**Percent**
No, under no circumstances	61
Might, depending on how fee was used	28
Yes, favor under any circumstances	11
Preferred Use of Fishing License Money	**Percent**
Managing only bays' fisheries	44
Managing all Maryland fisheries	33
Managing regional coastal fisheries	23

Fishermen were also asked to indicate an amount they would be willing to pay for a coastal bays' fishing license, even if they did not support the idea of a license. Only 10 percent indicated that they would not pay anything. The majority of fishermen (57%) indicated a willingness to pay between $6 and $10 to fish in the coastal bays. The average amount fishermen were willing to pay was $8.58 (Figure 16).

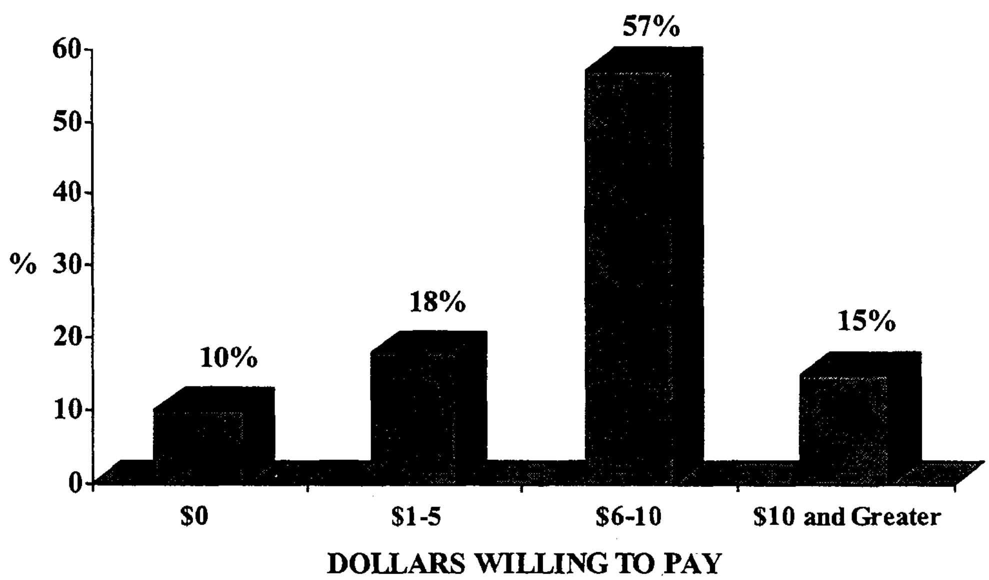


Figure 16. Amount Willing to Pay for Coastal Bays' Fishing License

Finally, a series of management tools for managing fisheries were presented to fishermen. They were asked to indicate whether they supported or opposed the measures, using a 5-point scale, with 1 = Strongly Oppose and 5 = Strongly Support. Daily bag limits (4.3) and size limits (4.3) received the most support. These are also the types of tools that are typically used to manage sport fisheries and fishermen have a fairly good understanding of them. There was also strong support for stricter enforcement of fisheries regulations (3.8) (Table 11).

Table 11. Support for Fisheries Management Tools (Based on 5-Point Scale, 1 = Strongly Oppose and 5 = Strongly Support)

Management Tools	Average Rating
Daily Bag Limits	4.3
Size Limits	4.3
Stricter Enforcement	3.8
Catch/Release Fishing	3.6
Yearly Quotas	3.6
Seasonal Closures	3.6
Area Closures	3.4

Mail Survey Results

Introduction

A mail questionnaire was developed during the summer of 1999 to collect information from boaters who boat on Maryland's Coastal Bays. The questionnaire was primarily developed to be tested and modified as needed. During the fall of 1999, questionnaires were distributed to boaters at various locations. Approximately, 150 questionnaires were distributed by hand. The boaters were primarily affiliated with local boating and fishing organizations (e.g. Maryland Saltwater Sportfishing Association, Ocean Pines, MD Boat Club, and Ocean Pines Angler's Club, etc.). These individuals were mostly year-round residents with substantial boating experience in the coastal bays. Seventy-eight questionnaires were completed and returned, and this number proved to be an adequate number to assess the validity of the questions as well as to analyze information from this select group of boaters.

Profile of Maryland Coastal Bays' Boaters

The majority of the respondents were male (96%), with more than one-half (52%) indicating they were between the ages of 60 and 69. Another 29 percent noted they were between the ages of 70 and 79. The group was fairly well-educated, with 55% mentioning that they had college degrees, another one-third (32%) indicated they had some college training. Consistent with the age of the respondents, 75% of boaters indicated that they were retired; only 19% mentioned that they had full-time jobs. Two-thirds of all respondents noted that their annual family income was greater than $50,000, with 22% mentioning incomes greater than $100,000. Eighty-one percent mentioned that they belonged to a sportfishing club or recreational boating organization (Table 12).

When boaters were asked how long they owned the boat they used most often on the bays, 62 percent mentioned between 2 and 5 years and 20 percent mentioned between 6 and 10 years (Figure 17). Almost one-half (48%) of the respondents noted that they had participated in recreational boating as a boatowner for more than 20 years (Figure 18). About one-quarter (26%) participated for ten years or less. Two thirds (67%) of responding boatowners considered themselves fairly experienced boaters. When asked to rate their skill level, 56 percent indicated they were advanced in their skills, and 11 percent felt they were experts (Figure 19). This segment of boaters appears to have considerable flexibility with their boating time. Forty percent indicated they do most of their boating on weekdays and 48 percent mentioned they boated mostly on weekdays and weekends equally (Figure 20).

Table 12. Demographic Profile of Maryland Coastal Bays' Boaters	
Age	**Percent**
30 - 49	12
50 - 59	7
60 - 69	52
70 - 79	29
Sex (% Male)	96
Education	
Grade School	1
Some High School	4
High School Graduate	8
Some College	32
College Graduate	31
Post Graduate Education	24
Employment	
Full-time	19
Part-Time	4
Retired	75
Other	1
Income	
$10,000 - 19,999	2
$20,000 - 29,999	6
$30,000 - 39,999	12
$40,000 - 49,999	13
$50,000 - 74,999	24
$75,000 - 99,999	21
$100,000 and Above	22
Membership in Sportfishing Club or Boating Organization (% Yes)	81

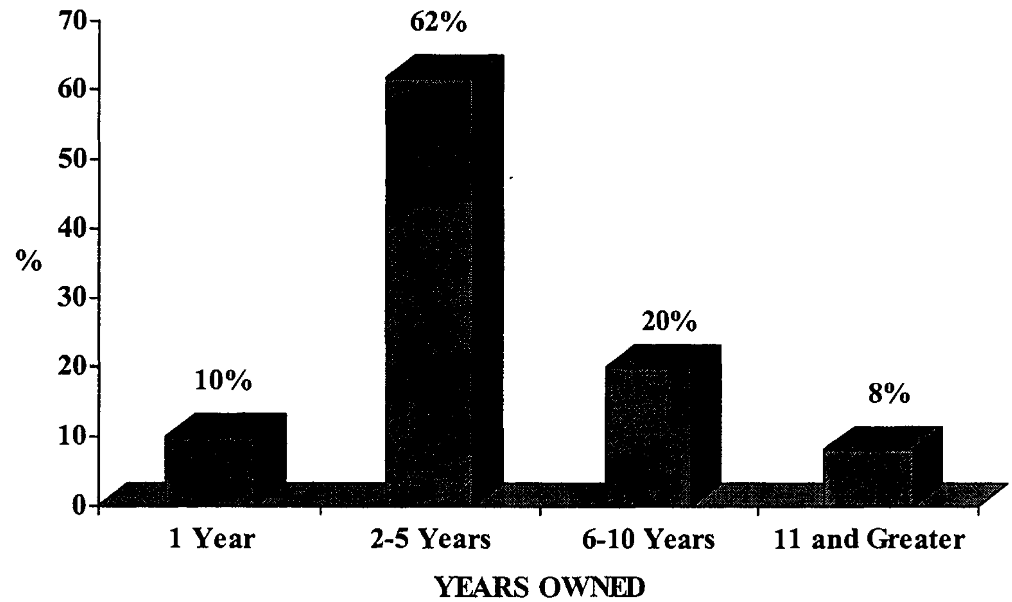


Figure 17. Years Owned Current Boat (Average = 5 Years)

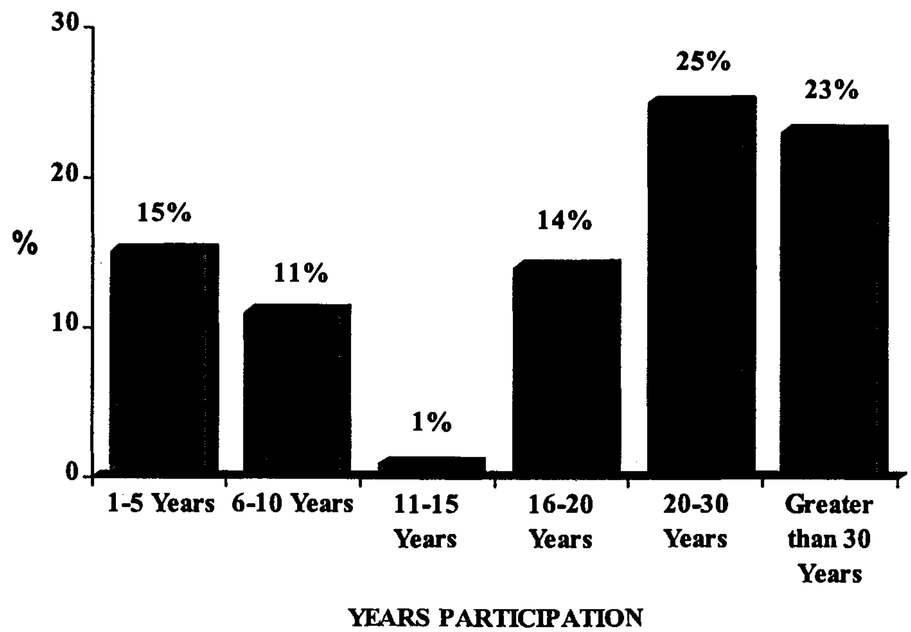


Figure 18. Years Participation as Boat Owner (Average = 23 Years)

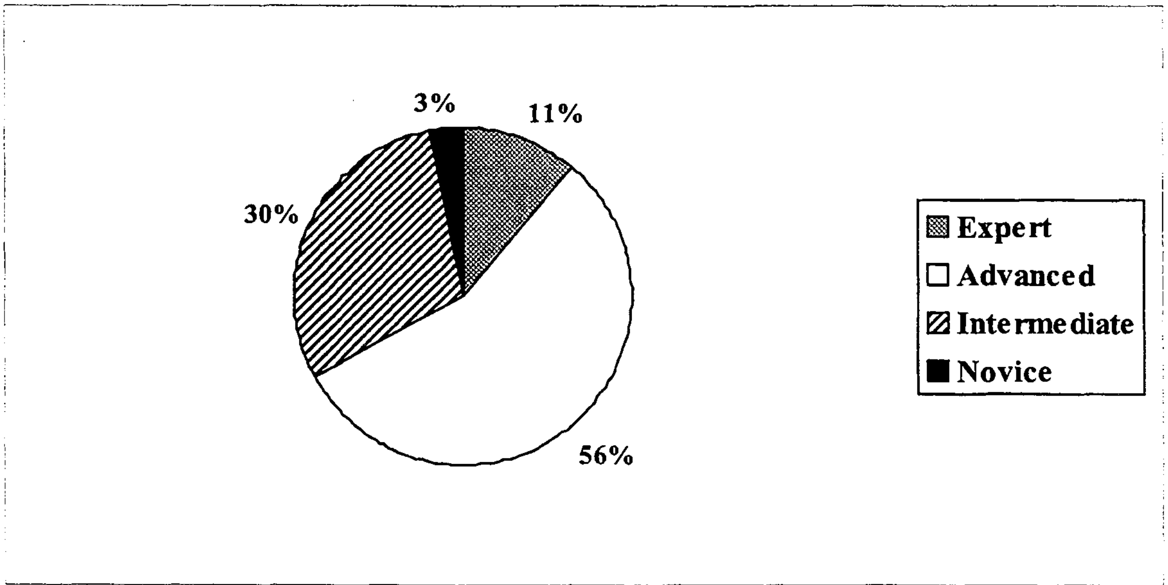


Figure 19. Skill Level of Maryland Coastal Bays' Boaters (Self-Rating)

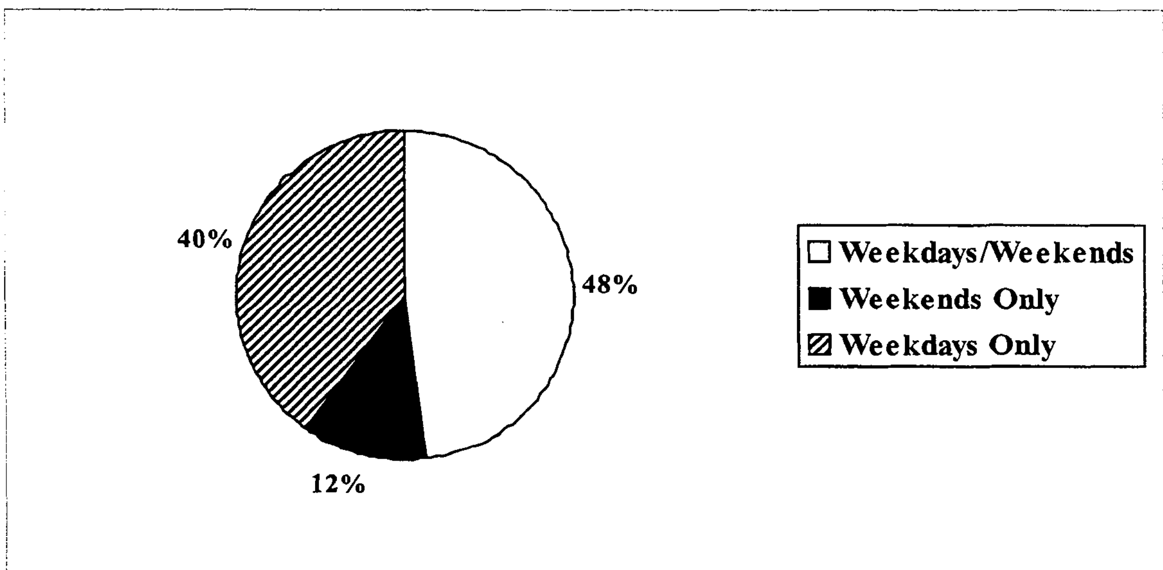


Figure 20. Frequency of Boating in Bays

PROFILE OF BOATS USED ON MARYLAND'S COASTAL BAYS

Two-thirds of all boats used most often on Maryland's Coastal Bays were sportfishing boats, followed by pontoon boats (13%) and kayaks/canoes (3%) (Figure 21). See Appendix D for other boats mentioned by mail survey respondents. Most boats (83%) were between 16 and 25 feet in length (Table 13). Fifty-eight percent of all engines were under 150 horsepower and 17 percent were greater than 250 horsepower (Table 13).

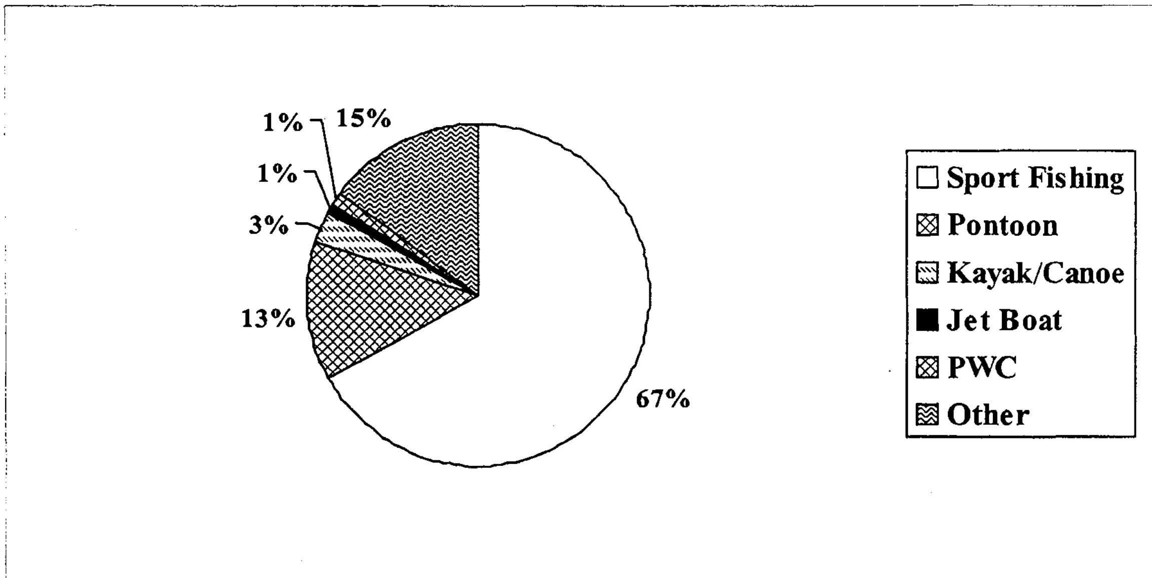


Figure 21. Type of Boat

Table 13. Boat Length and Horsepower	
Length	**Percent**
Less than 16'	7
16' - 20'	40
21' - 25'	43
26' and Greater	11
Horsepower	**Percent**
Less than 100	35
101 - 150	23
151 - 200	17
201 - 250	9
Greater than 250	17

Nearly three-quarters of all boaters carried the following equipment on their boats: depth finder (75%), compass (74%), and VHF radio (70%). Fifty-six percent had a cell phone that they carried onboard and 47 percent had Global Positioning Systems (GPS) (Figure 22). See Appendix E for other equipment mentioned by mail survey respondents.

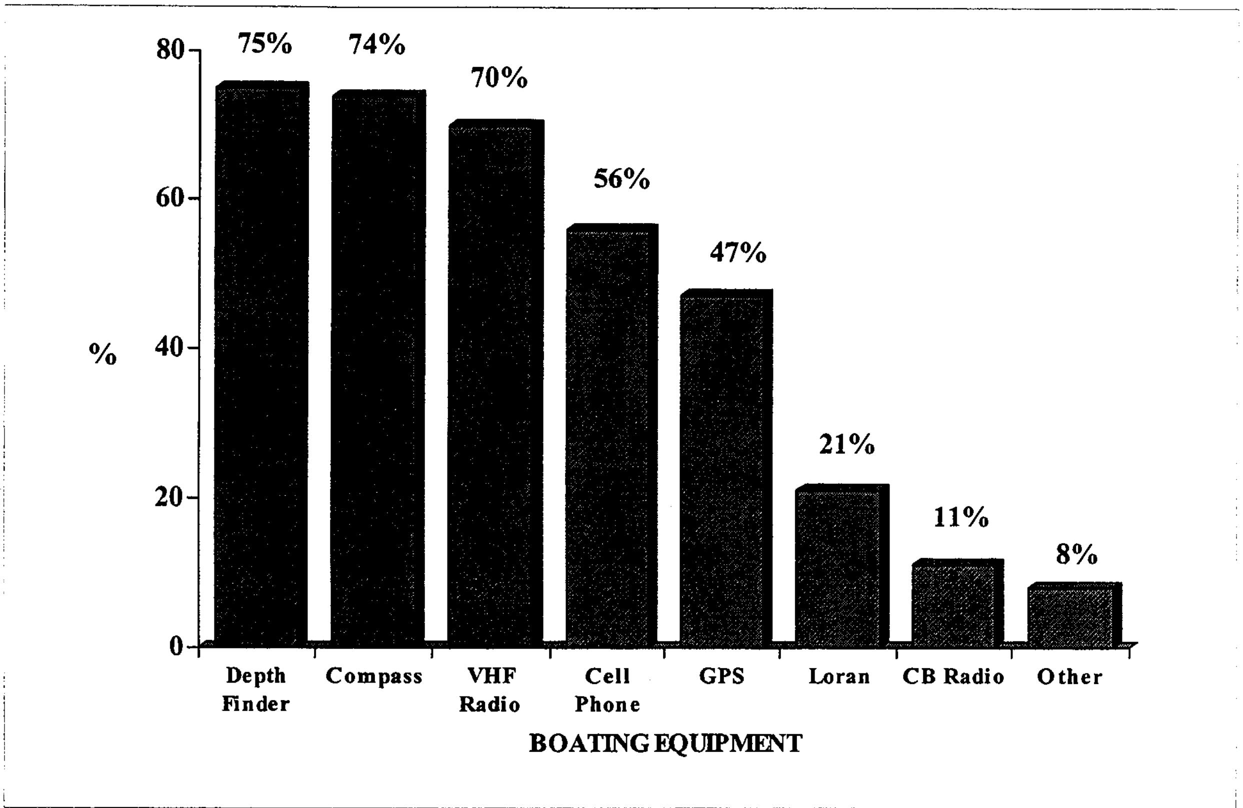


Figure 22. Equipment Carried on Boat

Eighty-four percent of respondents indicated that they keep their boat in the water on the coastal bays during the boating season. Eighty percent of those who keep their boat in the water kept it on a boat lift (41%) or at a private dock (39%). Another 16 percent kept their boat at a marina (Table 14).

Table 14. Boat Kept in Water on Maryland Coastal Bays During Boating Season

	Percent
Keep in Water	84
Where Keep Boat	**Percent**
Private Residence - Boat Lift	41
Private Residence - Private Dock	39
Marina	16
Other	3

BOATING SAFETY

Safety is a key ingredient in a quality boating experience and a series of safety-related questions were asked of boaters to gauge how they would respond. Eighty-five percent indicated that they familiarized themselves with new Coast Guard regulations each year. More than one-half (51%) receive a Coast Guard Auxiliary courtesy safety inspection. Eighty-nine percent of respondents felt that all boaters should be required to take a boating safety course. Eighty-four percent of responding boaters indicated that they had taken a course and 66 percent took their safety training during the 1990's. Two-thirds of all respondents noted that their insurance companies offered discounts on their boat insurance if they completed a safety course or received a safety inspection (Table 15).

Table 15. Boating Safety

Safety Issues	Percent		
Familiar With Coast Guard Regulations Each Year (% YES)	85		
Receive Annual Coast Guard Auxiliary Safety Inspection (% YES)	51		
Taken Boater Safety Course (% YES)	84		
Year of Last course	**Percent**		
1960's	4		
1970's	21		
1980's	20		
1990 - 1994	21		
1995 - 1999	45		
Require Boater safety training (% YES)	89		
Insurance Company Discounts For Safety Training	Yes	No	Unsure
	67	11	22

COASTAL BAY'S BOATING EXPERIENCE

As expected, peak boating times in Maryland's Coastal Bays occurs during the summer months, however, "fringe season" boating is also significant. Responding boaters mentioned considerable boating activity in May (86%), September (97%), October (88%) and November (75%) (Figure 23). When asked to specify what activities they engaged in during the boating season two activities dominated. Ninety-three percent mentioned they participated in fishing and 84 percent mentioned they spent time pleasure cruising. Boaters also mentioned crabbing (36%), waterskiing/tubing (22%) and swimming (18%) as activities they engaged in. Other responses included clamming as well as being a member of the Coast Guard Auxiliary (Table 16).

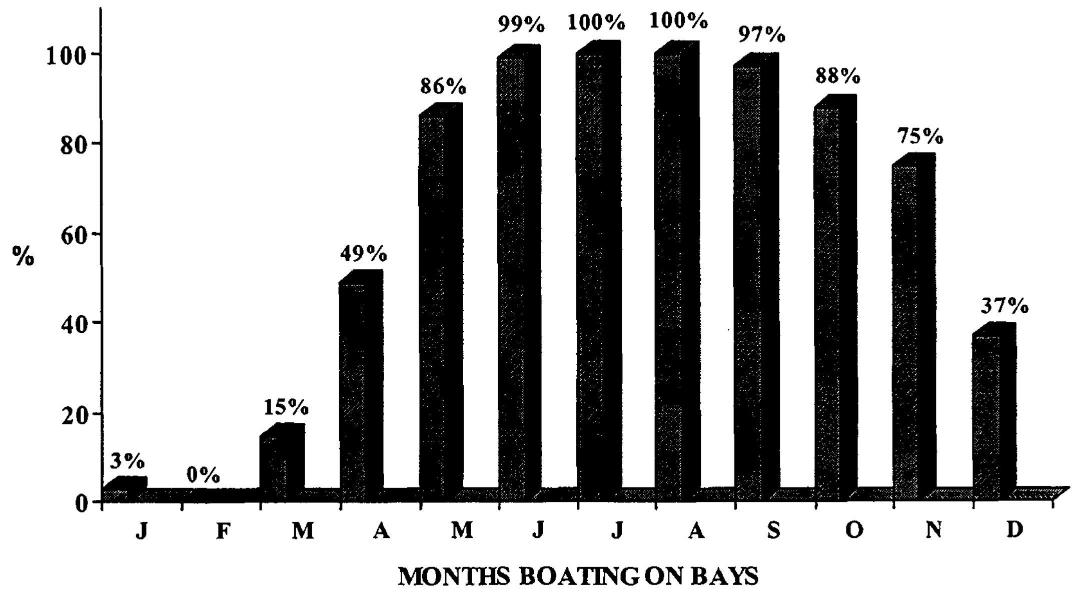


Figure 23. Months Boating on Maryland's Coastal Bays

Table 16. Boating Activity and Average Percent of Time Spent on Activity During Typical Boating Season		
Activity	**Percent of Boaters Indicating Participation in Activity**	**Average Percent of Boating Time Spent on Activity**
Fishing	93	53
Pleasure Cruising	84	30
Crabbing	36	6
Waterski/Tubing	22	4
Swimming	18	2
Overnight Cruising	4	<1
Day Sailing	1	<1
Other	12	4

Coastal bays' boaters had an average of 15 years experience boating on the bays. Forty-six percent mentioned having between 1 and 10 years of bays boating experience, 35 percent had between 11 and 20 years of experience, and 19 percent had more than 20 years of boating experience on the coastal bays (Figure 24). A vast majority of boaters indicated that of their total boating activity they do most of it on the bays. Eighty-six percent noted that they spend between 76 and 100 percent of their total boating time on the coastal bays (Figure 25). Responding boaters are quite avid in their boating frequency. They averaged 49 days boating on the bays in 1999. Almost one-half (48%) spent between 26 and 50 days boating on the bays, and 28 percent spent more than 50 days (Figure 26). When asked to rate their overall experience boating on Maryland's Coastal Bays, 13 percent indicated it was excellent (12%) or perfect (1%), 64 percent felt it was good (41%) or very good (23%), and 22 percent mentioned that it was poor (3%) or fair (19%) (Figure 27).

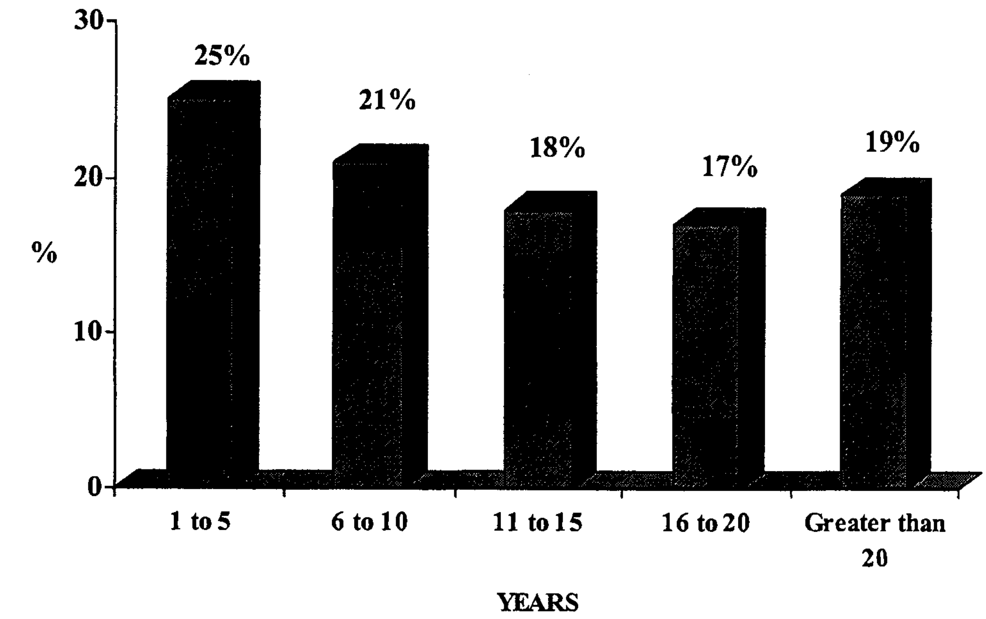


Figure 24. Years of Boating Experience on Maryland's Coastal Bays (Average =15 years)

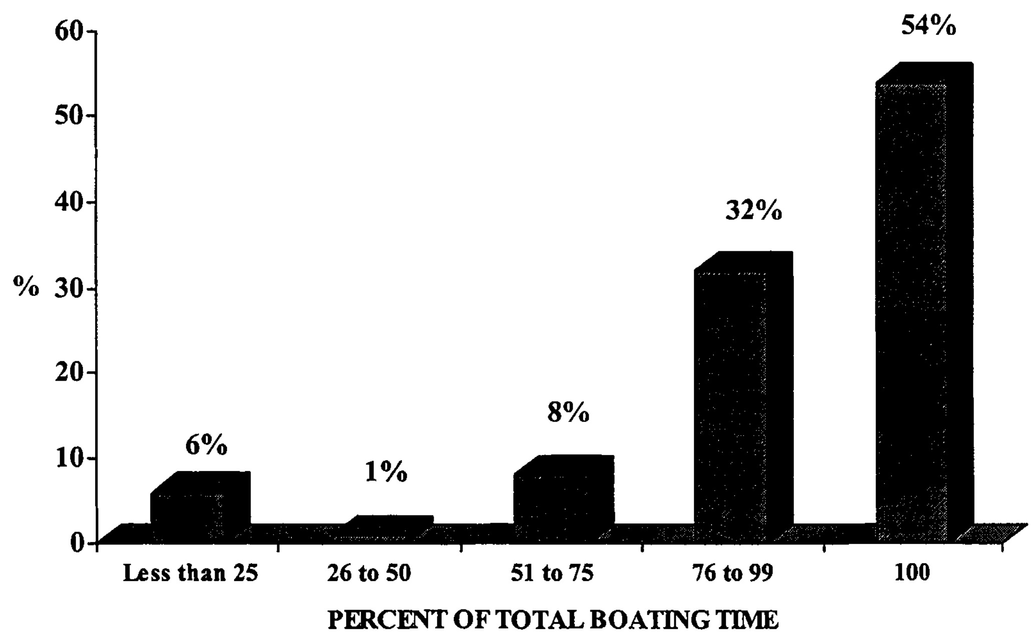


Figure 25. Percent of Total Boating Time Spent on Maryland's Coastal Bays

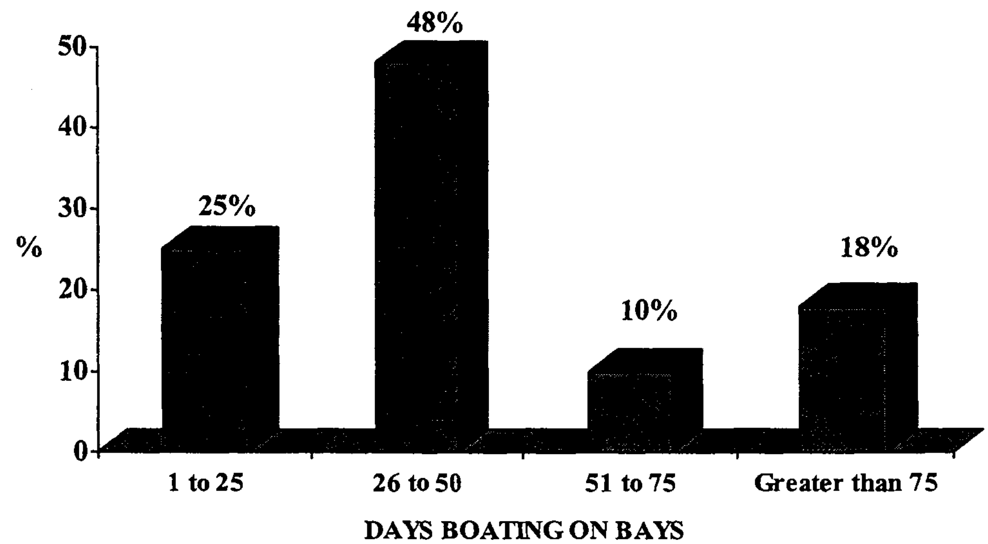


Figure 26. Total Days Boating on Maryland Coastal Bays in 1999 (Average = 49 days)

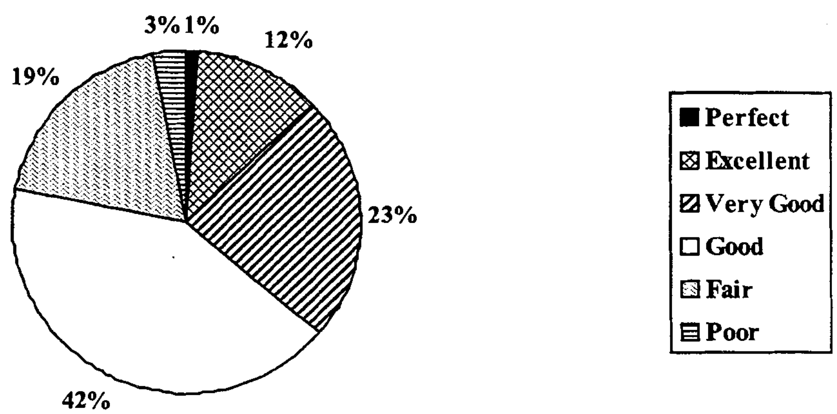


Figure 27. Rating Maryland Coastal Bays' Boating Experience

Boaters were provided with a series of attributes and asked to indicate which specific attributes attracted them to engage in activities on Maryland's Coastal Bays. The reason mentioned most often by boaters was that the bays were close to home or other lodgings (90%). Other attributes that were mentioned by a considerable number of boaters included: good fishing (49%) and the scenic qualities of the bays (43%) (Table 17). When boaters were asked to indicate if they felt the quality of boating had changed in the bays during the past few years, 56 percent felt that it had decreased, 26 percent felt that it had increased, and 18 percent felt that it had remained the same (Figure 28). Boaters provided many comments about why they feel the way they do about the changes in boating quality in bays. See Appendix G for a completed listing of boater's responses.

Table 17. Reasons for Boating on Maryland's Coastal Bays	
Attribute	**Percent**
Close to Home/Other Lodgings	90
Good Fishing	49
Scenic Bay Qualities	43
Observe Wildlife	29
Peaceful Location	26
Adequate Channel Markers	22
Good Water Quality	19
Adequate Water Depth	16
Little boating traffic	4
Other	10

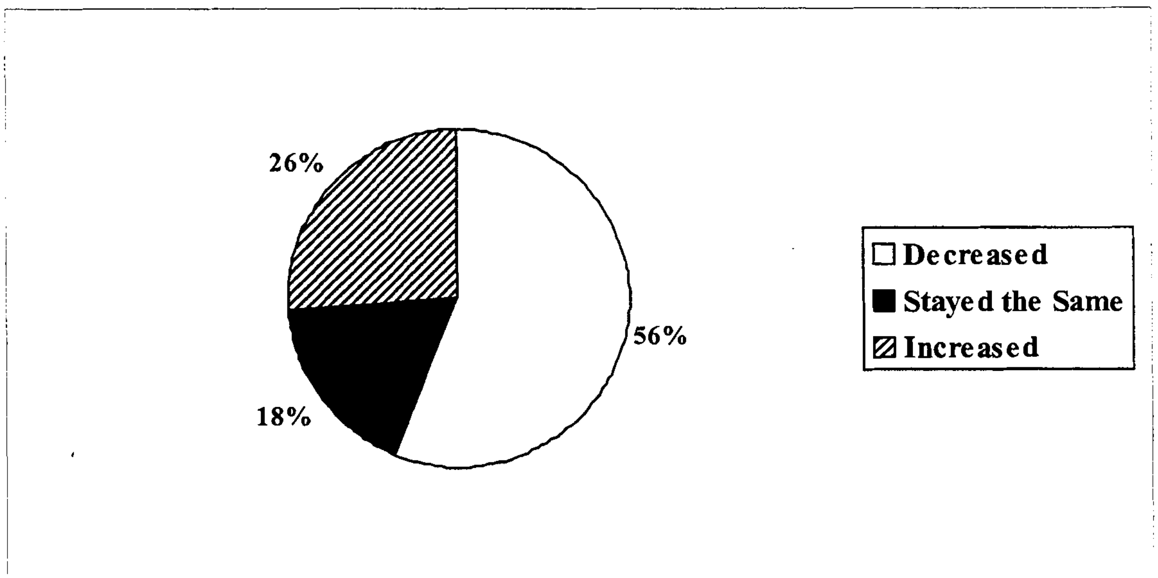


Figure 28. Change in Boating Quality in Maryland's Coastal Bays

COASTAL BAYS BOATING CONCERNS AND PROBLEMS

Almost three-quarters (74%) of responding boaters felt there were conflicts between users in the bays. The conflicts mentioned by boaters are included in Appendix J. About one-half (49%) indicated they had observed boating accidents, near accidents, or unsafe boating practices within the last year which could be attributed to conflicting uses on the bays (Table 18). These comments can be found in Appendix K.

A series of boating concerns were presented and respondents were asked to rate the importance of each item to them using a 5-point scale (1 = Not at All Important and 5 = Extremely Important). Both safety (boaters operating in an unsafe manner--4.5) and environmental issues (poor water quality affecting boating experience--4.2) were rated high. Other concerns receiving high ratings included: overcrowding of navigable waterways (4.1) and boaters operating under the influence of alcohol/drugs (3.9). This segment of boaters was least concerned about overcrowding at popular boat ramps (2.4) (Table 18). See Appendix H for a listing of other concerns mentioned by boaters.

Table 18. Boating Conflicts and Concerns Among Bay Users	
Observation of Conflicts/Accidents	**Percent**
Have Observed Conflicts (% YES)	74
Have Observed Accidents/Unsafe Boating (% YES)	49
Boating Concerns (Based on 5-Point Scale, 1=Not at all Important and 5=Extremely Important)	
Concerns	**Average Rating**
Boaters operating in an unsafe manner	4.5
Poor water quality affecting boating experience	4.2
Overcrowding of navigable waters	4.1
Boaters operating under the influence of alcohol/drugs	3.9
Lack of proper navigational aids	3.6
Lack of adequately maintained navigational channels	3.5
Lack of state marine enforcement	3.4
Boats drifting/anchored in navigation channels	3.4
Overcrowding at popular boat ramps	2.4
Other	4.8

To gauge whether crowding conditions occurred on the bays during the summer months, boaters were asked to describe boating conditions on the bays at three different geographic locations: Isle of Wight Bay (from the Route 90 Bridge to the Route 50 Bridge), the Ocean City Inlet area, and Sinepuxent Bay (from the inlet to the Verrazano Bridge). Respondents were asked to indicate their perception of crowding in these locations using a 9-point scale (1 = Not at All Crowded and 9 = Extremely Crowded). Boaters felt the Ocean City Inlet area (6.5) was most crowded, followed by Isle of Wight Bay (6.1). The Sinepuxent Bay was considered to be the least crowded, with a rating of 5.0 (Table 19).

Table 19. Crowding Conditions on Maryland Coastal Bays During Summer Months, (Based on 9-Point Scale, 1 = Not at All Crowded and 9 = Extremely Crowded)

Location	Average Rating
Inlet Area	6.5
Isle of Wight Bay (Rt. 90 Bridge to Rt. 50)	6.1
Sinepuxent Bay (Inlet to Verrazano Br.)	5.0

Since it is known the Ocean City Inlet area is heavily used by boaters and it received the highest crowding rating, a series of problems that could be encountered at the inlet were listed on the survey instrument and respondents were asked to provide their input. The question asked boaters whether they were aware of, or they had experienced, any of the problems and how serious they thought the problems were. A 5-point scale was used to rate the problems, with 1 = Least Serious and 5 = Most Serious. The highest-rated problem mentioned by boaters was jetskis zig-zagging in the inlet (4.4), this was followed closely by inexperienced boat operators in the inlet (4.3). Other highly-rated problems that were mentioned dealt with physical features of the inlet and water body. These included: narrow passageway (3.8), fast moving current (3.8), and water turbulence and wave action (3.6) (Table 20). See Appendix I for a listing of other problems mentioned by mail survey boaters.

Table 20. Route 50 Bridge and Inlet Problems, (Based on 5-Point Scale, 1 = Least Serious and 5 = Most Serious)	
Problem	**Average Rating**
Jetskis zig-zagging in inlet	4.4
Inexperienced operators	4.3
Narrow passageway	3.8
Fast moving current	3.8
Turbulence and wave action	3.6
Overloaded boats	3.5
Boats ahead moving too slow for your steerage	3.4
Excessive boat wakes	3.4
Boats not suitable for this area	3.4
Underpowered boats	3.1
Boats maneuvering until bridge opens	2.6
Other	4.7

ENVIRONMENTAL CONCERNS FACING MARYLAND'S COASTAL BAYS

Almost all boaters (97%) indicated that they were aware that certain living resources in the bays are important to creating a healthy bay ecosystem. See Appendix L for a list of living resources identified. A solid majority (72%) also said that they had adequate information to help protect and preserve the bays' living resources (Table 21). A number of boaters suggested additional ideas, these comments can be reviewed in Appendix M.

Table 21. Awareness and Information About Bay's Living Resources			
Aware of Living Resources Valuable to Healthy Bay Ecosystem (% YES)	97		
Have Adequate Information to Protect/Conserve Bays' Living Resources	**Yes**	**No**	**Unsure**
	72	15	13

To solicit additional information about the environmental health of the bays, boaters were asked to indicate if they had noticed any changes in the environmental quality and the living resource quality (e.g. fish, clams, crabs) of the bays since they had been boating there. More than one-half (58%) felt the environmental quality of the bays had deteriorated and about one-quarter (24%) felt that it had not changed very much. However, an overwhelming 83 percent of boaters felt that the living resources of the bays had deteriorated. Only 3 percent felt there had been an improvement in the bays' living resources (Figure 29).

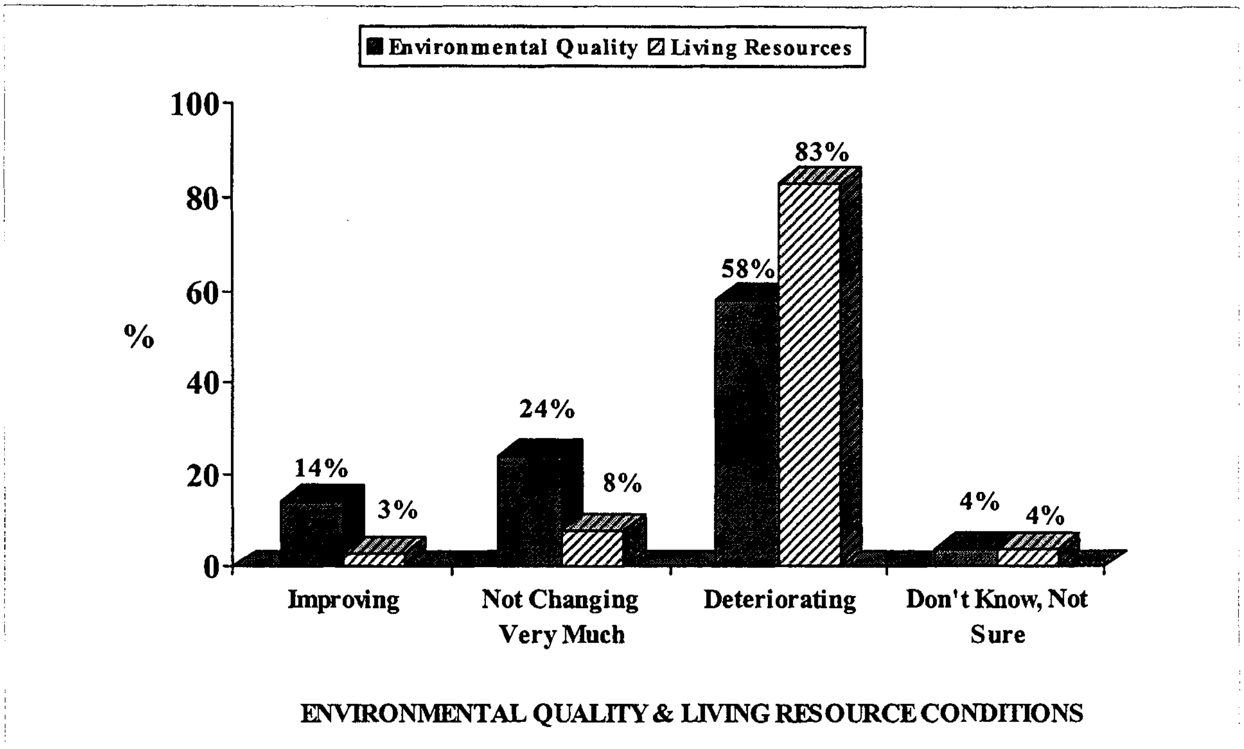


Figure 29. Perceived Changes in Environmental Quality and Living Resources

There is always concern about the potential environmental impacts caused by boaters in the bays. Recreational users and commercial users may cause different impacts. A series of possible impacts were listed and responding boaters were asked to identify which impacts they felt could be attributed to either recreational or commercial users. The most often-mentioned impacts attributed to recreational boaters included: creating excessive turbulence (56%), causing shoreline erosion (51%), discharging oil/gas (49%), propellor scouring of bottom sediment (45%), and disturbing nesting shorebirds (42%). There was almost unanimous agreement by respondents that commercial boats disturb sea grasses (93%). Between one-third and one-half also felt that commercial boats contributed to propellor scouring of sediment (49%), discharge of oil/gas (48%), and creating excessive turbulence (35%) (Figure 30).

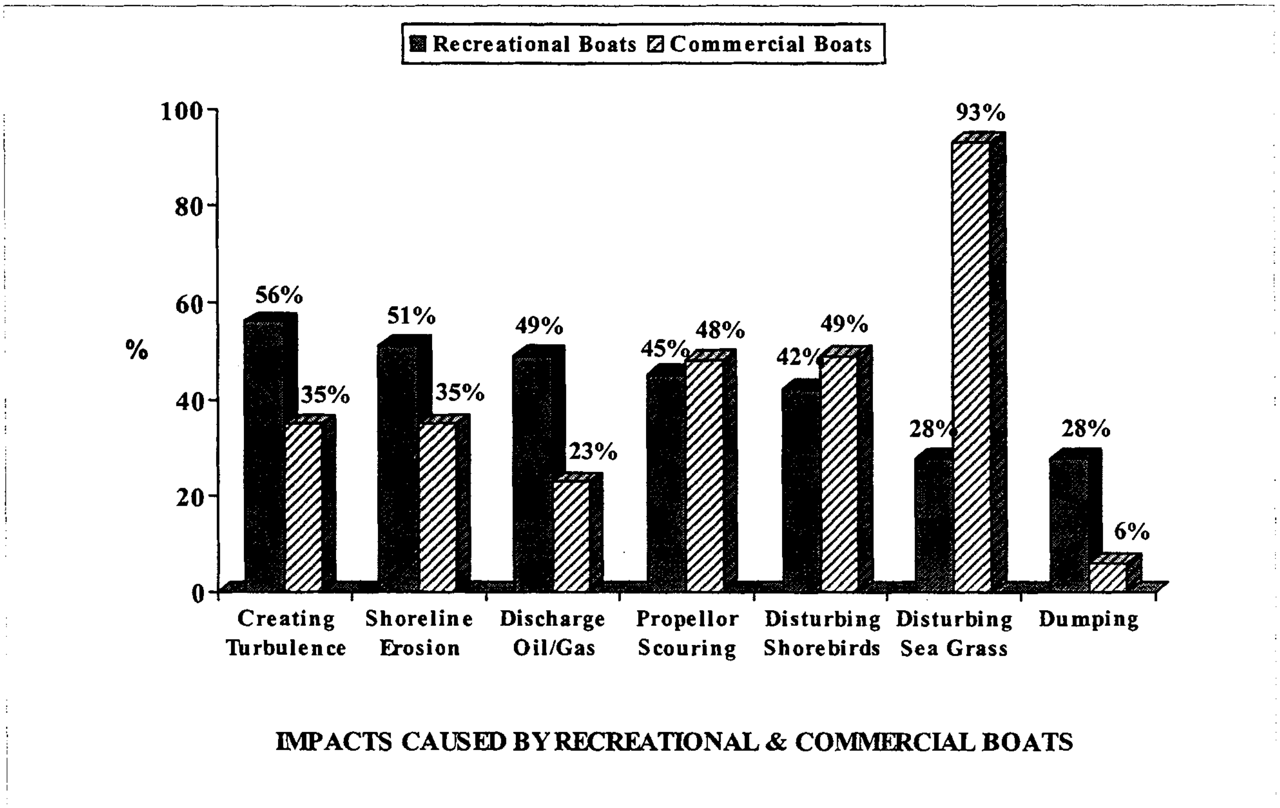


Figure 30. Negative Environmental Impacts Caused by Recreational and Commercial Boats

A hypothetical question was presented in the survey to gauge how boaters might spend their own money to improve Maryland's Coastal Bays. A series of bay improvement statements were listed and boaters were asked to rank the items between 1 and 8, with "1" being the highest priority and "8" the lowest. Boaters ranked environmental concerns the highest, with improving the bays' water quality (2.5), protecting existing fish, bird, and wildlife habitat (2.7), and creating new habitat (3.4) as the highest priorities. Issues related to navigation and enforcement were ranked in the middle, and building more and better launch ramps (6.5) was the lowest ranked improvement (Table 22). See Appendix N for a listing of other improvements suggested by boaters.

Table 22. Improving Maryland's Coastal Bays, (Based on 1 = Highest Priority and 8 = Lowest Priority	
Statement	**Average Ranking**
Improve water quality of bays	2.5
Protect existing fish, bird, and wildlife habitat	2.7
Create new habitat for fish, birds, and other animals	3.4
Deepen and widen the bay's navigation channels	4.2
Provide more marine enforcement on the water	4.3
Provide more and better channel markings	4.8
Build more and better launch ramps	6.5
Other	2.5

MANAGEMENT CONCERNS FOR MARYLAND'S COASTAL BAYS

A series of statements in the survey instrument focused on management issues pertinent to the coastal bays. Respondents were asked to indicate whether they opposed or favored the options. A 5-point scale was used, with 1 = Strongly Oppose and 5 = Strongly Favor. The highest-rated option was to limit the number of jetskis using the bays (4.4). There was also considerable support for additional regulations for the bays if they improve the bays' water quality (4.1). Other items that received favorable support included: restricting boat use in excessively shallow waters or around sensitive bay resources (3.9), stricter limits on fish and shellfish (3.7), and zoning the waters to provide for certain uses at specific places (3.6). Requiring a seasonal boating permit if funds were used for bay improvements (3.0) received neutral support. Three issues received limited support from boaters, they included: developing additional boating facilities (2.6), requiring a baywide fishing license if money was used to improve fishing in the bays (2.5), and limiting the number of boats using the bays (2.3) (Table 23).

Table 23. Potential Management Options for Maryland Coastal Bays (Based on 5-Point Scale, 1 = Strongly Oppose and 5 = Strongly Favor)	
Management Option	**Average Rating**
Limit number of jetskis using the bays	4.4
Additional regulations if they improve the bay's water quality	4.1
Restrict boat use in excessively shallow waters or around sensitive bay resources.	3.9
Stricter limits on the size and/or number of fish, clams, and crabs that can be taken	3.7
Zoning the waters to provide for certain uses at specific places	3.6
Require purchase of seasonal boating permit for bay use if money were used for bay improvements	3.0
Develop additional boat access facilities to the bay's waters	2.6
Require a baywide saltwater fishing license, if the money were used to improve fishing in the bay	2.5
Limit the number of boats using the bays	2.3

CONCLUSIONS

These study findings are not meant to be complete nor conclusive. The original intent of the mini-grant awarded to the Water-Based Activities Subcommittee was to design two survey instruments that could be used to collect data from boaters in the future. However, since Maryland DNR was interested in collecting specific fisheries information from boaters in Maryland's Coastal Bays, the subcommittee agreed to support their efforts. The on-site field data effort was designed to collect both fisheries information, as well as boating information from bay users. Trained volunteers collected the data at various sites around the bays. The study results provide a statistically valid sample of boaters using the bays.

The mail survey, on the other hand, was completed strictly as a pre-test to test the validity of the survey instrument. The targeted sample was selected by subcommittee members and represented a group of mostly year-round residents of the coastal bays, predominantly retired, well-educated, and with above-average incomes. In the future, any mail survey efforts would need to be based on statistically valid samples selected randomly from populations of Maryland boaters or other targeted boating groups.

With these methodology differences noted, there was still some very useful information that was collected during 1999 from both the field sampling effort and the mail survey. Some of the more useful information collected during the field survey focused on questions related to crowding and whether boaters felt satisfied with their boating experiences. Using a 9-point crowding scale (1=Not at all Crowded and 9=Extremely Crowded), boaters rated overall crowding to be 5.1 (a neutral or mid-range level). As confirmed by aerial observations collected by Maryland DNR, boaters noted that crowding was most intense below the Route 90 bridge to the Ocean City inlet and in the Ocean City Inlet area itself. There was minor crowding differences noted between the two weekends when field interviews took place. The average crowding rating on the first weekend (August 21 and 22) was 4.9 and on the second weekend (August 28 and 29) it was a 5.2. For the most part, this level of crowding did not seem to affect boaters and their enjoyment of the coastal bays. Overall, 92 percent of the responding boaters "agreed" or "strongly agreed" that they enjoyed their boating trip. In addition, when boaters were asked if boating conditions on the bays were safe, 81 percent of respondents indicated they "agreed" or "strongly agreed" that conditions were safe.

To further gauge whether boaters were affected by other boaters, 43 percent reported that they "agreed" or "strongly agreed" with the statement that they had observed boaters operating in an unsafe manner. Finally, boaters were asked to respond to the statement of whether the behavior of other boaters interfered with the quality of their boating experience. Less than one-half (40%) of boaters indicated that other boats interfered with the quality of their experience. Overall, these findings collected during two weekends in August suggest that boating is safe and very enjoyable in the bays, with modest levels of crowding impacting boaters during their days' activity.

A final observation related to boating safety, is that two-thirds of responding boaters indicated that they had taken a boating safety training course. The question was phrased in such a way as to discern whether boaters had extensive training in boat handling, rules-of-the-road, and other navigation-related skills, and not simply a quick safety message prior to renting watercraft for the day.

Other notable findings from the field data showed that almost three-quarters (74%) of the boaters reported that they fished in Maryland's Coastal Bays. This was not surprising as fishing was the number one reported activity engaged in by coastal bays' boaters overall, followed by pleasure cruising. An overwhelming majority or respondents (66%) feel that they are knowledgeable about how the state of Maryland develops its saltwater fishing regulations and policies.

In order to understand if fishermen were satisfied with their days' fishing experience a series of statements were presented. Ninety-four percent of all fishermen indicated they "agreed" or "strongly agreed" that they would fish in Maryland's Coastal Bays again. Eighty-six percent "agreed" or "strongly agreed" that they thoroughly enjoyed their fishing trip. Finally, 79 percent "agreed" or "strongly agreed" that the fishing trip was well worth the money they spent. Even though these responses indicate a high level of satisfaction for fishing in the coastal bays, a majority (61%) of anglers would not support a coastal bays' sportfishing license under any circumstances. When fishermen were asked to suggest one thing they would most like to see done to improve fishing in the bays comments focused on limiting or stopping commercial fishermen, controlling or banning jetskis, and reducing size limits on certain fish species. (See Appendix A.)

Mail survey respondents provided varied responses to a number of different questions other than those offered to on-site respondents. The focus of the mail survey instrument was strictly on boating in the bays and fishing-related questions were not included. Overall, 64 percent of this avid group of boaters indicated that the quality of boating in the bays was "good" (41%) or "very good" (23%), 22 percent rated it poor (3%) or fair (19%), and 13 percent felt that is was excellent (12%) or perfect (1%). Fifty-six percent of mail respondents felt that the quality of boating had decreased during the past few years and one quarter (26%) felt that it had increased.

When mail respondents were asked to indicate what concerns were most important to them, the highest rated concern was boaters operating in an unsafe manner. Eighty-nine percent mentioned that this was "very important" (21%) or "extremely important" (68%) to them. This concern was followed by poor water quality affecting their boating experiences. Eighty-one percent of mail survey boaters felt it was "very important" (37%) or "extremely important" (44%). Seventy-eight percent ("very important"--37%; "extremely important"--41%) of boaters felt that overcrowding of navigable waters was becoming an important concern. The concern about crowding was further noted when mail survey respondents were asked to rate their perceived level of crowding at three different locations in the coastal bays. Using a 9-point scale, (1=not at all crowded to 9=extremely crowded), the average crowding level at the Ocean City Inlet was the greatest (6.5), followed by Isle of Wight Bay (6.1) and Sinepuxent Bay (5.0). Overall, the major concerns voiced regarding boating safety at the Route 50 bridge and inlet area were jetskis "zig-zagging" in the inlet and inexperienced operators attempting to navigate in the narrow channel with fast moving currents.

Mail respondents were also asked to respond more about environmental issues and concerns than the on-site boaters. Overall, these boaters felt both the overall environmental quality of the bays (58%) and the bays' living resources (83%) were deteriorating since they had begun boating on the bays. They blame commercial fishermen (93%), more than they blame recreational boaters for disturbing sea grasses and blame both groups about equally for scouring bottom sediment (49%--commercial; 45%--recreational) and discharging oil and gas into the water (49%--recreational; 48%--commercial). More blame was attributed to recreational boats for disturbing nesting shorebirds (42% versus 9%), creating excessive turbulence (56% versus 35%), and for causing shoreline erosion (51% versus 23%).

Mail survey recipients also had the opportunity to rate potential management options for the coastal bays. They favored limiting the number of jetskis using the bays, with 84 percent "favoring" or "strongly favoring" this option. Seventy-six percent "favored" or "strongly favored" supporting additional regulations if they improved the bays' water quality. There was also strong support for restricting boat use in excessively shallow water or around sensitive bay resources, with 75% favoring or strongly favoring this option.

As a final way to gauge how boaters receiving the mail survey feel about Maryland's Coastal Bays, they were presented with a series of statements and asked if they were spending their own money, how would they improve the bays. The top three selections focused on environmental concerns: improving water quality of the bays; protecting existing fish, bird, and wildlife habitat; and creating new habitat for fish, birds, and other animals.

The responses received from these two segments of boaters are not directly comparable. In general, most of the questions that were presented in the field interviews were designed to gain an understanding of boaters during their day of boating. Mail survey respondents, on the other hand, were questioned about general boating habits and tendencies overall. In a few cases similar questions were asked of each subset of boaters. Comparing these results are useful to gain an understanding of the different samples that were reached through the two survey approaches.

For instance, mail survey respondents boated on the bays an average of 15.5 years, compared to 13.2 years for on-site respondents. A dramatic difference appears in the number of days boating in 1999. Mail respondents boated an average of 49 days in 1999, versus 32 days for boaters interviewed in the field. Mail survey respondents also had more flexibility in being able to boat during the week and that is reflected in their response to when they typically boat. On average, 48 percent of boaters in the mail survey reported that they boat on weekends and weekdays equally, 40 percent boat only on weekdays, and 12 percent boat only on weekends. In contrast, a similar number of boaters interviewed in the field survey boated on weekends and weekdays equally (43%), 8 percent boated only on weekdays and 39 percent boated only on weekends. Mail survey respondents consider themselves more skilled as boaters, with 67% considering themselves experts (11%) or advanced (56%) compared to field surveyed boaters, with 54 percent considering themselves experts (11%) and advanced (43%). Lastly, the subset of boaters who received the mail version of the survey instrument were considerably more safety conscious than the on-site boaters. Mail respondents (84%) were more likely to have taken a boating safety training course than the field respondents (64%).

The results presented in this report provide a "thumbnail sketch" of how two subsets of boaters feel about a variety of issues and concerns affecting Maryland's Coastal Bays. There is still much work needed to accurately describe and characterize bay users to fully understand their attitudes and perceptions concerning this unique resource. Many important decisions must still be made to address the actions and recommendations identified in the Comprehensive Conservation and Management Plan for Maryland's Coastal Bays. By gaining additional information and insight from all users, through survey efforts such as this, it is hoped the decisions will reflect all valid and vital concerns.

APPENDICES A - B

ADDITIONAL ON-SITE FIELD SURVEY COMMENTS

APPENDIX A

ON-SITE BOATERS COMMENTS ON WAYS TO IMPROVE FISHING IN MARYLAND'S COASTAL BAYS (QUESTION #18)

Personal Watercraft

- Ban jetskis (4)
- Outlaw PWC's (3)
- Less PWC's (2)
- Severely limit jetskiers
- Fewer jetskis
- Control jetskis
- Control jetskiers; establish separate area
- Restrict PWC's on the water to certain areas

Pollution

- Continue to monitor pollution
- Less pollution; stricter enforcement of pollution laws
- Enforce pollution laws
- Clean up the water
- Reduce pollution

Boating Concerns

- Everyone needs a boating course
- Speed controls in fish areas
- Make everyone take a water safety class
- Better ramps
- A boat sticker like the Chesapeake Bay
- Stop waterskiers

Commercial Fishing

- Eliminate oyster dredgers and crabbers
- Eliminate dredging for clams
- Keep workboats and commercial clammers out
- Reduce commercial bays fishing
- Limit alewive harvest
- Overfishing on commercial side
- Stop hydraulic clam dredging and fish netting in bays
- Overfishing by commercial fishermen

- Too much netting near inlet
- Less commercial fishing
- Control commercial fishers
- Reduce commercial crabbing
- Stop clammers in the bay
- Stop clam dredging; control commercial fishing
- Eliminate commercial clamming
- Limit commercial fishermen
- Limit or stop commercial fishing by-catch losses
- limit commercial clammers
- Control commercial fishing better
- Limit commercial fishing and shellfishing

Dredging and Navigation

- Channel work; dredging
- Dredging channels deeper and wider
- The bays need deeper channels
- Channeling--better markers; map
- Dredge bay
- Dredge channel and put sand on beach

Enforcement and Regulations

- Keeping minimum size fish needs to be increased
- Lower restrictions on fish size
- Have less government involvement
- Flounder size is too long/large
- Ease up on rockfish size to 18"
- Lower size restrictions
- Policing the limits on all fishing
- Hardhead size limit should be 12"; flounder size should be 16"
- Increase minimum size fish
- Adopt limits and stronger enforcement
- Reduce flounder minimum to 14"
- Enforcement of regulations
- Continue to enforce regulations
- Limit size of catches (number and size)
- More DNR police
- Lower rockfish minimum size
- Raise crab size to 7" and males only
- Limit size of fish and lower creel limit

Miscellaneous

- More fish (7)
- All is OK (2)
- Keep as is (2)
- Bigger fish
- Increase population of fish
- Protect breeding grounds
- Fairness between commercial and sport
- Stock the bays

APPENDIX B

ADDITIONAL COMMENTS PROVIDED BY ON-SITE BOATERS

- Better control of jet boats

- Get rid of jetskiers not under control

- Need everyone to take a good training course

- Stop gill netting and clam dredging

- Enforce speed limits more; problems with jetskiers cutting in and out

- Too many crab pots in the water

- I would like to see the jetskis be required to stay out of main fishing and boating channels

- I like it the way it is now

- Rockfish regulation needs changing; large fish should go back

- I had a good time; I live near the New Jersey shore, but would rather be down here

- Fish should be protected

- Its very clean

- Get boat ready before launching to avoid delays; have traffic director on weekends

- Notified too late on flounder plan closure, affected vacation plans

- Limit tuna to one take-home per year

- Do more to stop developing wetland areas

- I like the bays a lot; Chesapeake is dirtier

- I enjoy them and feel fortunate

- Should not have a 6 knot speed sign on yacht club day marker 2

- Day marker 2 has 6 knot restrictions and it is located far from land--remove it

- I am happy with Sinepuxent Bay

- I'm glad the bays are here

- I love it here

- Limit commercial clamming

- I am concerned about commercial clamming and lack of crabs

- They are beautiful

- Commercial fishermen need to have catch limits placed on them

- I enjoy the bay experience; people don't slow down in their boats when passing

- Need sign for PWC's to slow down at bridge

- They are too shallow

- DNR should keep a computerized record of boat inspections for illegal fish; I think I am being harassed in spring and fall by too many inspectors

- Clam dredging is destroying the bay; commercial fishermen are taking most of the fish

- I always enjoy it here

- Problem with large private fishing boats at Route 50 bridge; need more channels under the bridge to separate big and small boat traffic

- Need common-sense speed limits in certain areas (e.g. thorough-fare and other high density places)

- Clammer rules should be enforced

- Keep channels dredged and marked adequately

- Channel markers need lighting, hard to see at night

- Need ramps and parking increased; special area to park PWC trailers

- Too dirty, moving back to Long Island

- Control jetskis

- Treat out-of-staters better
- Provide special areas for jetskiers
- Better channel markings
- Better dredging, wider channels
- Control areas where jetskiers can go
- I enjoyed it
- Clearly marked channels
- Need launching fee to eliminate congestion
- See no reason for 6 mile speed limit out as far as day marker 2 at yacht club
- Decrease the number of jetskiers and wave runners, they are unsafe and dangerous
- Outlaw PWC's
- At the boat ramps, have a boat and trailer rinse-off system
- The bays have too many sandbars, not deep enough for safe boating
- Water quality has improved
- We need smarter boaters
- Legal to net for fish after Labor Day; no clamming
- Jetskis a problem; should not allow fishing in channels
- I would like any improvements
- No fishing in channels
- Better channels/maps and markers
- Overfishing by commercial fishermen
- Maryland should require boat drivers' licenses
- Outlaw clam dredging in Maryland's coastal bays

APPENDIX E

OTHER EQUIPMENT MENTIONED BY BOATERS (QUESTION #4)

- **Radar (5)**
- **EPIRB (2)**
- **Single Side Band Radio**

APPENDIX F

OTHER ACTIVITIES PARTICIPATED IN BY BOATERS (QUESTION #9)

- Coast Guard Auxiliary (4)
- Clamming (3)
- Navigation Contests

APPENDIX G

BOATER'S COMMENTS ON BOATING QUALITY IN MARYLAND'S COASTAL BAYS (QUESTION #16)

INCREASED QUALITY

- Water quality
- Better water clarity
- Additional enforcement by DNR police
- The buoy system and charts are continually updated

DECREASED QUALITY

- Increase in jetskis (21)
- Increased boat traffic (15)
- Poor quality of water (6)
- Inadequate water depth (2)
- Water too shallow (2)
- Increased shoaling (2)
- Too many hydraulic dredgers (2)
- Poorer fishing (2)
- Jetski boaters are all over and noisy
- Rental jetskis from Ocean City (dangerous)
- Increased boat traffic--Ocean City
- Overpopulated with boats
- Too busy
- Too many boats on water on weekends
- low water
- Construction runoff
- More people moving into area; increased population; more visitors
- Too many people are relocating here and everyone has a boat
- Significant increase in number of boats, particularly PWC's
- Great increase in boat traffic and fishermen
- Very few know what they are doing
- Increased unqualified traffic
- Larger numbers of inexperienced boat operators
- Too many unskilled boaters
- Discourteous/bad boaters
- Weekenders renting boats with little or no experience becoming serious problem
- Need boating safety courses for all captains

- Channel at Route 50 bridge
- Speeding boats in channel (dangerous and life threatening)
- Assawoman bay (dangerously shallow); poor flushing
- More unqualified boaters causing safety problems in congested areas
- Boats anchored in channels
- Narrow channels with boats stopped (fishing in channels)
- Murky water from clam dredging
- Commercial crabbers in April (bay is covered in pots); in fall clammers chew up bottom
- Poor water (clammers messing up bottom)
- Clam dredging adversely affects water quality
- Commercial clammers destroy fishing from May to October
- Poor markers; need better markers
- Build up of sand all over bays
- A lot more boaters fishing every year
- More fishing and clamming
- Clammers dredging bay waters and disrupting fishing and water life
- More and more sandbars
- Commercial clammers destroying bottom of bays with dredging
- Silt from hydraulic clammers
- PWC's becoming excessive
- Clammers
- Noise from jetskis
- Decrease in fish due to hydraulic clamming boats
- Fewer fish; loss of fish in general; less marine life
- Degradation by commercial fishing and shellfishing
- Marina far up the creek
- Overcrowded to the point I do not like to boat on weekends
- Backfilling, including channels; channels filling up
- Not enough law enforcement
- Need dredging
- Dirty water
- Poultry plant nearby discharges pollutants (St. Martin's River area)
- Pesticides, lawn care, golf courses are increasing pollutant impacts
- Pfiesteria found (although inactive here, is still a concern)
- Uncontrolled activities--too many boaters which are inexperienced
- Water quality problems make fish quality and health doubtful

APPENDIX K

BOATER'S COMMENTS REGARDING OBSERVED BOATING ACCIDENTS OR UNSAFE BOATING PRACTICES (QUESTION #27)

- First time jetskier powered-down when approaching my boat, lost steering capacity and rammed my boat
- Jetskis and untrained boaters
- PWC operators
- Boat speeding in channel
- Speed boats (too close and too fast) going through drifting boats
- Jetskis operated by obvious novices
- Jetskis being operated unsafely
- Swerving to avoid crab pot lines and moving in front of others
- Jetskis out of control
- Jetski operators not watching where they are going
- Rockfish season at Route 50 bridge gets pretty competitive
- Boat coming over the stern of the boat in front of him at Route 50 bridge
- Observed numerous close calls between boaters
- Jetskis moving at high speed through drifting or anchored boat groups
- Jetskier nearly ran into two women in a canoe
- I've had to stop my boat to avoid a collision from boats coming across port side (passing wrong side)
- 3 jetski accidents at the inlet
- Avoiding jetskiers
- Fast moving boats are not showing any concern for small boats that are anchored.
- Jetskis impacting each other and docks
- Jetskis, especially in the inlet and vicinity
- PWC's speeding, wake action in heavy fishing area
- Jetskis zigzagging and jumping wakes
- At Route 50 bridge twice saw boats strike piers due to current; one caused injury; saw many unsafe incidents from small boats going through the bridge with current; wake problems
- Inexperienced jetskiers
- Boats running aground in Sinepuxent Bay under full power.
- Jetskiers going 40 mph and 40-50 feet from other boats and jumping wakes
- Near accidents with jetskis
- Yes, but not conflicting uses; rather lack of courtesy, education and experience
- Jetski running into a boat
- Operator of jetski hitting a privately maintained piling off Manklin Creek (which has never been replaced)
- Boats too close and breaking fishing tackle; swamping of small boats by large boat's wake

Appendix L

Boaters Comment Regarding Living Resources in Bays (Question #31)

- SAV (17)
- Sea grasses (11)
- Grasses (8)
- Crabs (12)
- Clams (9)
- Oysters (6)
- Marine plants (4)
- Horsehoe crabs, shellfish
- Fish fry
- Filter feeders such as clams, oysters
- All, I write a fishing report weekly for the beachcomber
- SAV and wetlands and all shallow areas need to be protected
- Grasses generate oxygen, a home for fish and crabs and a breeding ground for both
- Need marine plants and animals to "resurrect" water quality
- Various birds and animals
- Decline of any marine plants and animals will affect the others
- Fish
- Clams and oysters filter the water; underwater grasses are nursery for small fish
- Widgen grass and eel grass
- Fish, seashore birds, marshes
- Mussels, horseshoe crabs, shorebirds
- Benthic filter feeders, finfish filter feeders (menhaden)
- Decrease in oyster population affecting the filtration system
- All the living resources have a value
- Trees, shoreline
- SAV very important to marine habitat
- Shellfish
- Sea Grasses act as a nursery area for all of our finfish; oysters and clams are filter feeders
- Benthic organisms, clams, crabs--all living things
- Waterfowl, fish
- Marsh grasses for fish and wildlife nursery
- Interaction of all resources--habitat and food chain
- Molluscs
- Various grasses and baitfish
- SAV needed for better fishing and crabbing
- Natural vegetation

- Clams (filtering), small forage fish
- Aquatic grasses
- Underwater grasses
- Molluscs--clean and/or oxygenate the water
- Symbiotic relationships--grass, fish, bivalves filter water, habitat, etc
- Fish, birds
- Catfish
- Complete aquatic food chain is essential from smallest animals to larger species; vegetation and wetlands provide the nursery for babies and smallest species; pollutants and toxins are most damaging to the smallest species and to plant life

Appendix M
Comments on How the Maryland Coastal Bays Program Can Better Inform Boaters
(Question #32)

- Send literature to all boatowners

- We don't need another layer of regulations--just action and enforcement of present regulations

- Do what you are presently doing--make us more aware

- Improve on the public information dissemination to the public via news releases, articles, etc.; this has improved but more can be done

- Education--classes in schools similar to the DNR/Team

- We learn our mistakes after we have caused the damage; educating the youth on our mismanagement is one of the best ways

- Publicize methods more

- I've joined the group and offered my help

- Getting better all the time

- More Dave Wilson articles

- Send out condensed information with new boat ID

- Educate boaters

- Make more information available; indicate where more complete information may be found

- All public information and outreach are definitely needed and are appropriate; local residents are easier to reach with information than visitors; boat rental operators could do more to inform renters-- flyers at facilities are suggested to help inform boat rental clients; slogans could be posted on piers, in boats and on billboards (e.g. HELP KEEP BAY WATER CLEAN)

- Send information semi-annually

- Publish and distribute information

- **Distribute more information to boatowners**

- **Get brochures out to retail stores/marinas to educate and join with other groups to reduce or eliminate clam dredging in the bays**

- **More information for public**

Appendix N

Other Comments on How Boaters would Spend Their Own Money to Improve Maryland's Coastal Bays (Question #33)

- Give out tickets for drinking or speeding
- Stop the clammers
- Equalize the rules between commercial and recreational
- Protect against dredging
- Ban hydraulic clamming
- Eliminate hydraulic clam dredging
- Stop all forms of SAV damage
- Stop all commercial fishing
- Lighted channel markers
- Eliminate personal watercraft
- Get rid of commercial clammers
- Eliminate jetskiers
- Prohibit/restrict pesticides and chemicals from being sold and used locally; stop toxic mosquito spraying

APPENDIX O

ADDITIONAL COMMENTS FROM BOATERS

- Commercial hydraulic clam dredges must go. No commercial netters should be allowed in state waters (3-mile limit).

- Locals own much of the undeveloped bay area land and they speculate that their land will bring them great wealth, so they fight "do-gooders" who are infringing on their rights. It's known as greed. They should understand land speculation is no different than stock and bond speculation, you win some and you lose some.

- I think the main aim should be to make our bays navigable.

- Put more publicity in the local daily and weekly papers and TV about the bays and the coastal bays' programs.

- Outlaw hydraulic clammers (i.e. DE and VA).

- Protection of the habitat is key--all user groups put their demands first, but unless the resource/habitat is protected and respected we will have a declining situation in the coastal bays--the ecosystem is too fragile.

- The survey appears biased toward commercial uses of the bay.

- More restrictions should be placed on the harvesting of female crabs. Crabs reproduce at such a great rate that there should never be a shortage of crabs. But so many crabs (female) are harvested that the shortage of crabs are increasing year-after-year.

- I don't feel jetskis should be targeted for limited number, but feel certain areas should be off-limits, (e.g. inlet).

- I also do water monitoring for the Maryland Coastal Bays Program and participate in SAV monitoring with Ocean Pines Boat Club.

- If the Maryland Coastal Bays Program would adopt a logo/mascot this could be extremely helpful in public recognition and perhaps even fundraising. M.R. DUCKS made a lot of money for its private company. "Smokey the Bear" promoted forest protection awareness and public cooperation. Perhaps the coastal bays program could use something cute like a happy crab, or some other cute mascot (with wide-spread appeal) that could promote coastal bay's interest.

- Use of our bays by up to 24 commercial clam dredgers from October to May is a disgrace. All the good things we try to do to protect the waters are destroyed as they tear up the bottom.

- The major adverse impacts on the bay waters or habitat are caused by the hydraulic clammers. The use of hydraulic clamming must be prohibited in the coastal bays.

- Stop the hydraulic clamming.

- I belong to the Coast Guard Auxiliary, and am very interested in safe boating on the waters in the bays of Ocean City.

Appendix P

Mail Survey Instrument

UNIVERSITY OF DELAWARE

SEA GRANT
COLLEGE PROGRAM

University of Delaware
Hugh R. Sharp Campus
Lewes, Delaware 19958-1298

Fall 1999

Dear Maryland Boater:

We are conducting a study of recreational boating on Maryland's Coastal Bays. At the present time, little information is available concerning activity patterns and attitudes of boaters using these waters. The information you provide is especially important since it will be useful in planning for the state's recreational boating needs in the future.

The accuracy of this study depends on the number of questionnaires returned. It should only take between 10 and 15 minutes of your time to complete the survey. Once you have answered the questions, please place the questionnaire in the enclosed postage-paid envelope and return it as quickly as possible. Any information you provide will be strictly confidential. Only group totals will ever be published. Your name or individual responses will never be reported in any way.

If you would like a copy of a summary report when the study is completed, please write your name and address on a separate sheet of paper and enclose it in the return envelope along with your questionnaire, or send it separately if you wish. Information from boaters, like yourself, is vital to insure that recreational boating continues to be a safe and enjoyable activity in Maryland waters. We greatly appreciate your help and interest in this study.

Sincerely,

James M. Falk
Project Coordinator

Maryland Coastal Bays Boating Study

Maryland Coastal Bays Program ◆ University of Delaware Sea Grant Marine Advisory Service

1. What type of boat do you use most often in Maryland's Coastal Bays **(select only one)**?
   ___Pontoon Boat ___Kayak/Canoe ___Sportfishing Boat ___Jet Boat
   ___Personal Watercraft (jetski) ___Sailboat ___Other (Specify)____________

2. If this boat has a motor(s), what is the total horsepower? ______Horsepower

3. What length is this boat? _____Feet

4. Does this boat have any of the following specialized equipment? ___Depth finder ___LORAN ___Compass
   ___GPS ___ VHF Radio ___CB ___Cell Phone ___ Other (specify) ________________________

5. How long have you owned this particular boat? ______Years

6. How long have you participated in recreational boating as a boat owner? _____Years

7. How many years have you boated on Maryland's Coastal Bays? _____ Years

8. How would you rate yourself as a boater? ___Novice ___ Intermediate ___Advanced ___Expert

9. Below is a list of boating activities you may participate in with this boat. Please estimate what percent of time you spend on each of the following activities, on Maryland's Coastal Bays, during a typical boating season (**Make sure total selections add to 100%**)?
   ____Pleasure Cruising ____Waterskiing/Tubing ____Fishing ____Crabbing ____Swimming
   ____Day Sailing ____Overnight Cruising ____ Other (Specify) __________________

10. When you consider all of the boating that you do in a typical year, what percent is done on Maryland's Coastal Bays?
    ______________ %

11. How many total days did you boat on Maryland's Coastal Bays in 1999 (estimate your total for the year even if you have not completed your boating activity as yet)? _______days.

12. Do you do most of your boating on **(check only one)**: ___Weekdays ___Weekends ___Weekdays/Weekends equally

13. What months of the year do you boat on Maryland's Coastal Bays? **(Check all that apply)**
    ___Jan ___Feb ___Mar ___Apr ___May ___ Jun ___Jul ___Aug ___Sep ___Oct ___Nov ___Dec

14. Why do you choose to engage in boating activities on Maryland's Coastal Bays? **(Check all that apply)**
    ___Good water quality ___Close to home/other lodgings ___Adequate water depth
    ___Adequate channel markers ___Scenic qualities of the bays ___Good fishing
    ___Peaceful location ___Not a lot of other boating traffic ___To observe wildlife
    ___Other (specify) ________________________

15. Overall, how would you rate boating on Maryland's Coastal Bays?
    ___Poor ___Fair ___Good ___Very Good ___ Excellent ___Perfect

16. During the past few years do you feel the quality of boating in Maryland's Coastal Bays has:
    ___ Increased, if so why ____
    ____
    ___ Stayed the same
    ___ Decreased, if so why ____
    ____

17. Do you currently keep this boat in the water (at a marina, private dock, boat lift, etc.) on Maryland's Coastal bays during the boating season? ___ Yes ___ No

If Yes, where do you keep it: ___ Marina ____ Private dock ___ Boat lift ___ Other (Specify) _______________

18. As a recreational boater in Maryland's Coastal Bays, please indicate which of the following concerns are of most importance to you. Circle the number that corresponds to your answer (**1 = Not at all Important; 2 = Slightly Important; 3 = Moderately Important; 4 = Very Important; 5 = Extremely Important)**

Poor water quality affecting my boating experience	1	2	3	4	5
Overcrowding of navigable waters	1	2	3	4	5
Boaters operating under the influence of alcohol/drugs	1	2	3	4	5
Boaters operating in an unsafe manner	1	2	3	4	5
Lack of state marine enforcement	1	2	3	4	5
Lack of adequately maintained navigational channels	1	2	3	4	5
Lack of proper navigational aids (buoys, lights, etc)	1	2	3	4	5
Overcrowding at popular boat ramps	1	2	3	4	5
Boats drifting/anchored in navigational channels	1	2	3	4	5
Other (specify) ______________________	1	2	3	4	5

Safety is a key ingredient for enjoyable boating. Please answer the following questions as they pertain to safe boating.

19. Do you familiarize yourself with new Coast Guard regulations each year? ___Yes ___No

20. Do you annually receive a Coast Guard Auxiliary courtesy safety inspection? ___ Yes ___ No

21. Have you ever taken a boating safety training course? ___ Yes ___ No
If Yes, what year did you last take a course? _______________

22. Do you feel that all boaters should be required to take a boating safety training course? ___ Yes ___ No

23. Does the insurance company that covers your boat offer discounts if you complete a boating safety course or receive a safety inspection? ___ Yes ___ No ___ Unsure

24. In an effort to improve safety of navigation at the Rt. 50 bridge and inlet, we would like your help in identifying any problems of which you are aware or have experienced **(Please indicate the importance of the following by selecting 1 = Least Serious and 5 = Most Serious).**

	Least Serious				Most Serious
Fast moving current	1	2	3	4	5
Turbulence and wave action	1	2	3	4	5
Narrow passageway	1	2	3	4	5
Underpowered boats	1	2	3	4	5
Boats not suitable for this area	1	2	3	4	5
Inexperienced operators	1	2	3	4	5
Overloaded boats	1	2	3	4	5
Boats ahead moving too slow for your steerage	1	2	3	4	5
Excessive boat wakes	1	2	3	4	5
Boats maneuvering until bridge opens	1	2	3	4	5
Jetskis zig-zagging in inlet	1	2	3	4	5
Other (specify) ______________________	1	2	3	4	5

25. Using the following crowding scales, how would you describe boating conditions on Maryland's Coastal Bays, in key locations, during the summer months (June - August)? **(Please circle the number that corresponds to your answer.)**

A. **Isle of Wight Bay (Rt 90 Br. to Rt 50 Br.)**	1	2	3	4	5	6	7	8	9
	Not at all crowded			Slightly crowded		Moderately crowded		Extremely crowded	
B. **Inlet Area**	1	2	3	4	5	6	7	8	9
	Not at all crowded			Slightly crowded		Moderately crowded		Extremely crowded	
C. **Sinepuxent Bay (Inlet to Verrazano Br.)**	1	2	3	4	5	6	7	8	9
	Not at all crowded			Slightly crowded		Moderately crowded		Extremely crowded	

26. Do you feel there are any conflicts between users of Maryland's Coastal Bays? ___ Yes ___ No
If yes, please explain ____
____

27. Have you observed any boating accidents, near accidents, or unsafe boating practices within the last year which you believe were a direct result of conflicting uses on the bays? ___ Yes ___ No
If Yes, please explain ____
____

Environmental concerns are very important to boaters. Please answer the following questions to make us aware of your concerns and feelings about the coastal environment.

28. Since you have been boating on Maryland's Coastal Bays, do you think the **environmental quality** of the bays has been:
___ Improving ___ Not changing very much ___ Deteriorating ___ Don't know, not sure

29. Since you have been boating on Maryland's Coastal Bays, do you think the bay's **living resources** (fish, crabs, clams, etc.) have been: ______ Improving ______ Not changing very much ______ Deteriorating ______ Don't know, not su

30. Recreational/Commercial users may negatively impact the resources of Maryland's Coastal Bays in certain ways. Please identify which impacts you are aware of that may be caused by these bay users (**check all that apply**).

	Recreational Boats	**Commercial Boats**
Disturbing sea grasses	______	______
Creating excessive water turbulence	______	______
Dumping of porta-potties or MSD's in bay waters	______	______
Shoreline erosion	______	______
Propeller scouring of bottom sediment	______	______
Disturbing nesting shorebirds	______	______
Discharges of oil/gas	______	______

31. Are you aware that certain living resources (marine plants and animals) in the bays are important to creating a healthy bay ecosystem? ___ Yes ___ No ___ Unsure

If Yes, describe which living resources you are aware of: ______________________________
____

32. Do you feel that you have adequate information to do your part to protect and conserve the bays living resources?
___ Yes ___ No ___ Unsure

If No or Unsure, what could the Maryland Coastal Bays' Program do to help inform you better.
____
____

33. If you were spending your own money to improve Maryland's Coastal Bays, how would you rank the following items **(Place a 1 near the highest priority item, place a 2 near the second highest priority item and continue until all of the items have been ranked).**

___ Improve the water quality of the bays
___ Create new habitat for fish, birds, and other animals
___ Build more and better launch ramps
___ Protect existing fish, bird, and wildlife habitat
___ Provide more marine enforcement on the water
___ Deepen and widen the bay's navigational channels
___ Provide more and better channel markings
___ Other (specify) ______________________

34. Would you favor or oppose each of the following issues for Maryland's Coastal Bays (**1=Strongly Oppose; 2=Oppose; 3=Neutral; 4=Favor; 5=Strongly Favor).**

a. Additional regulations if they improve the bay's water quality 1 2 3 4 5
b. Limit the number of boats using the bays 1 2 3 4 5
c. Zoning the waters to provide for certain uses at specific places 1 2 3 4 5
d. Restricting boat use in excessively shallow waters or around sensitive bay resources 1 2 3 4 5
e. Require the purchase of a seasonal boating permit for bay use, if the money were used for bay improvements 1 2 3 4 5
f. Develop additional boat access facilities to the bay's waters 1 2 3 4 5
g. Stricter limits on the size and/or number of fish, clams, and crabs that can be taken from the bay's waters 1 2 3 4 5
h. Require a baywide saltwater fishing license, if the money were used to improve fishing in the bay 1 2 3 4 5
i. Limit the number of jetskis using the bays 1 2 3 4 5

The following questions are about you personally and will help us to know more about boaters. We should stress that all of your answers are strictly confidential.

35. What is your age? ___

36. Are you: ____ Male ____ Female

37. How much formal education have you had? ___ Grade School ___ Some High School ___ High School Graduate
___ Some College ___ College Graduate ___ Post Graduate

38. Which best describes your present employment status?
___ Employed Full-Time ___ Not Employed ___ Student ___ Employed Part-Time ___ Retired
___ Other (specify) ______________________

39. Which best describes your total annual family income before taxes?
___ under $10,000 ___ $10 - 19,999 ___ $20 - 29,999 ___ $30 - 39,999 ___ $40 - 49,999
___ $50 - 74,999 ___ $75 - 99,999 ___ $100,000 & above

40. Are you a member of a sportfishing club or recreational boating organization? ___ Yes ___ No
If yes, name the organization(s)______________________________________

Please feel free to add any additional comments you desire.

That concludes the survey, thank you for your time.
Please return the completed survey form
in the stamped, self-addressed envelope provided.

APPENDIX Q

PERCEPTIONS OF CROWDING BY ON-SITE BOATERS
(TABLE AND MAPS IDENTIFYING BOATERS' LOCATIONS OF CROWDING)

Table Q-1. Perceived Crowding Points by On-Site Boaters in Maryland's Coastal Bays by Date and Location								
Date	**Assawoman Bay**		**Isle of Wight Bay**		**Ocean City Inlet**		**Sinepuxent Bay**	
	#	%	#	%	#	%	#	%
Sat. 8/21/99	0	0	8	38	8	38	5	24
Sun. 8/22/99	1	3	15	47	7	22	9	28
Sat. 8/28/99	1	4	16	70	3	13	3	13
Sun. 8/29/99	0	0	13	56	5	22	5	22
Total	2	2%	52	53%	23	23%	22	22%

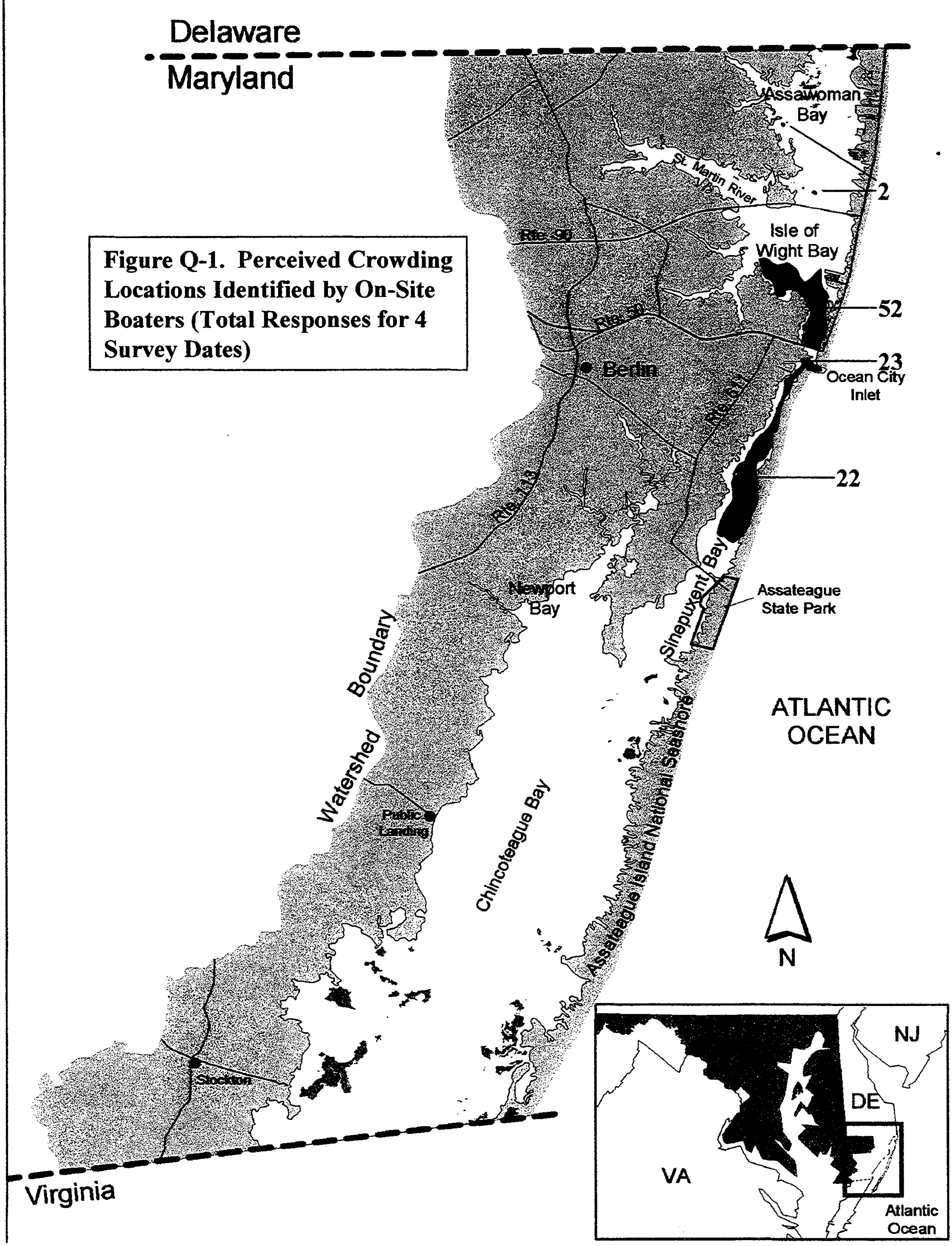
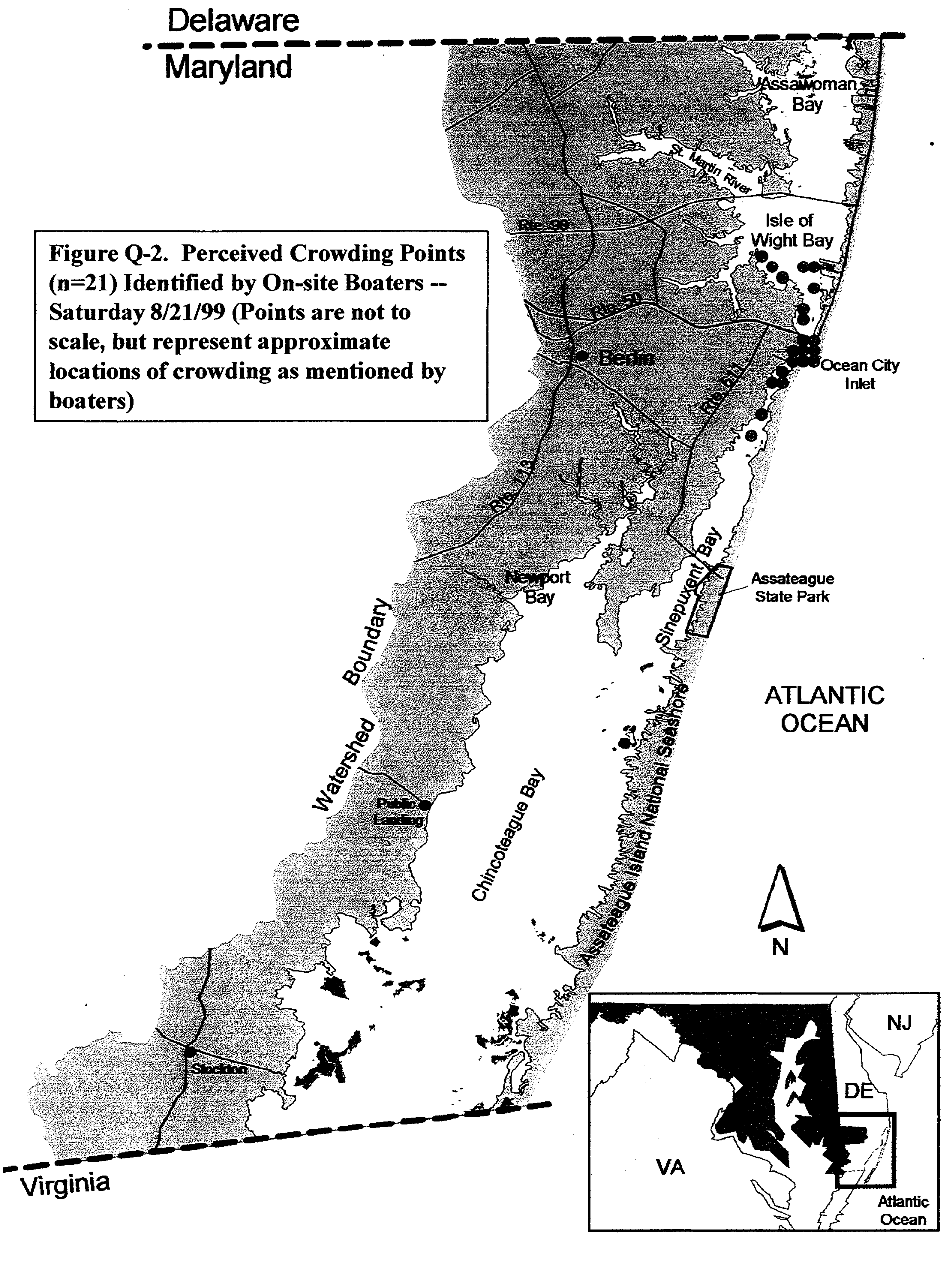


Figure Q-1. Perceived Crowding Locations Identified by On-Site Boaters (Total Responses for 4 Survey Dates)

Figure Q-2. Perceived Crowding Points (n=21) Identified by On-site Boaters -- Saturday 8/21/99 (Points are not to scale, but represent approximate locations of crowding as mentioned by boaters)



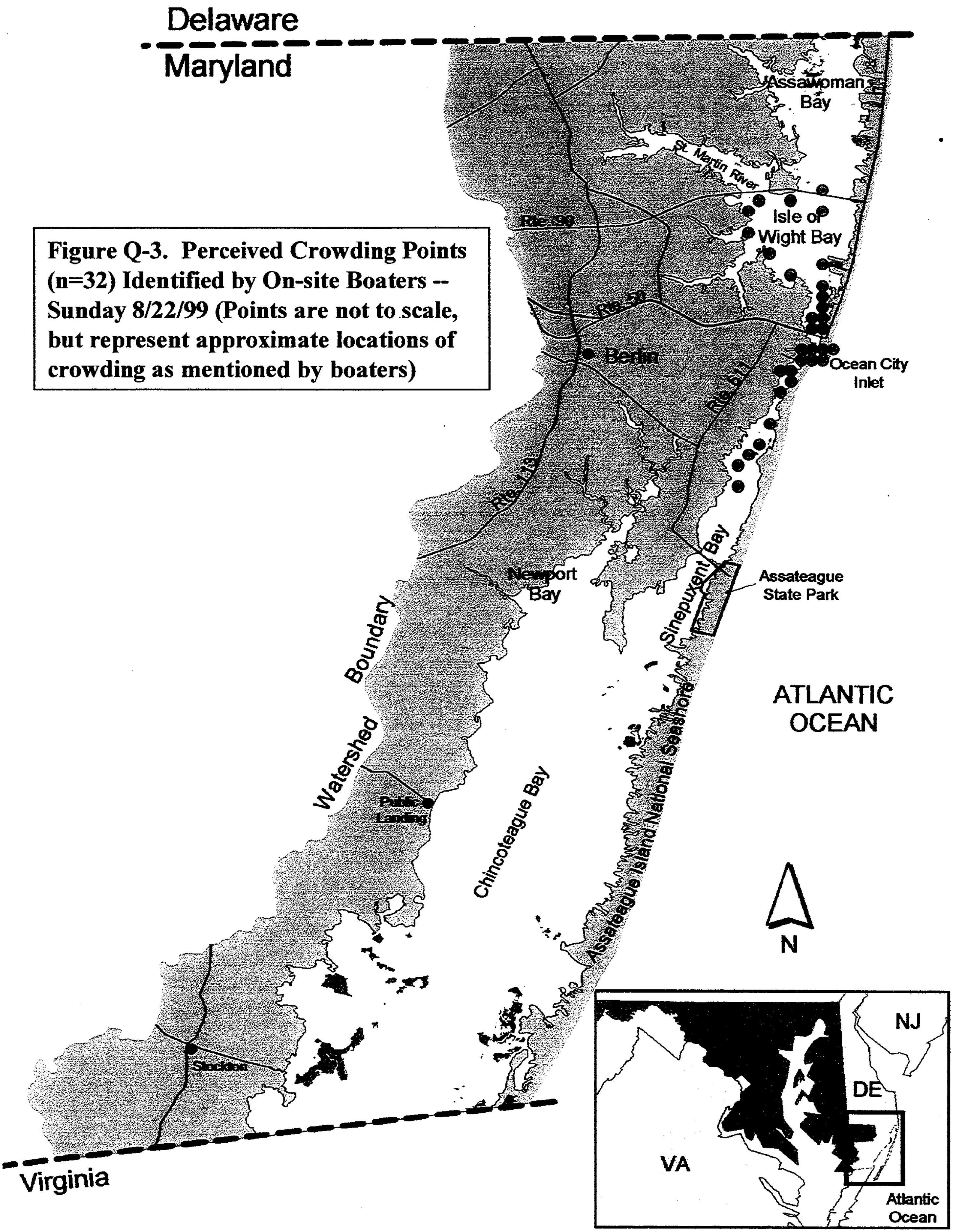


Figure Q-3. Perceived Crowding Points (n=32) Identified by On-site Boaters -- Sunday 8/22/99 (Points are not to scale, but represent approximate locations of crowding as mentioned by boaters)

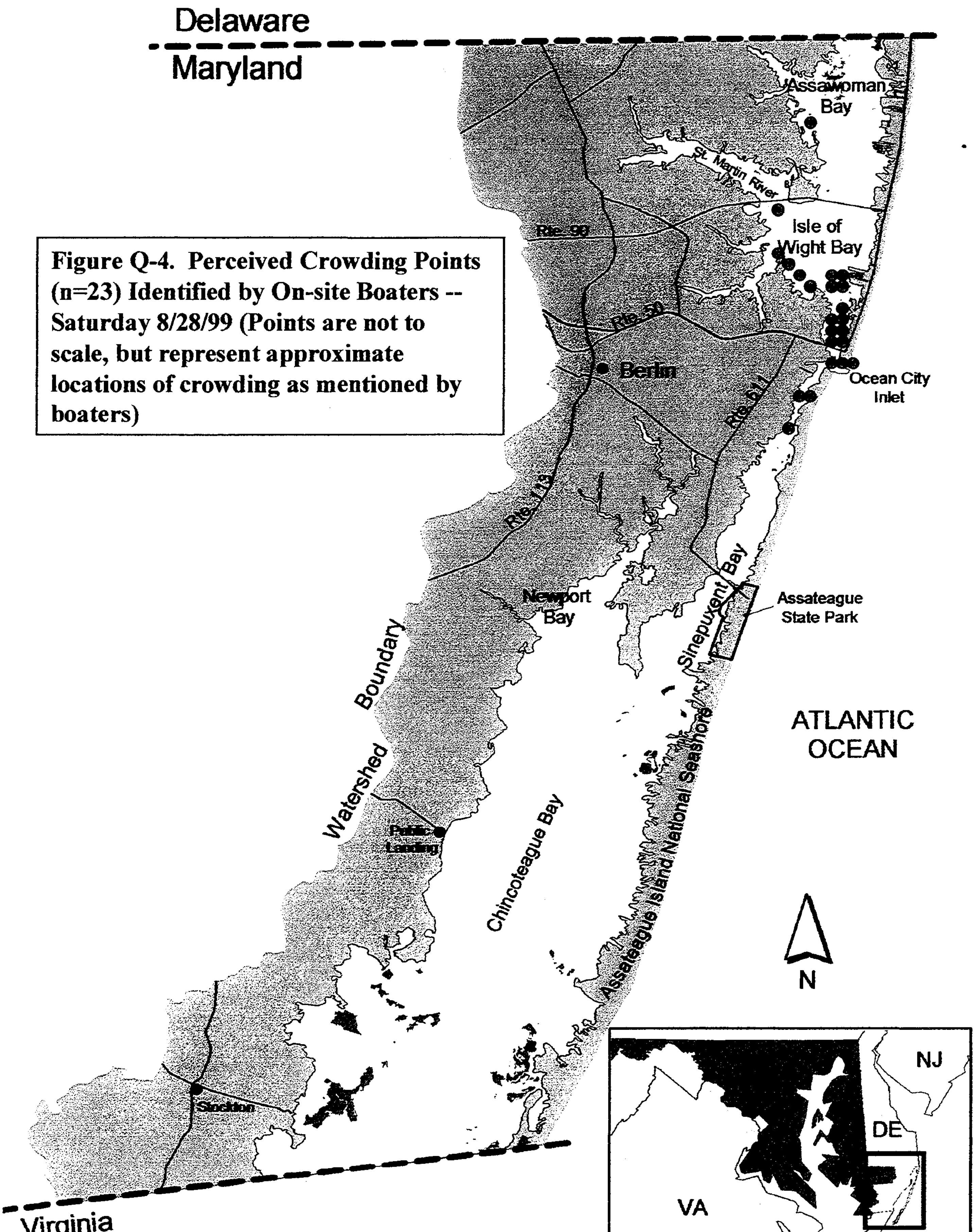
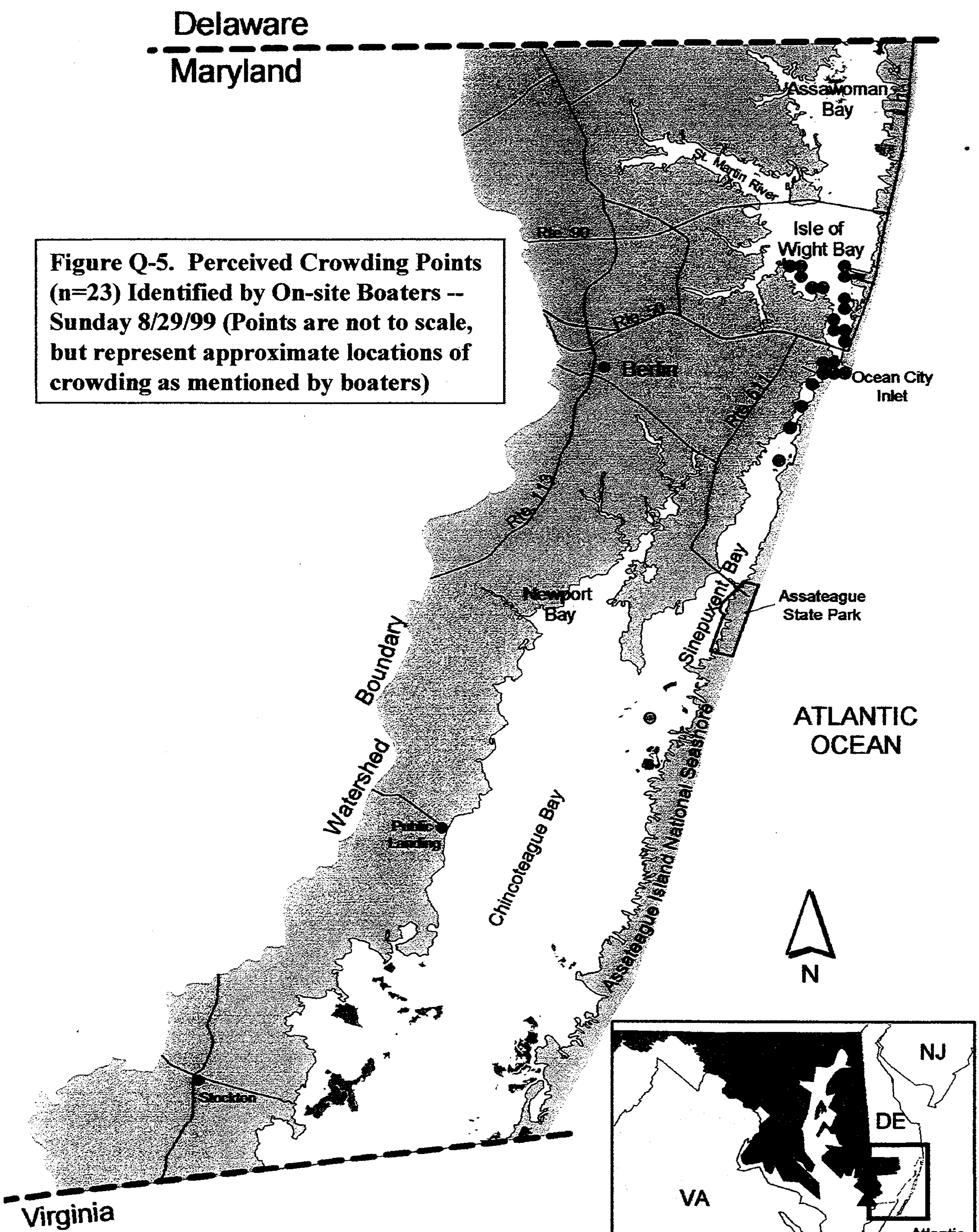


Figure Q-4. Perceived Crowding Points (n=23) Identified by On-site Boaters -- Saturday 8/28/99 (Points are not to scale, but represent approximate locations of crowding as mentioned by boaters)

Figure Q-5. Perceived Crowding Points (n=23) Identified by On-site Boaters -- Sunday 8/29/99 (Points are not to scale, but represent approximate locations of crowding as mentioned by boaters)



APPENDIX R

BOATING OBSERVATIONS ON FIELD SURVEY DATES BY LOCATION AND ACTIVITY (BASED ON AERIAL FLIGHTS CONDUCTED BY MARYLAND DNR)

Table R-1. Total Boating Observations On Field Survey Dates on Maryland Coastal Bay Segments (Based on Aerial Flights Conducted by MD DNR)

Bay Segment	Saturday 8/21/99	Sunday 8/22/99[1]		Saturday 8/28/99[2]		Sunday 8/29/99[3]	
		#	%	#	%	#	%
St. Martin River	NO DATA COLLECTED	49	7%	22	5%	21	4%
Rt. 90 Bridge to DE Border		72	11	73	15	77	16
Rt 90 Bridge to Rt 50 Bridge		268	41	205	43	198	41
Inlet		122	19	89	19	91	19
Inlet to Trappe Creek		148	22	83	18	94	20
TOTAL		659	100	472	100	481	100

[1] Totals based on two flights
[2] Total based on one flight
[3] Totals based on one flight

Table R-2. Observed Boating Activity on Field Survey Dates (Based on Aerial Flights Conducted by Maryland DNR)

Activity	Saturday 8/21/99	Sunday 8/22/99[1]		Saturday 8/28/99[2]		Sunday 8/29/99[3]	
		#	%	#	%	#	%
Cruising Boats	NO DATA COLLECTED	299	66	161	34	168	35
Anchored/Drifting Boats		170	26	198	42	195	41
Jetskiing		137	21	63	13	64	13
Sailing		11	2	5	1	4	1
Parasailing		6	1	--	0	2	<1
Kayaking/Canoeing		27	4	1	<1	10	2
Headboat Fishing/Sightseeing		5	1	--	0	3	1
Anchored to shore		--	0	43	9	31	6
Swimming		1	<1	1	<1	3	1
Waterskiing		--	0	--	0	1	<1
Commercial Clamming		2	<1	--	0	--	0
Commercial Crabbing		1	<1	--	0	--	0
TOTAL		659	100	472	100	481	100

[1] Totals based on two flights
[2] Totals based on one flight
[3] Totals based on one flight

APPENDIX S

BOATING ACTIVITY LOCATION MAPS
(BASED ON AERIAL FLIGHTS CONDUCTED BY MARYLAND DNR)

Maryland's Coastal Bays

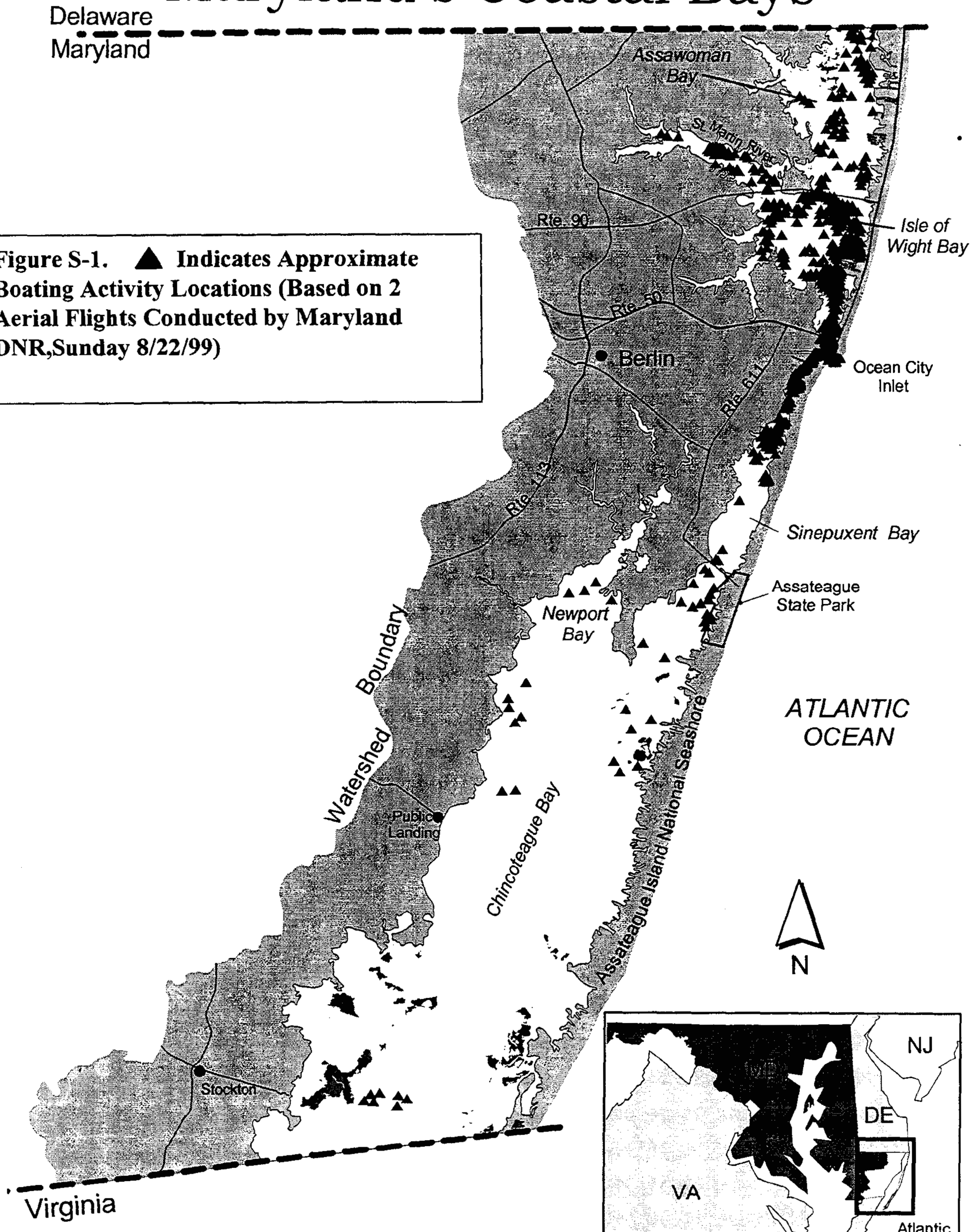


Figure S-1. ▲ Indicates Approximate Boating Activity Locations (Based on 2 Aerial Flights Conducted by Maryland DNR,Sunday 8/22/99)

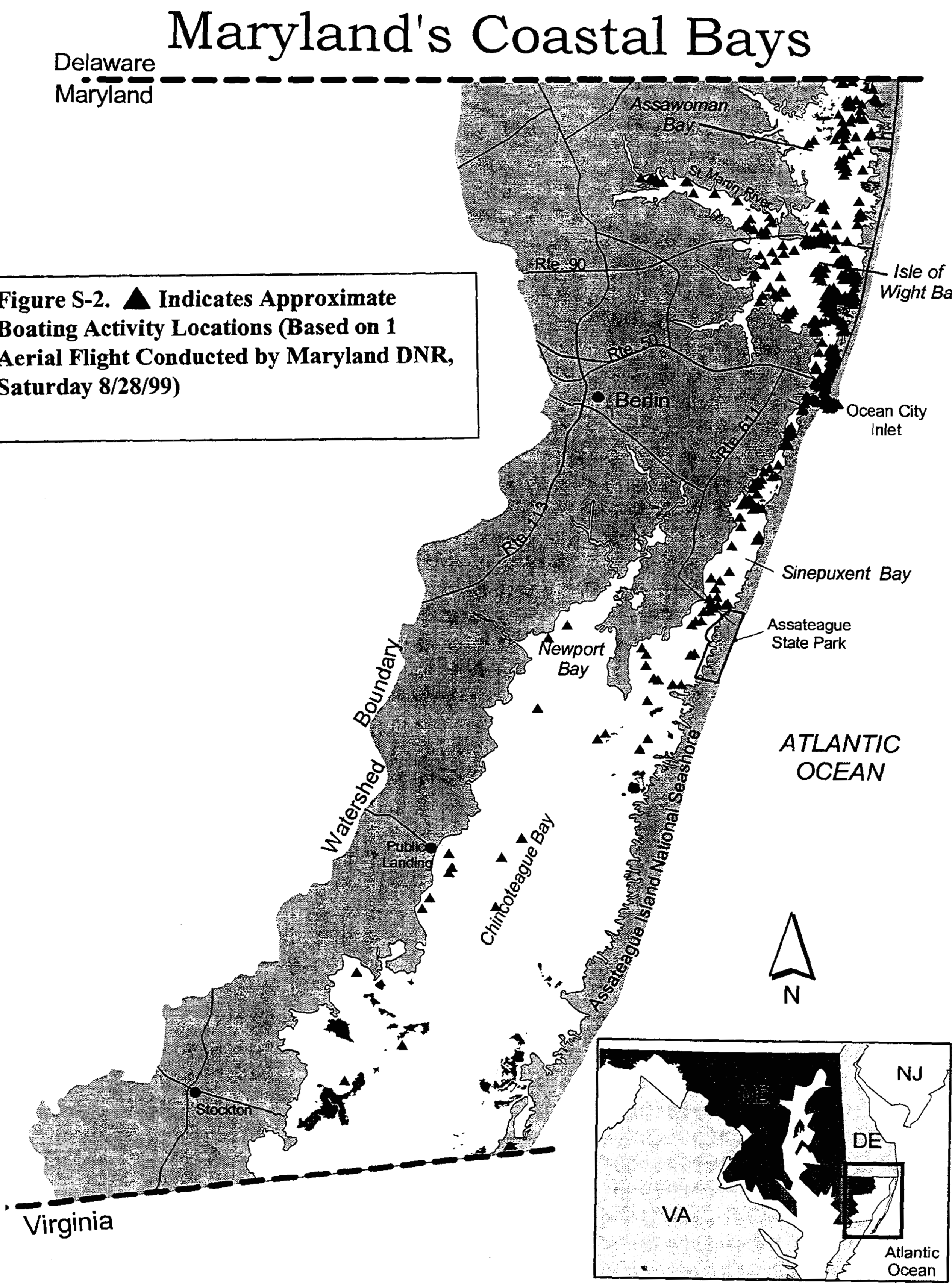


Figure S-2. ▲ Indicates Approximate Boating Activity Locations (Based on 1 Aerial Flight Conducted by Maryland DNR, Saturday 8/28/99)

Maryland's Coastal Bays

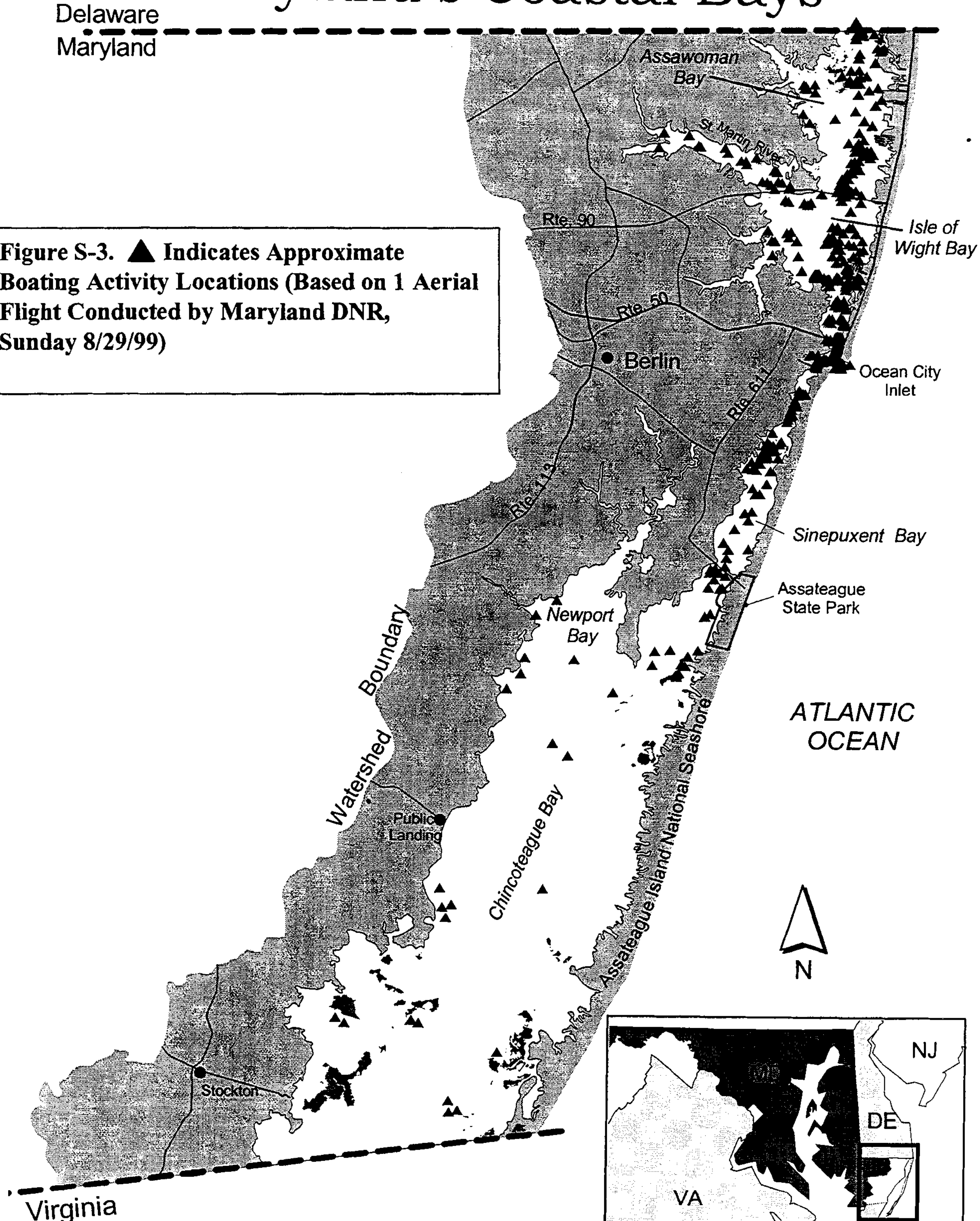


Figure S-3. ▲ Indicates Approximate Boating Activity Locations (Based on 1 Aerial Flight Conducted by Maryland DNR, Sunday 8/29/99)

MARYLAND COASTAL BAYS PROGRAM

Today's Treasures for Tomorrow: Towards a Brighter Future

A Progress Report On Year One Challenge Updates and Year Two Challenges

October 2000 - September 2001

Report prepared by the Implementation Committee
and the Tracking And Evaluation Subcommittee
September 2001

Today's Treasures for Tomorrow: Towards a Brighter Future

A Progress Report On Year One Challenge Updates and Year Two Challenges

October 2000 - September 2001

Table of Contents

	Page
Forward	1
Year Two Report Card	2
Summary of Issues	3
Section One: Issues and Related Challenges	
• *Buffers*	6
• *Forestry*	8
• *Measurements of Success (Metrics)*	10
• *Submerged Aquatic Vegetation*	13
• *Water Quality*	15
• *Wetlands*	19
Section Two: Other Challenges	21
List of Acronyms	56

Maryland's coastal bays make up a one-of-a-kind, shallow estuary on the eastern seaboard. For more than a century, agriculture, forestry, fishing, hunting, and more recently tourism, have sustained ways of life built on the land and water resources in this coastal paradise.

To the east of Route 113, the modest watershed of the coastal bays includes Berlin, Ocean City, parts of Snow Hill and Pocomoke and the Assawoman, Isle of Wight, Sinepuxent, Newport, and Chincoteague bays.

Each lure 10 million annual visitors who flock to the bays to fish, boat, swim or just enjoy the atmosphere in their favorite bayside restaurant. Today, Worcester's forests and 474 farms still contribute hundreds of millions of dollars annually to the local economy. Both also provide the open space and natural land essential to the unique wildlife which call this part of the Eastern Shore home.

To safeguard this heritage, Worcester County residents from all walks of life have been working together to devise common sense ways of protecting the bays behind Ocean City and Assateague. This effort, the Maryland Coastal Bays Program, has culminated in a comprehensive conservation and management plan aimed at preserving this precious coastal resource.

Created by representatives from the development, farming, golf, tourism, recreational and commercial fishing industries, the plan represents a consensus of the best means needed to preserve the economic and ecological prosperity of the coastal bays in the next century.

The Maryland Coastal Bays Program is a cooperative effort between Ocean City, Berlin, Worcester County, and a host of state and federal agencies which have united scientists and diverse stakeholder groups for this common cause.

The program exists under the umbrella of the National Estuary Program, designed to protect the most economically and environmentally significant areas in the United States. The coastal bays behind Assateague Island and Ocean City make up one of only 28 other estuaries nationwide which have received the special attention. In these regions, the health of the economy is especially tantamount to the health of the environment.

In the coastal bays, the burgeoning population centers in the north are suffering from declining water quality and wildlife habitat. The coastal bays' health is slightly worse than that of the Chesapeake, although the two Maryland estuaries are nothing alike.

In comparison to the Chesapeake and its 64,000-square-mile watershed, the 175-square-mile coastal bays watershed has an average depth of 3.5 feet versus its sister's 24-foot average. The coastal bays also harbor high salinities and their watershed is host to the most diverse bird and reptile populations in the entire state. Sandy soils, indigenous plant life, barrier islands, and unlikely flow regimes add to the coastal bays' distinctive ecological medley.

Now, this jewel is in danger of being loved to death. With a growth rate of 50 percent from 1990-2000, the coastal bays watershed and its wildlife and water quality are in trouble. The six issues in this report highlight these declines and what needs to be undertaken to reverse them. Improvement in the areas of native plant buffers, forestry management, seagrass protection, wetlands, and water quality represent the focus of this report. Within this work, it is clear that without additional and sustained funding, this work will not be able to proceed. The cornerstone of this effort, water quality protection demands significant resources.

Following is a snapshot of these efforts and a report on their status.

REPORT CARD

ISSUES	FULL	SUBSTANTIAL	MODERATE	SOME	MINIMAL
BUFFERS	WQ 6.1 - Improve efficiency of sediment and erosion control program.	WQ 6.2 - Reduce shoreline erosion rates	CE 4.3 - Enhance the buffering capacity of the watershed's tidal and nontidal shoreline area.	WQ 2.2 - Improve stormwater quality from existing development.	
FORESTRY				FW 2.2 - Conservation of forest.	FW 2.1 - Improve songbird populations and forest habitat. FW 2.6 - Conservation and use of forested land.
MEASUREMENTS OF SUCCESS (METRICS)		FW 1.1 - Accurate fish harvest information.	WQ 3.1 - Improve understanding of atmospheric deposition of nutrients. WQ 5.2 - Improve understanding of tertiary sewage treatment needs. RN 3.1 - Reduce resource impacts from water -based recreational activities.	CE 2.3 - Enhance natural disaster planning.	
SUBMERGED AQUATIC VEGETATION		FW 1.6 - Seagrass protection and expansion			RN 5.2 - Increase public awareness of resource protection needs.
WATER QUALITY		WQ 2.1 - Reduce water quality impacts from stormwater discharges. WQ 1.2 - Update septic system designs. WQ 1.3 - Improve understanding of groundwater resource.	WQ 4.1 - Reduce nutrient pollution from farming.	WQ 1.1 - Reduce failure rate and inefficiency of on-site wastewater treatment. WQ 4.3 - Improve management of drainage systems.	FW 1.7 - Improve water quality in dead end canals.
WETLANDS				FW 3.1 Conservation of wetland resources.	FW 3.2 - Improvement of staging, wintering, and nesting areas. FW 3.4 - Coordination of wetlands regulations.

FULL Full implementation completed or nearing completion (75-100%).

SUBSTANTIAL Major progress has been made (50-74%).

MODERATE Fair level of progress made (25-49%).

SOME Progress beginning (10-24%).

MINIMAL Very limited progress (0-9%).

The ratings to each Challenge in this Report Card of the Maryland Coastal Bays Program's Progress Report on Year One Actions Updates and Year Two Actions are the results of an intense evaluation exercise performed by the Tracking And Evaluation Sub-committee, composed of MCBP staff, key partners, and citizens. The Implementation Committee partners provide the raw implementation status data and also review the draft Progress Report. This evaluation seeks to measure how items listed as progress in the Progress Report stacked up against the specific language and intent of the Comprehensive Conservation And Management Plan (CCMP).

ISSUES

Buffers

1. We allow people to fill their way out of the flood plain. This puts the stormwater and floodtide burden on their neighbors.
2. Protection of non-tidal streams produces the largest returns.
3. BMPs and retro-fits to existing lots should be investigated.

WQ 2.2	*Improve stormwater quality.*
WQ 6.1	*Improve efficiency of sediment and erosion control program.*
WQ 6.2	*Reduce shoreline erosion rates.*
CE 4.3	*Enhance buffering capacity of tidal and nontidal shoreline area.*

Forestry

1. Imperiled species need hardwood forests.
2. Species diversity of trees is not being understood and implemented.
3. Need to emphasize hardwood replanting for mitigation area - not Loblolly Pines.

FW 2.1	*Improve songbird populations and forest habitat.*
FW 2.2	*Conservation of forests.*
FW 2.6	*Conversion and use of forested land.*

Measurements of Success (Metrics)

1. Why is there a need for Indicators of Implementation Results and the funds to develop and execute these indicators, as well as monitor for results?
2. Many on-going implemented items must be revisited periodically to ensure results actually happen through changes in public attitudes and actions.
3. The judicial system must be educated - frequently when actions are taken, judges do not resolve the issue in favor of the ecosystem.
4. All actions that have incentives associated with them need to be reviewed and prioritized.

WQ 3.1	*Improve understanding of atmospheric deposition of nutrients.*
WQ 5.2	*Improve understanding of tertiary sewage treatment needs.*

FW 1.1 *Accurate fish harvest information.*
RN 3.1 *Reduce resource impacts from water-based recreational activities.*
CE 2.3 *Enhance natural disaster planning.*

Submerged Aquatic Vegetation

1. We have not gotten down to the management actions to protect the sensitive resources.

FW 1.6 *Seagrass expansion and protection.*
RN 5.2 *Increase public awareness of resource protection needs.*

Water Quality

1. Need research dollars for dead-end canals, their impact and methods to improve.
2. Funding for research of blue crab parasites must be found.
3. There is a significant problem in extracting data from residential septic files.
4. Management Areas need revision to reflect the Worcester County soil characteristics.
5. Groundwater research is Fed-funded in lower bays. Northern bays need research.

WQ 1.1 *Reduce failure rate and inefficiency of on-site wastewater treatment.*
WQ 2.1 *Reduce water quality impacts from stormwater discharges.*
WQ 1.2 *Update septic systems design.*
WQ 1.3 *Improve understanding of groundwater resource.*
WQ 4.1 *Reduce nutrient pollution from farming.*
WQ 4.3 *Improve management of drainage systems.*
FW 1.7 *Improve water quality in dead end canals.*

Wetlands

1. What improvement in our policy/strategy is needed to produce No Net Loss? Method of accounting is flawed due to fill-in, sea level rise, rip-rap, and other factors. We legally allow people to fill wetlands.
2. We are doing an ineffective job delineating wetlands, we must accurately identify where they are located.
3. There is no consolidated means to track loss of existing wetlands.

FW 3.1 *Conservation of wetland resources.*
FW 3.2 *Improvement of staging, wintering, and nesting areas.*
FW 3.4 *Coordination of wetlands regulations.*

Section One

Issues and Related Challenges

Maryland Coastal Bays Program

Issue – Buffers: Priority Challenge

Priority Challenge	Partner Initiatives & Activities	Current Gaps & Roadblocks	Ideas & Opportunities for Further Progress
Challenge CE 4.3 - Enhance The Buffering Capacity Of The Watershed's Tidal And Nontidal Shoreline Area. **Solution** - Promote Water Quality, Habitat Protection And Creation, Resource Conservation, And Economic Viability By Enhancing The Buffering Capacity And Function Of The Coastal Bays□ Tidal Shoreline And Portions Of The Watershed That Fall Within 1,000 Feet Of The Tidal Waters' Edge Or The Landward Edge Of Adjacent Tidal Wetlands.	**Moderate progress has been achieved on this Priority Challenge.** • WC Department of Comprehensive Planning presented the Stakeholders Committee's Recommended draft Isle of Wight Subwatershed Plan to the WC Commissioners on August 21, 2001. • Recommendations of the draft Plan in summary form are: Existing Lots and Land Uses - provide specified exemption areas in the designated Development Areas and to grandfather existing legally recorded lots in subdivisions, and existing legal land uses. Land Use Classifications - the land in the subwatershed is divided into the following categories: Development Areas, Transition Areas, and Resource Use and Conservation Areas. Reducing Development Impacts - conservation subdivision design can be used to reduce negative impacts on water quality from development and should be incorporated into the site planning process for all new development. Stormwater management shall be designed per the "2000 Maryland Stormwater Design Manual". Habitat Protection Areas - this plan establishes a buffer of 100 feet on both sides of all tidal waterbodies and wetlands from human disturbances. Further it provides for protection of nontidal streams through buffers and other alternative methods providing for biological cleansing. Forests shall be maintained and increased. Habitats of threatened and endangered species shall be avoided. Important plant and wildlife habitats shall be protected. Water Dependent Facilities - New or expanded development activities may be permitted within the buffer in development areas and transition areas under certain conditions. Public beaches, recreation and education areas may be permitted in the buffer in development areas. Any new marina construction of improvements to marinas shall be carried out in accordance with BMPs. The county should consider providing incentives for developers to establish community piers in subdivisions.	• Contention around single family exemptions and lack of mitigation. • Public information meeting during latter part of September 2001. • Creation of draft codification by the County Attorney and staffs, which is underway. • Public hearing of proposed legislation. • Legislative enactment of draft codification into law by Worcester County Commissioners. • Interim standards for the remaining 4 watersheds.	• Coastal Bays Watershed protection should go beyond the 1,000 feet Critical Area of Chesapeake Bay type program. • Even though the Stakeholder Committee's recommended draft plan is more comprehensive than the Critical Areas Law, it does not address the impacts associated with existing, developed lots. BMPs and retro-fits to existing lots should be investigated.

Issue – Buffers: Priority Challenge

Priority Challenge	Partner Initiatives & Activities	Current Gaps & Roadblocks	Ideas & Opportunities for Further Progress
CONTINUATION **Goal 4** - Enhance The Level Of Sustainability In Land Use Decision Making. **Challenge CE 4.3** - Enhance The Buffering Capacity Of The Watershed's Tidal And Nontidal Shoreline Area. **Solution** - Promote Water Quality, Habitat Protection And Creation, Resource Conservation, And Economic Viability By Enhancing The Buffering Capacity And Function Of The Coastal Bays' Tidal Shoreline And Portions Of The Watershed That Fall Within 1,000 Feet Of The Tidal Waters' Edge Or The Landward Edge Of Adjacent Tidal Wetlands.	Measures to Reduce Shoreline Erosion - riparian areas that are excessively eroding should be stabilized, preferable, with soft stabilization methods. Agriculture - Existing farmland with the Coastal Bays Protection Area should remain in agriculture. BMPs for control of nutrients, pesticides and sediment should be used to minimize the adverse effects on plant, fish and wildlife resources, and enhance water quality. Agricultural activities are permitted within the buffer as long as, at a minimum, either a farm management and nutrient management plan is in place or a 25-foot vegetated filter strip is maintained between such activities and any body of water. Surface Mining - measures must be used to minimize negative impacts of surface mining on the Coastal Bays Protection Area. Protected Natural Areas - the county should identify areas with the Coastal Bays Protection Area where protected natural areas could be established. Such establishment should take place through acquisitions, easements, designation or any other appropriate means. Wastewater Treatment - wastewater treatment has been the impediment to concentrated growth in areas beyond central sewer service areas. Additionally, on-site septic systems have resulted in groundwater pollution problems due to inappropriate locations, improper design or poor maintenance. To address these issues this Plan recommends that central sewer service be implemented to serve the majority of anticipated growth in the Isle of Wight subwatershed. Monitoring - the Plan's effectiveness can be judges by water quality monitoring. The county should continue to work with the Maryland Coastal Bays Program to implement the CCMP's volunteer and standard monitoring program. Restoration - opportunities for restoration projects should be identified and pursued as resources become available. Coordination With Delaware - because the Isle of Wight subwatershed spans the border between Maryland and Delaware. The county should cooperate and coordinate with agencies and organizations within Delaware to identify cross border problems and solutions in the subwatershed. Variances - a process to vary or waive the provisions of this Plan should be established for situations which may arise.		

Maryland Coastal Bays Program

Issue – Buffers: Associated Challenges

[redacted]

Challenge	Description	Priority	Draft Measure of Progress	Implementation Status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
WQ 2.2	Improve stormwater quality from existing development	High	Build new or retrofit SWM devices in existing developments and municipalities.	Some	New development and re-development will now be required to meet water quality criteria for SWM in OC and in new RPC in the County. Permits will require inspection and a routine maintenance program. Best Management Practices will be utilized to encourage bioremediation prior to discharge.	Participated in stormwater workshop, investigating low impact designs, comments on development, addressed Link Deposit Program with area banks.	County and municipalities are reluctant to borrow funds to implement NPS controls. Banks are resistant to Linked Deposit Program due to the red tape involved. Approach the Office of Smart Growth for help with Linked Deposit. Need to identify the target audience and advise them of incentives that are available.
WQ 6.1	Improve efficiency of sediment and erosion control program	High	Use an integrated enforcement strategy and expand use of vegetative buffers to reduce loading and turbidity from development.	Full & Ongoing	WC has taken on sediment control enforcement authority as a major step toward controlling sediment-laden runoff from development at the local level. MDE has approved the delegation of authority and will re-evaluate WC every two years. New stormwater regs promote environmentally sensitive design measures that provide incentives for the creation of buffers and natural conservation areas to help reduce the volume of runoff that needs to be treated.	MGS provided maps and discussion at CAC meeting	We have implemented a strategy and must now determine how well it works. What are the indicators of measurement?
WQ 6.2	Reduce Shoreline Erosion Rates	High	Limited shoreline development and soft shoreline protection methods in highly erodible areas.	Substantial	MDE using its Standard Operating Procedures. Shoreline changes have been mapped and erosion rates calculated for northern coastal bays. Southern bays on target for Oct, 2000. WC will form a local workgroup to coordinate with the newly established MD Shore Erosion Task Force charged with developing a comprehensive plan for prevention of shoreline erosion. MDE, ACOE and WC will encourage alternative wetland designs for new shoreline stabilization sites. Isle of Wight (IOW) project will stabilize substantial linear distance of eroding shoreline. Project planning underway. Construction initiated Fall, 2000. RFP sent to WC for stream restoration project funding. Future RFPs will be sent. Stream Corridor Assessment Survey completed for Isle of Wight; this will help identify potential restoration projects.	Provided comment and supported SATF recommendations. Liaison for homeowners looking for options. $13,000 grant for St. Martin assessment. Public education via speeches, newspaper, TV. Maps provided by MGS and presented at CAC meeting. When staff is trained and software installed, maps will be available for the public.	CCMP should say "manage shoreline erosion" in place of "prevent shoreline erosion". Final report of MD Shore Erosion Task Force has been issued. Need to deliver digital data for southern coastal bays to GIS. Shoreline Erosion State Task Force work is completed. WC staff time for implementing committee work at this time is limited. Need examples of where soft shoreline protection has been implemented, what are the incentives, and how it is being encouraged. Need to expand the public presentations of the shoreline changes.

Maryland Coastal Bays Program

Issue – Forestry: Associated Challenges

Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments
FW 2.1	Improve Songbird Populations and Forest Habitat	**TBD**	Determine the extent, spatial distribution and composition of forested habitat needed for neotropical and migrating birds.	Minimal	Actions are to be focused upon during phases 2 and 3 of the program, however, it needs to be pushed forward. Anecdotal evidence suggests that private lands in WC are currently in the harvesting phase of its cyclic forest products industry. Large tracts of older stand, mixed hardwood/pine forest are being clear-cut and replaced by monocultures of loblolly pines. The forest service has a new arsenal of suppressive spray which targets red maple and sweet gum trees, while allowing oak and tulip poplar trees to grow. Landowners can elect to use this herbicide when they sign up for spraying.	Continue to educate through newspaper articles, the importance of large tracts mixed woods for all interior dwelling species.	Actual harvest data is needed in place of anecdotal evidence. Because the recreational, aesthetic, and habitat values of old growth forests are economically undervalued, there is little incentive for private landowners to not harvest these stands and replant with pine monocultures. Need a task force to develop a strategy.
FW 2.2	Conservation of Forests	Medium / High	Develop a comprehensive county forest conservation strategy.	Minimal	CZM grant funds the staff for this project. Working on forest mitigation banking, pre-development, small area planning, mapping to aid implementation of FC law. The county has a draft code for forest mitigation banking as a permitted alternative to on-site protection of forest. Mitigation will be required in same watershed where loss occurred. WC is also working on using Fees-in-lieu.	$4,000 Bird Hill minigrant, $9,000 Poultry litter in pine forests grant, support for 1999 adjustment of mitigation fees (letter). Work with county, state and Ocean Pines foresters on forest mitigation and other projects. 1999 Daily Times column and public education. Strongly opposed clear-cutting on the Riddle Farm.	It is a challenge to protect large contiguous blocks of forest through this program because of other site plan requirements. Comprehensive Planning Dept working on this issue. Worcester County should hire a full-time land protection specialist to take advantage of land protection opportunities that are available (i.e. Rural Legacy, Greenprints, etc.)

Maryland Coastal Bays Program

Issue – Forestry: Associated Challenges

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments
FW 2.6	Conversion and Use of Forested Land	Medium	Provide economic incentives and improved management strategies that decrease conversion of forestland.	Minimal	MD Forestry Task Force Recommendation 9. Ongoing coordination with MDA forest Pest Management section to identify and control insect and disease, which includes IPM practices, silvicultural recommendations, species selection.	$9,000 Poultry litter in pine forests minigrant. Citizens Watch group being developed and educated. Public education.	There is a need to build broad legislative support for task force recommendations. Alternative pest control methods and progress need definition.

Maryland Coastal Bays Program

Issue – Measurements of Success (Metrics): Priority Challenges

[redacted]

Priority Challenge	Partner Initiatives & Activities	Current Gaps & Roadblocks	Ideas & Opportunities for Further Progress
Challenge RN 3.1 - Reduce Resource Impacts From Water-based Recreational Activities. **Solution** - Identify Sensitive Resources And Incompatible Recreational Activities. Develop Protection Mechanisms And Educate The Public To Reduce Damage To And Disruptions Of Sensitive Resources And Personal Property.	Moderate progress has been achieved on this Priority Challenge. • The Sensitive Areas Task Force has created a map of sensitive resource locations. The technical task force is working on finalizing mapping to identify priority areas of sensitive resources. These are scheduled to be mapped in September 2001. Initial efforts to identify and locate aquatic threats have been completed. Efforts are underway to create a ranked map. • The identifying of outstanding research/information needs related to recreational activity effects on natural resources is an on-going activity. An initial list of gaps has been created as part of the draft task force report and the ranking matrix. • Protection mechanisms used in other areas have been investigated and some found to be very controversial. • A formal request has been developed for designating the Maryland coastal bays as a federal No-Discharge Area under Clean Water Act Section 312. This first draft has been sent to EPA. • To develop specific protection measures, the Sensitive Areas Management Committee is currently being formed. Resource maps are being created. This activity will tie in with the Fishery Management Plan, the Navigation and Dredging plan, and the Boating Safety plan. The Sensitive Areas Management Committee will consider such issues as resource sanctuaries, types of use zones, sensitive habitat areas, catch-and-release fishing, time-of-year restrictions, and public education campaigns. To enhance public awareness of resource protection issues and needs, the actions have been completed: 6 newspaper columns, 30 newspaper articles, size & creel brochures distributed, snapshots of the week in local newspapers, newsletters, 4 TV appearances, tip cards (4000 distributed), PWC pamphlet distributed. The Coast Guard auxiliary uses coastal bays program resources during annual boat inspections (stickers, brochures, tip cards).	• We have not gotten down to the management actions to protect the sensitive resources. The Sensitive Areas Committee needs to complete mapping work before the Management Committee can begin. • In order to identify priority sensitive resource areas, it is necessary to map the resource rankings. This requires converting the current polygons in GIS to a matrix. Funding has been found to move this forward. • Some protection mechanisms used in other parts of the country are very controversial. • The development of protection measures specific for application in the coastal bays is waiting for information from maps and management committee recommendations. • Better timing with DNR as regulations change is needed for the publicizing of fishing size and creel limits.	• For publicizing fishing size and creel limits in popular land-based fishing areas and by boat launch facilities, 100 signs and 20,000 brochures showing size and creel have been distributed annually since 2000.

Maryland Coastal Bays Program

Issue – Measurements of Success (Metrics): Priority Challenges

Priority Challenge	Partner Initiatives & Activities	Current Gaps & Roadblocks	Ideas & Opportunities for Further Progress
Challenge CE 2.3 - Enhance Natural Disaster Planning. **Solution** - Modify Codes And Policies Within The County So Communities Are Designed With Safety Features That Protect Them From Coastal Hazards And Minimize Economic Loss.	**Some progress has been achieved on this Priority Challenge.** • Emergency plans flood hazards, natural disasters, flood mitigation, fire and emergency response times exist. Hazard mitigation plan being updated by WC Emergency Services department. • Bill has been drafted to amend code for local floodplain ordinances to require one foot of freeboard above the 100-year floodplain elevation for development in tidally influenced floodplains. • DNR has provided WC with general sea level rise technical information and offered technical assistance. • OC development codes are continually reviewed by staff. Amendments are made when necessary. The International Building Code and the new Maryland Stormwater regulations have recently been adopted by OC. • Roadway corridor plan for Route 50 completed, Route 611 corridor easement acquisition underway, Route 589 plan underway. • For individual business and community disaster plans, OC has annual public awareness efforts, dissemination of educational materials, and education of condominium groups. • Response plans exist (MDE, fire companies) for gas & oil spills, floating tanks, septic damage. • For regional evacuation planning, the Delmarva Emergency Task force meets regularly. They concentrate on the regional aspects of emergency management and evacuation. The OC Emergency Management Plan was last updated in 1998, next update due out in winter of 2001-2002. This will be reviewed by MEMA and FEMA and will also include an evacuation plan.	• There appears to be no plans for environmental hazards mitigation and minimization. Need to examine the plans from WC, OC and MDE. • WC has asked to defer the action of adopting regs that minimize National Flood Insurance Program incentives for building and rebuilding in floodplains. • Determining appropriate code changes to address sea level rise and erosion problems is considered low priority at this time. • Public perception is that everything is fine. Reality is that the Coastal Hazard plans need in-depth discussion. • Current regulations allow people to fill their way out of the floodplain. This puts the stormwater and flood tide burden on their neighbors. • Insufficient capacity of shelters for locals using the current evacuation announcement scheme. • The issue of flooding may not be as fully addressed as the issue of hurricane winds in existing evacuation plans and floodplain regulations.	• FEMA and MEMA need to be given more specific inputs from the MCBP. • All shelters must be capable of withstanding full hurricane winds. • Evacuate tourists first to their home locations. This will allow sufficient room in the shelters for locals.

Maryland Coastal Bays Program

Issue – Measurements of Success (Metrics): Associated Challenges [redacted]

Challenge	Description	Priority	Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
WQ 3.1	Improve Understanding of Atmospheric Deposition of Nutrients	High	Identify atmospheric sources and actions to decrease these inputs.	Moderate	NADP monitoring at Assateague State Park and National Park. Both county and Ocean City are experimenting with biodiesel fuel. Tri-county bus system has been initiated. New park and ride facility located in West O.C. There has been discussion of a Berlin-O.C. bus route.	MCBP helping to fund air deposition study. Seeking additional information regarding regional nutrient sources through existing EPA studies. Support for OC Park and Ride, succeeded in use of biodiesel as an alternative fuel. Work with county, state and regional efforts for air deposition studies. Public education via TV and newspaper.	Will take several years for significant results and trend analysis.
WQ 5.2	Improve Understanding of Tertiary Sewage Treatment Needs	High	Determine adequacy of existing systems and implement corrective actions as necessary.	Moderate	TMDL is being established for the Northern Coastal Bays, with other bays to follow. Six out of seven (86%) permit applications for spray irrigation systems were permitted. NPS proposing to release effluent into man-made wetland rather than into the bay as it is currently.	Involved in TMDL discussions. Supportive of innovative uses of treatment (Living Cell) and traditional upgrades (Perdue Showell plant).	Determine where the six approved spray applications are located.
FW 1.1	Accurate Fish Harvest Information	High	Funding secured to implement ACCSP recommendations and collect economic information to support fishery management decisions.	Moderate	Surveys of local, recreational fishermen given low priority. Voluntary surveys are going on. Funds being allocated for pilot study that conforms to ACCSP guidelines. Determining applicability of VIMS data collection methods. A daily logbook reporting system was implemented in WC in June 2000 as a pilot survey for MD. This survey is consistent with ASMFC recommendations, and if successful, will be expanded statewide.	Support and assist with DNR, MSSA and others with data collection efforts. Recreational boating survey revealed percentage of boaters fishing. Education and outreach on importance and need for good data.	Recreational fishing has a larger impact to the local economy than commercial fishing. Education of, and support by local communities would benefit licensing initiative. Saltwater or coastal bays fishing license will require legislative support.

Maryland Coastal Bays Program

Issue – Submerged Aquatic Vegetation: Priority Challenges [redacted]

Priority Challenge	Partner Initiative & Activities	Current Gaps & Roadblocks	Ideas & Opportunities for Further Progress
Challenge FW 1.6 – Seagrass protection and expansion. **Solution** – Identify, protect, enhance, and promote natural recovery of seagrass beds in order to improve water quality and fish habitat.	Substantial and on-going progress has been achieved on this Priority Challenge • Aerial photographs have provided recognition of problems and guidance in the development of methods to identify impacts. Benthos studies have begun as part of Coastal 2000 monitoring. • The first year of a 2-year study to determine the recreational impacts to SAV is complete, and will be ongoing. Recommendations are being drafted for the development of SAV setbacks, buoys to mark beds and public education. • Legislation passed in 1998 to protect SAV beds from impacts by clam dredging. As a result clammers have received education and NRP has increased enforcement efforts. • The Coastal Bays SAV Habitat taskforce has been formed to define habitat requirements, and are investigating PWC prohibition proposal. A study during 2001 concludes that damage to SAV from Jet-ski propulsion effects are depth related, and best addressed by marking avenues/channels to deeper waters.	• Techniques to quantify spatial extent of impacts yet to be completed. Currently underway, however, the completion date is unknown. All information to date is related to SAV impacts only. Data and techniques do not currently exist to evaluate impacts to benthic organisms. • Natural, inter-annual variations in SAV populations make firm conclusions difficult in a 2-year study. Funding opportunities are being explored to further the study period. • The current legislation is cumbersome and lengthy to implement. Funds not available to adequately mark presence of SAV beds. Revised legislation was proposed but defeated in 2000 and 2001. • There have been extreme difficulties in getting technical experts together to work on this effort. Identification of areas for restoration cannot occur until habitat requirements are identified. Monitoring, however, has been initiated.	• Revised legislation will likely be reintroduced in 2002.

Maryland Coastal Bays Program

Issue – Submerged Aquatic Vegetation: Priority Challenges

Priority Challenge	Partner Initiatives & Activities	Current Gaps & Roadblocks	Ideas & Opportunities for Further Progress
Challenge RN 5.2 - Increase Public Awareness Of Resource Protection Needs. **Solution** - Produce "Guide To The Coastal Bays" To Improve Recreational Activities And Protect Natural Resources.	Minimal progress has been achieved on this Priority Challenge. • Have begun to gather information for the "Guide To The Coastal Bays" project. Activity is centered on developing the lead-in information and material.	• The activities of this Challenge will be combined with six other Recreation and Navigation actions to accomplish all the action items in one concentrated activity plan. • During the current year, the team for this action has been waiting for NADAG and the Sensitive Areas Task Force to complete their drafts so that they could be incorporated into the "Guide To The Coastal Bays". • DNR will be doing most of the production of this publication, with MCBP staff providing much of the information and writing. The actual map will be done by DNR.	

Maryland Coastal Bays Program

Issue – Water Quality: Priority Challenges

Priority Challenge	Partner Initiative & Activities	Current Gaps & Roadblocks	Ideas & Opportunities for Further Progress
Challenge WQ 1.1 – Reduce failure rate and inefficiency of on-site wastewater treatment. **Solution** – Develop incentives, advanced technologies, and pretreatment options to mitigate failing or antiquated wastewater treatment systems and to properly maintain existing systems.	**Some progress has been achieved on this Priority Challenge**		
	• SEPTRAC software has been purchased and installed to convert the approximately 10,000 paper septic files to electronic files. When complete, this program will enable the county to notify homeowners when it is time to have their septic pumped and assess potential water quality impacts at the subwatershed level.	• Lack of time and staff familiar with the paper files has impeded the conversion of files. To date only 500 files have been entered. GIS capabilities are available and GPS (equipment is on order), will be used to groundtruth private systems. SEPTRAK grant expires Sept. 30, 2001.	• Funds are available until September 30, 2001 to hire a temp agency to complete SEPTRAC data entry.
	• County brochure is available regarding the installation and maintenance of On-Site-Disposal-Systems, it promotes regular maintenance as a cost efficient option to improve nutrient removal.	• It is difficult to promote pre-treatment unless WC has regulation. SEPTRAK must be used to define the contact audience.	• County brochure and newspaper inserts could be provided to septage haulers to leave with homeowners during routine maintenance calls.
	• A request for proposals for a consultant to draft the "Area of Special State Concern " (ASSC) plan, has been prepared and approved. Two bids have been received and are currently under staff review.	• Draft to be completed by the end of 2001. Cost-share programs will be addressed. Funds for retrofits to failing systems are available, with 3-10 applicants receiving help each year. The state "Linked Deposit" program is in place, however, it is not embraced due to the cumbersome paperwork.	• Need revision of the Septic Management Areas to reflect soil characteristics.
	• Production of a newspaper insert entitled "Maintaining Your Septic System" which details the function, maintenance, and signs of failure, in addition to groundwater considerations and conservation measures.		
	• Development of a continuing education course for developers and real estate professionals regarding environmental regulations and permits. Septic siting and maintenance issues are included.		• Septic systems owners could be assessed an EDU to help maintain septage receiving facilities.
	• Worcester County is investigating the feasibility of a central septage receiving facility to be located at the landfill.		

Maryland Coastal Bays Program

Issue – Water Quality: Priority Challenges

Priority Challenge	Partner Initiative & Activities	Current Gaps & Roadblocks	Ideas & Opportunities for Further Progress
Challenge WQ 2.1 – Reduce water quality impacts form stormwater discharges. **Solution** – Ensure that (1) new stormwater management devices are designed to address water quality as well as flood control needs, (2) impacts to on-site wastewater treatment systems on adjacent properties are considered, and (3) the cumulative impact of runoff from many small properties is treated.	**Substantial progress has been achieved on this Priority Challenge**		
	• Stormwater Design Manual and State Regulations became effective in August 2001.		• Identify priority areas for stormwater management retrofits throughout the watershed. Federal and State funding is available. MCBP or local government could consider providing cost-share funds or grants.
	• A workshop was convened to provide guidance for the new Stormwater Management Regulations and to discuss how Low Impact Design can affect development plans.		• To encourage multiple resource development, a regional stormwater brochure could be developed when all parties have finalized their ordinances. The benefit would be to educate and streamline the permitting process.
	• TMDL development for the Northern Coastal Bays incorporates the impact of stormwater.	• Final loading allotments to be released by the end of 2001.	• Future plans are to continue speaker series on design standards. Particularly those which incorporate innovative methods to achieve best management practices.
	• Residential stormwater impacts continue to be addressed via newspaper article, newsletters, Homeowners Guide, Isle of Wight sub-watershed plan, and speaking engagements.		• New areas and ways to promote wetlands and habitat will be investigated.
	• Riparian buffers and preservation of existing stream contours were promoted during the Streamwaders 2001 survey. The feasibility of constructing wetlands is demonstrated on the Wetlands Window CD.		
	• Demonstration bioretention project to be installed in Captain's Hill. Survey has been completed and construction will begin soon.		Fire districts could be realigned in areas that do not need the larger fire trucks, which require wider road standards. Coordination with Fire marshals would be conducive to achieving this.
	• Modifications have been made to road widths to decrease impervious surfaces.	• New ordinance applies to Residential Planned Communities only, it does not apply to any other development.	

Maryland Coastal Bays Program

Issue – Water Quality: Associated Challenges

Challenge	Description	Priority	Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
WQ 1.2	Update Septic System Designs	Medium	Watershed "Area / Special Concern" better manage onsite sewage disposal systems	Substantial	"Area of Special State Concern" designated, bid proposals are currently under staff review. Fees eliminated for innovative systems. Grant approved for updating groundwater protection report. Staff is working on revising Water and Sewer Plan. Targeted completion date is early/mid 2001. NPS submitting plans for effluent discharge to wetland.	Supported and commented on master water and sewer plan amendments. Septic education via newspaper inserts, brochures, CAC, and continuing education course. Plans are to provide a workshop for area policy makers regarding wastewater options.	The water and sewage plans will be revised early /mid 2002 to accomplish sand line trench guidelines and 60 minute percolation tests. Need to expand and grow MCBP relationship with UMCE.
WQ 1.3	Improve Understanding of Groundwater Resource	Medium	Define types, sources, spatial extent and degree of contaminants. Educate public.	Substantial	Identified 19 streams and did test samples, drilled and developed 28 shallow ground-water wells. Geophysical logging completed on all wells in March 2000. Identifying abandoned wells to extent possible. A two-year study funded by USGS and NPS will begin in Oct. 2001, to measure groundwater input in regards to land-use. Geology characteristics and nutrient loading rates will guide land management plans. A third study, initiated during the Summer 2001, will measure shallow bay sediment geology and groundwater via resistivity measurements.	Funded USGS groundwater study. Report due in Sept. 2001 Funding second USGS/NPS study. Education and outreach efforts - Homeowners Guide, Daily Times article on groundwater, newspaper insert on groundwater et., Public speeches (83)	Pursuing alternative means of locating/defining direct ground water discharge to the southern Coastal Bays. Remaining tasks include ID of direct bay-fed ground-water discharge patterns, data interpretation and report production. Need info on which abandoned wells have been identified and how many have been sealed. There is a significant need to fund and examine groundwater characteristics of the northern Coastal Bays.

Maryland Coastal Bays Program

Issue – Water Quality: Associated Challenges

Challenge	Description	Priority	Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
WQ 4.1	Reduce Nutrient Pollution From Farming	High	Increase financial, educational, and technical resources necessary to assist farmers in nutrient reduction.	Moderate	1 public hearing on PLTP regs, 2 public hearings on nutrient mgmt regs, PLTP presentations at DPI mtgs and local ag venues, PLTP brochures created for growers, articles in local papers. Cover crop program, WAIP, CREP. Investigating pelletizing and manure burning plants being proposed and impact on the CB watershed.	Speech to DPI and Farm Bureau. Support MDA and NRCS efforts for nutrient mgmt planning. Information to public on positive changes farmers are making via Daily Times column and "Ask the Expert" TV show. Attended grand opening of pelletizer plant, supporting manure-burning facilities. CAC Ag Subcommittee formed to further dialog with farmers.	Difficulty in measuring success in achieving action since PLTP voluntary, nutrient mgmt regs not finalized and deadlines will not require specific actions until Jan 2002 and July 2004. Co-permitting regulations are in-place and are being challenged. How will their effectiveness be measured? Challenges 4.1 & 4.2 may need to be rewritten to support what MDA is doing. Is the transportation of manure out of the watershed working effectively? How is the effectiveness and success of these state actions being measured and tracked regarding nutrient loads into the watershed?
WQ 4.3	Improve Management of Drainage Systems	High	Comprehensive approach to reducing impacts of agricultural ditches.	Some	PDA Task Force Report completed and discussed at Jan. 2001 I.C. mtg MDA received EPA funding for 2001 ($100,000)	Funded SCD minigrant. 83 speeches discussed nutrient transport w/o filtering. Support county, NRCS, MDA, SHA, and MDA on ditch conversions and improved management. Need to determine which BMP's are being adhered to. Also need to encourage coordination and education/training among SHA, WC, and farmers.	Some eligible PDAs unable to provide funding match. Control structures are blocking fish migration. The Delaware investigation perhaps gave us some insight but due to its limited time span and sampling procedures did not prove effective in answering our questions. Birch Branch construction was just completed and for us to learn, data must be collected for at least 5 years under variable conditions. There is a need to retrofit sub-divisions which were established prior to the new SWM regs.

Maryland Coastal Bays Program

Issue – Wetlands: Priority Challenge

Priority Challenge	Partner Initiative & Activities	Current Gaps & Roadblocks	Ideas & Opportunities for Further Progress
Challenge FW 3.1 – Conservation of wetland resources. **Solution** – Protect existing and new wetlands and increase the amount of wetlands by 10,000 acres in order to improve water quality, replace lost function of wetlands, and improve habitat for living resources.	**Some has been achieved on this Priority Challenge.** • A list of private wetlands that have been restored has been compiled and mapped using GIS technology. • Ocean Pines Saltmarsh Restoration Project was initiated in July 2001. Plans and specifications design for the Isle of Wight Saltmarsh Restoration Project are underway. • Demonstration bioretention project to be installed in Captain's Hill within the Isle of Wight. Staff positions have been created to coordinate stormwater, sediment, and erosion control issues. • Wetlands Planning Group brings agencies together to discuss wetlands issues and determine the strategies and resources for addressing them.	• Plans are being developed which will provide the most saltmarsh creation with the least impact to SAV beds • Considerable coordination with state agencies will be imperative to make significant progress. • Staff shortages may be the largest obstacle for creating, delineating, and assessment of wetlands. There is currently no way to measure the cumulative loss of small wetlands within the watershed.	• Determine the status of the list and circulate along with possible grant opportunities. • Existing SAV may need to be transplanted. This would provide an avenue for education, outreach, and community involvement. • Creation of a working group could coordinate needs and opportunities. Issues pertaining to wastewater, stormwater, sediment control, and bioretention areas could be addressed throughout the watershed. • A No Net Loss policy could be drafted to incorporate zoning and mitigation language.

Maryland Coastal Bays Program

Issue – Wetlands: Associated Challenges

Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments
FW 3.2	Improvement of staging, wintering, and nesting areas	High	Identify and protect critical habitats to promote healthy and diverse waterfowl, waterbird, neotropical songbird, and migrant butterfly populations.	Minimal	Habitat needs for waterfowl and water bird species are currently available through the USFWS website.	Public education via articles, promotion of wetlands initiatives, opposition to loss of wetlands.	Due to staffing and funding limitations, minimal progress has been made on this action. Old Growth forests desperately need protection. Time limits for grandfathering clauses are being developed for the permitting process.
FW 3.4	Coordination of Wetlands Regulations	Low / Medium	Evaluate if state and federal programs are being carried out in accordance with existing laws and regulations. Identify methods that reduce disturbance.	Minimal	Action is dependent on regulatory evaluation and conservation plan. The Coastal Bays will be a priority in the development of the statewide wetland conservation plan. MDE will include the evaluation of the implementation of state and federal laws in its application for a Wetlands Development Grant of $50,000 from EPA.	Participate and assist wetland-planning group.	Requiring wetlands delineation for minor subdivisions may be unnecessary burden. To address issue, DRP working on text amendment to increase minimum buildable area allowed per lot. Need a policy change with set criteria at the county level and better dialog between county and state. Delineations could be required by using a % hydric soils and/or by viewing historic maps. Landowners can go to regulatory agency first to see if a wetlands delineation "may be" required and, if they indicate "yes," then get one before coming to the County Planning Commission with their plans.

MARYLAND COASTAL BAYS PROGRAM

Section Two

Other Challenges

Maryland Coastal Bays Program - Water Quality
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

GOAL 1: Decrease Nutrient Inputs To Groundwater From Residential And Commercial Land Uses

Challenge	Description	Priority	Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
WQ 1.4	Reduce Excessive fertilization by turf professionals	Low	Require grounds management professionals to implement nutrient management plans and apply nutrients only as necessary.	Some	UMCE has completed recommendations for commercially managed turf grass that have been incorporated by reference into nutrient management regulations. Workshops on nutrient management have been targeted to grounds keepers, feature articles in industry publications. Grant funds are available to reprint these guidelines. Salisbury University conducting a survey of golf course managers.	Addressed Delmarva Greenskeepers, Supported and assisted UMES grant application to investigate nutrient application on golf courses in the watershed.	Method for tracking the voluntary compliance is needed.
WQ 1.5	Reduce Excessive Fertilization By Homeowners	Medium / High	Educate public on lawn and garden practices that reduce contamination	Substantial	Presentations made at Delmarva Chicken Festival. Area Horticulturist including 3 hours of home fertilizing info to Master Gardener's. Master Gardener's Program held in the fall of 2000 and another is planned for the Spring of 2002. Several BayScapes projects, CBT grant, mini-grants, native plant list, newsletter, articles and homeowner guide.	Several Bayscapes projects, CBT Grant, mini-grants, native plant list, newsletter, articles, and homeowners guide. Grants to school gardens and community gardens.	Need to include emphasis on impacts from driveways and parking lots.

Implementation Key: **Full**: Implementation complete or nearing completion (75-100%), **Substantial**: Major progress has been made (50-74%), **Moderate**: Fair level of progress made (25-49%), **Some**: Progress beginning (10-24%), **Minimal**: Very limited progress (0-9%), **Unknown**: Insufficient reporting data available

Maryland Coastal Bays Program - Water Quality
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

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GOAL 2: Decrease Nutrient Inputs From Stormwater Runoff

Challenge	Description	Priority	Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
WQ 2.3	Reduce Groundwater Contamination from Roadside Ditches	Medium	Establish policy/BMP for ditch point and non-point sources. Avoid WQ protection conflict. Educate maintenance crews.	Some	District 1 currently follows Stormwater Maintenance Guidelines, now obtaining new guidelines and will update practices. Mowers set to 4 inches per 1998 guidelines. Do not encourage the mowing of wet swales. Maintaining shallow depths and small slopes depends on elevations of structures, pipes, adjacent land and the highway. Vegetative buffers are encouraged. Training program is being developed to institute new stormwater maintenance guidelines. Grant has been received to provide County employees with training, and to implement a demonstration project.	Support county and SHA on developing ditch maintenance guidelines. Assist in location and applying for funding for ditch maintenance policy. General education to public on shallow depths and small slopes via presentations, articles, inserts and HO Guide. Supported and educated about new Route 113 ditch practices.	Obtaining new guidelines. This action included county ditches. So far all comments have come from SHA. WC has many more county than state roadside ditches. Need to change focus to county. Farmers need education also. The county owns the ditches but many farmers may be doing the maintenance.
WQ 2.4	Improve Coordination of Stormwater and Septic Systems	High	Modify BMP so adjacent stormwater management devices do not impact on-site waste water treatment systems	Moderate	Separation regs in place. Already working towards better coordination with existing staff. WC addressing the issue with better coordination among existing staff and a new employee to focus on stormwater and sediment and erosion control.	Support and assist county and OC to find and fund staff. Networking with new county and municipal employees.	With new staff person and new stormwater program the county no longer feel additional legislation is necessary. Need to determine what criteria are used to determine if there is adequate distance between septics and swm areas.

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Maryland Coastal Bays Program - Water Quality
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

GOAL 4: Decrease Nutrient Inputs From Agricultural Sources

Challenge	Description	Priority	Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
WQ 4.2	Improve Efficiency of Fertilizer Application Rates	Low	Take greater advantage of recent technological advances.	Moderate	EQIP priority 100,000 +. Met with John Tyndall (Tyndall Equipment) Takes 3-5 yrs to collect data to get an avg; need computer and take samples and cost $20/acre/yr to set up. About 2% of farmers beginning process. Applications for precision farming dominated years1998 and 1999. In 2000 all successful WC bids were for the second BMP eligible under the program - water control structures. It is estimated that to fully fund this practice for the Coastal Bays area would require $854K under the EQIP five-year program. Co-permitting regulations are in-place and will serve as an added regulatory enforcement mechanism.	Funded "Poultry Litter in Forests" minigrant. Investigate precision farming technologies and applicability to the future. Educate farmers and public on funding mechanisms to assist.	Problems with money, education and economy. EQIP is a good program. Farmers interested but still several years away from implementing. Costs will be a factor when equipment will be needed. $10K to $250K to retrofit existing equipment, more to purchase or lease. Tyndall recommended cost share from govt in 3 to 5 yrs when farmers will be prepared. Revisit in 3 years. No other funding sources are presently available. Most of the county farms are small and contracted out for fertilizer application. Better management could be achieved by getting the contractor the necessary information, not by attacking the more costly project of getting each farmer to own GPS systems. Most farmers are using the same contractor. The concerns reflected above need to be addressed.

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Maryland Coastal Bays Program - Water Quality
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

[redacted]

GOAL 5: Reduce Nutrient Inputs From Point Sources

Challenge	Description	Priority	Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
WQ 5.1	Re-use More Wastewater	Medium	Encourage wastewater reuse and sludge application as appropriate.	Some	EPA sludge letter has been sent to all applicants.	Support for Berlin, Mystic Harbor and county efforts with spray irrigation and application. Funded grant to monitor effluent in local river.	Determine if MDE has addressed WQ 5.1.3 to Worcester County's satisfaction. During the next couple of years, we need to determine where it is being applied and the cost of it. Also need to learn the fate of restaurant grease.

Implementation Key: **Full**: Implementation complete or nearing completion (75-100%), **Substantial**: Major progress has been made (50-74%), **Moderate**: Fair level of progress made (25-49%), **Some**: Progress beginning (10-24%), **Minimal**: Very limited progress (0-9%), **Unknown**: Insufficient reporting data available

Maryland Coastal Bays Program - Water Quality
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

GOAL 7: Decrease Inputs of Toxic Contaminants

Challenge	Description	Priority	Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
WQ 7.1	Reduce Runoff of Toxic Chemicals	Low	Increase the use of BMPs on commercial and residential properties and in state-run programs for gypsy moths and mosquitoes	Substantial	Homeowners guide published. Newsletter, article, presentations done. CAC investigating mosquitoes and gypsy moths and producing report. MDA fully knowledgeable of bio-control option for gypsy moths. Use of biological mosquito larvicides has more than doubled. Stocking of storm water ponds with mosquito fish continues. Aerial application reduced to public health threat only. MDA's "SWARM" brochure direct-mailed to 7,000 residents of Ocean Pines. Additional mailings will be targeted to residents of Berlin and Snow Hill in September. MDA gave presentation of gypsy moth and mosquito control to Implementation Committee. There is no aerial spraying of adult mosquitoes unless health issues occur; ground trucks spray private properties for adults only; larvacides also broadcast by plane, ground truck or boat over marshes.	HO Guide sections on alternatives, products to avoid, proper disposal, bird house design. Daily Times articles (4). Newspaper inserts. BayScapes projects contain pesticide and herbicide recommendations. Newsletter articles, Coast Day insert, including mosquito and chemical info. CAC work on mosquito spray impacts.	There are basically no viable biocontrol strategies for gypsy moths that are available for public implementation. The state program isn't designed to be used in our area. Resources required to fully implement a biological control program for mosquitoes are not available. Approximately 116 areas are sprayed by truck for adults, at the request of private property owners (50/25/25 cost share). Plane broadcast of larvacides done mainly in the spring. Ditches sprayed with larvacide throughout the season.
WQ 7.2	Better Management of Household and Farm Hazardous Waste	Medium	Reduce the use and improper disposal of household hazardous wastes	Moderate & On-going	Homeowners guide, articles, newsletter, presentations. Ocean City and Ocean Pines had community hazardous material pickup days.	Support county and Ocean Pines hazardous waste pick-up days. HO Guide sections on alternatives, products to avoid, and proper disposal recommendations. Daily Times articles (2). Newspaper inserts, newsletter articles, Coast Day insert.	Need to recognize the need for more education of the consumer on what and how to recycle - especially hazardous waste materials. The "game plan" needs revision after Program discussion with the state investigators of the county program. Need to publicize alternatives.

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Maryland Coastal Bays Program - Fish and Wildlife
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

[redacted]

GOAL 1: Increase Fish and Shellfish Species

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments
FW 1.2	Manage For Optimum Sustainable Fish Populations and Harvests Consistent With Other Goals of the Coastal Bays	Medium / High	Develop comprehensive plan for fish and shellfish populations that establishes harvest levels and protects and improves habitat and water quality.	Substantial	Formation and monthly meeting of Fishery Advisory Committee since Oct. 1999. Formed DNR Water-use Mgmt Plan Workgroup and advisory groups; (Sensitive Areas Task Force; Navigation and Dredging Advisory Group). Concept of water zoning being considered during development of FMPs and Water-use Mgmt Plan. DNR committed $300,000 to address identified issues. Additional NRP requested. Fisheries Service staff assigned to conduct surveys, analyze data, develop FMPs and coordinate Water-use plan. Limited discussions on aquaculture. Continue to delineate HSC spawning habitat.	Active participant in FAC providing funding for fisheries work and hosting fishery biologist at office. Coordinate and secure volunteers for striped bass, flounder and horseshoe crab monitoring. Provide information and education to legislature and public. Letter issued to NRP requesting additional coastal bay officers during the summer season	Insufficient data to address some of the concerns identified in CCMP. Final draft of Blue Crab FMP June, 2000. Development of Shellfish FMP draft in print. Finfish FMP will follow completion of Shellfish FMP.
FW 1.3	Maintain optimum sustainable clam and shellfish abundances	Medium / High	Prepare a shellfish fishery management plan. Research effects of hydraulic clam dredging, re-establishing bay scallops and promoting aquaculture.	Full & On-going	Shellfish FMP development began in May 2000. FMP objectives have been drafted, problem areas being identified, management options being developed. Hard clam FMP to be effective during Winter 2001. MD legislation prohibits hydraulic clam dredging in SAV. Literature review and report on dredging impact is in draft form. Final report will be complete in 2001. Shellfish monitoring efforts continue data collection and analysis. Historical Scallop data has been reviewed. DNR Fisheries Service considered habitat variables in a recent scallop re-establishment study. Report was submitted to NOAA.	FAC participation, MCBP funding for fisheries work, housing fisheries biologist. $7,000 bay scallops restoration project. Oyster gardening and restoration project. Supported clam dredging restrictions, SAV studies and $38,000 in minigrants for sea grasses. $10,000 for oyster habitat project.	Long-term funding is needed for DNR Shellfish Stock Assessment Monitoring Program. Community education is necessary.

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Maryland Coastal Bays Program - Fish and Wildlife
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

GOAL 1: Increase Fish and Shellfish Species

Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments
FW 1.4	Maintain Optimum Sustainable Crab Populations	Medium / High	Develop blue crab fishery management plan. Continue research on the crab parasite Hematodinium.	Full & On-going	Ongoing blue crab monitoring and data analysis by DNR Fisheries Service. Final Blue Crab FMP completed. Parasite Hematodinium research funding being explored. NOAA research provided. Available blue crab fishery data analyzed. Abundance of green crabs being monitored. Legislation of green crabs becomes effective Oct. 2001. DNR developing a statewide non-indigenous species mgmt plan, (including new staff position). Reproductive success of crabs has been reviewed and will be addressed in FMP.	FAC participation. Investigating funding mechanisms for research. Advertisement of plan. Funding for fisheries work. Housing fishery biologist. Terrapin Station Program. Blue Crab fact sheet in brochure.	There are funding limitations for parasite research and green crab impact research.

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Maryland Coastal Bays Program - Fish and Wildlife
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

GOAL 1: Increase Fish and Shellfish Species

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments
FW 1.5	Maintain Optimum Sustainable Finfish Fisheries	Medium / High	Develop finfish management plan that investigates stock management practices, habitat improvement and education opportunities.	Moderate & On-going	Development of Finfish FMP will follow the Shellfish plan, which is in draft form. Hard Clam FMP includes recommendations to improve habitat. Ongoing finfish monitoring and data analysis by DNR Fisheries Service. Importance of habitat to fish and impacts of habitat degradation stressed to Fishery Advisory Committee. A recreational fishing / crabbing brochure and sign specific to the coastal bays has been developed and distributed. Biological reference points and control measures discussed closely with Atlantic States Marine Fisheries Commission and Mid-Atlantic Fishery Management Council.	FAC work, MCBP money for fisheries work. Housing fishery biologist. Boater survey, Terrapin Station Program. 1999 Daily Times column on catch and release, Size & Creel signs and brochures.	Funding limitations impact habitat improvement recommendations investigations. DNR will work with MCBP to update this recreational fishing/crabbing brochure and sign information in a timely manner in future years.

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Maryland Coastal Bays Program - Fish and Wildlife
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

[redacted]

GOAL 1: Increase Fish and Shellfish Species							
Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments
FW1.8	Reduce Trash in the Coastal Bays	Low / Medium	Support "Trash-Free Bays" events and ideas that involve students and citizens.	Some & On-going	Coast Day, Isle of Wight, Canoe, Montego Bay, and Assateague Clean-ups are being conducted.	Support and sponsor several clean ups per year - Isle of Wight, Canoe, and Coastal cleanups. Education of public.	There is a concern about liability for roadside cleanups. Need more explanation of how roadside clean-up affects ditches. Need to address liability issue through state agency which handles the current roadside clean-up program that has signs placed along county roadways.

Implementation Key: **Full**: Implementation complete or nearing completion (75-100%), **Substantial**: Major progress has been made (50-74%), **Moderate**: Fair level of progress made (25-49%), **Some**: Progress beginning (10-24%), **Minimal**: Very limited progress (0-9%), **Unknown**: Insufficient reporting data available

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GOAL 2: Enhance Forest Habitats To Protect Songbirds, Other Wildlife Populations And Aquatic Resources

Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments
FW 2.4	Promote Backyard Habitats	Medium	Increase techniques and programs to improve backyard habitats unique to the coastal bays region.	Full & On-going	Master Gardener program is ongoing with high priority. MDA is working with Nurseryman's Assoc. to assure native plant stock is available. ACT held BayScapes workshop and native plant sale. USFW provides BayScapes info and seed packets. WC has native trees planted in several County parks and properties using FCA fees-in-lieu. Bird Hill Road project complete.	1998 $10,000 BayScapes grant given to South Point, 20 more planting projects completed including school projects totaling more than $10,000. All parts of the watershed have been planted. WC, Garden Club, OC, OP, Snow Hill, etc., all have done native species plantings.	Sustainability audit prepared by UMD-CP graduate students recommends a landscaping strategy for WC. This strategy needs to be implemented and incorporate native species. Kindregin property, if purchased by the County, would serve well as a passive park and forest mitigation area.
FW 2.5	Enhance Agricultural Habitats	Medium	Increase or enhance habitat on agricultural lands to protect wildlife and provide economic benefits to landowners.	Substantial	Completed 7,000 acre planning effort, 762 more acres are ready to be enrolled. EQIP, WRP, CREP. Cooperating with other groups to promote wildlife habitat.	Support and educate farmers and public on funding opportunities. Bird Hill minigrant, 1998 Daily Times column, MCBP intern and student work at NRCS.	Need to set up a volunteer program to do planting and let staff deal with new contacts. Knowledge, training, and certification an issue. NRCS deserves additional $ and staff.

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Maryland Coastal Bays Program - Fish and Wildlife
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

GOAL 4: Protect Threatened And Endangered Species

Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments
FW 4.2	Coordinate Species Protection Efforts	Low / Medium	Enhance coordination to identify threatened populations in order to retain, restore and create habitats.	Some	Acquired 2700 acres in easements via Rural Legacy. Planted 5 acres (in 2000) and 3.4 acres (in 2001) of trees with FCF monies. Working with POS to protect scenic viewshed of Rt. 611 (two appraisals completed, easement for one property being drafted.)	Support and consult on Rural Legacy, POS and LSLT activities.	Funding is available to buy property to reforest. Old growth, mixed species forested areas should be considered.

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Maryland Coastal Bays Program - Fish and Wildlife
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR 2 ACTIONS

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GOAL 5: Limit Impacts To Native Plants And Animals From Non-native And Nuisance Species

Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments
FW 5.1	Controlling Invasive/Exotic Species	Low	Reduce and control invasive/exotic species and reduce further introductions to protect native species habitat.	Unknown	DNR has established and filled a position to deal with exotic species in Maryland. BayScapes workshop addressed Purple Loosestrife as an exotic. MDE and ACOE working to remove acres of Phragmites. Legislation is in place to address green crabs.	Educated public and legislature on severity of problem. Investigating funding options with UMES and DNR. Educate and work with local nurseries. Native plants list. BayScapes projects and education. Daily Times column (3), HO Guide, minigrants, CBT grant, 1998-99 newspaper inserts. 83 public speeches.	Awaiting state task force formation. Hope to have representation from MCBP.
FW 5.2	Managing "Nuisance" Species	Low / Medium	Reduce impacts to water quality, native plant and animal habitats, and agriculture from "nuisance" species like macroalgae, resident Canada geese and snow geese.	Some	EPA has funded a 2 year study to create a management plan. Additional study is now in progress (three macroalgae surveys will be done during 2001) a workshop is planned for January 2002 to draft a strategy. This strategy will be incorporated into the management plan.	Funding investigation of macroalgae. Investigating and requesting involvement with state exotics task force. Work with local nurseries. BayScapes projects and education. Daily Times column (3), HO Guide, phrag minigrant, CBT grant, 1998-99 newspaper inserts. 83 public speeches. Newport Bay snow goose reduction work.	Relationships between eutrophication and macroalgae populations is less clear than anticipated, making evaluation difficult.

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Maryland Coastal Bays Program - Recreation and Navigation

A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR TWO ACTIONS

GOAL 1: Reduce The Amount Of Sand And Sediment Entering The Coastal Bays From The Inlet

Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
RN 1.1	Reduce Unnatural Sedimentation Due To Ocean City Inlet	Medium / High	Develop public and political support for implementation of ACOE/OCWRS recommendations related to inlet problems, long-term sand management, and habitat restoration	Full	Construction of Ocean Pines Saltmarsh Restoration Project initiated July 2001; Plans and Specification design for Isle Of Wight Saltmarsh Restoration Project underway, construction scheduled to be initiated in Fall 2001; Ocean City Harbor and Inlet Deepening Plans and Specifications design initiated in April 2001, construction scheduled for 2002; Assateague Island Short-Term Restoration Plans and Specifications completed in Summer 2001, construction scheduled for late 2001 or early 2002.		There have been no permit applications to MDE during this past year. Federal and Non-Federal funds are being budgeted in future years for construction of remaining projects. This action involves implementation of 7 separate projects: Ocean Pines Saltmarsh Restoration, Isle Of Wight Saltmarsh Restoration, Harbor and Inlet Deepening, Dog Island Restoration, South Point Spoils Island Restoration, Assateague Island Short-Term Restoration, and Long-Term Sand Management. This task was slated for Year 1 since the first project (Ocean Pines) was initiated in Year 1; however, the remaining projects are being budgeted for construction during the next 3-4 years.

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Maryland Coastal Bays Program - Recreation and Navigation
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR TWO ACTIONS

GOAL 2: Improve The Management Of Navigation And Dredging In The Coastal Bays							
Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
RN 2.1	Improve Coordination and Environmental Safeguards	High	Develop master plan to guide management of navigation and dredging in the coastal bays through an advisory group.	Substantial	Dredge material placement and beneficial use options information has been compiled and summarized; developing initial recommendations. Information on Best Management Practices has been compiled and summarized. Information on channel maintenance and responsibilities, navigational marker types and requirements, dredge material sediment testing, dredge material performance, and the permit process has been compiled and summarized; developing initial recommendations. Work sessions were held to discuss channel improvement needs. Bathymetric data collected for northern bays and Sinepuxent Bay to South Point. Preliminary information has been collected on the financing of non-federal channel maintenance. Held initial discussions of future marina locations. Developing initial recommendations Information on a range of dredging issues include beneficial use has been compiled. Established an education workgroup to select outreach materials and topics for further development.	NADAG meeting monthly to develop master plan; completed the development of education and coordination process between a number of organizations.	By doing RN 2.1, progress is also made toward accomplishing RN 5.2 First draft of the Master Plan is complete; workgroups were formed to further develop and refine recommendations. Name changed from "Master Plan□ to □Planning Guide□.

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Maryland Coastal Bays Program - Recreation and Navigation

A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR TWO ACTIONS

GOAL 2: Improve The Management Of Navigation And Dredging In The Coastal Bays

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
RN 2.1 (cont.)	Improve Coordination and Environmental Safeguards	High	Develop master plan to guide management of navigation and dredging in the coastal bays through an advisory group.	Substantial	PRELIMINARY DRAFT recommendations of the Planning Guide are: • Location of potential placement sites. • *Support for and promotion of the* beneficial use of dredged materials, including habitat restoration and creation. • Best Management Practices for dredging, including time-of-year restrictions, preferred methods, safeguards for sensitive areas, and contaminated sites management. • Channel improvements, possibility of new channels, and potential removal of shoaling in critical navigation areas. • Standards for and mechanisms to encourage marking of all existing channels and identification of responsible parties for non-federal channels. • Priority areas to improve channel markers, including □small channels□ leading to and from boat access points and the federal channel in Chincoteague Bay. • Timely updates to nautical charts. • Development of a long-range plan for scheduling/financing the maintenance of non-federal channels. • Evaluation of the need for monitoring dredge sediment quality from outside of major harbors. • Examination of performance of dredged materials placed in the coastal bays. Both physical monitoring and biological monitoring should be performed.		

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GOAL 2: Improve The Management Of Navigation And Dredging In The Coastal Bays							
Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
RN 2.2	Increase Public Awareness Of Dredging And Navigation Issues	Medium	Enhance public awareness of navigation/dredging issues and processes.	Some	Information has been collected but some gaps remain. Material must be formulated into education products.	NADAG is publicized in newspapers, TV, and radio at least 6 times per year.	The accomplishment of RN 2.2 is important to completing RN 5.2.

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GOAL 4: Improve Boating Safety In The Coastal Bays

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
RN 4.1	Improve Navigation Conditions At Route 50 Bridge and Inlet	Medium / Low	Identify and resolve safety concerns associated with navigation at the Ocean City Inlet and Route 50 bridge	Substantial	Survey of boating activity was conducted. SAR data was analyzed. No unusual or significant safety problems were attributed to this area. Navigation issues around the Route 50 bridge have been incorporated into NADAG meetings. Recommendations are expected out the end of July. The Navigation and Dredging Committee conducted a navigation analysis of the Coastal Bays channel area including the Route 50 bridge.	USCG Boating hotline published in Yellow Pages and advertised with USCG Auxiliary and local boat shops; also given to local organizations. Accident/incident information obtained; NRP and Coast Towing reports requested. No consistent problems found, will continue to monitor. Preliminary mail and intercept boat survey designs completed and published. Expanded survey due Oct 2001. SHA has determined that high profile signs on bridge approaches describing condition of current and safety warnings were not needed.	Auxiliary and Active duty forces conducted the survey. A follow-up review in 2001 indicated the same results from the survey. The only issue is shoaling. The ACOE has been engaged and beach replenishment of Assateague has been discussed. South Jetty modification project may also improve the long-term shoaling problem. This is an area that requires care and caution by boaters. Reducing current flow may be the right answer. Should/can jetskis and small rental boats activities be limited in the Inlet area.

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GOAL 4: *Improve Boating Safety In The Coastal Bays*

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
RN 4.1 (cont.)	Improve Navigation Conditions At Route 50 Bridge and Inlet	Medium / Low	Identify and resolve safety concerns associated with navigation at the Ocean City Inlet and Route 50 bridge	Substantial			Problems identified with the Route 50 bridge and inlet area included: Danger to boats and user group conflicts from fising activity on the bridge (possible solution would be to reserve one or two spans of the bridge just west of the draw span for transit by small boats including PWCs, fishing would be restricted from these spans, and some type of bumper system would have to be installed to protect the bridge supports from boat traffic.) Confusion in navigating the inlet area due to merging channels, the abundance of regulatory markers, and the speed of vessels. (possible solution would be to provide better information to the public on navigating the area and establish a minimum wake zone or 6 knot speed limit.)

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Maryland Coastal Bays Program - Recreation and Navigation

A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR TWO ACTIONS

GOAL 4: Improve Boating Safety In The Coastal Bays							
Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
RN 4.2	Reduce Conflicts Between Water-based Activities and User Groups	Medium / High	Identify and resolve recurring user conflicts and problem areas to improve boater safety and quality of recreational experience	Substantial	Part of completed and planned Boating Surveys and the Salisbury University Public Survey.	Assist, support and provide information to USCG,NRP on boating safety classes. Funded pilot Boating survey. Daily Times column. NADAG work.	Need to make recommendations when survey complete. Completion scheduled for Oct 2001.

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Maryland Coastal Bays Program - Recreation and Navigation

A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR TWO ACTIONS

GOAL 4: Improve Boating Safety In The Coastal Bays

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
RN 4.3	Increase Public Awareness Of Boating Rules and Regulations	High	Enhance public awareness of boating rules and regulations to improve boating safety and protect natural resources.	Moderate	NRP contacted the MCBP and added information to the Boating Book. Posters and brochures are at rental facilities. These materials summarize boating rules and regulations. Video for PWC safety and proper use has been made and distributed. All renters of PWC are required to take a test. Renters of other craft are required to take a test if a temporary certificate of education is needed.		Additional information may be incorporated into the Boating Book, however, this will increase the cost of production. Data has been gathered by NADAG and others. Due to staffing and budget constraints, the boater's atlas project has not been initiated. PWC video should use local specific information and material. A renter's test is needed for all boat renters, not just PWC. The Boat Renters program should be the same as for PWC rentals. The bays have become too crowded to allow the tourist lobby to prevent rental boat training. We need to do more to publicize what a Coast Guard inspection can do for a boater.

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GOAL 4: Improve Boating Safety In The Coastal Bays

Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
RN 4.3 (cont.)	Increase Public Awareness Of Boating Rules and Regulations	High	Enhance public awareness of boating rules and regulations to improve boating safety and protect natural resources.	Moderate			The topic of potential safety and resource protection problems related to boat rental facilities has not been addressed yet by the Navigation and Dredging Committee. NRP does have in place special requirements for PWC livery operators that include education of operators and guide requirements. A law was enacted in 1998 that requires all livery vessels to be in a seaworthy condition and properly equipped for the waters in which used. It also requires that the livery owner, agent or employee possess a boating safety education certificate.

Maryland Coastal Bays Program - Recreation and Navigation

A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR TWO ACTIONS

GOAL 4: Improve Boating Safety In The Coastal Bays

Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
RN 4.4	Increase Compliance With Safe Boating And Resource Protection Rules	Low	Develop additional law enforcement capability to protect sensitive resources and promote boating safety in the coastal bays.	Minimal	DNR NRP has initiated the NRP Reserve Officers Program in the coastal bays to enhance existing law enforcement efforts.		Need to define how many Reserve Officers there are at this time.

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GOAL 5: Improve Water-based Recreational Opportunities And Diversity Of Access To Coastal Bays And Tributaries

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments
RN 5.1	Enhance Recreational Access, Opportunities and Infrastructure	Medium	Enhance sustainable recreational use and public access in the coastal bays and tributaries.	Minimal	Herring Creek Nature Park, a 44 acre passive recreation facility, was completed last year. The 2000 Land Preservation and Recreation Plan includes an inventory of facilities. Recreation Dept has considered offering kayaking/canoeing trips/classes. County has acquired Public Landing marina. Draft County Comprehensive Plan will include the passive recreation in requested areas. Rural Legacy Program will protect sensitive land in these areas. County's Birding Weekend has events in these areas. Tourism Dept has received funding to do water trail/brochure for E.A. Vaughn area.	Due to lack of staff time and resources, have not been able to work with boat dealers to encourage sales of appropriate boats for desired uses in the shallow coastal bays. County brochures on recreational areas and DNR bay access guides have been distributed at Trade Shows and Sunfest.	8 state/federal parks have trails; 4 have fishing; 3 have canoe launch; 11 offer bird watching. 2 county facilities have trails; 7 offer fishing; 2 have canoe launch; 13 offer bird watching. 6 municipal parks have trails; 9 have fishing; 2 have canoe launch; 8 offer bird watching. In the Public Landing marina, 25 to 35 boat slips are planned. These plans may conflict with the original CCMP intent. County Tourism Dept is looking for technical assistance with development of E.A. Vaughn brochure.

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GOAL 6: Create Guidelines For Locating New Facilities							
Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments
RN 6.1	Reduce Resource Impacts From Marinas Due To Location and Design	Medium	Establish guidelines for the location and design of new marinas.	Minimal	MDE continues to review other federal, state and local regulatory programs. County has asked to defer their evaluation of marina locations. It is anticipated that this process will be addressed when the Coastal Bays Sensitive Areas Task Force's work is complete.	Discussions of what constitutes a marina have been held with the CAC and NADAG.	MCBP has a problem finding time, staff or volunteers to research marina definition issue. Suggestion is to use the Maryland Clean Marina Standards for new marinas in the interim.

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GOAL 7: Implement Sustainable Management Practices At Harbors And Marinas

Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments
RN 7.1	Reduce Water Pollution From Marina Operation and Practices	Medium	Identify, evaluate and improve BMPs and pollution control infrastructure and practices at harbors and marinas	Substantial and On-going	DNR has conducted surveys to identify areas of water that would benefit from designation as a No Discharge Zone. Survey was also conducted for recycling facilities, but results have not been reviewed yet. Draft NDZ for northern coastal bays has been sent to EPA. Once recycling survey questions are reviewed, DNR will determine next steps to be taken. The Clean Marina Initiative was developed in association with industry partners beginning in the fall of □97. The CMI has developed a comprehensive pollution prevention manual for marina operators and an awards program to recognize environmentally-responsible marinas. The CMI, with funding from EPA, made grants available to marinas in the Isle Of Wight Bay watershed to cover 75% of the cost of purchasing and implementing pollution prevention measures.		The Maryland Clean Marina Guidebook addresses: fish offal; disposal of sewage, used fuel, oil and antifreeze. Through the Guidebook, tip cards, tip sheets, advertisements, exhibits, press releases, videos, and the lesson plan, the CMI promotes the use of proper maintenance techniques.

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GOAL 7: Implement Sustainable Management Practices At Harbors And Marinas

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments
RN 7.2	Reduce Resource Damage From Oil and Hazardous Material Spills	Low	Evaluate existing pollution response capabilities and the need for new policy and permit requirements.	Minimal	Letter sent to USCG requesting information. Response provided Coast Guard capabilities and a website address. Evaluation of pollution response capabilities has been requested. Mid-Atlantic Coastal Committee is re-evaluating response capabilities and contingency plans. The Ocean City Fire Marshall attends regular training sessions. Recently received training in oil spill response and cleanup from the Coast Guard. Also has completed training in biological and chemical terrorism. This is an ongoing effort. Specialized equipment is tested periodically.		Need to send letter to fire departments. Lack of staff time and resources. MDE has the "First Response" responsibility. Need to discuss plan development strategy with MDE.

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Maryland Coastal Bays Program - Community and Economic Development
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR TWO ACTIONS

GOAL 1: Educate And Inform The Population So It Can Make Knowledgeable Decisions About What It Wants For Its Community And Future

Challenge	Description	Priority	Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
CE 1.1	Increase Public Participation	High	Increase the community's understanding of growth impacts to increase involvement and foster informed decision-making	Moderate	Consultant prepared study "Economic Impacts of Growth and Land Use Change on Coastal Bays Resources" on fiscal impacts; DNR, MDP, and Worcester County currently reviewing study results and methodology. Ocean City organized and supports the Ocean City Development Corporation, which is a non-profit dedicated to the revitalization of downtown Ocean City. The Maryland Rehabilitation Code is also being implemented.	Coast Day is held annually. Weidman Farm, Burbage projects and other community developments. Support for "green" coastal lab & The Landings charette, visioning and Worcester 2000. Newspaper columns, Alternative Futures, Adopt-a-Street, hotel door hangers, Chamber of Commerce/HMRA articles, Homeowners Guide, TV, radio, newsletters.	Lack of MCBP staff resources, time and funding. Need to investigate how to get mailing list & set up system. This action, CE 1.1.7B, should be transferred to WC as the Lead Agency.
CE 1.2	Improve Planning Tools	High	Provide tools and information, examples of successful local ordinances, and information on sub-watershed based planning to local decision makers	Full and On-going	Present and provide information to County Commissioners, OC Town Council and available to local government staff.	MCBP resources available to local governments but are not being used to the fullest extent.	Acceptable tools change yearly and so does membership of governmental bodies. Need to develop a workshop to familiarize new County Board members with outstanding issues and current plans in the Coastal Bays watershed. This workshop should be on a yearly schedule.

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GOAL 2: Foster A Community Consensus On The Desired Future Condition Of The Maryland Coastal Bays Region And A Vision Of How To Promote The County As A Vacation Destination, Farming Region, Resource Protection Area, And Retirement Community, While Protecting And Preserving The Coastal Bays

Challenge	Description	Priority	Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
CE 2.1	Reduce threat of development to cultural and natural resources	High	Promote the culture and character of the region by continuing to preserve, restore, and enhance wetlands, forests, and cultural resources and educating the public about available tools.	Some	Lower Eastern Shore Heritage Plan being developed. These components will also be incorporated into the Comprehensive Plan. This recommendation is related to CE2.2.1. Basically they are both about providing information, analysis, and examples to augment Smart Growth in the Coastal Bays. As part of this recommendation, MDP is providing the following publications from its Model and Guideline series: Preparing a Sensitive Areas Element for the Comprehensive Plan; Sensitive Areas, Volume II; Key Growth Management and Preservation Tools for Successful Rural Legacy Proposals; Transferable Development Rights; Smart Growth and Neighborhood Conservation Initiatives; Urban Growth Boundaries; Revisiting the Comprehensive Plan-The Six Year Review; Sizing and Shaping Growth Areas. These documents are designed for local planners and others involved in these issues. They provide background, descriptions, purpose, and examples of some of the more relevant planning tools for Smart Growth in the Coastal Bays.	Weekly column, newsletter, Homeowners Guide, snapshot of the week, speaking engagements.	MDP and others have provided a large amount of information in response to the CCMP. Public education that appropriately communicates this information is always a challenging task. In addition, acting (e.g., changes to policies, regulations, etc.) on this information is pivotal for these efforts having any effect on the Coastal Bays. Providing timely information on these issues as they arise is a perennial task. This information can be used in the updating of the WC Comprehensive Plan.

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Maryland Coastal Bays Program - Community and Economic Development
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR TWO ACTIONS

GOAL 2: Foster A Community Consensus On The Desired Future Condition Of The Maryland Coastal Bays Region And A Vision Of How To Promote The County As A Vacation Destination, Farming Region, Resource Protection Area, And Retirement Community, While Protecting And Preserving The Coastal Bays

Challenge	Description	Priority	Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
CE 2.2	Articulate Long-term Vision	Medium	Present "alternative futures".	Full and On-Going	Conducted OP's Alternative Futures Analysis in the Summer and Fall of 1999. Turned over all of the data and related information to Worcester County's consultant for their Worcester 2000 work. Completion of Round 3 of the Alternative Futures analysis by MDP. Draft of final report provided to MCBP and WC. Final report due in August, 2001	Published results of Visioning Survey. Worcester 2000 is completed. MDP, consultant and WC are producing recommendations.	Comprehensive Plan scheduled to be completed by the end of 2001. Regardless of the Alternative Futures project, this effort is perennial to some degree. MDP has produced report but it does not cover Carrying Capacity.

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Maryland Coastal Bays Program - Community and Economic Development [redacted]
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR TWO ACTIONS

GOAL 3: Manage The Watershed To Maximize Economic Benefits While Minimizing Negative Resource Impacts

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
CE 3.1	Reduce Impacts From Tourism	Medium	Plan for the impacts of tourists.	Moderate	The hotel/motel industry has enthusiastically received the "conservation door hanger" and 23,000 have been distributed. WC and OC tourism groups working cooperatively on issues of natural resources.		
CE 3.2	Reduce Loss Of Farmland	High	Retain strong agricultural zoning and foster other incentives to preserve farmland and forestland.	Some	Commissioners remain committed to maintaining integrity of A-1 zoning. Have researched Agricultural Preservation Program and identified steps for certification. Plan to complete this within the next year.	Support county's efforts for strict A-1 zoning. Education and outreach efforts on importance of maintaining agricultural character. 83 public speeches. Support and assist with LSLT and POS. Support county's efforts for a Route 50 Corridor plan. Minigrants, Rural Legacy and Weidman Farm.	Responsibility for the Agricultural Preservation Program has been shifted from Development Review and Permitting to Dept of Comprehensive Planning as of 7/20/01.
CE 3.3	Establish Sustainable Development Patterns	Low	Enhance or strengthen a diversified and sustainable economic base by promoting eco-friendly businesses.	Some	This is the primary role of the Worcester County Tourism Dept. Tourism Dept is developing consolidated brochure on heritage tourism in Worcester and updating 100 mile View Trail brochure. MDA routinely provides information and technical assistance for aquaculture development in responding to all requests. This is the primary role of the Worcester County Economic Development Dept., which is pursuing natural gas pipeline opportunity to serve industrial sites.		DNR has been unable to have any activities in this area due to budget and staffing constraints. 1% Room Tax should be revisited for targeting to non-traditional tourism.

Implementation Key: **Full**: Implementation complete or nearing completion (75-100%), **Substantial**: Major progress has been made (50-74%), **Moderate**: Fair level of progress made (25-49%), **Some**: Progress beginning (10-24%), **Minimal**: Very limited progress (0-9%), **Unknown**: Insufficient reporting data available

Maryland Coastal Bays Program - Community and Economic Development
A PROGRESS REPORT ON YEAR ONE ACTION UPDATES AND YEAR TWO ACTIONS

GOAL 3: Manage The Watershed To Maximize Economic Benefits While Minimizing Negative Resource Impacts

Challenge	Description	Priority	Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
CE 3.4	Manage Groundwater Consumption	Medium	Promote water conservation.	Moderate and On-Going		Water conservation education stressed via Homeowner's Guide, newspaper columns, newsletter, TV, conservation door hangers used by the hotel/motel industry, articles in the Chamber of Commerce and HMRA newsletters.	The conservation door hangers have been greeted very enthusiastically by the Ocean City hotel/motel industry. These door hangers promote minimization of towel & sheet changes and water conservation.

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GOAL 4: Enhance The Level Of Sustainability In Land Use Decision Making

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
CE 4.1	Promote Planned Growth	High	Ensure growth is compatible with existing or planned services in order to maximize funding sources, while minimizing the local tax burden and impacts to natural resources	Minimal	DNR Growth and Resource Conservation Division considers this action identical to CE 1.1.1. WC has produced Route 50 corridor and Worcester 2000 projects. Alternative Futures analysis by MDP. Report is in progress. Office of Smart Growth is working with Counties to promote new standards and conservation initiatives. The Worcester County Comprehensive Plan is currently being updated. New plan will be effective March 2002. Isle of Wight Subwatershed Plan recommends conservation site planning.	Funded Alternative Futures report and Groundwater study. Support, review and comment on Route 50 Corridor Plan and Worcester 2000 projects. Hosted Speaker Series which featured the most prominent smart growth, development and design professionals from around the country. The speakers included Bill Browning, Ed McMahon, Tom Hylton, and Kennedy Smith.	This is not identical to CE 1.1.1 Achieving CE 1.1.1 will help with achieving CE 4.1, however the audiences are different. CE 1.1 calls for public participation. CE 4.1 calls for policy change. There has been considerable discussion regarding the effects of Smart Growth. Citizens, municipal/county officials, and professionals who deal with development and growth issues, have concerns that Smart Growth initiatives may have a detrimental affect on the quaintness of small Eastern Shore towns. While the concept of smart growth is supported, the **perception** is that it works better in urban areas. The state policy of concentrating growth around small towns could destroy the "small town" atmosphere. Perhaps policy should allow for the creation of new, quaint small towns. Smart growth is difficult; MCBP will work with partners to promote sustainable communities while preserving regional ambiance and heritage.

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Maryland Coastal Bays Program - Community and Economic Development
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GOAL 4: Enhance The Level Of Sustainability In Land Use Decision Making

Challenge	Description	Priority	Draft Measure of Progress	Implementation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
CE 4.2	Promote Environmental Protection Incentives	Low	Provide incentives to developers to encourage and include natural resource preservation and restoration.	Some and On-Going	Jim Perdue doing full-page ads around the country stressing his company's commitment to the environment. The ads show him by a pile of chicken manure and talk about the Perdue pelletizing plant. The incentive is an improved market share for his product, if the buying public responds to environmental stewardship. Flexible design standards to be include in WC comprehensive plan but code changes probably won't occur until year 3. Encouragement for aesthetically pleasing streetscapes, etc is being addressed by the WC Planning Commission in the Comprehensive Plan and also the Route 50, 611 and 589 corridor plans.	Education provided via Real Estate course, Technical Review Committee, Wetland Planning Group. Realtors course designed and taught during 2000. 21 realtors and builders attended.	Need to participate as instructors in the Ed Smith Real Estate course. WC adopted new road standards in PUDs.
CE 4.4	Improve Efficiency Of Transportation Systems	Low	Improve transportation efficiency and reduce reliance on automobiles.	Some and On-Going	The State of Maryland has changed emphasis on rural mass transit. SHA is limiting access to Route 113. Ocean City has implemented a Park-and-Ride facility in West Ocean City and is discussing another for North OC. There has been an expansion of the regional bus system.		Do not judge success by early ridership figures. WC and OC did a pilot bio-diesel test, but did not continue the program. The price has recently dropped by a dollar per gallon.

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GOAL 4: Enhance The Level Of Sustainability In Land Use Decision Making

Challenge	Description	Priority	Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
CE 4.5	Make The Enforcement Of Environmental Laws More Consistent	High	Achieve and maintain adequate enforcement of all applicable laws and regulations.	Minimal	Delegation for sediment and erosion control enforcement was granted to Worcester County. The new staff person is on board. Assateague Coastal Trust has initiated the development of a Bay Keeper Program. County has set up coordination mechanism; State reps are informed of meetings. Bi-monthly wetlands meetings are attended by state reps. With regard to maintenance agreements, local governments and municipalities are required to adopt a stormwater mgmt ordinance. The Ordinance contains inspection and maintenance requirements for stormwater mgmt measures. The new Stormwater Design Manual provides planning, design, construction and maintenance specifications for structural and non-structural stormwater BMPs. County strategy is to gain compliance by working with landowners and project managers. Fines are generally used when all other options have been exhausted.	Continuously educated public. Numerous citizen calls relayed to appropriate agency weekly. Supported WC in getting sediment and erosion control authority. Many on-going implemented items must be revisited periodically to ensure results are actually accomplished through changes in public attitudes and actions. Annual surveys of public perceptions are essential. The Awards sub-committee of the CAC has plans for the Coastal Bays' Special Award of Excellence and Stewardship. Turner Sculpture of Onley, Virginia will be contracted to produce an Osprey sculpture of significant beauty. It will have a unique display area in one of the new OC parks.	Judges need to be educated. When actions are taken and proceed to a court hearing, judges often do not resolve in favor of the ecosystem. Current county policy is "gain compliance" while public perception is non-compliance. So, the county should embark on an effort to publicize how their policies are gaining compliance. When projects are under consideration, MDE will implement Supplemental Environmental Projects in the damaged area to the extent possible. MDE encourages pre-application meetings. Training material to assist the regulated community is being developed. MDE has material for judges, but has not been able to set up meetings with judges and judicial staff. Need indicators and measurements to track how well voluntary compliance is working.

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Challenge	Description	Priority	Draft Measure of Progress	Implemen-tation status	Partner Activities	MCBP Role	Comments/Gaps & Roadblocks
CE 4.6	Enhance Coordination Between Delaware, Maryland and Virginia	Low	Establish a collaborative tri-state coastal bays effort.	Some	The partners are taking advantage of events which have been initiated as parts of other programs. Some events have been specifically initiated by the partners. The Delmarva Tri-State Conference, Hurricane planning, Water Quality measurement and planning, Macroalgae measurement and planning, Agricycle.		Although this was placed into Phase 3, there may be some things happening sooner, ie, macroalgae and groundwater.

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LIST OF ACRONYMS

ACT	Assateague Coastal Trust
ACCSP	Atlantic Coastal Cooperative Statistics Program
ACOE	Army Corps of Engineers
AD	Atmospheric Deposition
AG	Agriculture
ANEP	Association of National Estuary Programs
APF	Adequate Public Facilities
ASIS	Assateague Island National Seashore
ASMFC	Atlantic States Marine Fisheries Commission
ASP	Assateague State Park
BER	Town of Berlin
BMP	Best Management Practice
BRD	Biological Resources Division
BZA	Board of Zoning Appeals
CBF	Chincoteague Bay Foundation
CCMP	Comprehensive Conservation and Management Plan
CFR	Code of Federal Regulations
COMAR	Code of Maryland Regulations
CRP	Conservation Reserve Program
CREP	Conservation Reserve Enhancement Program
CT	Chemical Contamination
CWA	Clean Water Act
CZM	Coastal Zone Management
DBED	Department of Business and Economic Development
DHCD	Department of Housing and Community Development
DIB	Delaware Inland Bays
DMRs	Discharge Monitoring Reports
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DPI	Delmarva Poultry Industry
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EQIP	Environmental Quality Incentives Program
FCA	Forest Conservation Act
FEMA	Federal Emergency Management Agency
FHO	Forest Harvest Operation
FMP	Fishery Management Plan
FSA	Farm Service Agency
GIS	Geographic Information System
GPS	Global Positioning System
GW	Groundwater
HM	Harbors, Marinas and Related Facilities
IPM	Integrated Pest Management
LESHC	Lower Eastern Shore Heritage Committee
LOA	Letter of Authorization
LSLT	Lower Shore Land Trust
MACAC	Mid-Atlantic Coastal Area Committee
MACS	Maryland Agricultural Water Quality Cost-Share
MAFMC	Mid-Atlantic Fishery Management Council
MCBP	Maryland Coastal Bays Program
MCBF	Maryland Coastal Bays Foundation, Inc.
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
MDOT	Maryland Department of Transportation
MEMA	Maryland Emergency Management Administration
MES	Maryland Environmental Service

MFA	Maryland Forests Association
MFTF	Maryland Forestry Task Force
MGS	Maryland Geological Survey
MHT	Maryland Historical Trust
MOU	Memorandum of Understanding
MSSA	Maryland Saltwater Sportfishing Association
ND	Navigation and Dredging
NDAG	Navigation and Dredging Advisory Group
NFIP	National Flood Insurance Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPDES	National Pollution Discharge Elimination System
NPS	Non-point Source or National Park Service
NRCS	Natural Resources Conservation Service
NRP	Natural Resources Police
NWS	National Weather Service
OC	Town of Ocean City
OMWM	Open Marsh Water Management
OP	Maryland Office of Planning
OCWRS	Ocean City Water Resources Study
PDA	Public Drainage Association
PDR	Purchase of Developable Rights
PPI	Planning, Permits and Inspections (Worcester County)
PT	Point Source
PWC	Personal Water Craft
RFP	Requests for Proposals
RU	Recreational Use
SAV	Submerged Aquatic Vegetation
SCWQP	Soil Conservation and Water Quality Plans
SH	Town of Snow Hill
SHA	State Highway Administration
SIP	Stewardship Incentives Program
SRF	State Revolving Fund
SW	Stormwater
TBD	To Be Determined
TDR	Transferable Development Rights
TEAM	Teaching Environmental Awareness in Maryland
TES	Threatened and Endangered Species
TRC	Technical Review Committee (Worcester County)
UDEL	University of Delaware
UMCE	University of Maryland Cooperative Extension Service
UMD	University of Maryland
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USDOC	United States Department of Commerce
USDOD	United States Department of Defense
USDOI	United States Department of the Interior
USDOI BRD	United States Department of the Interior Biological Resource Division
USDOT	United States Department of Transportation
USFWS	United States Fish and Wildlife Service
USGS	United State Geological Survey
VIMS	Virginia Institute of Marine Science
WASWaste	Management Administration (MDE)
WC	Worcester County or Water Clarity
WER	Within Existing Resources
WHIP	Wildlife Habitat Incentives Program
WMA	Water Management Administration (MDE)
WQIA	Water Quality Improvement Act
WRP	Wetland Reserve Program
WSCD	Worcester Soil Conservation District
WWTP	Waste Water Treatment Plant

Coastal Bays Blue Crab Fishery Management Plan

Prepared by:
Maryland Department of Natural Resources
Coastal Bays Fishery Advisory Committee

September 2001

MARYLAND COASTAL BAYS

POLICY COMMITTEE

ENDORSEMENT STATEMENT

BLUE CRAB FISHERY MANAGEMENT PLAN FOR MARYLAND'S COASTAL BAYS

We, the undersigned, endorse the 2001 Blue Crab Fishery Management Plan for Maryland's Coastal Bays. We agree to accept the 2001 Blue Crab Fishery Management Plan for Maryland's Coastal Bays as a guide to conserving the blue crab resource of the coastal bays, protecting its ecological and socio-economic value, and optimizing the long-term use of the resource. We further agree to support implementation, by the dates set forth in the Plan, the management actions recommended to assess the impact of *Hematodinium* (disease), conduct a comprehensive stock assessment, control crabbing effort and harvest rates, improve the quality of recreational crabbing, protect blue crab habitat, and implement effective enforcement.

We recognize that the 2001 Blue Crab Fishery Management Plan for Maryland's Coastal Bays is based on the science as we know it today, and not an endpoint. We recognize the need to commit long-term, stable, financial support and human resources to the task of managing the blue crab resource of the coastal bays and addressing important research needs. In addition, we ask the Maryland Department of Natural Resources to periodically review and update the Plan and report on progress made in achieving the Plan's management recommendations.

For Maryland Department of Natural Resources

Chuck Fox, Secretary

For Worcester County

John Bloxom, President

Jeanne Lynch, Commissioner

For Town of Ocean City	James Mathias, Mayor
For Ocean City Council	Rick Meehan, President
For U.S. Environmental Protection Agency	Richard Kampf
For Maryland Department of Agriculture	Royden Powell
For Maryland Department of the Environment	Jane Nishida, Secretary
For Maryland Department of Planning	Rich Hall
For Assateague Island National Seashore	Mike Hill, Superintendent
For MCBP Scientific Technical Committee	Rick Kutz
For Local Citizens	Jack Burbage
Carolyn Cummins	Edward Lee
	Louise Gulyas, Commissioner

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Jim Hall, Town of Ocean City
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TABLE OF CONTENTS

EXECUTIVE SUMMARY 7

SECTION 1. GOAL AND OBJECTIVES 8

SECTION 2. BIOLOGICAL BACKGROUND 9
- Life History 9
  - Larval and Postlarval Phases 9
  - Settlement and Recruitment 10
  - Early Juvenile Stages 11
  - Adults and Reproduction 11
- Predator - Prey Relationships 12
- Disease 13
- Habitat Requirements 13
  - Dissolved Oxygen 14
  - Salinity 14
  - Turbidity 14
  - Temperature 15
  - Contaminants 15
- Marine Protected Areas 15
- Multispecies Interactions 16
- Research and Monitoring 17
- Status of the Coastal Bays Blue Crab Stocks 19
- Description of the Coastal Bays Blue Crab Fisheries 20
  - Commercial Fishery 20
  - Recreational Fishery 24

SECTION 3. MANAGEMENT STRATEGY 25
- OBJECTIVE 1: Improve our understanding of how *Hematodinium* contributes to the mortality and population abundance of blue crabs. 25
  - Problem 1.1: Research and Monitoring 25
- OBJECTIVE 2: Improve our understanding of blue crab biology and stocks. 25
  - Problem 2.1: Stock Status 25
  - Problem 2.2: Commercial Catch and Effort Data 26
  - Problem 2.3: Recreational Catch and Effort Data 27
  - Problem 2.4: Invasive, Non-Indigenous Species 27
  - Problem 2.5: Functional Role of Blue Crabs in the Natural Ecological Community 28
- OBJECTIVE 3: Maintain an economically stable and sustainable commercial blue crab fishery. 28
  - Problem 3.1: Commercial Crabbing Effort 28
  - Problem 3.2: Harvest of Female Crabs 29

Problem 3.3: Wasteful Harvest Practices 31
OBJECTIVE 4: Improve the recreational crabbing experience. 32
Problem 4.1: Satisfaction of Recreational Crabbers 32
OBJECTIVE 5: Protect, maintain and enhance blue crab habitat. 32
Problem 5.1: Submerged Aquatic Vegetation (SAV) 32
Problem 5.2: Overwintering Habitat 33
Problem 5.3: Shallow Water and Shoreline Habitats 34
Problem 5.4: Dissolved Oxygen 34
Problem 5.5: Nutrient, Sediment, and Chemical Inputs 35
OBJECTIVE 6: Improve enforcement of crabbing restrictions. 35
Problem 6.1: Enforcement of Conservation Measures 35

REFERENCES 36

APPENDIX 1. LOCATION OF TRAWL AND SEINE SAMPLING SITES IN MARYLAND'S COASTAL BAYS. 42

APPENDIX 2. CHEMICAL TOXICITY TO BLUE CRABS[a] 43

APPENDIX 3: DESCRIPTION OF COMMERCIAL LICENSE CATEGORIES 44

EXECUTIVE SUMMARY

In July 1999, a Comprehensive and Conservation Management Plan was adopted for Maryland's coastal bays. This Plan distinguished Maryland's coastal bays as a separate, unique ecosystem from the Chesapeake Bay, and included a recommendation that the Maryland Department of Natural Resources (DNR) address fishery issues specific to Maryland's coastal bays. Fishery issues were divided into three categories: finfish, shellfish and blue crabs. This document specifically addresses the issues related to blue crabs, and sets forth management strategies for improving blue crab management in the coastal bays.

The status of the coastal bays blue crab stock is difficult to assess because of uncertainties in the population's stock recruitment relationship. Fishery dependent and independent data indicate relatively stable populations which fluctuate annually, and without any discernable long-term trends. Localized declines may not be apparent in the data and is of concern, especially in regards to the declining satisfaction among recreational crabbers.

The goal of the Blue Crab Fishery Management Plan (FMP) for Maryland's Coastal Bays is to manage blue crabs in a manner which conserves the coastal bay stock, protects its ecological and socio-economic values, and optimizes the long-term use of the resource. To achieve this goal, the following objectives have been defined: 1) Improve our understanding of how disease (*Hematodinium*) contributes to the mortality and population abundance of blue crabs; 2) Improve our understanding of blue crab biology and stocks; 3) Maintain an economically stable and sustainable commercial blue crab fishery; 4) Improve the recreational crabbing experience; 5) Protect, maintain and enhance blue crab habitat; and 6) Improve the enforcement of crabbing restrictions.

A series of management strategies have been developed to address the objectives of this FMP. Some of the more significant actions include: assessing the impacts of disease (*Hematodinium*) on blue crabs; improved monitoring of the blue crab stock and commercial fishery; stabilizing commercial crabbing effort; protecting important blue crab habitats; obtaining recreational catch and effort estimates; maximizing the reproductive potential of female crabs; and reducing bycatch mortality of crabs, as well as air breathing animals.

The development of this FMP is based on the science as we know it today. This FMP is not an endpoint but establishes a management framework for protecting the blue crab resource. It provides a format by which the Department can adjust management recommendations as new information on Maryland's coastal bays blue crab resource becomes available.

SECTION 1. GOAL AND OBJECTIVES

The goal of the Maryland Coastal Bays Blue Crab Fishery Management Plan is to manage blue crabs in Maryland's coastal bays in a manner which conserves the coastal bay stock, protects its ecological and socio-economic value, and optimizes the long-term use of the resource.

To achieve this goal, the following objectives must be met:

1) Improve our understanding of how disease (*Hematodinium*) contributes to the mortality and population abundance of blue crabs;

2) Improve our understanding of blue crab biology and stocks;

3) Maintain an economically stable and sustainable commercial blue crab fishery;

4) Improve the recreational crabbing experience;

5) Protect, maintain and enhance blue crab habitat; and

6) Improve the enforcement of crabbing restrictions.

SECTION 2. BIOLOGICAL BACKGROUND

Introduction

The blue crab, *Callinectes sapidus*, is a dominant epibenthic predator in estuaries, lagoons and coastal habitats of the Western Atlantic, Caribbean and Gulf of Mexico (Williams, 1984). It is also an economically important resource throughout its range. For example, the commercial blue crab fishery in Maryland and Virginia has the highest value of any state commercial fishery. Reported dockside value has ranged from $53.3 million to $66.5 million between 1995 and 1999. In addition, there is a recreational fishery which contributes an unknown, but believed to be, significant quantity to the economy of the region. The blue crab is an important natural resource requiring sound management to protect its long-term health and economic benefits.

Maryland's Atlantic coastal bays comprise a separate, unique ecosystem from the Chesapeake Bay. The coastal bays watershed is much smaller than the Chesapeake Bay watershed, covering an area approximately 525 km^2. The coastal bays support an important blue crab fishery that is similar but distinct from the Chesapeake Bay. Fishery independent data from the coastal bays indicate year-to-year variation but no trends in blue crab abundance. The commercial harvest of blue crabs has also fluctuated without trend. Causes of population fluctuations are poorly understood. Between 20-60% of the variance in the Virginia commercial dredge fishery can be explained by a spawning stock-recruitment model developed from a 20-year database (Lipcius and Van Engel, 1990). Understanding processes associated with postlarval and early juvenile stages are necessary for the development of population models applicable to the blue crab and its fisheries. In particular, processes affecting transport (i.e. dominant wind patterns during there recruitment season and runoff), settlement, metamorphosis (physiological state, behavior, nursery habitat availability and salinity effects) and post-settlement survival (mortality from fishery harvest and natural predation including cannibalism) that influence juvenile survival appear critical to understanding blue crab population fluctuations.

Life History

Larval and Postlarval Phases

The life history of the blue crab is similar to that of other marine species with complex life cycles and open populations. Larvae (zoeae) are released by mature females in high salinity water, typically near the mouth of bays, sounds and estuaries (Van Engel, 1958). The larvae are transported to the continental shelf where development continues through 7 or 8 zoeal (larval) stages and usually takes between 30 and 45 days (reviewed in Millikin and Williams, 1984; McConaugha et al., 1983; McConaugha, 1988). Larvae require salinities in excess of at least 30 parts-per-thousand (ppt) for optimal development (Costlow 1967) and are poorly adapted to undergo development in salinities less than 26 ppt. During development, larvae feed on zooplankton and plant material (Truitt, 1939).

Larvae metamorphose (transform) into a postlarva or magalopa stage which occurs on the nearshore shelf (Epifanio et al., 1984). The duration of the postlarval stage is plastic and may have important consequences for settlement and recruitment to juvenile populations (Sulkin and Van Heukelem, 1986). Postlarvae exhibit transitional behavior, morphology and physiology between the larval and early juvenile stages, and return to estuarine waters from offshore areas (Cronin and Forward, 1982; Sulking and Van Heukelem, 1986; McConaugha, 1988; Lipcius et al., 1990; Metcalf and Lipcius, 1992). A retention mechanism has been postulated for blue crabs which involves the along-shore southerly flow of water carrying early zoeae stages away from their origin. A circular pattern is created with the mid-shelf and wind generated flow of surface water to the north which later-stage larvae and postlarvae are returned to estuarine areas. For the Chesapeake Bay, the dispersal and recruiting phases of the blue crab are thought to be retained near the mouth and subsequently re-enter the estuary. Within the bay, postlarvae utilize nocturnal, tidal-flood currents to reach shallow, estuarine nursery habitats (Meredith, 1982; Mense and Wenner, 1989; Olmi, 1993). The nursery habitats are predominantly seagrass beds where the postlarvae metamorphose to the first juvenile instar stage (Orth and van Montfrans, 1987).

Larval transport into and out of the Maryland coastal bays may not function in the same manner as transport into larger estuaries. The Maryland coastal bays are connected to the Atlantic Ocean by an inlet at Ocean City and an inlet at the southern end of Chincoteague Bay in Virginia. Since the mouth of the Ocean City inlet is only 200 yards wide, there may be some natural restrictions to returning larvae. All female crabs may not leave the coastal bays to spawn. The coastal bays are predominantly polyhaline (>25 ppt salinity) with a mean bottom salinity of 31 ppt. Average salinity in Chincoteague Bay is about 2 ppt greater than the three other coastal bay areas (EPA, 1995) and can reach as high as 35 ppt in the summer due to slow water exchange rates and evaporation (Linder et al., 1996). Considering the salinity data, some spawning and larval development may occur within the coastal bays. Larvae have been found in the coastal bays but the extent of annual survival is unknown.

Epifanio et al. (1984) suggests there is a mixing of blue crab larvae from a variety of sources along the continental shelf. It is believed that the wind and tide ultimately distribute the larvae back to the estuaries. Consequently, settlement of postlarvae does not necessarily occur in the "parent" estuary. In addition, postlarval settlement does not occur uniformly in time, but as a series of pulses associated with wind events. For a wind event to be effective, it must occur when postlarvae are close enough to the estuary to allow transport into the estuarine habitat. This random process of events can provide an explanation of inter-annual variability in blue crab populations (Epifanio, 1995). This process has further implications for blue crab populations. The various estuaries of the Mid-Atlantic Bight are most likely subpopulations of one open population (Roughgarden et al., 1988) or metapopulation (Grosberg and Levitan, 1992). Results from a genetic study indicate there is gene flow between all blue crab populations from New York to Texas (McMillen-Jackson et al., 1994). Management strategies regarding the blue crab fishery in the coastal bays need to consider the role of larval transport, survival and recruitment, and how it contributes to the variability in commercial/recreational harvests. In addition, because there is a strong impact on future harvest by offshore larval processes, the offshore habitat should also be considered.

Settlement and Recruitment

As postlarvae enter estuaries, they progress through well-defined morphological and physiological changes which influence their behavior patterns and prepare for postlarval settlement. Planktonic individuals collected along an offshore (coastal ocean) to onshore (York River mouth) transect exhibited progressively more advanced molt stages, indicating a direct relationship of advanced physiological state with ingress into the estuary. Individuals from natural settlement habitats were in late premolt and approaching metamorphosis to the first juvenile instar (Lipcius et al., 1990; Metcalf and Lipcius, 1992).

In many marine species, larval or postlarval abundance and settlement set the limits within which population size is determined, since these individuals represent the survivors of early life-history phases (Fritz et al., 1990). Blue crab postlarval abundance, though highly variable, generally follows a neap-spring tidal cycle, with brief periods of high abundance following spring tides by several days. This suggests that entry into estuaries is facilitated by increased tidal excursion. Superimposed on this fortnightly pattern are peaks of abundance related to wind events that transport postlarvae towards the coast and into estuaries via non-tidal volume exchange (Goodrich et al., 1989). Once within an estuary, postlarvae migrate vertically in response to light and tide, utilizing nocturnal flood tides to augment their transport up the estuary to shallow-water settlement sites (Olmi, 1993).

Postlarval settlement patterns are relatively unknown in the coastal bays. Settlement of blue crab postlarvae has been assessed in Chesapeake Bay using artificial settlement substrates, and occurs primarily between July and mid-November each year. Settlement is characterized by episodic pulses during periods surrounding full and new moons (Orth and van Montfrans, 1987; van Montfrans et al., 1990). The same fluctuating pattern of settlement has been observed annually, with substantial variation in timing and magnitude. Episodic settlement peaks account for more than half the annual total. Artificial settlement substrates may provide a measure of postlarval abundance and could serve as an indicator of blue crab harvest.

Early Juvenile Stages

In the coastal bays, juveniles often inhabit mats of bryozoans, bottom detritus and seagrass beds. As the juveniles increase in size, they move into shallow, muddy, marsh-lined tidal guts generally 18 inches to 4 feet (0.4 to 1.2 m) in depth. These areas generally contain the largest abundance of juvenile crabs and are also utilized as overwintering habitat for crabs < 1 inch (25 mm).

Adults and Reproduction

In estuaries with distinct salinity regions, large male crabs generally occupy the upper reaches of tributaries while females generally migrate towards higher salinity (Hines et al., 1987). In the coastal bays where differences in salinity are small to nonexistent, adults appear to segregate in relationship to the Ocean City Inlet. A higher percentage of mature female crabs dominate Sinepuxent Bay, Isle of Wight and the St. Martin's River, areas that are slightly higher in salinity and closer to the Ocean City Inlet. Male crabs are found at higher percentages in Newport and Chincoteague Bays, areas that are farther from the Ocean City Inlet (S. Doctor, MDNR, personal communication).

Most mating occurs from May through October. Males carry and protect the females during molting and mating takes place while the females is in the soft-shell stage of the pubertal molt. Pubertal-molt female crabs initiate their final molt at approximately 100 mm in the coastal bays, smaller than in the Chesapeake Bay (115 mm) (Knotts, 1989). After this final interval of growth, the average size of adult females is 134 mm in the coastal bays and 155 mm in the Chesapeake (Knotts, 1989; Hines et al. 1987). The pairs separate and after the shell hardens, females migrate to staging areas in Sinepuxent and Isle of Wight Bays, 2.5 to 4.5 miles (4.0 to 7.0 km) from the Ocean City Inlet. Early arrivals will spawn prior to winter while latecomers spawn the following spring after winter hibernation.

Females carry their egg mass on their underside, beneath their aprons, and open to the water to expose an orange, round, sponge-like mass. Depending on crab size, the "sponge" may contain from 750,000 to 8,000,000 eggs (Prager et al., 19990). Blue crabs are serial spawners and can spawn up to three times in a season (McConaugha et al., 1983; Jones et al., 1990). Crab larvae are hatched and released from the egg mass to enter a planktonic existence where they are subject to a host of environmental pressures such as wind-driven circulation patterns, tidal currents, temperature, salinity and extensive predation. Postlarve generally reinvade estuarine areas, metamorphose to juveniles, and disperse throughout low salinity shallow waters (Hines et al, 1987). Blue crabs mature at approximately 12 to 18 months of age (Van Engel, 1958) with an expected average lifetime of two to three years under heavy fishing pressure. The number of crabs recruiting to the coastal bays in any given year, relies partly on the size of the spawning stock. The spawning stock includes all mature females that survive natural and fishing mortality. The spawning stock is not limited to female crabs with an egg mass. Any juvenile female crabs larger than 80-100 mm (3.2-3.9 inches) has a high potential to reproduce if not removed by the fishery. The reproductive success of female blue crabs may also be limited by the availability of males (Hines et al., 2000). When regulating harvest and effort, consideration should be given to the proportion of female/male harvested.

Predator - Prey Relationships

Blue crabs serve as both predator and prey in the benthic and planktonic food webs of estuaries and bays. Movement through the water column by postlarvae make them a food source for plankton feeders such as menhaden, as well as other finfish that forage in the water column (Olmi, 1993). Settled postlarve and young juveniles become prey for numerous predators including summer flounder, American eel, drum, spot, croaker, striped bass, weakfish, some sharks and cownose rays. Juvenile crabs are also prey for large blue crabs and other species of crabs such as the lady crab, *Ovalipes ocellatus*, and the lesser blue crabs, *Callinectes similis*. The endangered Kemp's Ridley sea turtle, *Lepidochelys kempii*, prefer large blue crabs. Although the number of Kemp's Ridley is quite low, they have been reported in the Chesapeake region. Two other sea turtles, the Green turtle, *Chelonia mydas,* and the loggerhead turtle, *Caretta caretta*, can also be found in the Chesapeake region and are known to feed on crabs. Recent questions have been raised about the resurgence of striped bass and their effects on the blue crab resource. Goshorn and Casey (1993) and Mosca et al. (1995) examined the relationship between striped bass abundance and blue crab landings in Chesapeake Bay and found no significant relationship. Food habits of large striped bass (>450 mm) were examined in the Chesapeake Bay in 1997 and 1998. Results indicated that large striped bass infrequently ingest blue crabs and contributed little to the overall weight of stomach contents (Austin and Walter, 1999). Another study, however, conducted in the lower Chesapeake Bay had different results. Three fish species (striped bass, red drum and croaker) were sampled in lower bay seagrass beds. These species consumed substantial numbers of large blue crabs (van Montfrans et al., 2000). Striped bass food habits may change with age/size of the fish. Regional differences in food preferences and/or availability may also occur.

Blue crab prey include bivalves, crustaceans, fish, annelids, plants and detritus (Darnell, 1958; Tagatz, 1986; Alexander, 1986). Although the blue crab is an opportunistic predator (Laughlin, 1982; Mansour, 1992), it prefers soft-shelled clams (i.e. *Macoma* spp. and *Mya arenaria*). Blue crab feeding habits may control some bivalve populations (Lipcius and Hines, 1986; Egleston, 1990; Mansour and Lipcius, 1993; Eggleston et al., 1992). In intertidal marsh habitats, blue crabs prefer the marsh periwinkle but killifish are also an important food item (Van Heukelem, 1991). Blue crabs readily cannibalize smaller blue crabs (Mansour, 1992; Mansour and Lipcius, 1993). Recent research on feeding habits of blue crabs indicate that when their preferred food item becomes depleted, cannibalism on juvenile crabs increases in intensity (Mansour, 1992). Cannibalism may serve as a self-regulating control on crab populations, particularly during periods of high crab abundance or low alternative prey abundance (Mansour and Lipcius, 1993). The incidence of cannibalism in blue crabs has been measured in several areas and ranged from 25% (York and Rappahannock Rivers, 1988-1989) to as high as 90% (Rhode River, A.H. Hines, Smithsonian Environmental Research Center, 1990). Cannibalism may play an important role in the coastal bays since blue crabs are found in high densities (S. Doctor, MDNR, personal communication).

Disease

Adult and juvenile crabs from the coastal bays of the Delmarva region have been found to be infected with an unusual parasitic dinoflagellate, *Hematodinium perezi*. This dinoflagellate lives in the hemolymph of blue crabs, where it rapidly proliferates and kills its host. Beginning in 1992, Maryland watermen from the coastal bays reported dead crabs in their baited crab pots. Studies conducted since 1992 have found a seasonal pattern of disease prevalence in the coastal bays. Up to 90% of juvenile crabs have infections during the early winter but heavy mortalities in adults are reported by watermen during the summer months. Prevalence of infected crabs appears to vary with location. Infections are found more often in shallow coastal bays than in deeper, larger estuaries (Messick & Shields, in prep). Other factors, such as host size, influence the prevalence of disease infections. Experiments have shown a decrease in infection intensity at lower temperatures (Messick et al., 1999). The apparent 0% prevalence from later winter through spring in the coastal bays is probably related to low water temperatures (Messick 1994). Blue crabs presumed uninfected (there was no detectable disease in their hemolymph) have developed infections when held in warmer temperatures for 2 weeks (Messick et al. 1999).

The impact of *Hematodinium* on the blue crab resource in the coastal bays in unknown. Mortality rates during epizootic events are difficult to estimate because dead crabs sink (Shields 2000). In non-epizootic years, disease prevalence has varied between 20 to 50% on the Delmarva peninsula. Under laboratory conditions, disease-induced mortality occurred after approximately 30 days. The laboratory studies indicate that disease is a significant threat to blue crab fisheries occurring in high salinity estuaries (Shields 200). How disease contributes to mortality in the coastal bays is an important management consideration.

Habitat Requirements

Habitat within the Maryland coastal bays is biologically diverse. Over 11,000 acres of salt marsh have been estimated for the coastal bays (Christoffers 1990). For the Delmarva peninsula, submerged aquatic vegetation (SAV) has increased from 2,129 hectares in 1986 to 7,200 hectares in 1999. There was a 17% increase in the total hectares of SAV from 1998 (6,155 hectares) to 1999 (7,200 hectares) (VIMS website). Although seagrass beds are a good overwintering habitat for juvenile crabs, shallow, muddy marsh-lined tidal guts also provide excellent winter habitat for crabs (<1 inch). In the coastal bays, large numbers of small crabs have been found in marshy, tidal guts. In areas where seagrass, marsh channel and oyster habitats coexist within an area, juvenile blue crab densities have been greatest in the seagrass, followed by the marsh channel habitat. Given the presence of seagrass and/or marsh channels, oyster habitats are minimally used (Frazer et al., 200).

In general, the habitat requirements for blue crabs are quite varied. Crabs utilize a wide range of salinities and a wide range of bottom habitat types including oyster bars, sand bottoms, salt marshes, and seagrass beds (Engel and Thayer 1998). On a regional basis, vegetated habitat areas and commercial harvests of blue crabs have been significantly correlated (Orth and van Montfrans, 1990). For example, vegetated habitats were most important for juvenile crabs in the lower Chesapeake Bay (Heck and Thoman, 1981; Penry, 1982; Heck and Wilson, 1987; Wilson et al., 987; Orth and van Montfrans, 1987; Montane et al., 1993). The availability and functional ecology of vegetated habitats in concert with recruitment processes, may influence blue crab population size. Beds of submerged vegetation such as eel grass (*Zostera marina)* and Widgeon grass *(Ruppia maritima)* fall within the salinity constraints of invading postlarvae and provide developing juveniles with significant protection from predators during initial growth (Pile, 1993) and provide molting refugia for subadults (Ryer et al., 1990). Growth rates of juvenile crabs in seagrass beds are higher than in adjacent unvegetated areas (Perkins, 1993). Grass beds also serve as overwintering habitat for juvenile crabs. Where seagrass beds are sparse, juvenile and mature males bury in unvegetated creek and river channels, as well as deeper areas in the mainstem of bays (Hines et al., 1987). Macroalgae also serve as important habitat for juvenile crabs in the coastal bays. Habitat use by young juveniles in not static. As juveniles grow larger than about 25 mm in carapace width, they migrate out of grass beds and disperse throughout other shallow-water habitats. Juvenile crabs also use oyster bars as habitat. Juvenile distribution can be altered by physical disturbances such as tropical storms. Tidal guts of small creeks and rivers in and around salt marshes provide additional shallow-water habitats for juvenile and male crabs to feed and take refuge during molting. Tidal gut areas are especially important in the coastal bays.

The following habitat parameters are summarized from the document, "Habitat Requirements for Chesapeake Bay Living Resources" (Funderburk et al. 1991) for blue crabs.

Dissolved Oxygen

Blue crabs avoid areas with low dissolved oxygen (DO) and are known to leave the water to escape hypoxic (low oxygen) water (often referred to as a "crab jubilee"). Studies have found about 50% mortality associated with crabs held in waters with < 2ppm oxygen at depths below 7 m (Carpenter and Cargo, 1957). Hypoxic water has been shown to effect the recruitment and migratory success of postlarval (megalopae) blue crabs by altering behavior associated with shoreward transport and settlement processes (Tankersley and Ziegler 2000). Besides affecting blue crab physiology, anoxic waters (no oxygen) may also reduce the benthic food supply and limit blue crab distribution. Maintaining a DO greater than 3mgL at 25-28°C should provide an adequate area to support blue crabs.

Salinity

Blue crabs can inhabit freshwater (0 ppt) to hypersaline water (>36 ppt) but are most often found in brackish or waters of intermediate salinity. Egg and larval development require salinities of greater than 20 ppt with optimum salinity around 30 ppt.

Turbidity

The effects of turbidity on blue crabs is unknown. Turbid water might interfere with swimming ability of the early larval stages. Increase turbidity can have serious consequences on the survival of seagrass beds. Seagrasses are dependent on adequate transmitted light for survival. Because seagrass is used as a nursery area for young crabs and a refuge for molting crabs, its loss could have long-term effects on blue crab populations (Engel and Thayer, 1998).

Temperature

Blue crabs exhibit a wide range of temperature preferences. Temperature tolerance limits have been examined in the laboratory. Juvenile and adult female tolerance limits were similar. The upper temperature limit of crabs acclimated at 30°C and 24 ppt was 39°C and the lower limit was 4.6-4.9°C. For crabs acclimated at a lower salinity, 6.8 ppt and 30°C, had an upper limit of 37°C and a lower limit of 5.3-6.0°C. In general, blue crabs are less tolerant of low temperatures at low salinities. Thus, their behavior has survival value. During cold weather and in low salinity areas, blue crabs migrate to deeper water.

Contaminants

Juvenile blue crabs have been used in a variety of toxicity tests. The U.S. Environmental Protection Agency (EPA) has compiled the results (Mayer 1987, Addendum I). Generally, the larval stages are more sensitive to toxic materials than the juvenile or adult stages. The sublethal effect of toxic substances on the larval stage is a lengthening of the developmental period. Juveniles and adults can be exposed to toxic substances by burying in the sediment, by runoff from urban, suburban, and agricultural areas, and by eating contaminated food, especially bivalves (Van Heukelem, 1991).

Marine Protected Areas

Preventing the overexploitation of a fishery resource is a major issue for management consideration. Although advancements have been made in fishery science, there is uncertainty associated with stock assessment analyses. Uncertainty also arises from the complex nature of the aquatic environment and from incomplete biological information. Besides uncertainty associated with the environment and estimates of fish populations, there are additional biases associated with fishing mortality. They include under reported harvest, bycatch, and incidental mortality (Lauck et al., 1998). Given these restraints, the ability to detect overfishing and predict the collapse of a stock is limited. In spite of these limitations, management strategies need to be developed whether the information is complete or not. It is now an acceptable practice to allow for uncertainty and inaccuracies in projected sustainable catch levels (Lauck et al. 1998).

The use of marine protected areas (MPAs) to protect fish populations and marine/estuarine ecosystems has been suggested as a viable management tool and a possible means to address uncertainty in fishery science. Marine protected areas are also referred to as reserves or sanctuaries. Designating closed areas to fishing is not a new concept. What makes an MPA different from a fishing closure, which is usually species-and/or gear-specific, would be the length of time an area is closed and the complete elimination of all fishing activity. Protected areas have the potential to affect a variety of functions, depending on the species. They could be used to restrict access to sensitive habitats such as the use of marine zoning in the Florida Keys (Causey, 1999). They could be used to protect spawning/nursery grounds or preserve biodiversity by protecting aquatic ecosystems from the effects of fishing (Nowlis and Roberts, 1998). In areas where there is high exploitation, MPAs allow populations to increase in size and density. As adults grow larger and older, their contributions to reproduction becomes greater. If the larger adults move out of the protected areas, they become available to harvest and increase fishing yield. If spawning takes place within the MPA, larvae may also move out of the protected area and enhance recruitment. Data from the Merritt Island National Wildlife Refuge documented an increase in abundance and the availability of larger fish compared with an area outside the refuge. Tagging results from his protected area also documented emigration from the protected area to unprotected areas (Johnson et al., 1999). Although the positive effects of MPAs have been highlighted, MPAs have limitations and their use alone cannot guarantee protection of a particular fish/shellfish populations. The use of MPA's is limited by processes that are unique to aquatic systems such as hydrographic circulation patterns, episodic events (El Nino), and large-scale patterns of population replenishment and anomalous climatic effects (Allison et al., 1998).

Determining the size and area of a MPA depends on the life history and habitat requirements of the species under consideration. Computer modeling of MPAs suggest that heavily-fished populations benefit from MPAs and may help to reduce large yearly population fluctuations (Lauck et al., 1998). Computer models also suggest that MPAs should be large, 40-80% of the populations range, to gain full benefits. Before establishing MPAs, there should be a clear goal. Since the effectiveness of MPAs has only been documented in a few cases, a monitoring program should be established to determine whether or not MPAs are achieving their desired objectives.

Establishing a MPA in the coastal bays to benefit blue crabs could be a viable management tool. After mating, female blue crabs congregate in specific staging areas to overwinter. In the spring, they are particularly vulnerable to harvest. A MPA in one of these areas could contribute to enhancing the blue crab population and support ecological functions in several ways. A MPA would protect spawning females in the spring from harvest. It would also have the potential to protect important blue crab habitats (i.e. shallow water and shoreline habitats, SAVs) and contribute to stabilizing commercial and recreational effort.

Multispecies Interactions

The northern diamondback terrapin *(malaclemys terrapin)* is a resident species in Maryland's coastal bays. It is classified as a brackish water species that inhabits shallow estuarine bays, lagoons, creeks and marshes, especially *Spartina* grass (Carr, 1952). Terrapins generally prefer creeks and marsh edges rather than open waters of sounds or bays but will utilize open water as they swim from area to area. Terrapins can withstand a wide range of salinity but are never found in freshwater ponds, streams or rivers. Terrapins are active from April through October and usually hibernate from November through March. Terrapins are top predators in the aquatic food chain and feed on a variety of bivalves, gastropods, fish and crustaceans. There is some evidence to suggest that females have a more varied diet than males and that food preferences can vary depending on their locality from year to year (Wood ,1995). The status of terrapins in Maryland's coastal bays is unknown and there is a limited amount of information on terrapin distribution. In the Delaware Bay, terrapins are relatively common along the shoreline but their overall distribution is patchy (Wood, 1995).

One of the major sources of mortality for terrapin populations is drowning in crab pots (Roosenburg et al., 1996; Seigel and Gibbons, 1995). Several aspects of their life history contribute to their vulnerability in crab pots. Terrapins are air-breathing reptiles and crab pots do not allow access to air. Terrapins are most active during the entire blue crab fishing season (April through November).

The habitat of terrapins overlaps with blue crabs. Crab pots are placed in areas where terrapins are present and terrapins are attracted to the types of bait typically used in crab pots such as razor clams, menhaden, and other fish species. Terrapins are probably more vulnerable to being caught in crab pots in the coastal bays then in the Maryland portion of the Chesapeake Bay. In the Chesapeake Bay, the use of crab pots is restricted to the Bay's mainstem. Commercial crab pots can be fished anywhere in the coastal bays including the tributaries. The recreational use of crab pots by landowner is of particular concern for terrapins. Landowners are allowed to use two crab pots from their pier or waterfront property. Many recreational crab pots are therefore, placed in shallow rivers and creeks inhabited by terrapins (Roosenburg et al., 1996).

Crab pots contribute to terrapin mortality at two levels, a constant background mortality from crab pots used on a regular basis and occasional large kills from abandoned crab pots (Roosenburg et al., 1996). A single, abandoned crab pot has killed as many as 29 and 49 terrapins, in North Carolina (Bishop, 1983) and Chesapeake Bay (Roosenburg, 1991), respectively. The extent of the large kills by abandoned pots is unknown. Annual mortality due to crab pots has been estimated between 15% and 78% for the Patuxent River terrapin population (Roosenburg et al., 1996). Male terrapins are smaller than females and are vulnerable to being caught in crab pots throughout their lives. Female terrapins are vulnerable to being caught in crab pots up to age 8 and then become too large to be caught (Roosenburg et al., 1996). Crab pot induced mortality may contribute to differential survivorship and skew sex ratios. The use of a terrapin excluder or bycatch reduction device in crab pots has been effective at preventing the capture of terrapins and reducing mortality. Beginning in April 1999, a crab pot set in Maryland waters from private piers and waterfront property must have a bycatch reduction device (BRD) attached to each entrance. The BRD may be constructed of metal wire or plastic and should be rectangular (1 3/4" by 4 3/4"). The size of the BRD has been shown to successfully exclude terrapins from crab pots without affecting the crab catch. New Jersey and Delaware also require terrapin excluder devices in crab pots. Virginia does not require any terrapin BRD.

Research and Monitoring

The Maryland Department of Natural Resources Fisheries Service has conducted trawl and seine surveys in the coastal bays since 1972. The primary function of these surveys is to sample the annual relative abundance of juvenile and adult marine species. The annual coastal bays trawl survey samples the relative abundance of blue crabs. The survey has 20 sites (Appendix 1) which are sampled by a 16 foot balloon otter trawl, each month from April through October. Data from the trawl survey are analyzed for trends in abundance and size. The most recent data (2000) indicates that blue crab abundance in the coastal bays has increased from 1998 but is not as high as it was from 1993 through 1996 (Figure 1). Catch per unit effort (CPUE) also increased in recent years (1999 and 2000) is higher than its been since 1994 (Figure 2).

Figure 1. Annual abundance of blue crabs in the Maryland coastal bays (1972-2000).

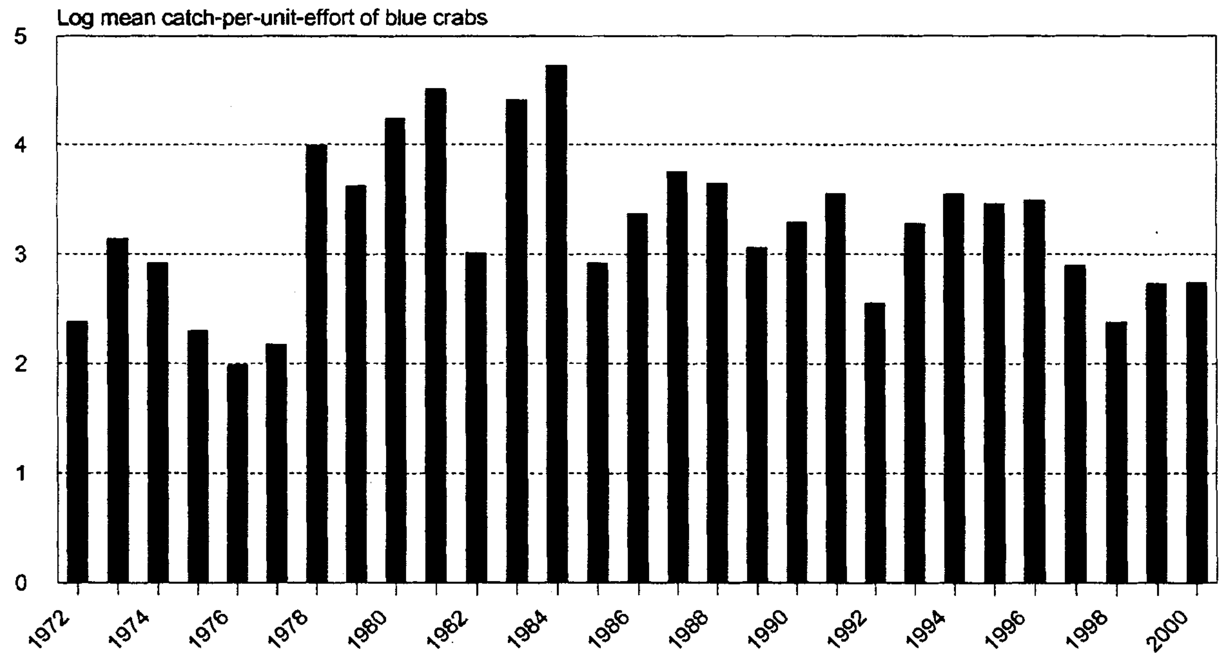
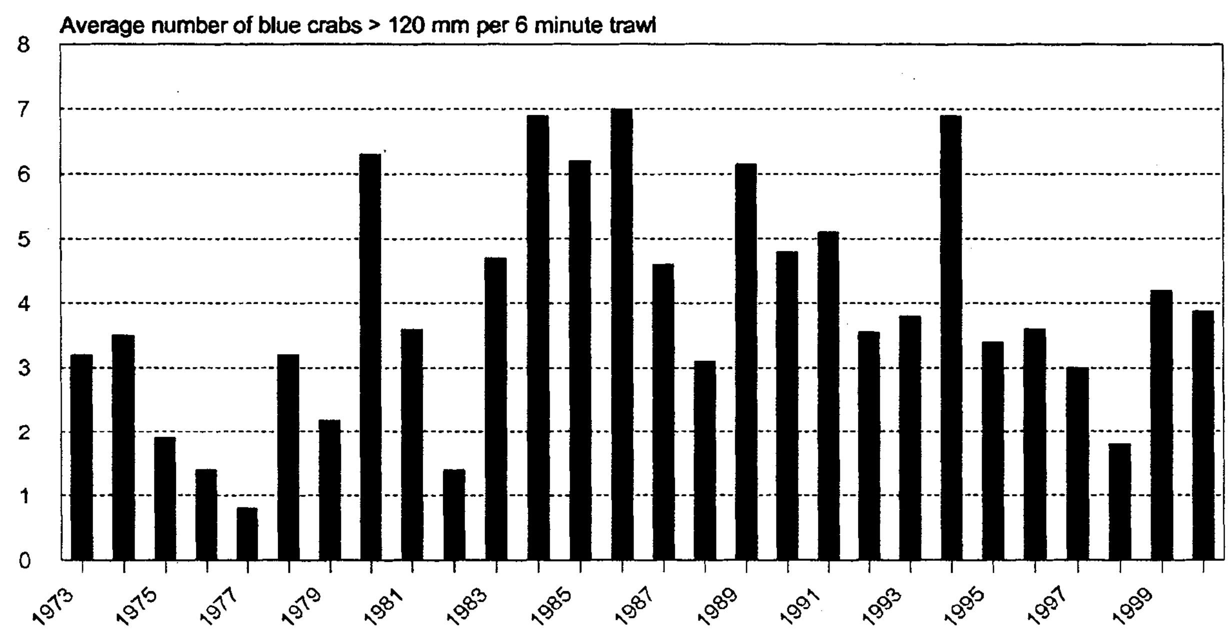


Figure 2. Catch-per-unit-effort of blue crabs (>120 mm (4.72 in.)) per 6 minute trawl in the Maryland coastal bays (1973-2000).



The mean size of blue crabs in the coastal bays is smaller than the mean size of crabs in the

Chesapeake Bay (Table 1). In the coastal bays, 95% of the blue crabs are less than the minimum legal size of 127 mm, while in the Chesapeake Bay, 79% of the crabs are below the minimum size. The difference is size can be attributed to high salinities in the costal bays. Generally, crabs from higher salinity areas reach maturity at a smaller size than those from lower salinity areas **(Reference)**.

Table 1. Mean size of blue crabs from the Maryland coastal bays trawl survey and the Chesapeake Bay summer trawl survey.

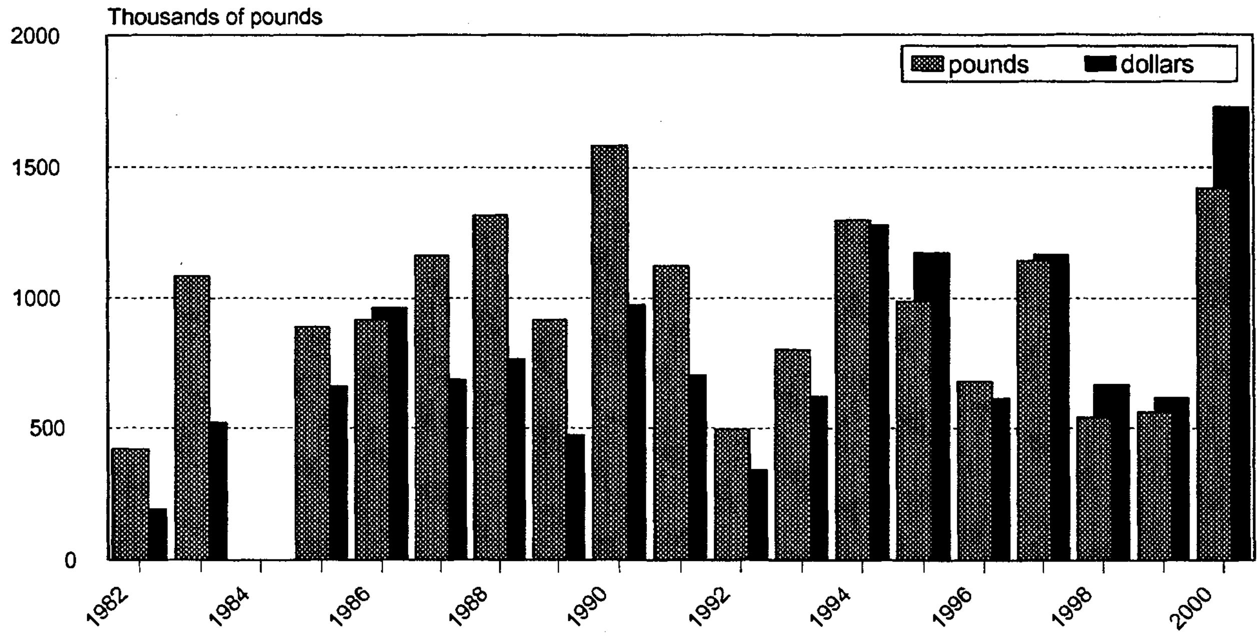
Size Category	Coastal Bays	Chesapeake Bay
All sizes and sex	58.8 mm	87.4 mm
Males >126mm	137.8 mm	146.7 mm
Mature Females	134.0 mm	151.0 mm

The density of all sizes of crabs appears to be higher in the coastal bays than in the Chesapeake Bay. The mean catch per tow of all size crabs from the coastal bays from 1989 through 1999, was 49 crabs per tow. The mean catch per tow for all size crabs from the Chesapeake Bay blue crab summer trawl survey for the same time period was 22 crabs per two. A high density of crabs in the coastal bays could be due to a variety of factors. The coastal bays habitat is a preferred depth for blue crabs throughout the whole of the coastal bays and the smaller size of the crabs probably allow for greater densities.

Status of the Coastal Bays Blue Crab Stocks

Over the past 10 years (1991-2000), annual reported commercial landings have varied from 0.5 million to 1.5 million pounds. This is similar to the 1980's when landings varied to 0.4 to 1.5 million pounds (Figure 3). Commercial coastal bay landings of hard crabs and soft/peelers has been highly variable without trend over the past 26 years. In 2000, landings increased substantially from an average of 550,000 pounds in 1998 and 1999 to 1.4 million pounds (Figure 3). Commercial landings alone do not provide an adequate description of blue crab abundance. Maryland DNR requires all commercial watermen to report their harvest, gear usage, and area fished on a monthly basis. Although there is mandatory reporting, not all commercially licensed individuals report their landings. Reporting compliance is between 73% and 79% for TFL license holders and between 90% to 93% for LCC license holders. The accuracy of the landings/harvest data has been questioned but is the best available information to date.

Figure 3. Commercial blue crab harvest and dockside value in the Maryland coastal bays (1982-2000).



The annual fishing intensity on hard crabs and soft/peeler crabs is variable. A substantial part of this variation is driven not only by natural population fluctuations but also by weather conditions, the timing and intensity of the peeler run versus that of the Chesapeake's peeler run, the outlook for the overall Chesapeake crab fishery, and the outlook for dockside prices paid by dealers. Even with this variability, there is no discernible increasing trend in the rate of commercial fishing on either the hard crab or soft/peeler fishery.

Since 1973, the fishery independent coastal bay trawl project has sampled in excess of 236,000 crabs. The annual surveys indicate the number of crabs has been highly variable but within historical values for small (<2.4 in.), medium (2.4 in. - 4.7 in.), and large (>4.7 in.) crabs. Reproduction, as measured by the relative abundance of small crabs in the trawl survey, is variable but within the historical range of values. The conclusion from the fishery independent data is that the crab stock throughout the coastal bays is relatively stable and fluctuates without any discernible long-term trends.

The impact of the recreational fishery on the blue crab stock in the coastal bays is unknown. Anecdotal evidence indicates there is a declining satisfaction among recreational crabbers, however, the fishery-independent population trends do not indicate a problem.

Description of the Coastal Bays Blue Crab Fisheries

Commercial Fishery

Commercial crabbing in the coastal bays has existed at varying intensities since the late 19th century. Over the past 10 years, at least seven different types of crab gear have been used with varying degrees of success (Table 2). During this period, crabs pots were the major gear type and accounted for approximately 98% of the harvest. Over the past seven years (1994-2000), an average of 226 commercial watermen were licensed annually in Worcester County (Table 3). Over the same period, an average of 172 licensed commercial watermen crabbed the coastal bays with an average of 70% (111 licensees) being Worcester County residents. Worcester County resident watermen do not crab strictly in the coastal bays. Approximately 26% of Worcester County residents also crab in the Chesapeake at some time during the year.

Approximately 63% of coastal bays commercial crabbers have a LCC license. Although the number of LCC license holders dominates the commercial fishery, they only land 11 to 26% of the total harvest. The LCC license permits the use of 50 pots, unlimited trotline, dip nets, collapsible traps and scrapes. The LCC licensee reports an average use of 13 to 19 pots. (Table 4). Pot use by LCC licensees also varies by month with the largest number of licensees crabbing during the summer months (June-August) (Figure 4). Those watermen with the TFL and CB3 licenses are permitted all types of legal gear. There is a 300 pot limit per boat permitted in the coastal bays. These crabbers fish the largest number of pots, averaging 200 per licensee (1994-1999) (Table 5). Although this group represents only 37% of the crabbers, they land 74% to 89% of the total commercial crab harvest. Over the past six years, the average number of pots used per licensee has varied without trend. In the last few years there has even been a slight decline in number of licensees.

The price paid for crabs is a result of market conditions, interstate imports and the economy. In 2000, the average price paid for peeler/soft crabs was $5.15/pound. Over the last 10 years, prices for this category have varied from a low of $1.54 to a high of $6.38. For hard crabs in 2000, the average price paid per pound was $0.96 for No. 2's and $1.73 for No. 1's. The total value of the blue crab harvest from the coastal bays has varied between $340,000 (1992) and $1.7 million (2000) over the past 10 years (Figure 4).

Commercial crabbers are primarily attracted to the coastal bays for its spring peeler run. Since 1995 Worcester County resident crabbers have outnumbered non-county crabbers in both the spring peeler run and the year-long hard crab fishery. Consequently, fishing intensity, pot use and landings have varied without any discernible long-term trends.

Figure 4. Average number of pots reported by LCC licensees in the Maryland coastal bays by month (1995-1999).

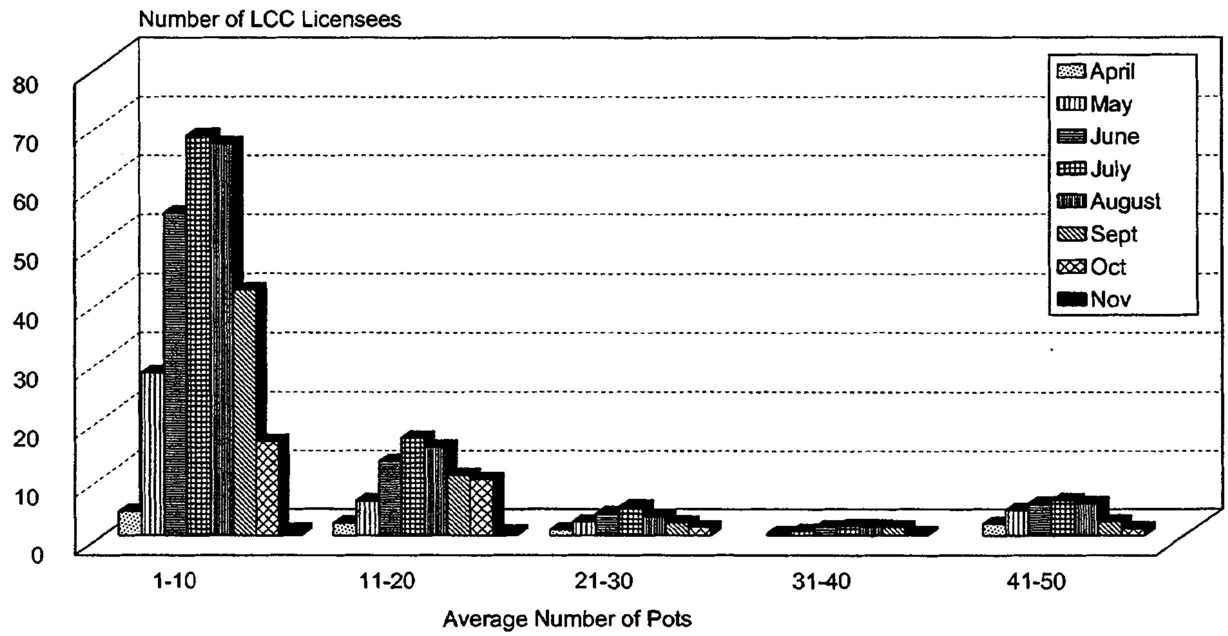


Table 2. Summary of coastal bays blue crab landings (lbs) by gear type (1990-2000).

Year	Crab Pot	Trotline	Collapsible Trap	Crab Scrape	Crab Bank Trap	Dip Net	Net Rings	Unknown
1990	1,600,000	5,058	419	—	—	—	—	—
1991	1,100,000	2,371	1,607	—	—	—	—	—
1992	500,000	—	209	—	—	—	—	—
1993	800,000	—	—	—	—	—	—	—
1994	1,200,000	13,325	65	1,891	603	—	—	794
1995	1,000,000	8,852	13	—	—	36	—	3,552
1996	700,000	2,906	13,459	—	72	31	—	2,041
1997	1,100,000	77,161	—	—	—	16	77	5
1998	5,975,000	5,975	341	—	—	—	—	—
1999	1,441,000	1,441	—	—	—	—	—	—
2000	1,419,991	1,380	-----	-----	—	-----	22	885

Table 3. Licensed crabbers in Worcester County and the coastal bays, 1994-2000.

Year	Number of Worcester County Licensed Crabbers (a)	Total Number of Licensee's Crabbing in Coastal Bays (b)	Number of Resident Worcester County Crabbers (c)	Total Number of Crabbers Working Only in Coastal Bays (d)
1994	168	193	77	145
1995	256	195	124	162
1996	249	162	115	144
1997	236	181	116	153
1998	225	159	114	149
1999	224	159	115	151
2000	222	158	114	145

(a) Not all Worcester County licensed crabbers work only or seasonally in the coastal bays. Part of the county fronts on the lower Pocomoke River and many work exclusively or seasonally in the Chesapeake Bay and its tidal tributaries.
(b) This is the total number of licensed Maryland crabbers who work at least part of the time in the coastal bays. Many are out-of-county crabbers who come over for the spring peeler run then return to the Chesapeake Bay.
(c) This is the number of resident Worcester County licensed crabbers who indicate that they work only in the coastal bays. Again, this may be seasonal and/or part time work.
(d) This is the total number of licensed Maryland commercial crabbers, both county and non-county Maryland residents who indicate that they crab only in the coastal bays. This category also includes the totals from column (c). Again, this may be seasonal and/or part time work.

Table 4. Number of commercial crabbers with the LCC and TFL license and average number of reported pots used per LCC and TFL licensee in Maryland's coastal bays, 1994-2000.

Year	LCC License Holders		TFL License Holders	
	# of Licenses	Average # of Pots Used Per Licensee	# of Licenses	Average # of Pots Used Per Licensee
1994	122	13	65	219
1995	131	14	57	216
1996	114	14	46	194
1997	112	17	53	209
1998	111	19	43	167
1999	92	15	35	192
2000	106	11	43	195

Recreational Fishery

The recreational fishery for blue crabs in the coastal bays has not been documented. There is a need for accurate annual recreational estimates of crabbing in the coastal bays. It is generally believed to be not as large as the recreational blue crab fishery in the Chesapeake Bay which is approximately 25% of the commercial harvest. In the Chesapeake Bay, recreational landings have been estimated between 11 and 40 million pounds annually. Recreational crabbers in the coastal bays believe there has been a decrease in crab abundance based on what they use to catch. Waterfront property owners are no longer catching large number of crabs. Current data limitations make it difficult to discern if the decrease in satisfaction is due to a decrease in crab abundance or another unknown reason.

Recreational crabbing in the coastal bays is primarily a small boat fishery. Much of the recreational effort is centered in the two northernmost coastal bays, the Isle of Wight and Assawoman. The small boat fishery primarily uses collapsible traps but some illegal use of crab pots occurs. Crab pots are considered as commercial gear in Maryland but not in Virginia which may cause some confusion. Another source of confusion comes from waterfront landowners who are allowed to use two crab pots from their property. The Natural Resources Polic have confiscated as many as 50 pots during the summer months. Tributaries like Turville Creek, Mancklin Creek and the St. Martin's River are popular locations for the small boat fishery.

Crabbing from shore in the coastal bays is limited because the region does not have the numerous natural, shoreside and public access sites found in Chesapeake Bay. Most shoreside sites in the coastal bays are privately owned. The few, well-used public access sites near Ocean City are bulkheads, bridges and piers. Most of these sites are not optimum for crabbing because of strong currents, shallow waters and boating activity. These areas are better for fishing than crabbing. Only three small public sites are regularly used for crabbing, the public ramp bulkhead at south Point, the Assateague State Park pier, and the public pier in Northside Park, Ocean City. Other public sites found in the coastal bays are isolated and generally unknown except by the local residents. Throughout the coastal bays, there are approximately seven other land sites (in addition to the three already mentioned) with public access, that are used to varying degrees for fishing and/or crabbing: St. Martin's Neck Road causeway, north of the Isle of Wight; south shore, the Isle of Wight; fishing/crabbing pier at Sandy Point, Assateague State Park; bulkhead, South Point public boat ramp; public pier, village of Public Landing; and, bulkhead, Taylor's Landing public boat ramp. Shoreside crabbing takes place along the bulkheads and private piers in developments and along the southern side of the Isle of Wight. In these instances, handlines are the gear of choice with some use of collapsible traps.

SECTION 3. MANAGEMENT STRATEGY

OBJECTIVE 1: Improve our understanding of how *Hematodinium* contributes to the mortality and population abundance of blue crabs.

Problem 1.1: Research and Monitoring - Adult and juvenile crabs from the coastal bays have been found to be infected with a parasitic dinoflagellate, *Hematodinium perezi.* Up to 90% of juvenile crabs have infections during the early winter and high mortalities in adults are reported by watermen during the summer months. How the disease contributes to mortality and impacts the blue crab population is an important management issue.

Action 1.4.1: DNR and MCBP will identify potential funding sources to support the following research and monitoring activities:

a) Assess the impact of *Hematodinium* in the coastal bay's blue crab population (i.e. identify what intensity of *Hematodinium* infection causes mortality, and identify other factors, environmental and/or biological, that may influence blue crab mortality from *Hematodinium*).

b) Identify factors which influence *Hematodinium* proliferation, elucidating different life stages, determining the full life cycle of the parasite, and eventual production of a more specific diagnostic tool either by immunoassay or molecular assay techniques.

c) Examine how crabs become infected with *Hematodinium.*

Implementation (a-c): 2001

Action 1.4.2: DNR will define the criteria under which a Marine Protected Area can be effective in assessing the impacts of *Hematodinium* on blue crabs.

Implementation: Initiate in 2001

OBJECTIVE 2: Improve our understanding of blue crab biology and stocks.

Problem 2.1: Stock Status - Fishery dependent and independent data indicate relatively stable crab populations which fluctuate annually without any discernable long-term trends. Localized declines may not be apparent in this data and is of concern given the declining satisfaction among recreational crabbers. Factors influencing crab abundance are not well understood and more information is needed to facilitate future management efforts.

Action 2.1.1: Adopt an overfishing threshold consistent with Chesapeake Bay that preserves a minimum of 10 percent of the blue crab's spawning potential (F_{10} percent), and a fishing target that preserves 20 percent of an unfished stock. (F_{20} percent).

Implementation: 2001

Action 2.1.2: DNR will work towards implementing the necessary research and monitoring programs to determine the appropriate fishing mortality rates that will achieve the established fishing target of F_{20} percent. (Chesapeake Bay mortality rates (fishing and natural) are not necessarily transferable to Maryland's coastal bays.)

Implementation: Continue current fishery independent and dependent surveys, and implement additional research and monitoring, as necessary, based upon available funding.

Action 2.1.3: DNR will work towards allocating funds specific to the Department's coastal bays blue crab monitoring program and data analysis.

Implementation: Initiate in 2001

Action 2.1.4: DNR and MCBP will encourage research that examines the stock - recruitment relationship of blue crabs in the coastal bays, level of localized reproduction and entrapment of larvae, and effects of environmental parameters which influence fluctuations in crab abundance (i.e. including this action in the FMP will identify these research needs as a high priority which will better enable DNR, MCBP, Universities and others to obtain support for funding these research projects).

Implementation: 2001

Action 2.1.5: DNR will examine the utility of developing a public outreach indicator(s) of blue crab abundance which can be used to inform the community on the annual status of blue crab stocks in the coastal bays.

Implementation: 2001

Problem 2.2: Commercial Catch and Effort Data - Maryland modified the blue crab commercial reporting system in 1994 by implementing mandatory monthly reporting. Despite this effort, many fishermen still do not provide monthly reports (i.e. 25 percent and 10 percent of TFL and LCC license holders, respectively) and their harvest has to be estimated. The effects of this reporting change and accuracy of the current reporting system are unknown. Further, the harvest of crabs by individuals who begin the crabbing season (i.e. April and May) in the coastal bays prior to returning to Chesapeake Bay for the remaining season is not accurately monitored. Commercial crabbers are currently required to identify the body of water for which the majority of their monthly harvest was taken. Individuals who crab commercially in both the coastal bays and Chesapeake Bay during one month (i.e. May) may be reporting the entire months harvest as Chesapeake Bay. Implementing a new reporting system may affect the utility of long-term landings data but is necessary to address management issues in the coastal bays.

Action 2.2.1: DNR will establish, implement and evaluate a commercial reporting monitoring program to obtain accurate catch and effort data from anyone crabbing commercially in Worcester County consistent with recommendations of the Atlantic Coast Cooperative Statistics Program.

a) Evaluate the effectiveness of the "pilot" daily logbook reporting system implemented in 2000 for commercial crab harvesters and dealers in Worcester County.

Implementation: 2001

b) Consider using the Chesapeake Bay's commercial crab reporting system, but make it specific to the coastal bays, including more detailed information on location of harvest and effort data.

Implementation: 2001

Action 2.2.2: DNR will improve the enforcement of mandatory monthly reporting.

Implementation: 2001

Problem 2.3: Recreational Catch and Effort Data - There is no information on the harvest, effort, and economic impact of recreational crabbing in the coastal bays.

Action 2.3.1: DNR will design and implement a recreational crabbing survey in the coastal bays consistent with the pilot recreational crabbing survey in Chesapeake Bay.

Implementation: 2001 - Dependent on funding.

Action 2.3.2: DNR will identify potential funding mechanisms to fund and complement monitoring efforts outlined in Strategies 2.3.1 and 2.1.1.

Implementation: 2001

Problem 2.4: Invasive, Non-Indigenous Species - The coastal bays support eight species of walking crabs and three species of swimming crabs, one of latter sharing the same genus as the blue crab. Two of the former, the green crab (*Carcinus macnas*) and Japanese shore crab (*Hemigrapsus sanguineaus*) are exotic (non-native) species which have recently arrived in the coastal bays. The green crab first appeared in the Ocean City inlet and has since expanded its range north and south in the coastal bays. Green crabs prey upon bivalves and other crab species. In Maine, the green crab has been blamed for the collapse of the soft-shell clam industry (ASMFC 1999). Although both non-indigenous crab species in the coastal bays are known to feed on other crabs and generally the same forage, their effect on the native blue crab population is speculative at this time.

Action 2.4.1: DNR will continue to monitor the abundance and impact of green crabs and other invasive, non-indigenous crab species.

Implementation: Ongoing, but limited due to funding.

Action 2.4.2: DNR will evaluate the following management strategies related to green crabs:

a) DNR will prohibit the possession and sale of imported green crabs, and promote the harvest and sale of locally harvested green crabs.

b) DNR will prohibit the importation and sale of green crabs.

Implementation: 2001

Action 2.4.3: DNR will continue to work with Maryland's Non-Indigenous Species Task Force to examine invasive species issues, and develop an Aquatic Nuisance Species Plan to become eligible for Federal funding.
Implementation: Ongoing

Action 2.4.4: MCBP will develop an outreach program (i.e. brochures) to educate the coastal bays community on the impacts of exotic species.
Implementation: 2001

Problem 2.5: Functional Role of Blue Crabs in the Natural Ecological Community - The natural ecological functions of blue crabs in the coastal bays needs to be determined and considered in the blue crab fishery management plan. Outside of the information on the predator-prey relationships of blue crabs, little information is available to determine the natural ecological function of blue crabs in the coastal bays.

Action 2.5.1: DNR will examine methods/studies to better understand the natural ecological functions of blue crabs in the coastal bays, including the establishment of a Marine Protected Area in the coastal bays.
Implementation: Dependent on funding.

OBJECTIVE 3: Maintain an economically stable and sustainable commercial blue crab fishery.

Problem 3.1: Commercial Crabbing Effort - The available data indicate that commercial crabbing effort in the coastal bays is within an acceptable level. Given the current difficulties in accurately assessing the coastal bays' crab stock, limited understanding on the factors which influence population fluctuations, and concerns about the accuracy of commercial effort data, it would be prudent to prevent effort from increasing until an accurate stock assessment is available.

Action 3.1.1: DNR will improve the accuracy of effort data in the coastal bays' commercial blue crab fishery by implementing actions related to Problem 2.2 - Commercial Reporting.
Implementation: Initiate in 2000

Action 3.1.2: DNR will continue to manage the coastal bays commercial blue crab fishery through the use of time limits, seasons, gear restrictions, catch limits, size limits, limited entry, and other management strategies as necessary, to prevent further increases in fishing effort.
a) **Gear Restrictions** - Prohibit the taking of blue crabs in the coastal bays by scrape and dredge to prevent these fisheries from developing, and lessen the gear impacts on blue crab habitat;

b) **Time Restrictions** - Establish similar time restrictions to those in the Chesapeake Bay to prevent a shift in crabbing effort from the Chesapeake Bay to the coastal bays during years when crab abundance is low in the Chesapeake Bay.

1) For 2001 - Prohibit the taking of crabs for commercial purposes between 2:00 p.m. and 5:30 a.m.

Implementation: 2001

Problem 3.2: Harvest of Female Crabs - The harvest of sponge crabs and females at other life history stages may result in a loss of reproductive capacity. It is difficult to assess whether or not the protection of females will result in an increase in abundance of blue crabs in the coastal bays without understanding if there is a stock-recruitment relationship, and the impacts of Hematodinium. If research (Action 2.1.3) indicates localized reproduction and entrapment within the coastal bays is significant, it may be prudent to establish short-term management measures aimed at protecting female crabs, and monitor the effects of these measures on the coastal bays' blue crab population to determine if they should be continued on a long-term basis.

Action 3.2.1: DNR will continue to prohibit the harvest of sponge crabs, and limit the taking of female crabs in the coastal bays through the use of time limits, seasons, area closures, gear restrictions, catch limits, and size limits, as necessary.

a) **Area Closures** - DNR will delineate areas where female blue crabs are concentrated (Action 5.2.1(a)), and determine the appropriate time periods for which commercial crabbing and hydraulic clam dredging should be allowed within these areas. The following areas have been identified as potential closure areas (Figure 6) but need to be delineated further:

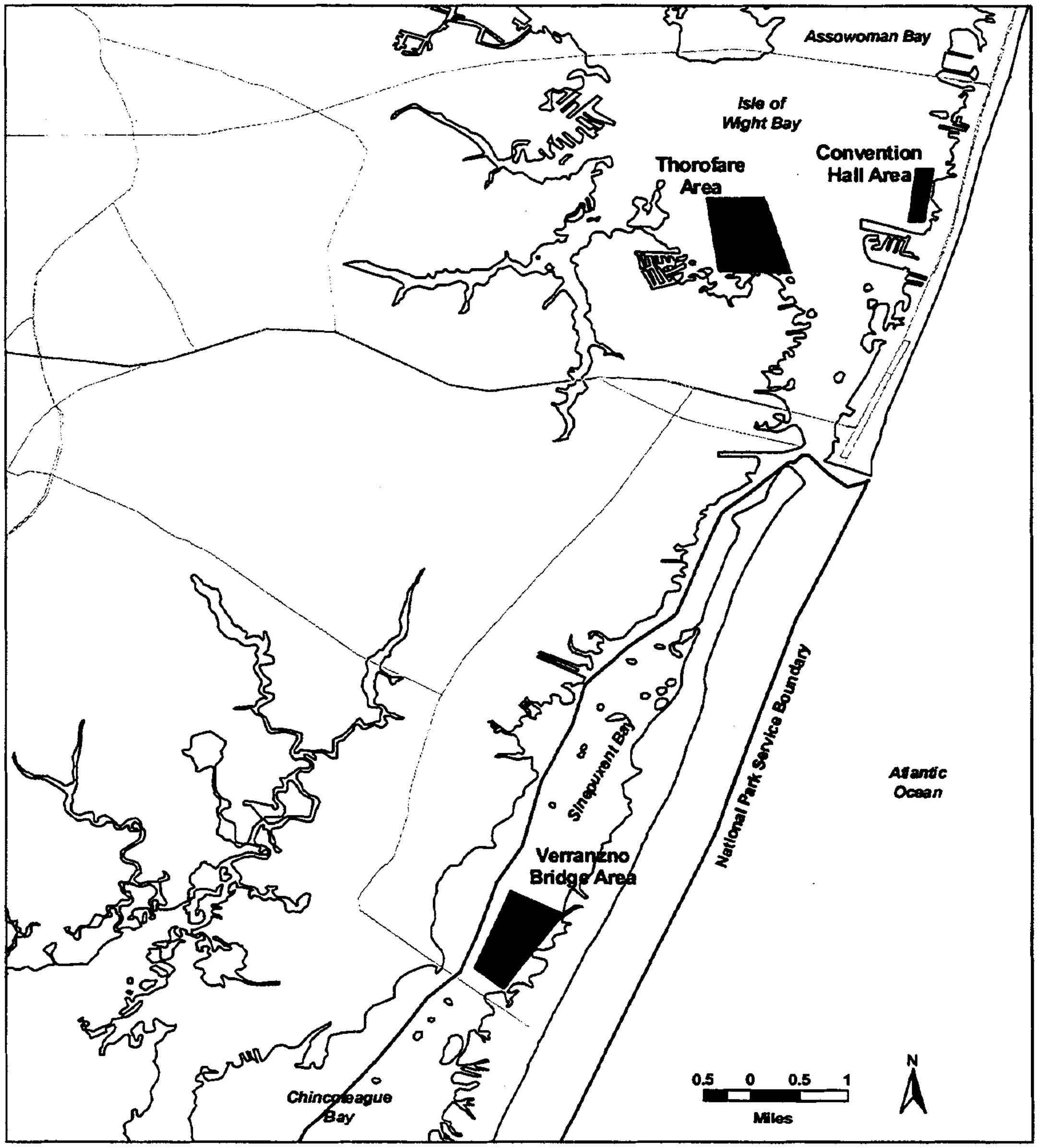
1) The Convention Hall site, bayside of Ocean City roughly between 36th and 50th Street; and

2) The Thorofare site, in southern Isle of Wight Bay;

3) The Bridge site, just north of the Verrazano Bridge on the barrier island side.

Implementation: Delineate areas in 2001, and implement area closures, if necessary, in 2002.

Figure 6. Potential Protection Areas for Female Blue Crabs



b) **Catch and Size Limits** - Determine if the current catch and size limits for female crabs are appropriate.

Implementation: Dependent on funding (potential University research project).

Action 3.2.2: DNR will investigate the economic impact of prohibiting the possession and sale of sponge crabs within the state.

Implementation: 2001

Problem 3.3: Wasteful Harvest Practices - Harvesting undersized crabs does not maximize economic value of the resource. Cull rings allow the escapement of small, legal-size peelers and mature females during certain seasons. Cull rings that allow sublegal crabs to escape are required in Maryland, however, current legislation allows cull rings to be obstructed when fishing for peelers. Lost or abandoned crab pots are attractive refuge sites that trap, and eventually result in significant mortality of crabs and finfish, as well as air breathing animals, such as terrapins, that inhabit tributaries and near-shore waters. Crab pots often become lost when boat propellers cut buoy lines and during storms. Abandoned pots can also be navigational hazards for boats.

Action 3.3.1 DNR will require unobstructed cull rings in crab pots from June 1 through April 30, and will adjust cull ring requirements based upon further research (peeler pot cull ring study being planned on Chesapeake Bay).

Implementation: 2002

Action 3.3.2: DNR will determine if measures are necessary to reduce the bycatch mortality of crabs in the hydraulic clam dredge fishery (i.e Action 3.2.1(a) - prohibition of hydraulic clam dredging in areas where female crabs are concentrated).

Implementation: 2002

Action 3.3.3: DNR will continue to require terrapin excluders in crab pots set for noncommercial purposes, encourage watermen to install terrapin excluders in commercial crab pots, and investigate the feasibility (i.e. effects on catch; economic impact) of requiring terrapin excluders in all crab pots set in the coastal bays.

Implementation: Evaluate in 2001; implement in 2002, if appropriate.

Action 3.3.4: MCBP will coordinate an annual/seasonal volunteer effort to locate and remove derelict pots.

Implementation: 2001

OBJECTIVE 4: Improve the recreational crabbing experience.

Problem 4.1: Satisfaction of Recreational Crabbers - There is anecdotal evidence that suggests a declining satisfaction among recreational crabbers. The implementation of this FMP should result in an improved blue crab stock in the coastal bays, and ultimately improve recreational crabbing. The more specific actions under Objective 4 should further enhance the recreational crabbing experience.

Action 4.1.1: DNR and MCBP will obtain information on satisfaction levels of recreational crabbers in the coastal bays to evaluate the effectiveness of management measures.

Implementation: Obtain baseline data from the 2000 water-use assessment study.

Action 4.1.2: DNR will examine the effects of habitat quality on the success rates of recreational crabbing in the coastal bays.

Implementation: Initiate in 2000.

Action 4.1.3: DNR and MCBP will develop and distribute the following information pertaining to the recreational crab fishery in the coastal bays:

a) Recreational crabbing brochure summarizing crabbing restrictions;
b) Recreational crabbing sign for access points (i.e. boat ramps and fishing/crabbing piers);
c) Maps of land-based public access and boat based crabbing locations, list of boat ramps and marinas with rental boats, and recreational crabbing tips.

Implementation: (a-c) Ongoing - dependent on funding.

Action 4.1.4: DNR, MCBP, Town of Ocean City and Worcester County will work towards increasing the number of land-accessible areas for recreational crabbing.

Implementation: Ongoing

OBJECTIVE 5: Protect, maintain and enhance blue crab habitat.

Problem 5.1: Submerged Aquatic Vegetation (SAV) - SAV is an important habitat component for blue crabs, as well as hard clams which is an important food source for blue crabs, and has been increasing in the coastal bays over the last few years. Activities which contribute to the destruction of SAV (i.e. shoreline development that reduces shallow water habitat, heavy boat traffic, crab scraping, and clam dredging) should be minimized.

Action 5.1.1: DNR will alleviate the impact of hydraulic clam dredging and prop scarring to SAV in the coastal bays by:

a) Prohibit hydraulic clam dredging in SAV;
b) Annually documenting the areas and extent of impact;
c) Researching seagrass recovery time;
d) Investigating the use of buoys to mark beds, SAV setbacks, depth restrictions, GPS equipment to identify boundaries, and education as tools to protect beds from damage; and
e) Implementing and enforcing necessary regulations to protect SAV from hydraulic clam dredging.

Implementation (a-e): Ongoing

Action 5.1.2: By implementing Action 2.1.2, DNR will prohibit the taking of blue crabs in the coastal bays by scrape and dredge to prevent these fisheries from developing and impacting SAV.

Implementation: 2001

Action 5.1.3: DNR and MCBP will continue to identify SAV species needing protection and activities needing restrictions.

Implementation: Ongoing

Action 5.1.4: MCBP will expand surveys/citizens monitoring to groundtruth SAV species composition and determine accuracy of photo interpretive maps.

Implementation: Ongoing

Action 5.1.5: DNR and Natural Resources Conservation Service (NRCS) will develop habitat requirements for the growth of seagrasses in the coastal bays by:

a) DNR will develop water quality requirements for seagrassess;
b) DNR will identify areas that meet water quality requirements for restoration purposes;
c) NRCS will compile data relating coastal bay soil types to bottom communities and identify other variables having effects on seagrass establishment and maintenance; and

Implementation (a-c): 2000

d) NRCS will complete soil mapping effort for entire coastal bays

Implementation: 2000

Problem 5.2: Overwintering Habitat - After mating, female blue crabs migrate to staging areas in the coastal bays. Early arriving females will spawn prior to winter, while latecomers will spawn the following spring after winter hibernation. During this time, females are vulnerable to harvest by nature of their dense distribution in specific areas. Protecting the areas where females overwinter may be beneficial to the spawning stock. Overwintering habitats of juvenile and male blue crabs also need protection.

Action 5.2.1: DNR will identify and protect blue crab overwintering areas in the coastal bays by:

a) Delineating and mapping overwintering areas; and
b) Prohibiting hydraulic clam dredging in important overwintering areas year-round, unless data indicates that these areas can be opened on a seasonal basis (see Action 3.2.1(a)).
c) DNR will define the criteria under which a Marine Protected Area can be effective in protecting blue crab overwintering areas.

Implementation: (a) 2000 and 2001; (b) 2002; (c) 2003

Problem 5.3: Shallow Water and Shoreline Habitats - Fishery independent sampling results indicate that small crabs utilize shallow water areas especially in marshy, tidal guts and grassbeds (SAV). These areas provide protection from predation and are essential for growth and feeding.

Action 5.3.1: DNR will support actions in the CCMP, specifically "Challenge 1.9 of the Fish and Wildlife Section" to protect and enhance shallow water and shoreline habitats important to blue crabs. DNR and Worcester County are the lead agencies for the majority of these actions. Refer to the CCMP for more specific information on these actions.

Implementation: Ongoing

Problem 5.4: Dissolved Oxygen - Blue crabs avoid areas with low dissolved oxygen (DO) and are known to leave the water to escape hypoxic (low oxygen) water (often referred to as a "crab jubilee"). Studies have found about 50% mortality associated with crabs held in waters with < 2ppm oxygen at depths below 7 m (Carpenter and Cargo, 1957). Hypoxic water has been shown to effect the recruitment and migratory success of postlarval (megalopae) blue crabs by altering behavior associated with shoreward transport and settlement processes (Tankersley and Ziegler 2000). Besides affecting blue crab physiology, anoxic waters (no oxygen) may also reduce the benthic food supply and limit blue crab distribution. Maintaining a DO greater than $3mgL^{-1}$ at 25-28°C should provide an adequate area to support blue crabs.

Action 5.4.1: DNR will support actions in the CCMP, specifically in the "Water Quality Section" and "Fish and Wildlife Section" to minimize the impacts of unsuitable dissolved oxygen levels to blue crabs in the coastal bays. Maryland's Coastal Bays Program, Town of Ocean City, and Worcester County are the lead agencies for the majority of these actions. Refer to the CCMP for more specific information on these actions.

Implementation: Ongoing

Action 5.4.2: DNR will identify areas which have unsuitable levels of dissolved oxygen (i.e. < 3 mg/L) for blue crabs.

Implementation: Ongoing

Problem 5.5: Nutrient, Sediment, and Chemical Inputs - Refer to pages 10 and 11 for a description of the effects of nutrient, sediment and chemical inputs on blue crabs.

Action 5.5.1: DNR will support actions in the "Water Quality" section of the CCMP to control nutrient, sediment and chemical inputs which will protect and enhance blue crab habitats. Worcester County and Maryland's Coastal Bays Program are the lead agencies for the majority of these actions. Refer to the CCMP for more specific information on these actions.
Implementation: Ongoing

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OBJECTIVE 6: Improve enforcement of crabbing restrictions.

Problem 6.1: Enforcement of Conservation Measures - There is a lack of enforcement personnel to address many of the natural resources and conservation laws in the coastal bays.

Action 6.1.1: DNR will consider increasing the number of enforcement personnel in the coastal bays, specifically during the crabbing season.
Implementation: Ongoing

Action 6.1.2: DNR will consider expanding the Natural Resource Police reserve officer program.
Implementation: Ongoing

REFERENCES

Alexander, S. 1986. Diet of the blue crab, *Callinectes sapidus* Rathbun, from nearshore habitats of Galveston Island, Texas. Texas J. Sci. 38:85-89.

Allison, G.W., J. Lubchenco, and M.H. Carr. 1998. Marine reserves are necessary but not sufficient for marine conservation. Ecol. Applic. 8(1) Supplement, 579-592.

Austin, H. and J. Walter. 1999. Food habits of large striped bass in the lower Chesapeake Bay and its tributaries. A final report submitted to the Marine Recreational Fisheries Advisory Board and Commercial Fisheries Advisory Board, Virginia Marine Resources Commission. Contract Number RF-97-08 and Cf-97-08.

Bishop, J. M. 1983. Incidental capture of diamondback terrapins in crab pots. Estuaries 6:426-430.

Carpenter, J. and D. Cargo. 1957. Oxygen requirement and mortality of the blue crab in the Chesapeake Bay. Ches. Bay Inst. Tech. Rep. 13.

Carr, A. 1952. The handbook of turtles. Cornell University Press, Ithaca, New York.

Causey, B. 1999. Use of marine zoning in the Florida Keys National Marine Sanctuary to balance resource protection with utilization. In: Kutz, F, P. Koenings, and L. Adelhardt. Proceedings - Delmarva Coastal Bays Conference III: Tri-State Approaches to Preserving Aquatic Resources. U. S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, Narrangansett, RI. EPA/620/R-00/001

Christoffers, E. 1990. The fisheries of Maryland's coastal bays. In: Focus on Maryland's Forgotten Bays. The Belton fund. U.S. EPS, Region III, Institute for Cooperation in Environmental Management.

Costlow, J. Jr. 1967. The effect of salinity and the harvest of potential spawning stock or the female stock temperature on survival and metamorphosis of megalops of the blue crab *Callinectes sapidus*. Helgolander wiss. Meeresunhters. 15:84-97. Cited in Van Heukelem, 1991.

Darnell, R. 1958. Food habits of fishes and larger invertebrates of Lake Pontchartrain, Louisiana, an estuarine community. Texas University Inst. Of Mar. Sci. Publ. 5:353-416.

Eggleston, D. 1990. Foraging behavior of the blue crab, *Callinectes sapidus*, on juvenile oysters, *Crassostrea virginica*: effects of prey density and size. Bull. Mar. Sci. 46:62-82.

Eggleston, D., R. Lipcius and A. Hines. 1992. Density-dependent predation by blue crabs upon infaunal clam species with contrasting distribution and abundance patterns. Mar. Ecol. Prog. Ser. 85:55-68.

Engel, D and G. Thayer. 1998. Effects of habitat alteration on blue crabs. J. of Shell. Res. Vol. 17, No 2, 579-585.

Environmental Protection Agency (EPA). 1995. Assessment of the ecological condition of the Delaware and Maryland coastal bays. U.S. EPA Contract No. 68-DO-0093, Versar, Inc.

Epifanio, C. 1995. Transport of blue crab (*Callinectes sapidus*) larvae in the waters off mid-Atlantic states. Bull. Mar. Sci. 57(3): 713-725.

Epifanio, C., C. Valenti, and A. Pembroke. 1984. Dispersal and recruitment of blue crab larvae in Delaware Bay, U.S.A. Estuarine, Coastal, and Shelf Sci. 18:1-12.

Frazer, R., S. Blitch, M. Posey, T. Alphin and T. Glancy. 2000. Habitat use by juvenile blue crabs along Florida's north central Gulf coast. Blue Crab Symposium, 29th Annual Meeting, North Carolina Sea Grant. University of North Carolina, Wilmington, N.C.

Funderburk, S, J. Mihursky, S. Jordan, and D. Riley. 1991. Habitat requirements for Chesapeake Bay living resources: Blue Crabs. Habitat Objectives Workgroup, Living Resources Subcommittee, Chesapeake Research Consortium, Inc. Solomons, Maryland

Goshorn, D. and J. Casey. 1993. An examination of the relationship between striped bass and blue crabs. Maryland Department of Natural Resources. Fish. Tech. Memo. Ser. 3, Jan. 1993

Goodrich, D, J. van Montfrans and R. Orth. 1989. Blue crab megalopae influx to Chesapeake Bay: evidence for a wind-driven mechanism. Estuarine; Coastal and Shelf Science. 29:247-260.

Grosberg, R. and D. Levitan. 1992. For adults only? Supply-side ecology and the history of larval biology. Trends Ecol. Evol. 4:16-20.

Heck, K. and T. Thoman. 1981. Experiments on predator-prey interactions in vegetated aquatic habitats. J. Exp. Mar. Biol. Ecol. 53:125-134.

Heck, K. and K. Wilson. 1987. Predation rates on decapod crustaceans in latitudinally separated seagrass communities: a study of spatial and temporal variation using tethering techniques. J. Exp. Mar. Biol. Ecol. 107:87-100.

Hines, A., P. Jovoff, P. Bushmann, D. Wolcott, J. van Montfrans, S. Reed, and T. Wolcott. 2000. Evidence for sperm limitation in blue crabs. Blue Crab Symposium, 29th Annual Meeting, North Carolina Sea Grant. University of North Carolina, Wilmington, N.C.

Hines, A., R. Lipcius and A. Haddon. 1987. Population dynamics and habitat partitioning by size, sex, and molt stage of blue crabs *Callinectes sapidus* in a subestuary of central Chesapeake Bay. Mar. Ecol. Prog. Ser. 36:55-64.

Johnson, D.R., N.A. Funicelli, and J.A. Bohnsack. 1999. Effectiveness of an existing estuarine no-take fish sanctuary within the Kennedy Space Center, Florida. N.Amer. J. of Fish. Man. 19:436-453.

Jones, C., J. McConaugha, P. Geer and M. Prager. 1990. Estimates of spawning stock size of the blue crab, *Callinectes sapidus*, in Chesapeake Bay, 1986-1987. Bull. Mar. Sci. 46:159-169.

Knotts, K. 1989. Preliminary Stock Assessment of the Chesapeake Bay Blue Crab Population. Thesis submitted to University of Maryland. 206 pp.

Lauck, T., C.W. Clark, M. Mangel, and G.R. Munro. 1998. Implementing the precautionary principle in fisheries management through marine reserves. Ecol Applications, 8(1) Supplement, pp.572-578.

Laughlin, R. 1982. Feeding habits of the blue crab, *Callinectes sapidus* Rathbun, in the Apalachicola estuary, Florida. Bull. Mar. Sci. 32:807-822.

Linder, C., J. Casey and S. Jordan. 1996. Ecological integrity of Maryland's coastal bays: effects of water quality, physical habitat, and land use characteristics. Maryland Department of Natural Resources, Tidewater Administration, Chesapeake Bay Research and Monitoring Division.

Lipcious, R. and A. Hines. 1986. Variable functional responses of a marine predator in dissimilar homogenous microhabitats. Ecology 67:1361-1371.

Lipcius, R. and W. Van Engel. 1990. Blue crab population dynamics in Chesapeake Bay: variation in abundance (York River, 1972-1988) and stock-recruit functions. Bull. Mar. Sci. 46:180-194.

Lipcius, R., E. Olmi, J. Van Montfrans. 1990. Planktonic availability, molt stage and settlement of blue crab postlarvae. Marine Ecol. Prog. Ser. 58:235-242.

Mansour, R. 1992. Foraging ecology of he blue crab, *Callinectes sapidus* Rathbun, in the lower Chesapeake Bay. Dissertation for Ph.D., Virginia Institute of Marine Science, College of William and Mary, Gloucester, VA.

Mansour, R. and R. Lipcius. 1993. The feeding ecology of blue crabs in the lower Chesapeake Bay. Virginia Sea Grant Program, Virginia Mar. Res. Bull. 25(1-2):8-9.

Mayer, F. Jr. 1987. Acute toxicity handbook of chemicals to estuarine organisms. U. S. Environmental Protection Agency, April 1987.

McConaugha, J. 1988. Export and reinvasion of larvae as regulators of estuarine decapod populations. Amer. Fish. Soc. Sympos. 3:90-103.

McConaugha, J., D. Johnson, A. Provenzano and R. Maris. 1983. Seasonal distribution of larvae of *Callinectes sapidus* (Crustacea:Decapoda) in the waters adjacent to Chesapeake Bay. J. Crust. Biol.

3(4):582-591.

McMillen-Jackson, A., T. Bert, and P. Steele. 1994. Population genetics of the blue crab Callinectes sapidus: modest population structuring in a background of high gene flow. Mar. Bio. 118:53-65.

Messick, G. 1994. *Hematodinium perezi* infections in adult and juvenile blue crabs, *Callinectes sapidus*, from coastal bays of Maryland and Virginia. USA. Diseases of Aquatic Organisms 19:77-82.

Messick, G., S. Jordan and W. van Heukelem. 1999. Salinity and temperature effects on *Hematodinium* sp. in the blue crab *Callinectes sapidus*. J. Shellfish Res. 18.

Metcalf, K. and R. Lipcius. 1992. Relationship of Habitat and Spatial Scale with Physiological State and Settlement of Blue Crab Postlarvae in Virginia. Masters Thesis. Virginia Institute of Marine Science. Gloucester Pt., VA.

Millikin, M. and A. Williams. 1984. Synopsis of biological data on the blue crab, *Callinectes sapidus* Rathbun. FAO Fisheries Synopsis No. 138. NOAA Technical Report NMFS 1. pp 1-39.

Mosca, R, P. Ruderhausen and R. Lipcius. 1995. Do striped bass and blue crab abundance correlate in Chesapeake Bay? Va. J. of Sci. 46(4):249-258.

Nowlis, J.S. and C.M. Roberts. 1998. Fisheries benefits and optimal design of marine reserves. Fish. Bull. 97:604-616.

Olmi, E. 1993. Immigration of Blue Crab (*Callinectes sapidus*) Megalopae in the York River, Virginia: Patterns and Processes. Dissertation presented to the College of William and Mary, Virginia Institute of Marine Science.

Orth, R. and J. van Montfrans. 1987. Utilization of a seagrass meadow and tidal marsh creek by blue crabs *Callinectes sapidus*. I. Seasonal and annual variations in abundance with emphasis on post-settlement juveniles. Mar. Ecol. Prog. Ser. 41:283-294.

Orth, R. and J. van Montfrans. 1990. Utilization of marsh and seagrass habitats by early stages of *Callinectes sapidus*. II. Spatial and temporal patterns of molting. Bull. Mar. Sci. 46:95-104.

Penry, D. 1982. Utilization of *Zostera marina* and *Rupia maritima* habitat by four decapods with emphasis on *Callinectes sapidus*. M.A. Thesis, College of William and Mary, Williamsburg, VA.

Pile, A. 1993. Effects of habitat and size-specific predation on the ontogenetic shift in habitat use by newly settled blue crabs, Callinectes sapidus. Master's thesis, Virginia Institute of Marine Science, College of William and Mary, Gloucester Pt, VA.

Prager, M., J. McConaugha, C. Jones, P. Geer. 1990. Fecundity of blue crab, *Callinectes sapidus*, in Chesapeake Bay: biological, statistical, and management considerations. Bull. Mar. Sci. 46(1):170-179.

Roosenburg, W.M., W. Cresko, M. Modesitte, and M.B. Robbins. 1996. Diamondback terrapin (Malaclemys terrapin) mortality in crab pots. Cons. Biol. Vol. 11 (No. 5): 1166-1172.

Roosenburg, W. M. 1991. The diamondback terrapin habitat requirements, population dynamics, and opportunities for conservation. In A. Chaney and J. Mihursky, editors. New perspectives in the Chesapeake system: a research and management partnership. Proceedings of a conference. Publication no. 13, Chesapeake Research Consortium, Solomons, Maryland.

Roughgarden, J., S. Gaines and H. Possingham. 1988. Recruitment dynamics in complex life cycles. Science 241:1460-1466.

Ryer, D., J. van Montfrans and R. Orth. 1990. Utilization of a seagrass meadow and tidal marsh creek by blue crabs *Callinectes sapidus*. II. Spatial and temporal patterns of molting. Bull. Mar. Sci. 46:95-104.

Shields, J. 2000. Infection and mortality studies in blue crabs infected with *Hematodinium perezi*. Blue Crab Symposium, 29th Annual Meeting, North Carolina Sea Grant, University of North Carolina, Wilmington, N.C.

Seigel, R. A., and J.W. Gibbons. 1995. Workshop on the ecology, status and management of the diamondback terrapin (Malaclemys terrapin), Savannah River Ecology Laboratory, 2 August 1994: final results and recommendations. Chelonian Conservation and Biology 1:240-242.

Sulkin, S. and W. van Heukelem. 1986. Larval recruitment in the crab Callinectes sapidus Rathbun: an amendment to the concept of larval retention in estuaries Page 459-475 in V.S. Kennedy, ed. Estuarine comparisons Academic press, New York.

Tagatz, M. 1968. Biology of the blue crab, Callinectes sapidus Rathbun, in the St. Johns River, Florida. Fish. Bull. 67:17-33.

Tankersley, R. and T. Ziegler. 2000. Spawning behavior of the blue crab *Callinectes sapidus*: II. Temporal patterns of migration. Blue Crab Symposium, 29th Annual Meeting, North Carolina Sea Grant. University of North Carolina, Wilmington, N.C.

Truitt, R. 1939. Our water resources and their conservation. Ches. Biol. Lab. Contribution 27:1-103.

Van Engel, W. 1958. The blue crab and its fishery in the Chesapeake Bay. Part I. Reproduction, early development, growth and migration. Comm. Fish. Rev. 20(6):6-17.

Van Heukelem, W. 1991. Blue Crab, *Callinectes sapidus*. In: Habitat requirements for Chesapeake Bay living resources. Chesapeake Research Consortium, Inc. Solomons, MD.

van Montfrans, J., R. Orth, J. Fishman, and D. Combs. 2000. Predation impact by three recreational fishes on blue crabs in a Chesapeake Bay seagrass bed. Blue Crab Symposium, 29th Annual Meeting, North Carolina Sea Grant. University of North Carolina, Wilmington, N.C.

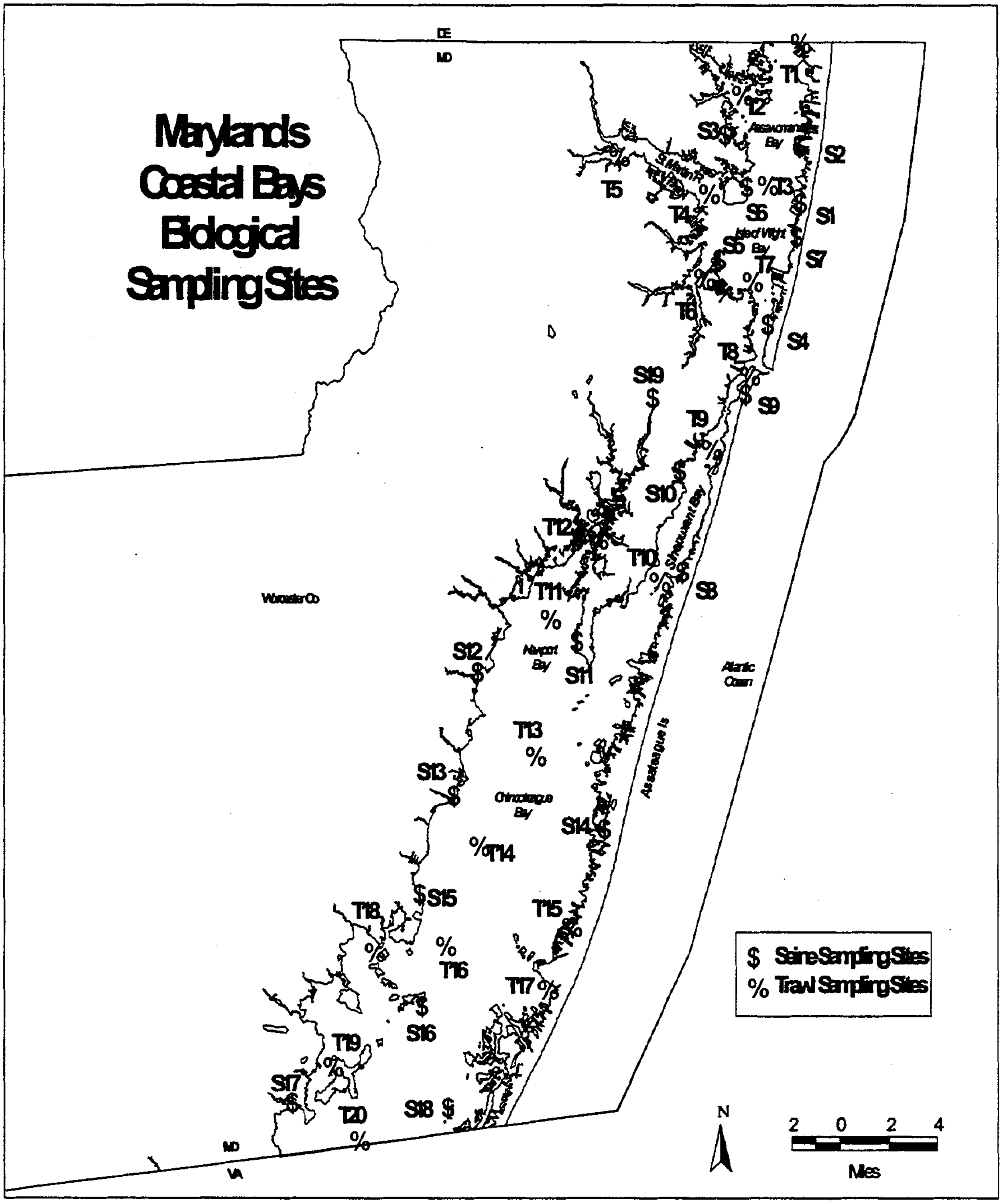
van Montfrans, J., C. Peery and R. Orth. 1990. Daily, monthly and annual settlement patterns by *Callinectes sapidus* and *Neopanopeus sayi* megalopae on artificial collectors deployed in the York River, Virginia: 1985-1988. Bull. Mar. Sci. 46:214-229.

Williams, A. 1984. Shrimps, Lobsters and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida. Smithsonian Inst. Press, Washington, D.C. 550 pp.

Wilson, K., K. Heck and K. Able. 1987. Juvenile blue crab, *Callinectes sapidus*, survival: an evaluation of eelgrass, *Zostera marina*, as refuge. Fish. Bull. 85:53-58.

Wood, R. 1995. Diamondback Terrapin. In L.E. Dove and R.M. Nyman, eds., *Living Resources of the Delaware Estuary*. Delaware Estuary Program, pp. 299-304.

APPENDIX 1. LOCATION OF TRAWL AND SEINE SAMPLING SITES IN MARYLAND'S COASTAL BAYS.



APPENDIX 2. CHEMICAL TOXICITY TO BLUE CRABS[a]

Chemical	Temperature (°C)	Salinity (ppt)	Duration (hours)	Flow[b]	Test	Concentration
aldrin[1]	28	21	48	FT	EC_{50}	23ugLl[-1]
antimycin A[2]	25	29	48	FT	EC_{50}	>100ugLl[-1c]
azinphos-Methyl[1]	27	27	48	FT	EC_{50}	320ugLl[-1c]
carbaryl[1]	30	28	48	FT	EC_{50}	320ugLl[-1c]
chlordane[1]	29	23	48	FT	EC_{50}	260ugLl[-1c]
chlodecone (Kepone)[1]	19	20	96	FT	LC_{50}	>210ugLl[-1d]
chlorpyrifos[1]	17	20	48	FT	EC_{50}	5.2ugLl[-1c]
2,4-D Proplene GI Butyl Ether Ester[3]	24	29	48	S	EC_{50}	2,800ugLl[-1c]
dieldrin[1]	18	26	48	FT	EC_{50}	240ugLl[-1c]
endosulfan[1]	30	24	48	FT	EC_{50}	19ugLl[-1c]
endrin[1]	11	16	48	FT	EC_{50}	15ugLl[-1c]
fenthion[1]	28	25	48	FT	EC_{50}	2.3ugLl[-1c]
heptachlor[1]	17	27	48	FT	EC_{50}	68ugLl[-1c]
malathion[1]	30	25	48	FT	EC_{50}	>1,000ugLl[-1c]
methoxy-chlor[1]	31	24	48	FT	EC_{50}	320ugLl[-1c]
mirex[1]	31	24	48	FT	EC_{50}	>2,000ugLl[-1c]
naled[1]	28	25	48	FT	EC_{50}	220ugLl[-1c]
ozone[1]	25	7.4	96	S	LC_{50}	0.26ugLl[-1d]
toxaphene[1]	19	27	48	FT	EC_{50}	180ugLl[-1c]

[a] Source: Mayer 1987.
[1] insecticide; [2] piscicide; [3] herbicide; [4] water sterilant
[b] FT = Flow Through; S = Static; [c] Nominal Concentration; [d] Measured concentration

APPENDIX 3: DESCRIPTION OF COMMERCIAL LICENSE CATEGORIES

There are several types of Maryland commercial crabbing licenses. Among coastal bay crabbers, the most common licenses are the Limited Crab Catcher (LCC) and the Tidal Fish License (TFL). These licenses permit the following crab gears:

1. The LCC license permits the use of up to 50 crab pots, unlimited yardage of trotline as well as the use of dip nets, traps, pounds and scrapes.

2. The TFL license permits the use of all gear legal for the purpose of taking finfish and shellfish. This includes up to 300 pots.

Other commercial crabbing licenses available include:

3. CB3: only permits the use of up to 300 crab pots

4. CB3/CB6: only permits the use of up to 600 pots. Not applicable to the coastal bays.*

5. CB3/CB9: only permits the use of up to 900 pots. Not applicable to the coastal bays.*

6. TFL/CB6: similar to #2 above but also permits up to 600 pots. Not applicable to the coastal bays.*

7. TFL/CB9: similar to #2 above but also permits up to 900 pots. Not applicable to the coastal bays.*

* NOTE: By regulation, vessels operating in Maryland's coastal bays are permitted a maximum of 300 pots/vessel.

The Maryland Coastal Bays:

A Survey of Community Attitudes

A Report Prepared for the

Maryland Coastal Bays Program

September 2001

By

PACE

The Institute for Public Affairs and Civic Engagement
at
Salisbury University

The mission of the Institute is to serve the public communities on the Eastern Shore of Maryland and the students and faculty of Salisbury University by enhancing our understanding of the public good, by fostering, in a non-partisan way, a more informed and responsible citizenry, and by promoting ethics and good government at the local and state levels through policy and survey research, through educational programs, and through projects in civic engagement.

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The Maryland Coastal Bays Program was established in 1996 to assist the region in developing and implementing a comprehensive plan to restore and protect the five embayments behind Ocean City and Assateague Island. The Program is a partnership among the towns of Ocean City and Berlin, National Park Service, Worcester County, U.S. Environmental Protection Agency, and the Maryland Departments of Natural Resources, Agriculture, Environment, and Planning. The Program is a culmination of efforts and resources from individuals, community groups, and governmental agencies that share a common interest in a healthy environment and a prosperous region.

The purpose of this survey is to gauge the community's perception of local environmental issues and the value provided by the Maryland Coastal Bays Program. It is our hope to use the survey results as a management tool to better serve our community.

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Contents

	Page
Preface	iv
Introduction	1
What Does the Community Like About the Maryland Coastal Bays?	4
Who is Responsible for Protecting the Maryland Coastal Bays?	10
What Are the Important Environmental Issues?	15
How Does the Community Evaluate the Maryland Coastal Bays Program?	24
What Policy Options Does the Community Support?	33
How Do People Behave Towards the Environment?	42
Conclusion	47
Appendix:	
A. Who Responded to the Survey?	49
B. Methodology of the Survey	54
C. Questionnaire and Frequency Distributions of Responses	59
D. Response to Open-ended Question on the Effect of Growth	75

Preface

The preparation and writing of this report, as well as the survey itself, were under the direction of Harry Basehart, Professor of Political Science and Co-Director of the Institute for Public Affairs and Civic Engagement (PACE) at Salisbury University, Salisbury, Maryland. Carol Cain, Technical Coordinator, Maryland Coastal Bays Program and John Roeder, Chair of the Citizens Advisory Committee, provided valuable insights from the writing of the very first survey question through the preparation of the final report. PACE's Co-Director, Francis Kane, and Managing Director, Pauline Gehnrich, greatly assisted in the overall management of the project, especially with the supervision of the telephone interviewing phase. Jeanette Wolinski, Associate Director, Information Technology, Salisbury University, provided timely and expert technical assistance for the Computer-Assisted Telephone Interviewing System (CATI). Data analysis benefited from the computer skills of PACE students Carson Friedman and Jennifer Snow.

Introduction

This report presents the findings of the first-ever survey of environmental attitudes of people living in the Maryland Coastal Bays Watershed; it is the result of a collaborative effort by two groups. The first is the Tracking and Evaluation Subcommittee (TAES) of the Citizens Advisory Committee, which is part of the Maryland Coastal Bays Program. TAES has as its primary goal the measurement of progress in the implementation of the Comprehensive Conservation and Management Plan. The second group is Salisbury University's newly established Institute for Public Affairs and Civic Engagement (PACE), which coordinates faculty and student resources to assist governmental and non-profit groups in the analysis of local policy problems.

Six environmental topics were covered in this survey. First, we wanted to find out what people like and enjoy about the Maryland Coastal Bays. The second and third topics focus on people's perceptions concerning who is responsible for protecting the Maryland Coastal Bays and what they view as the most important environmental problems that could harm the bays. The fourth topic looks at how the local community evaluates the Maryland Coastal Bays Program and its activities. The last two topics examine community support for various policies that could affect the bays and how people rate their behavior toward the environment.

Of what use is a survey of environmental attitudes? Few would argue that surveys or polls should replace representative democracy, but surveys can provide important information for policy makers, the media, and the public. At the minimum, knowing the public's views should assist policy makers in setting priorities and planning educational efforts.

In a survey of this size, it's easy to get lost in all of the data and try to interpret what small differences in percentages might mean. We are presenting the data from this perspective: Are there clear messages from the public? When we have found clear messages, we have said so; and when we haven't found clear messages, we have said so. It's also important to remember that surveys report the opinions and perceptions of the public, which are influenced by newspapers, television, and radio as well as the public's attention or lack of attention to environmental issues. Because surveys deal with perceptions, it may be possible to find inconsistencies between the public's views and the results of scientific environmental research.

We encourage all readers of this report to look at the data carefully. To facilitate this process, the text of each question, in the order that it appears in the questionnaire, along with the frequency distributions for responses to each question, can be found in Appendix C.

Finally, as described in detail in Appendix B, conducting a public opinion survey within the Maryland Coastal Bays Watershed, a major tourist destination, presented many challenges and questions. The first question was to decide whom we wanted to interview. Of course, it was a given that permanent residents of Worcester County would be interviewed. It also was decided that the owners of second homes or vacation homes in Worcester County would be interviewed. These two groups, it was reasoned, have an immediate stake in the watershed and have the most access to local decision makers. On the other hand, tourists or those working in the area for the summer were not interviewed.

We obtained interviews with 512 respondents for a margin error of +/- 4 percent. This means, for example, if 58 percent of the respondents in our sample report that the current rate of growth and development in the county is a "Big Problem" than the actual percentage for all people living within the watershed could range from between 54 percent to 62 percent.

What Does the Community Like About the Maryland Coastal Bays?

People participate in any number of activities within the Maryland Coastal Bays watershed. The first set of questions was designed to identify those activities that people find the most enjoyable. The activities included the following: sailing, motor boating, swimming at the beaches, fishing, crabbing, jet skiing, bird watching, looking at the natural beauty of the Bays, and canoeing/kayaking. Respondents could choose from "High," "Medium," or "Low" to indicate their level of enjoyment in a particular activity; a "Don't Participate" response was also available.

To find out what people enjoy the most, we decided to rank the activities by looking at the percentage of respondents indicating "High" (Figure 1).

Without any doubt, "looking at the natural beauty of the Bays" is enjoyed the most, receiving a "High" ranking by over 70 percent of the respondents. This rather aesthetic approach to the Maryland Coastal Bays far exceeds all other activities. The second most enjoyed activity, swimming at the beaches, received a "High" ranking by 42.7 percent of the respondents, almost 28 percentage points below the most enjoyed activity.

Other activities such as fishing, motor boating, bird watching, followed by crabbing, earned a "High" mark by percentages that varied from 27 to 17 percent. They are clearly in the middle in terms of "High" level of enjoyment.

At the lower end of participation and enjoyment are the following activities: canoeing/kayaking, jet skiing, and sailing. "High" rankings for these activities range from 8 percent to 6 percent. And as one might expect, the "Don't participate" levels for these three activities are very high, 65.8 percent, 76.4 percent, and 82.8 percent respectively.

Complete responses for each activity are presented in the bar charts found in Figure 2 through Figure 10.

Figure 1

Maryland Coastal Bay Activities:
"High" Enjoyment Level

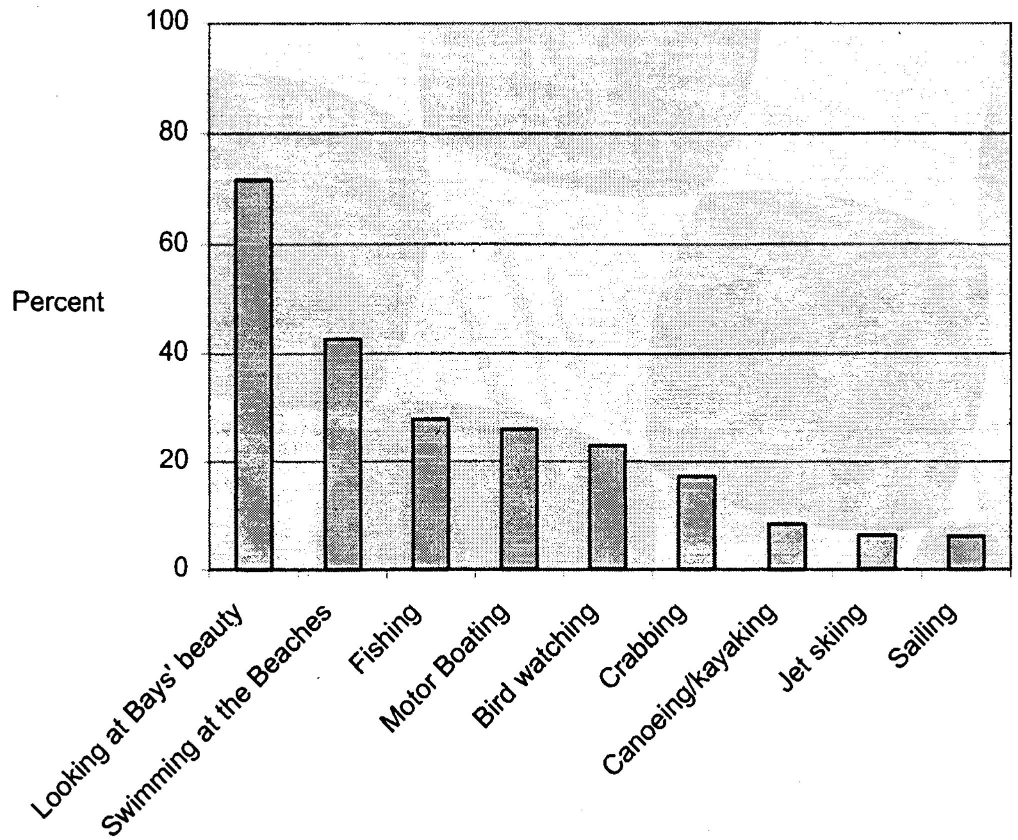


Figure 2

Looking at the Bays' natural beauty

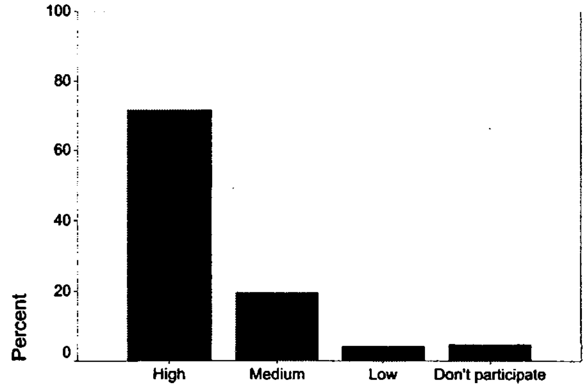


Figure 3

Swimming at the Beaches

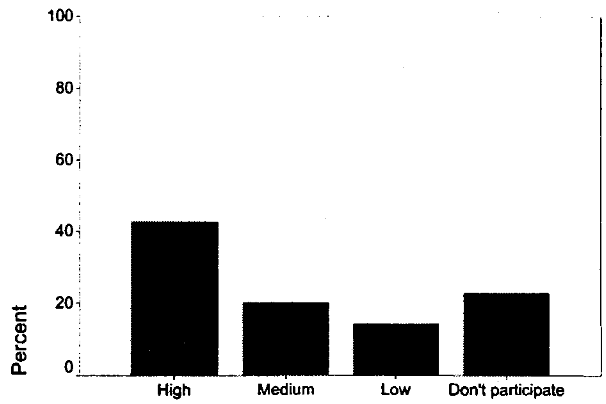


Figure 4

Fishing

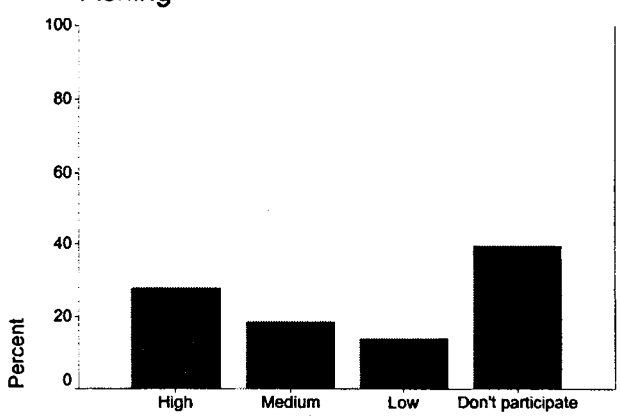


Figure 5

Motor Boating

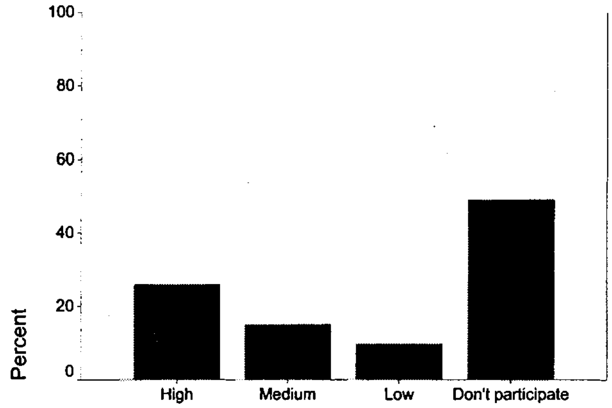


Figure 6

Bird Watching

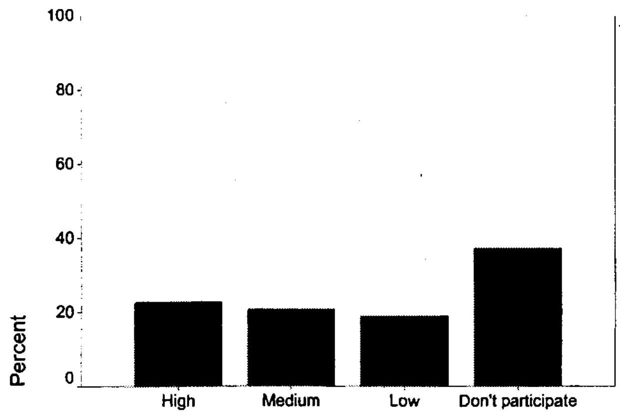


Figure 7

Crabbing

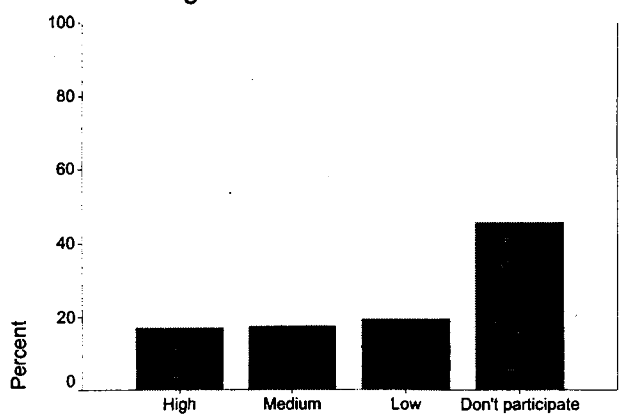


Figure 8

Canoeing/Kayaking

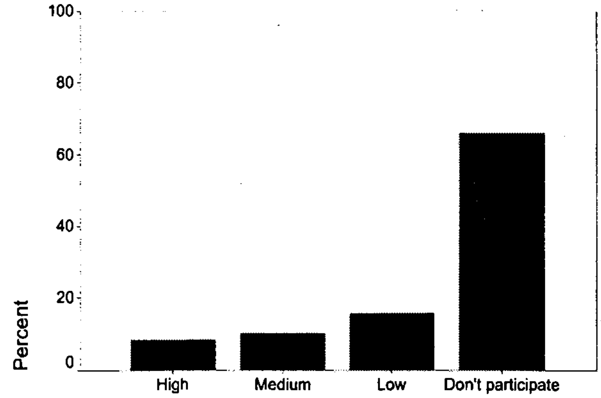


Figure 9

Jet skiing

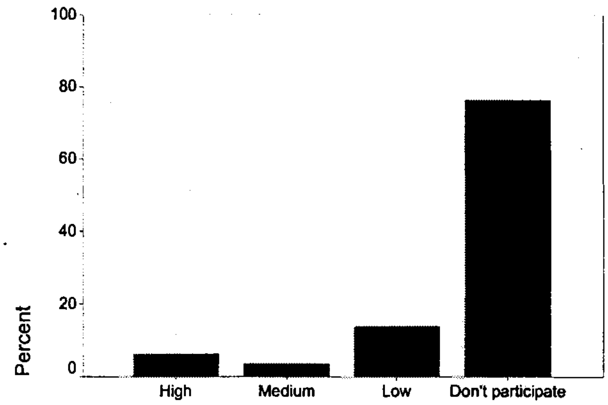
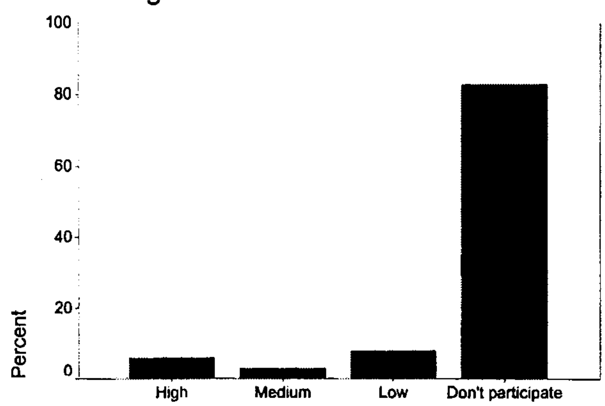


Figure 10

Sailing



Who is Responsible For Protecting the Maryland Coastal Bays?

The decision making process that affects the quality of the Maryland Coastal Bays is the focus of this section. General questions concerning progress and responsibility in protecting the Coastal Bays will be examined first, then a series of questions will be looked at that asks citizens their perceptions of the groups that are involved in the making of decisions.

When asked to rate the progress that has been made in preserving and protecting the quality of the Maryland Coastal Bays, a slight majority, 50.6 percent, picked the "Some" response (Figure 11). About one in four respondents, 26.8 percent, said that "A Lot" of progress has been made. Taking these two percentages together, over 75 percent of the respondents believe that progress is being made, while only 14.1 percent said "Not much" progress is being made.

The best way, in general terms, to go about protecting the Coastal Bays is the subject of another question. Respondents were presented with three alternative approaches, and one was clearly preferred over the other two. A large percentage of respondents, 67.7 percent, believe that the best approach is for "Government officials to work with citizens to develop a plan to protect the bays." The responses that people should be able to do what they want with their own land or that government officials should adopt and enforce regulations to protect the bays were selected by a minority, 11 percent and 18 percent, respectively. (See Figure 12.)

The question of which level of government would do the best job in protecting the Coastal Bays elicited fairly clear responses, with the perception that local government would do the best job being chosen by over a majority of respondents, 54.9 percent.

State government was preferred by 35.5 percent; the Federal government receives the lowest amount of support, with less than 10 percent of the respondents saying it would do the best job (Figure 13). However, when asked how often decisions by "state and local government officials" show that they are interested in protecting the quality of the Coastal Bays, 59 percent said "Only some of the time." Close to one-third of the respondents said "Almost all of the time" and a very small percentage said "Never" (Figure 14.) This may appear contradictory, however, respondents are probably saying that they think local and state governments can do a better job than the federal government, but that does not mean that they are entirely satisfied with the job local and state governments are doing.

The next four questions in the survey asked respondents if there are "any groups in Worcester County whose views on the Maryland Coastal Bays are consistently left out of the process of making decisions, rather than being part of the process." Generally, all of the groups identified in the questions were perceived as being part of the process. "Environmental groups" scored the highest with 75.0 percent of the respondents saying they are "Part of the decision making process." Environmental groups were far ahead of real estate developers who were second at 53.7 percent. Farmers and recreational boaters and crabbers were on the low end: 48 percent perceived that farmers were part of the process and 41.3 percent concluded the same about recreational boaters and crabbers. Still it's important to note that close to one-third of the respondents perceived that "recreational boaters and crabbers" and "farmers" were "left out of the decision making process." (See Figure 14 through Figure 18.)

Figure 11

Progress in Protecting the Coastal Bays

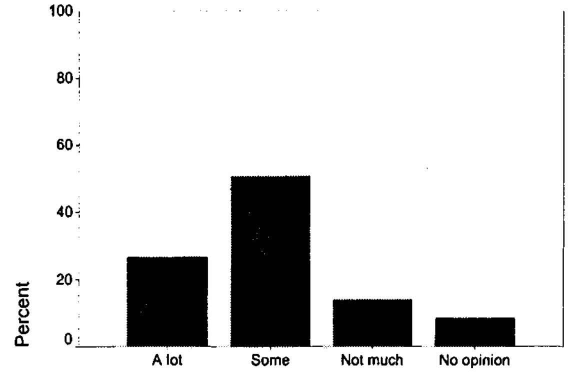


Figure 12

Ways to Protect the Bays

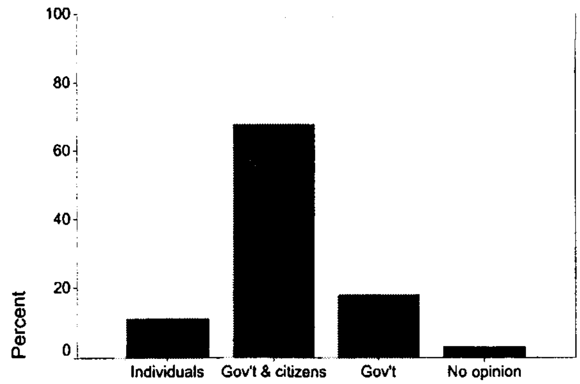


Figure 13

Gov't That Would Best Protect Bays

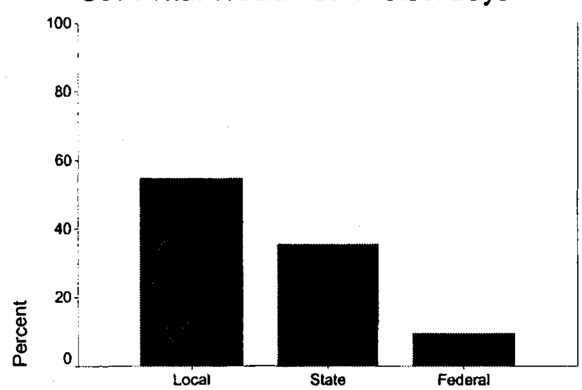


Figure 14

Interest of Officials in Protecting Bays

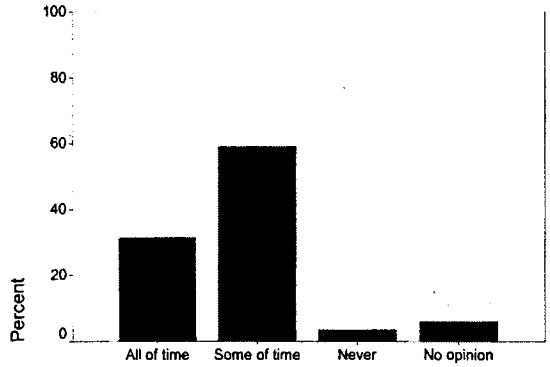


Figure 15

Decision Making Process:

Environmental Groups

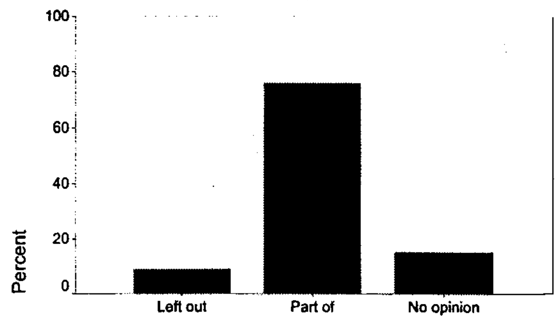


Figure 16

Decision Making Process:

Real Estate Developers

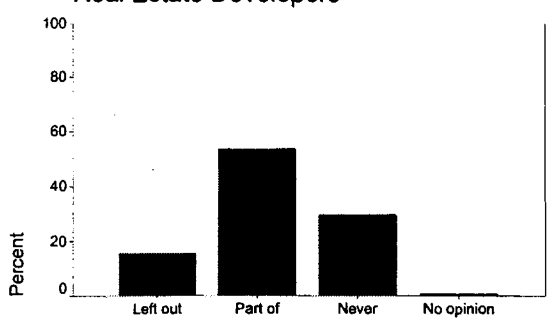


Figure 17

Decision Making Process

Farmers

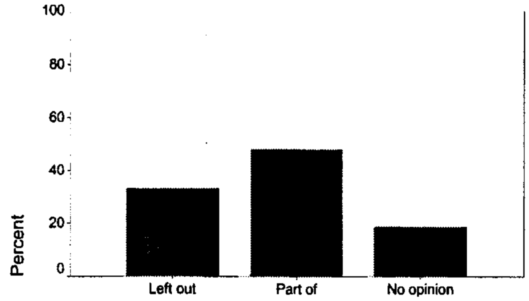
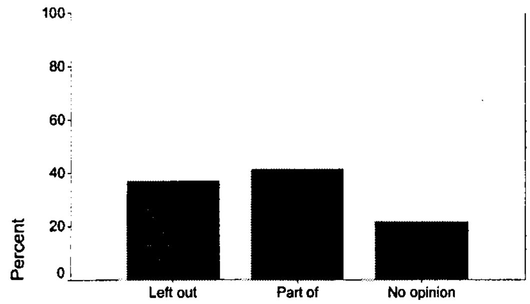


Figure 18

Decision Making Process:

Recreational Boaters and Crabbers



What Are the Important Environmental Issues?

How citizens perceive 13 environmental issues and their potential to harm the Coastal Bays is one of the most important topics in this survey. To each issue, respondents could say that it is a "Big Problem," "Little Problem," "Not a Problem," or "Don't Know."

An overview of the findings is presented in Figure 19 and details of the findings can be found in Figure 20 through Figure 32. Figure 19 summarizes the percentage of respondents identifying an environmental issue as a "Big Problem." "Runoff from agricultural fields including those with chicken houses" is viewed as a "Big Problem" by 73.2 percent of the respondents, and leads by far all other potential problems that are identified in the questionnaire. Near the top, but still some distance from agricultural runoff, are the following: poorly maintained septic systems, destruction of underwater plants, current rate of growth, and chicken processing plants. They are identified as a "Big Problem" by anywhere from 60 percent to 55 percent.

In a middle range, identified by 43 percent to 31 percent as a "Big Problem," are recreational use of jet skis, growth of non-native species, homeowners who fertilize their lawns, storm water runoff, and recreational use of motorboats.

At the bottom of the "Big Problem" list are the following: municipal sewage treatment plants (27.9 percent), homeowners who erect piers and bulkheads (18 percent), and waterfront property owners with small vegetation buffers (4.5 percent). (Please note: This question refers to "small" vegetation buffers; the response probably would have been different if it had been worded to say "no" vegetation buffers. We expect that a

"Big Problem" response would have been much higher with a "no" vegetation buffers question.)

To take a closer look at the effect of growth and development in Worcester County within the last five years, respondents were asked whether growth has had a "Positive Effect," "No Effect," or a "Negative Effect" on their lives. The responses could not be much more evenly divided; 32.3 percent said the effect has been positive, 36.2 percent see no effect, and 28.8 percent see a negative effect (Figure 33).

If a respondent said positive or negative, he or she was asked in a follow-up question to describe the main positive or negative effect. This was an open-ended question that required our interviewers to type each respondent's answer into the data base for this survey. A positive effect was chosen by 165 respondents while 157 said the effect was negative, but only 35 and 25 respondents, respectively, answered the open-ended question.

With such a small number of respondents answering this question the results should be looked as suggestive and not the final word. (All of the responses can be found in Appendix D.) Financial benefits, along with more conveniences and services, are the dominant ideas from those who see positive effects in recent growth and development. For example, one respondent said, "more people, more money." Other comments were, "property values increased," "easy access to stores," and "new amenities (libraries, YMCA)."

"Too crowded" and "too many people" is probably the best way to summarize the comments of those who see negative effects from growth and development. One respondent commented, "more people in recreational activities causes pollution."

Another said that the area is "growing too quickly and too fast and environment is suffering."

Figure 19

Important Environmental Issues:
Percent Saying "Big Problem"

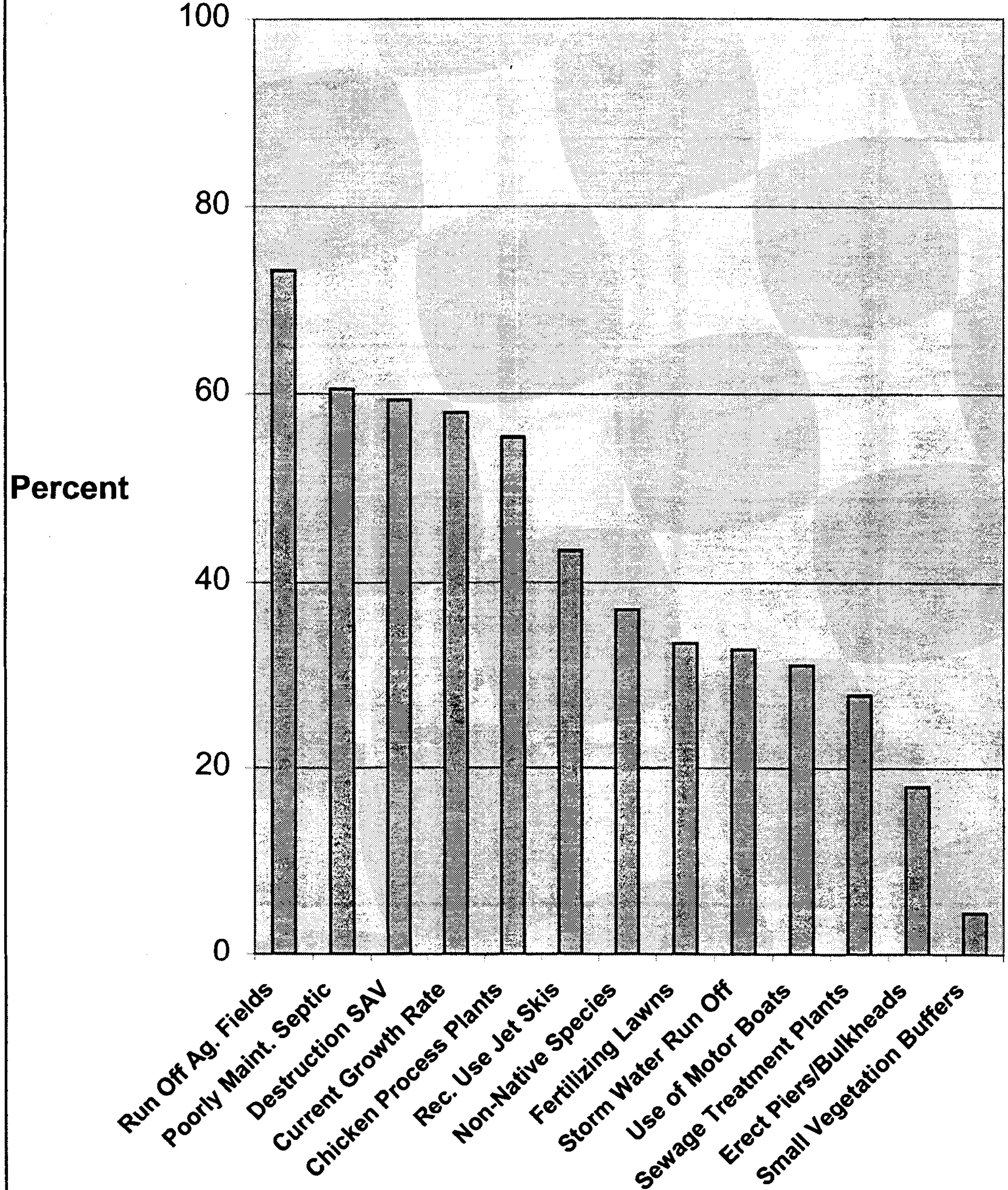


Figure 20

Important Environmental Issues:

Run Off From Fields

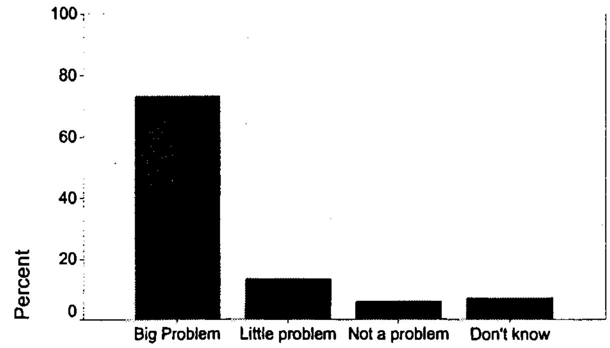


Figure 21

Important Environmental Issues:

Poorly Maintained Septic

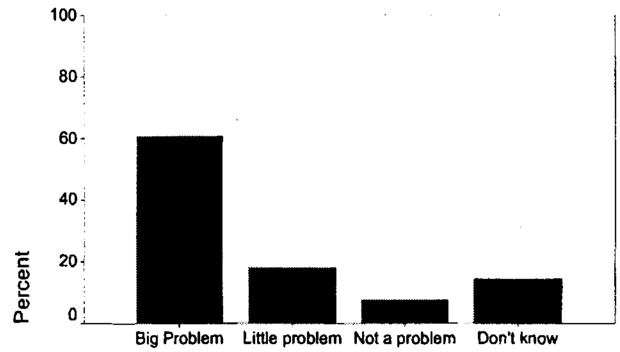


Figure 22

Important Environmental Issues:

Destruction of Underwater Plants

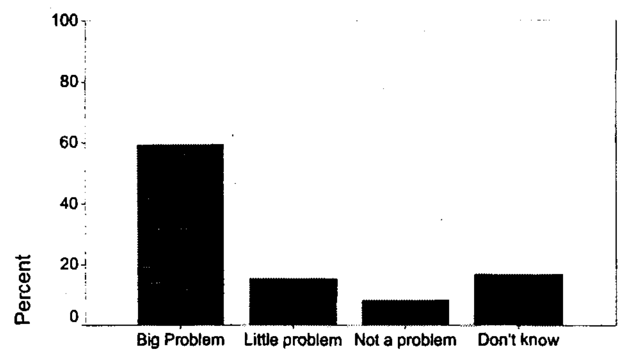


Figure 23

Important Environmental Issues:

Current Rate of Growth

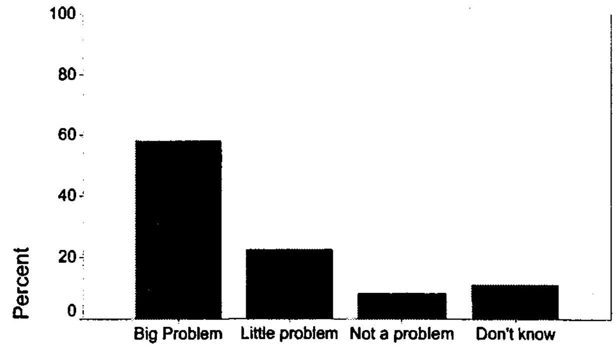


Figure 24

Important Environmental Issues:

Chicken Processing Plants

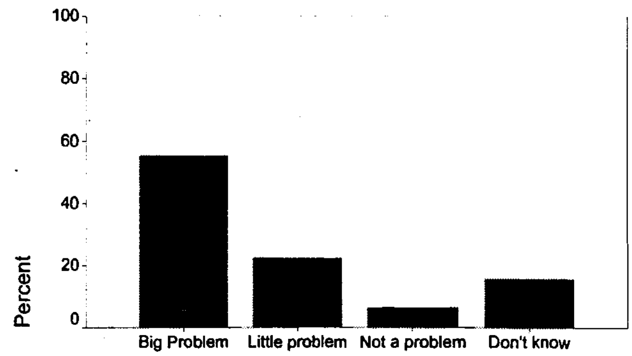


Figure 25

Important Environmental Issues:

Recreational Use of Jet Skis

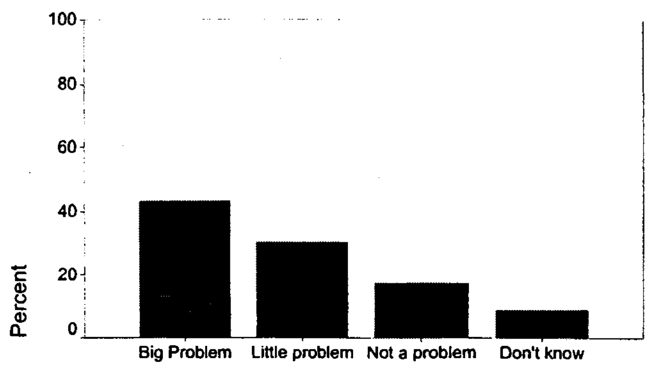


Figure 26

Important Environmental Issues:

Growth of Non-Native Species

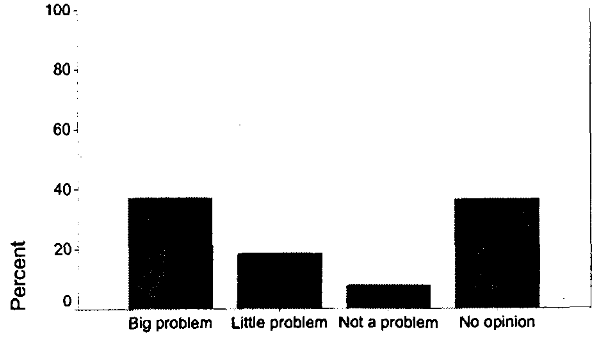


Figure 27

Important Environmental Issues:

Homeowners Who Fertilize Lawns

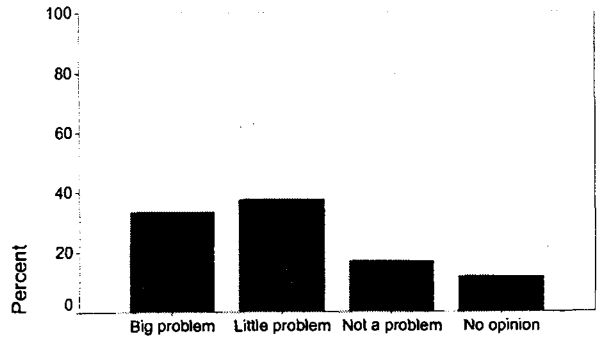


Figure 28

Important Environmental Issues:

Storm Water Run Off

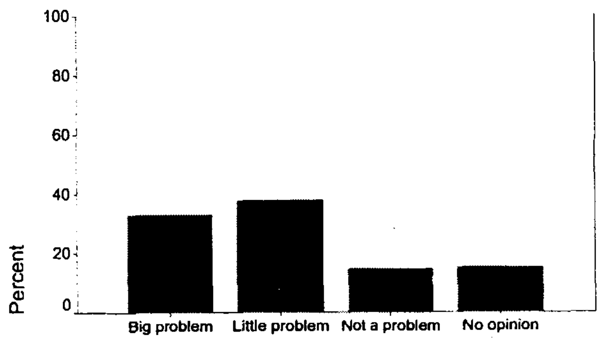


Figure 29

Important Environmental Issues:

Recreational Use of Motor Boats

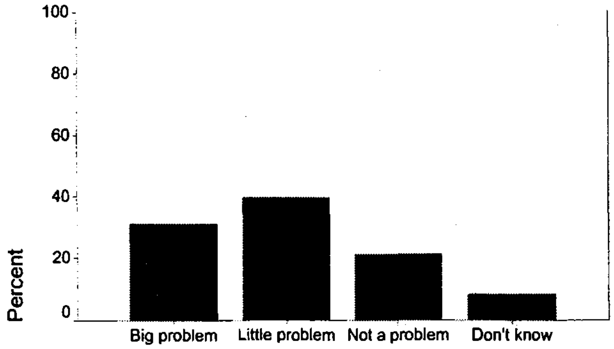


Figure 30

Important Environmental Issues:

Sewage Treatment Plants

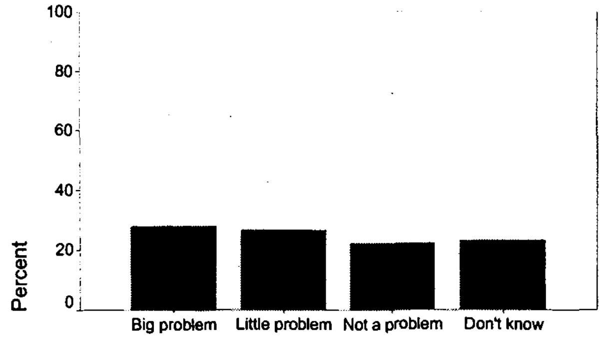


Figure 31

Important Environmental Issues:

Homeowners Who Erect Piers Of Bulkhead

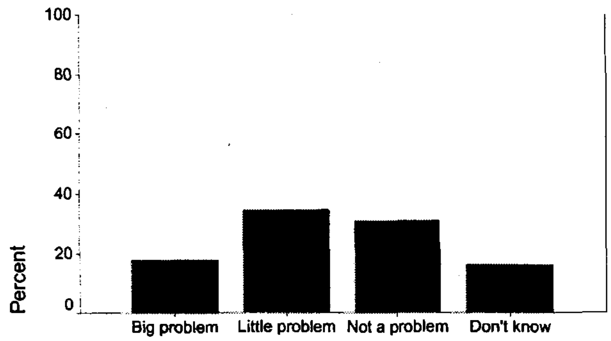


Figure 32

Important Environmental Issues:

Homeowners With Small Vegetation Buffers

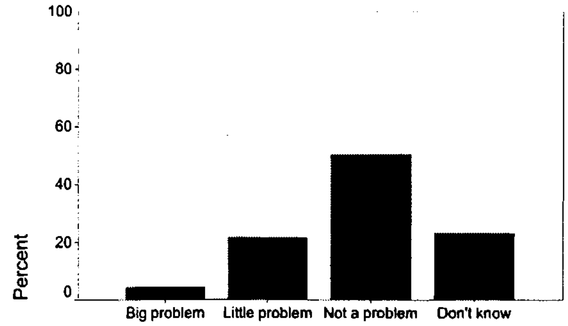
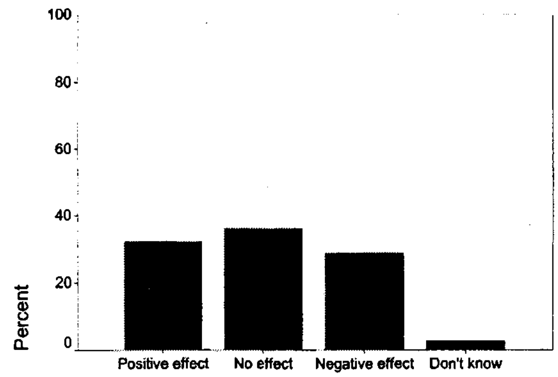


Figure 33

Effect of Growth in Worcester County



How Does the Community Evaluate the Maryland Coastal Bays Program?

This is an important section of the survey because it contains a number of questions to find out how much knowledge Worcester County citizens have of the Maryland Coastal Bays Program and to gauge how they evaluate the MCBP.

The Maryland Coastal Bays Program is well recognized in the county, 83.2 percent of the respondents have heard of MCBP (Figure 34). MCBP's leadership "in working with different community groups to restore and protect the quality of the Coastal Bays" is rated as "Good" by 44.6 percent of the respondents, with 13.4 percent saying "Excellent," 12.5 percent "Fair," 3.5 percent "Poor" (Figure 35). (The "Not sure" category was rather large at 25.9 percent.) In addition, MCBP's goal to "restore and protect the quality of Maryland's Coastal Bays" is thought to be "Very Important" by 85.8 percent of the respondents (Figure 36).

A series of questions asked respondents whether they had heard of specific events sponsored by MCBP. The activities that are most widely known are the canoe cleanup at Assateague (57.5 percent) and the Isle of Wight cleanup (52.8 percent). Awareness of the Maryland Coast Day and the Earth Day boat trip are lower at 44.4 percent and 31.7 percent, respectively. (See Figures 37, 39, 41, and 43.)

Respondents who knew about an event also were asked if they had attended the event. As one might expect, many more people knew about these events than actually attended them. (See Figures 38, 40, 42, and 44.) Surprisingly, the best-known event, canoe cleanup at Assateaque, is not the best attended, attendance is 7.8 percent. Maryland Coast Day has the best attendance with 16.7 percent; that is, 16.7 percent of the respondents who knew about this event actually attended it. On the other hand, monthly meetings of the Citizens' Advisory Committee of MCBP are not well know (26 percent), but the percentage of those who know about them and attend the meetings is 15 percent, second to Maryland Coast Day.

How do people learn about these activities? "Newspaper articles" were the leading source of information on MCBP activities according to 49.2 percent of the respondents, and "Neighbors and friends" was next with 25.4 percent. A second question asked whether "there was any other way that you have heard of the Coastal Bay activities," and "Television," "Newspaper Articles," and Neighbors and friends" were reported at about the same level. (See Figure 47 and Figure 48.)

Figure 34

Aware of Maryland Coastal Bays Program

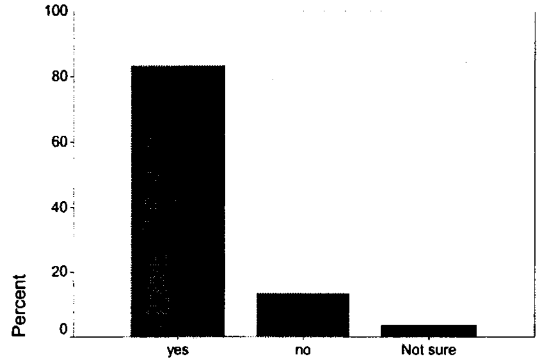


Figure 35

Rating of MCBP in Providing Leadership

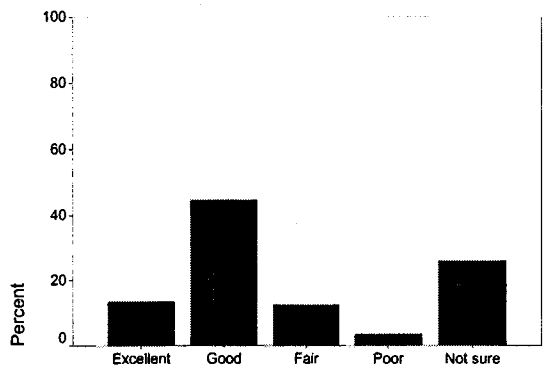


Figure 36

Rating of the Goals of MCBP

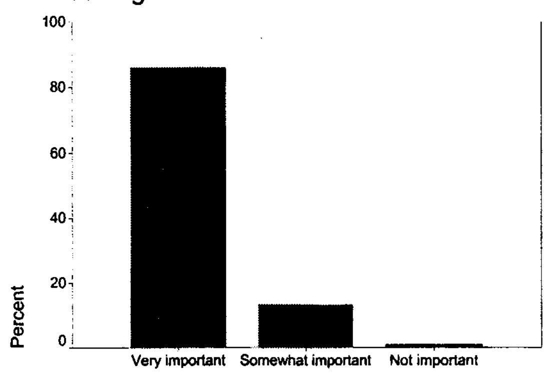


Figure 37

Did You Hear About:

Canoe Cleanup at Assateague?

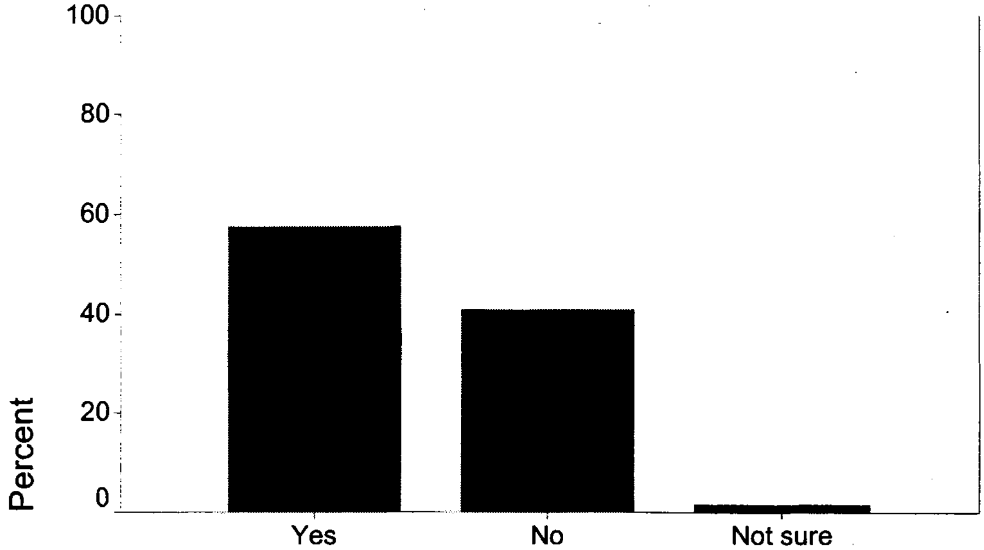


Figure 38

Did You Attend This Event?

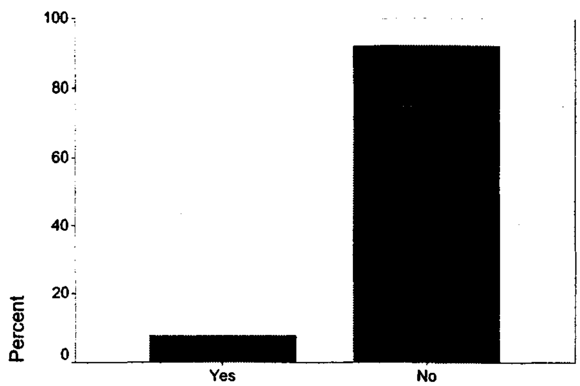


Figure 39

Did You Hear About:

Earth Day Boat Trip?

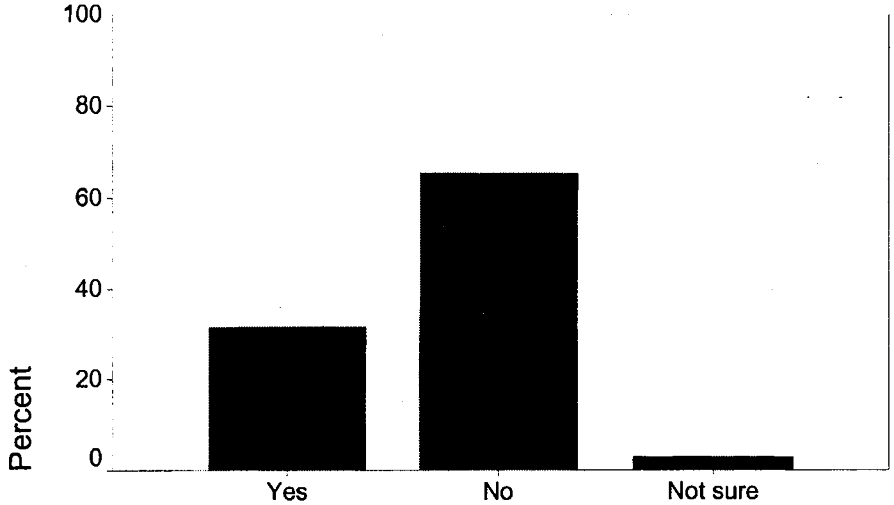


Figure 40

Did You Attend This Event?

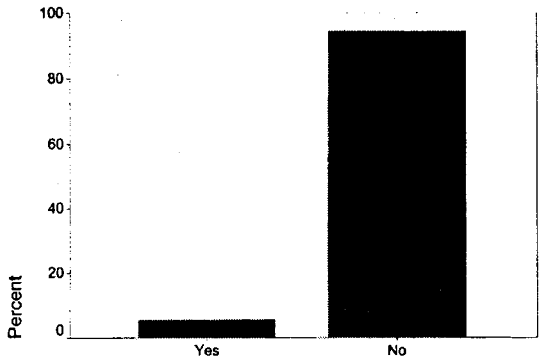


Figure 41

Did You Hear About:

Isle of Wight Cleanup?

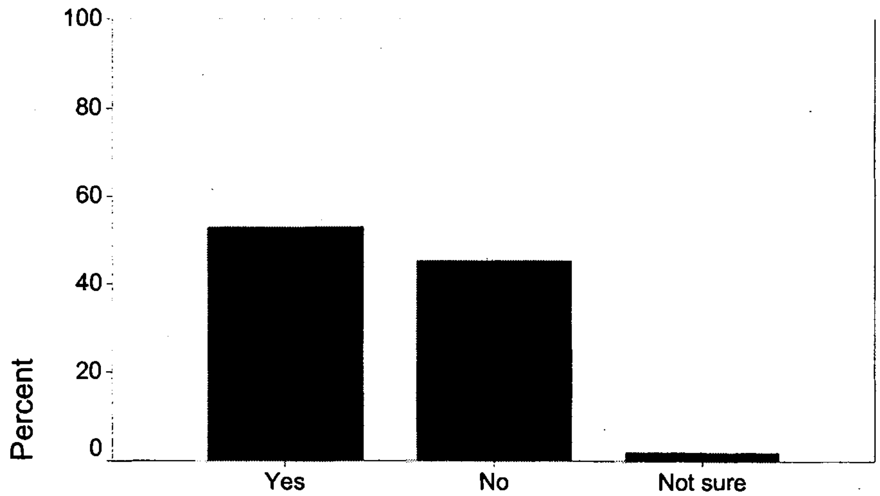


Figure 42

Did You Attend This Event?

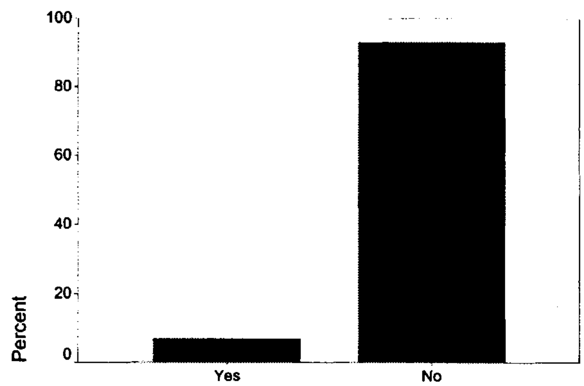


Figure 43

Did You Hear About:

Maryland Coast Day?

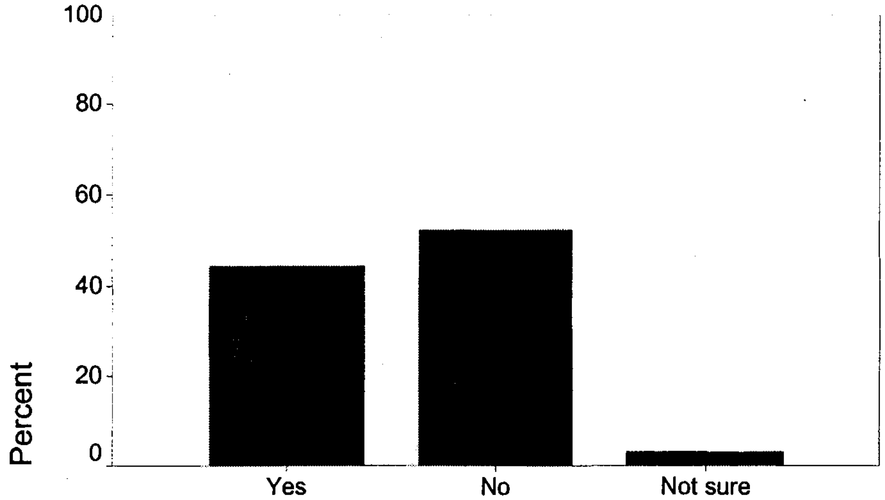


Figure 44

Did You Attend This Event?

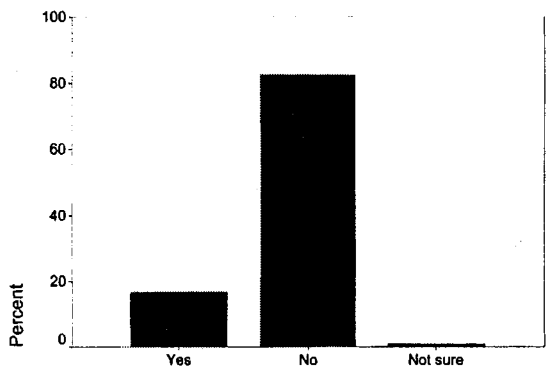


Figure 45

Aware of Monthly Meetings of:

Citizens' Advisory Committee

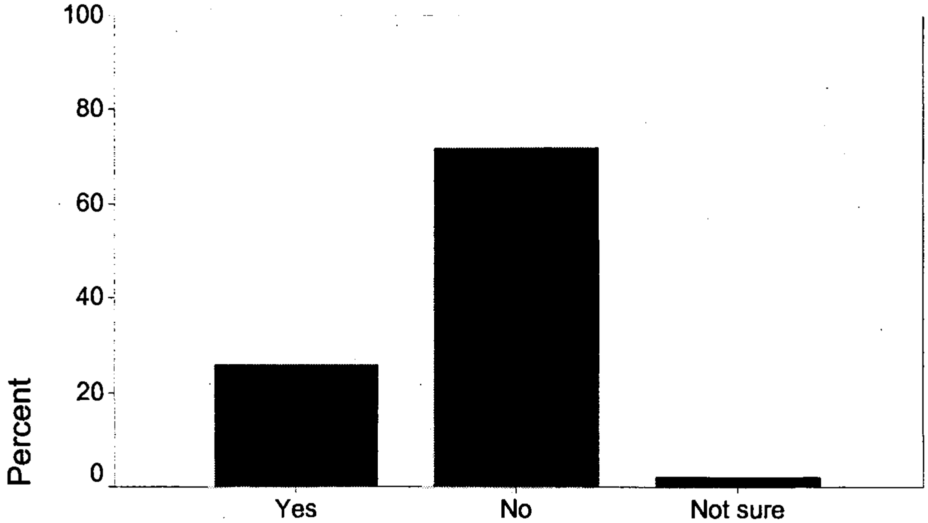


Figure 46

Did You Ever Attend These Meetings?

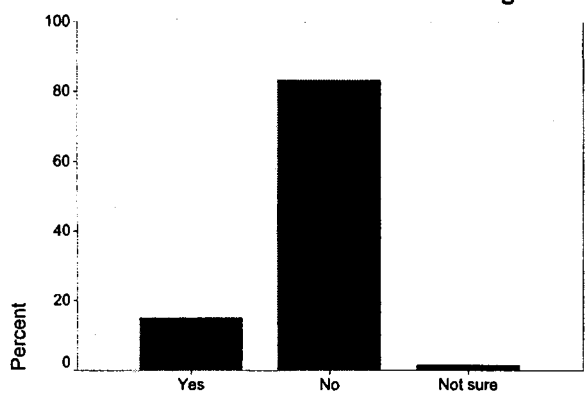


Figure 47

First Source of Information

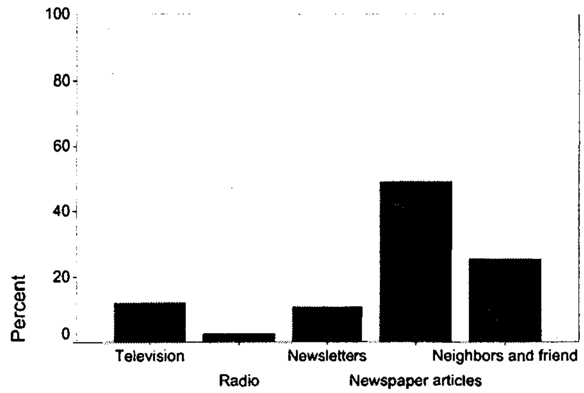
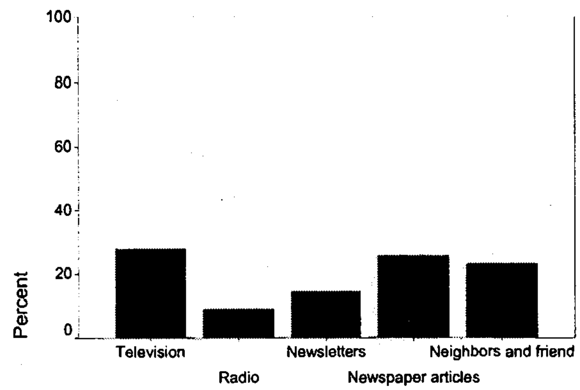


Figure 48

Second Source of Information



What Policy Options Does the Community Support?

Disagreement over policy options for the Maryland Coastal Bays is frequent. This set of questions summaries a number of policy options and asks the respondents to indicate their degree of support for each option by selecting from the following responses: "Strongly Favor," Somewhat Favor," "Somewhat Oppose," or "Strongly Oppose."

An overview of the findings is in Figure 49. (More detailed findings are in Figures 50 – 56.) Substantial majorities responded "Strongly Favor" to three policy options: protection of habitat such as nesting and spawning areas (72.3 percent), protection of underwater plants such as sea grass beds (70.5 percent), and protection of existing open spaces such as agricultural lands and forests (67.6 percent). In fact, support for these three policies pushes over the 90 percent level when those who "Somewhat Favor" are combined with the "Strongly Favor."

The policy option of reducing runoff from agricultural land has less support than those just mentioned. This option is strongly favored by 59.3 percent of the respondents. Strong support is much less for dredging the Coastal Bays for better navigation (31.7 percent), reducing the length of the season for crabbing (19.1 percent) and fishing (13.3 percent). Reducing the length of the fishing season has the highest amount of opposition, 39.6 percent in the "Somewhat Oppose" and "Strongly Oppose" categories.

Requiring waterfront property owners to plant a vegetation buffer was the subject of two separate questions. The first question was worded this way: "As you may know, one of the most controversial issues is the requirement that property owners plant a buffer of trees and shrubs along tidal wetlands and waterways that border their property. Would you say you "Strongly Favor," "Somewhat Favor," "Somewhat Oppose," or "Strongly Oppose" the buffer requirement?" The "Strongly Favor" category was selected by 50.2 percent of the respondents, a bare majority and placing it in the middle in terms of support when compared to policy options discussed above. The "Somewhat Favor" category had 28.3 percent of the respondents, raising the overall to level to 78.5 percent, slightly below that of 81.4 percent for reducing runoff from agricultural land. (See Figure 57.)

The second question dealing with buffers was this: "What width do you favor for a buffer of trees and shrubs?" The largest response was "Don't Know/No Opinion" which was selected by 39.1 percent of the respondents. The next largest response was 25 feet (26.8 percent) followed by "50 Feet" (17.8 percent), 75 feet (2.3 percent), 100 feet (6.4 percent), and more than 100 feet (4.1 percent); 3.4 percent said "0 Feet" or no buffer. A simpler way to look at the data is to say that 57.4 percent of the respondents favor a buffer of at least 25 feet, 39.1 percent don't know or have no opinion, and 3.4 percent oppose any buffer. (See Figure 58.)

In looking at responses to these questions, it is interesting to point out that support is highest for policy options that are worded in a general way such as protection of nesting and spawning areas and protection of underwater plants; however, as the policy options become more specific, support tends to decrease. For example, support for reducing runoff from agricultural land and requiring vegetation buffers is in the 50's. And when the question moves to the size of vegetation buffers almost 40 percent of the respondents say they don't know or have no opinion. This is a fairly normal pattern in public opinion surveys.

A second question concerning open space was asked and it approached the topic from a slightly different angle. Respondents were asked to indicate their agreement with this statement: "Future growth and development in Worcester County should be concentrated in currently developed areas rather than in outlying and less populated areas." With this wording, support for open space drops somewhat; a total of 71.5 percent agreed with the statement, 35.3 percent were at the strongly agree level. Support for open spaces is higher when it refers to "agricultural lands and forests," as it did in the policy option question mentioned above, than when the reference is to "outlying and less populated areas." (See Figure 59.)

Two questions focused on tourism in Worcester County. The first question asked respondents whether they would prefer to see the winter season as a "downtime" period with fewer tourists or would they rather have year-round tourism (Figure 60). "Downtime" is favored by 54.2 percent of the respondents and year-round tourism is favored by 38.4 percent (7.4 percent were not sure). The importance of promoting ecotourism opportunities such as nature tours and bird watching was the topic of the second question (Figure 61). Over 90 percent of the respondents said it is important to promote ecotourism; responses are almost evenly divided between those who believe it is "Very important" and those who think it is "Somewhat important. The "Not important" and "Don't Know/No Opinion" categories have only 8.8 percent of the respondents.

Figure 49

Coastal Bays Policy Options:
Percent Saying "Strongly Favor"

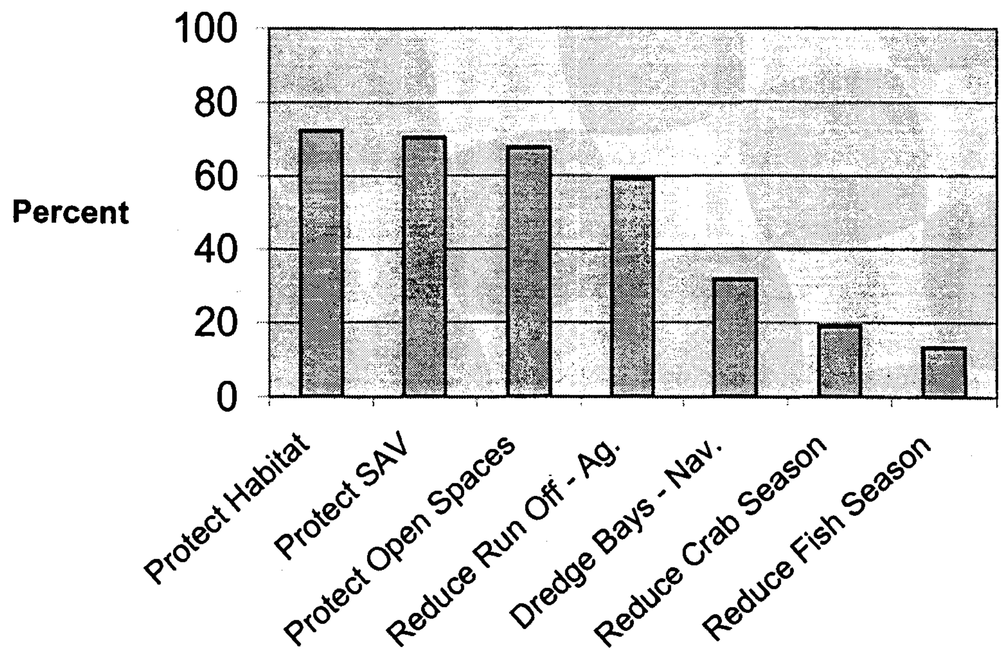


Figure 50

Coastal Bays Policy Options:

Protect Habitat

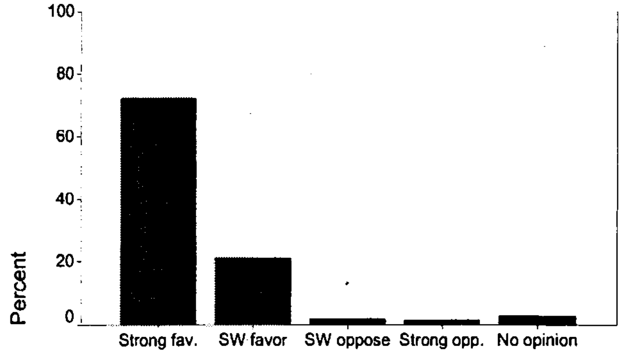


Figure 51

Coastal Bays Policy Options:

Protect SAV

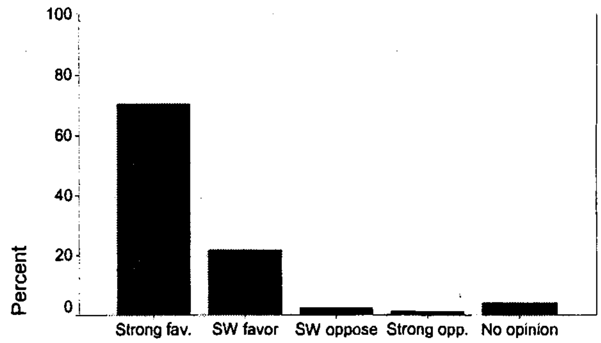


Figure 52

Coastal Bays Policy Options:

Protect Open Spaces

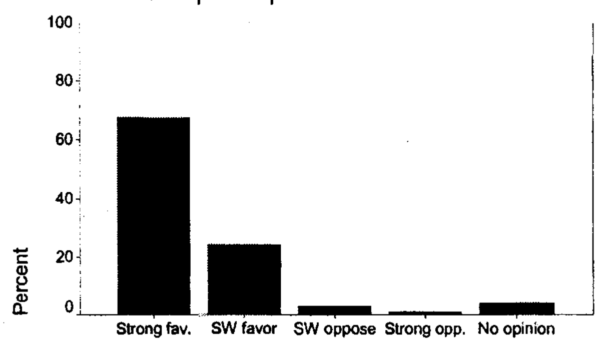


Figure 53

Coastal Bays Policy Options

Reduce Run Off From Agricultural Land

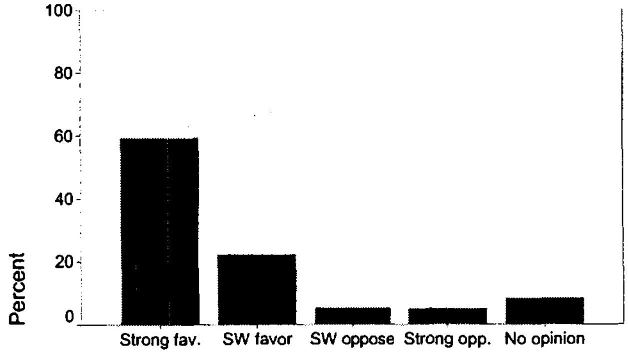


Figure 54

Coastal Bays Policy Options:

Dredge the Bays for Better Navigation

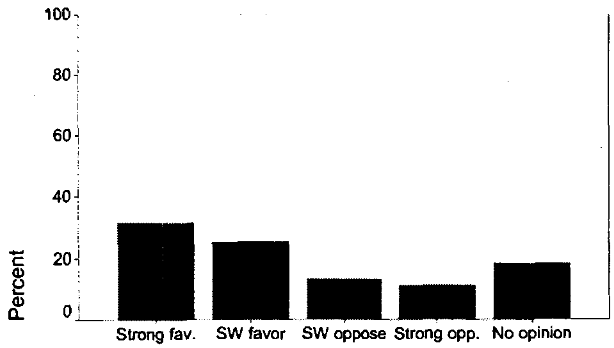


Figure 55

Coastal Bays Policy Options

Reduce Length of Crabbing Season

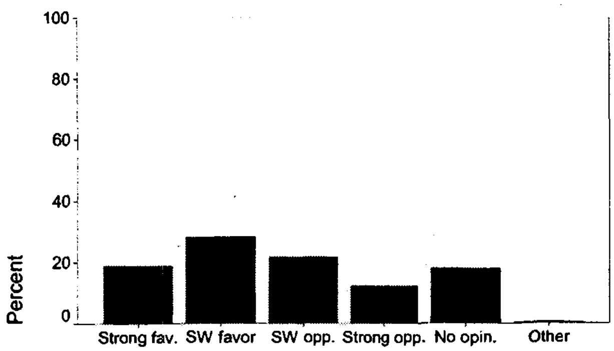


Figure 56

Coastal Bays Policy Options

Reduce Length of Fishing Season

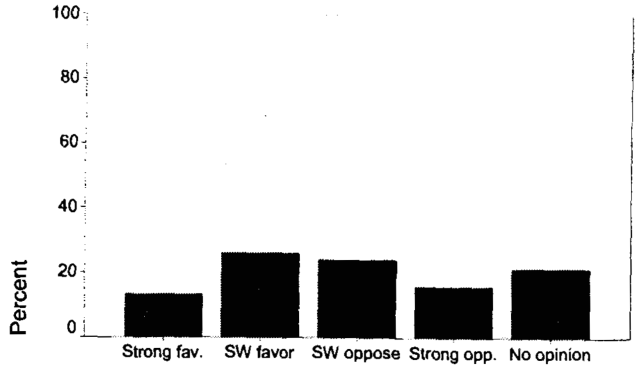


Figure 57

Buffer of Trees and Shrubs:

Level of Support

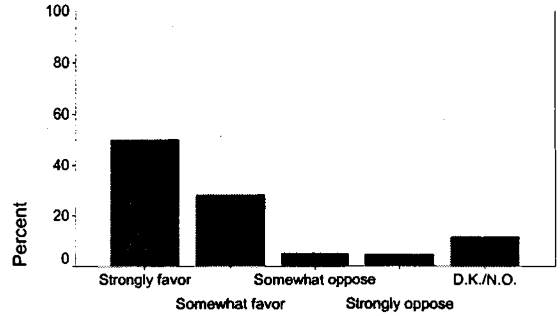


Figure 58

Buffer of Trees and Shrubs:

Proper Width

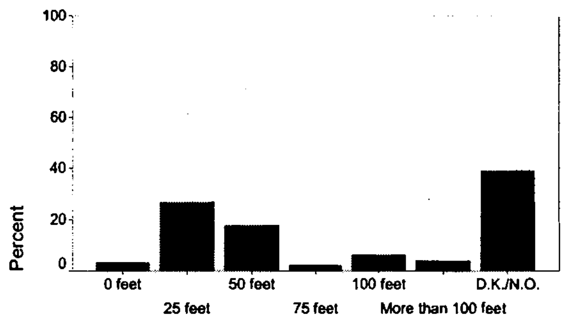


Figure 59

Concentrate Growth in Developed Areas

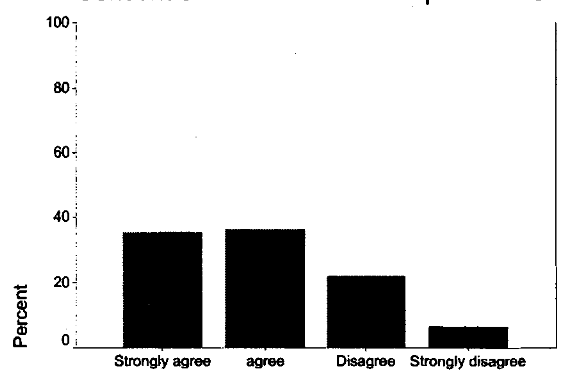


Figure 60

"Downtime" vs. Year-Round Tourism

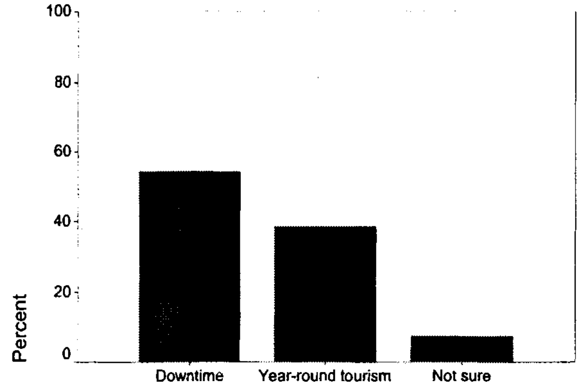
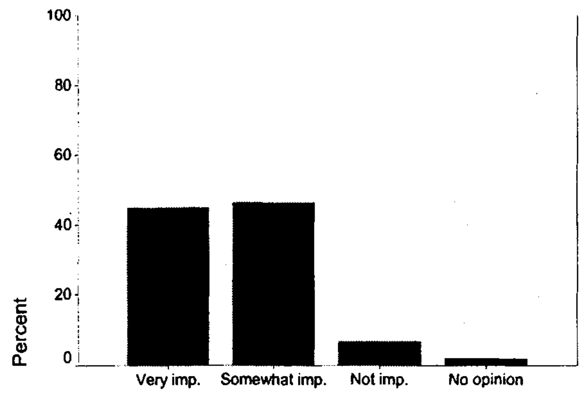


Figure 61

Promotion of Ecotourism



How Do People Behave Towards the Environment?

The last section of the questionnaire has several questions that center on individual behavior towards the environment and how that behavior compares to five years ago. Respondents could choose "More," "About the same," or "Less" to describe their behavior.

A slight majority of respondents (50.6 percent) say that they are recycling cans, bottles, and newspapers "More" than they did five years ago. The "More" response for conserving water and the proper disposal of motor oil/ chemicals is in the 40 percent range. When it comes to conserving water, properly disposing of motor oil/chemicals, and littering, more than 50 percent of the respondents report that they are at "About the same level." For littering, the "Less" response is at 34 percent. (Figures 62-65.)

Just over 36 percent of the respondents said that they have a septic system at their residence (Figure 66). And of those respondents with septic systems, 66.7 percent said that it had been pumped within the last three years (Figure 67).

Finally, two questions were asked about jet skis. Only 12.9 percent of the respondents said that they own or rent jet skis. Use of jet skis by these respondents was reported as follows: 60.8 percent "Once or twice a month" and 39.2 percent once a week or more. (Figures 68-69.)

Figure 62

Compared to Five Years Ago:

Do you Recycle?

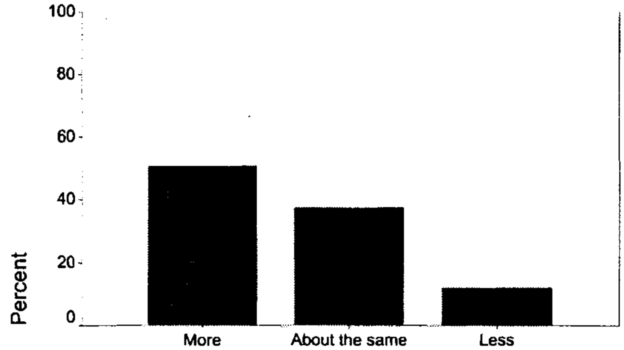


Figure 63

Compared to Five Years Ago:

Do You Conserve Water?

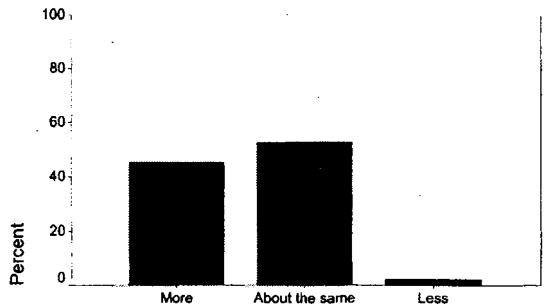


Figure 64

Compared to Five Years Ago:

Do You Dispose of Motor Oil Properly?

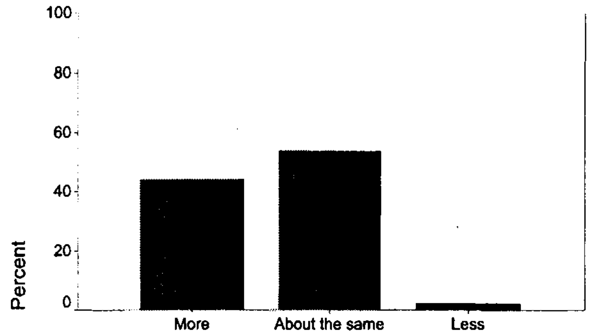


Figure 65

Compared to Five Years Ago:

Do You Litter?

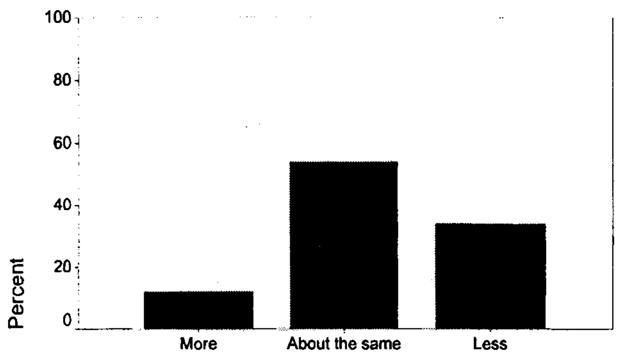


Figure 66

Does Your Residence Have a Septic?

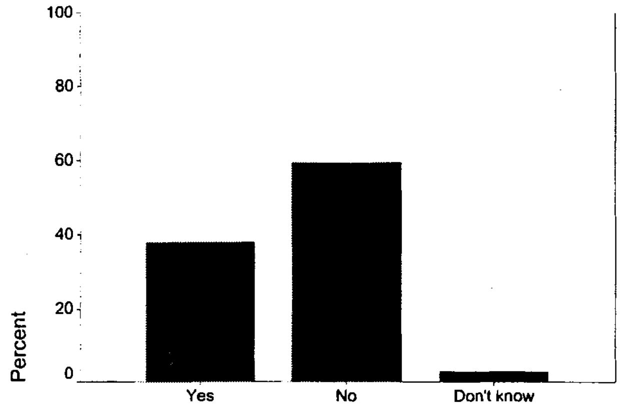


Figure 67

Was Septic System Pumped

Within Last Three Years?

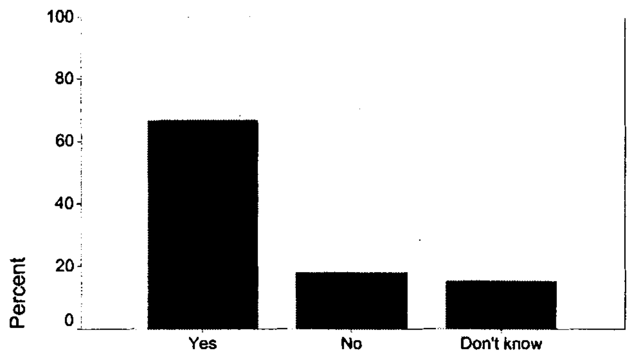


Figure 68

Do You Own/Rent a Jet Ski?

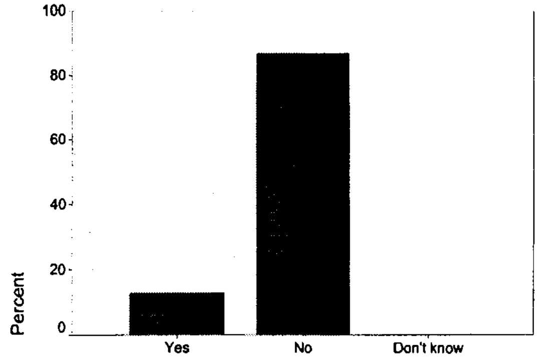
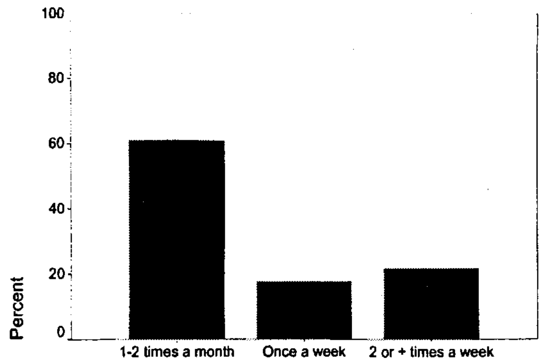


Figure 69

How Often Do You Use a Jet Ski?



Conclusion

Readers of this report may choose to emphasize different findings based on their own knowledge and interests. This conclusion, however, will attempt to draw together the findings that have the widest agreement among the survey's respondents.

What do respondents enjoy most about the Maryland Coastal Bays? Here there is no doubt, "looking at the natural beauty of the Coastal Bays" outdistances all other activities. To preserve and protect the Coastal Bays, government officials should work with citizens, and it is believed that local government, followed by the state government, would do the best job of protecting the bays. On the other hand, more than a majority of respondents say that decisions made by state and local officials show "only some of the time" that they are interested in preserving and protecting the quality of the bays.

The Maryland Coastal Bays Program is widely recognized within the watershed. The majority of respondents evaluate its leadership on Coastal Bays' issues as excellent or good. And the MCBP goal of restoring and protecting the quality of the Maryland Coastal Bays is thought to be very important by 85 percent of the respondents. The best know event sponsored by MCBP is the canoe cleanup at Assateague and the event with the best attendance is Maryland Coast Day.

In terms of specific environmental problems and their potential to harm the Maryland Coastal Bays, respondents ranked runoff from agricultural fields, including those with chicken houses, and poorly maintained septic systems as the number one and number two problems. The policy options that receive the greatest support are protecting habitat such as nesting and spawning areas and protecting underwater plants. On the question of shoreline buffers, a substantial majority of the respondents strongly favor or favor requiring property owners to plant a buffer of trees and shrubs along tidal wetlands and waterways. There is less certainty as to the appropriate width of the buffer, with a majority favoring a buffer of at least 25 feet.

Appendix A

Who Responded to the Survey?

Are the respondents geographically representative of the people living in Maryland Coastal Bays Watershed? We are interested in the opinions of *all* of the people living in the watershed. Thus the results would not be representative of all of the people if we only interviewed people living in Ocean City, or Berlin, or Ocean Pines or Girdletree. To find out where people live, we asked this question: "Which of the following places do you live in or which one is closest to your home?" Percentage of respondents who selected each place are listed below:

Berlin – 19.0	Ocean Pines – 34.3
Bishopville – 8.7	Public Landing – 2.2
Girdletree – 2.8	Snow Hill – 2.4
Newark – 3.6	Stockton – 3.4
Ocean City – 20.2	West Ocean City – 3.4

To facilitate comparing these percentages to census data, these 10 places were grouped into three geographic areas: Group 1 consists of Bishopville and Ocean Pines (42.9 percent), Group 2 is Ocean City and West Ocean City (23.6 percent), and Group 3 is composed of Berlin, Girdletree, Newark, Public Landing, Snow Hill, and Stockton (33.5 percent). Table 1 has a comparison of how the survey's respondents were distributed geographically to the actual distribution as revealed by census data.

Table 1

	Sample Distribution	Census Distribution
Group 1 (Ocean Pines & Northwestern Worcester County)	42.9	42.2
Group 2 (Ocean City & West Ocean City)	23.6	32.5
Group 3 (Berlin & Southern Worcester County)	33.5	25.3

This table shows that 42.9 percent of our respondents live in Group 1 (Ocean Pines and Northwestern Worcester County), almost the exact same proportion that they are in the census data (42.2 percent). Our respondents under-represent those living in Group 2 (Ocean City and West Ocean City), 23.6 percent of our respondents versus the census figure of 32.5 percent. For Group 3 (Berlin and Southern Worcester County), there is an over-representation in our sample with 33.5 percent, while the census data figure is 25.3.

To determine if the moderate under-representation of Group 2 and over-representation of Group 3 affect the results, an analysis was performed that weights the sample respondents in the same proportion as they are in the census data. When the frequency distributions for responses to the questions were compared, there was almost no difference between the two sets of data; the frequency distributions for the responses varied by +/- 1 percent. Consequently, it was decided to use the unweighted data in this report.

Although we wanted to include people in our sample who own a second home in the Maryland Coastal Bays Watershed, we discovered that this was almost impossible. Second homeowners make up only 10 percent of our sample. We talked to 332 people who were not second homeowners and were vacationing or working in the area for the summer. Undoubtedly, a number of the phone numbers we dialed where no one answered or where we reached an answering machine were located in vacation or second homes. This has had two consequences: First, for all practical purpose our sample is of permanent residents of the watershed. Second, the responses rate, that is the percent of phone numbers that yielded interviews out of all eligible numbers, is lower than we would like. The response rate is 19 percent. Again, we believe this low response is primarily caused by the large number of phone numbers for non-permanent residents.

Additional information on the characteristics of the respondents, including length of residence (or length of time owning a second home) in Worcester County, age, race, and sex are in Figure 70 through Figure 74.

Figure 70

Length of Residence

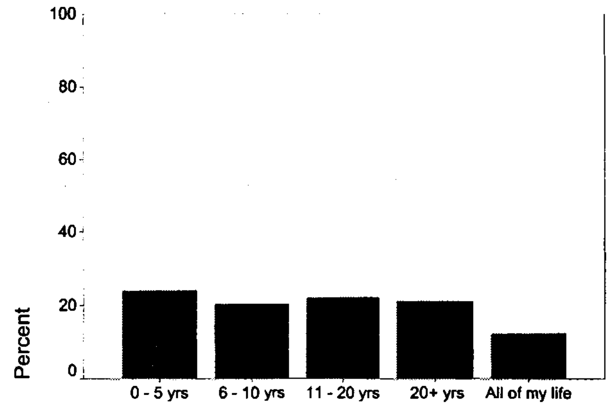


Figure 71

Place You Live In or Closest To

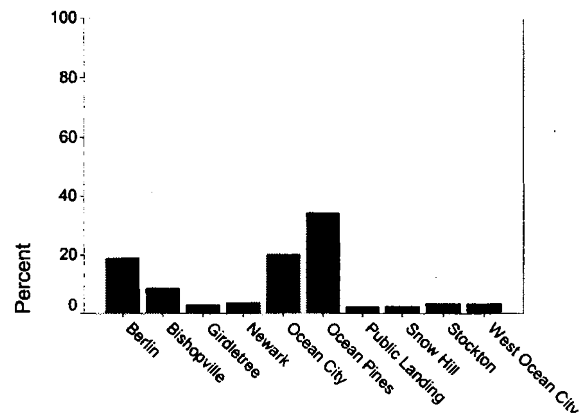


Figure 72

Age

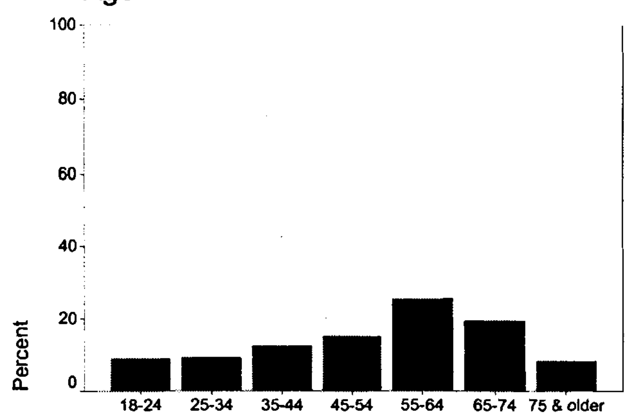


Figure 73

Race

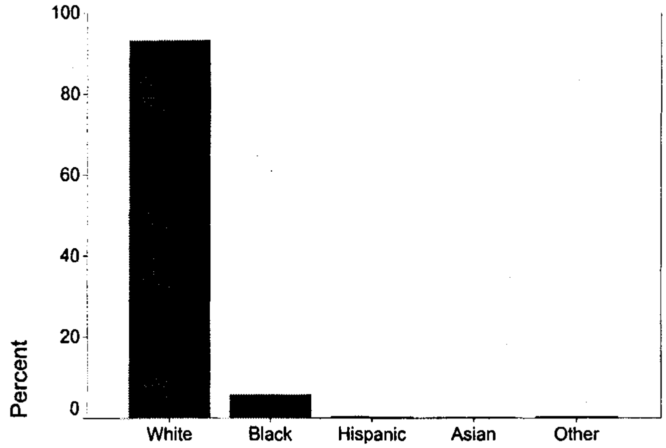
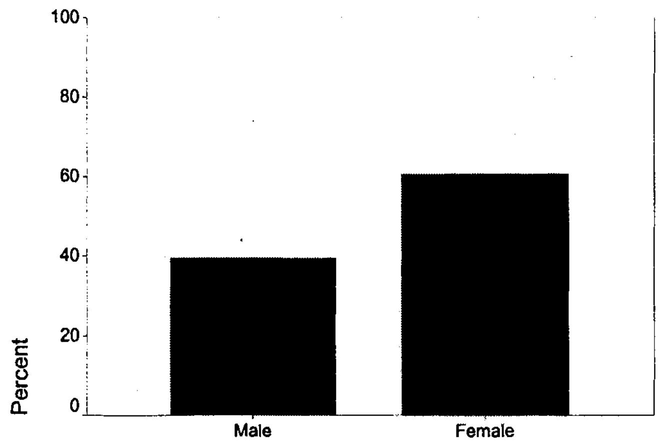


Figure 74

Sex



Appendix B

Methodology of the Survey

This appendix will describe sampling and interviewing procedures, briefly mentioning PACE's new Computer-Assisted Telephone Interviewing system (CATI).

Sampling procedures, that is, determining whom to interview in a telephone survey of a medium-sized county such as Worcester County is usually fairly simple. For example, there is no question of the population that is of interest; it is people who live in the county. Moreover, there is a definite governmental boundary within which these people live. With this information, a company such as Survey Sampling, Inc. in Fairfield, Connecticut, can provide a list of telephone numbers that is randomly generated for the county's telephone prefixes. (This type of sampling is known as Random Digit Dialing, RDD.) Once the numbers are in hand, the interviewing can begin.

However, it was not that easy for this survey. The first complicating factor is that only people living within the Maryland Coastal Bays Watershed are the population of interest, not everyone in the county. The watershed comprises the eastern one-third of Worcester County. The second complication is that during any period of time, but especially during the summer, there are large numbers of people in the watershed who are vacationing. Ocean City, which can have close to four million tourists during the summer, many of them on one-week visits, is the obvious example. The permanent resident population of the watershed is small by comparison, just under 36,000. So two questions had to be answered: Can phone numbers of people living within the watershed be identified? How can we interview only permanent residents and the owners of second homes? Fortunately, we found positive answers to both of these questions.

First, let's look at the question concerning phone numbers. With information from the 2000 census, and the assistance of Eric Stiles, GIS Analyst, Department of Comprehensive Planning, Worcester County, it was possible to identify the census block group numbers of the Maryland Coastal Bays Watershed. It's not a perfect match, but certainly a very good approximation. (See map on the next page. Census block groups for the watershed are in blue.) SSI could then match the block group numbers to telephone prefixes.

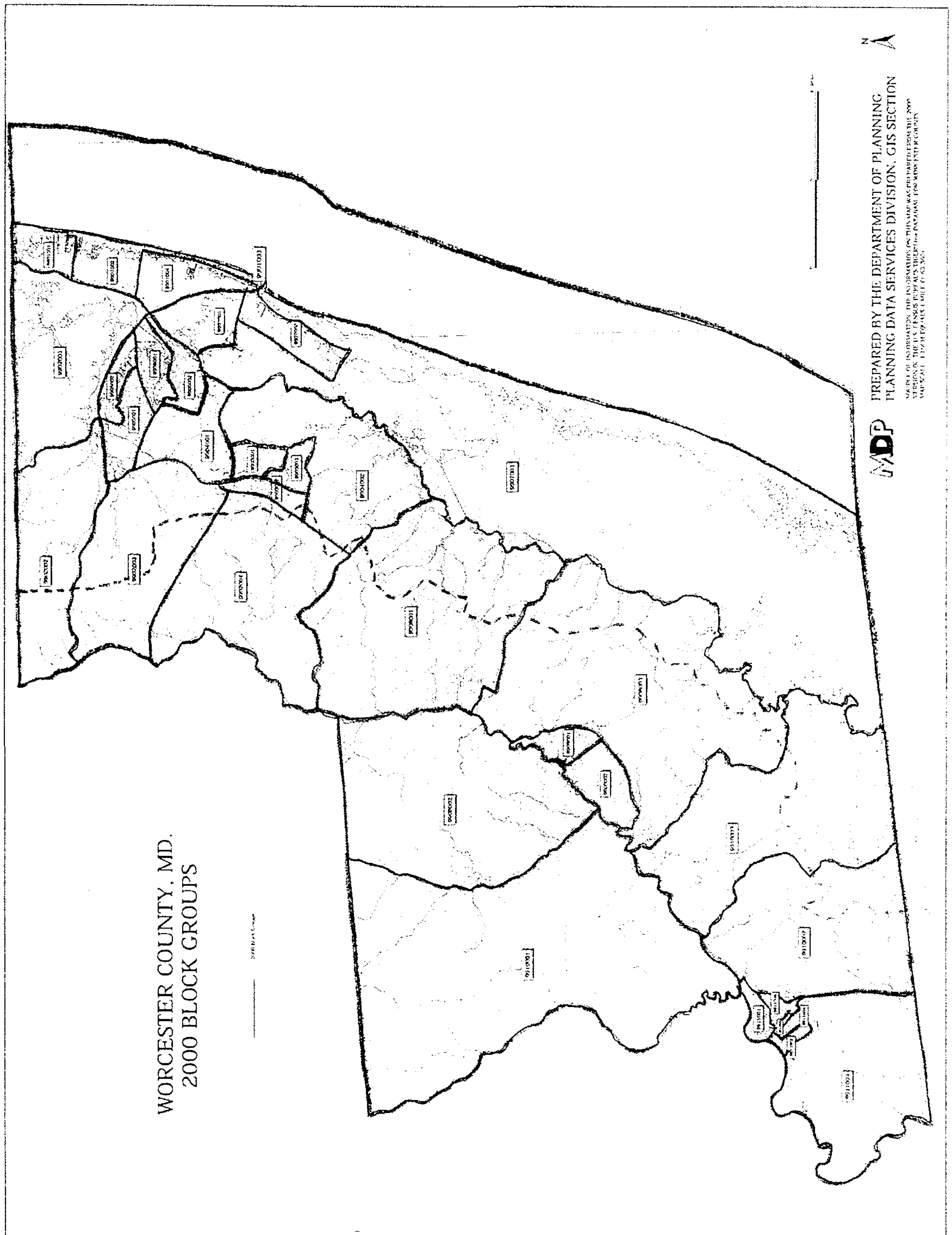
Second, permanent residents and second homeowners were identified by a screening question, which was the first question in the survey. The text of the screening question is below:

Q-01. Which one of the following best describes you?

1. I am a permanent resident of Worcester County and own or rent a house or apartment in the county.
2. I own a second home in Worcester County, but it is not my primary residence.
3. I'm in Worcester County on vacation or working here during the summer and I'm not a permanent resident.

Only respondents who answered #1 or #2 were interviewed.

Finally, it is important to note that we decided to use a listed sample of phone numbers rather than an RDD sample. A listed sample is one that draws phone numbers from residential numbers that are published in telephone directories. As in life's decisions, almost all sampling decisions involve trade-offs. By using a listed sample, we gained a list of numbers for residences only; business phone numbers were

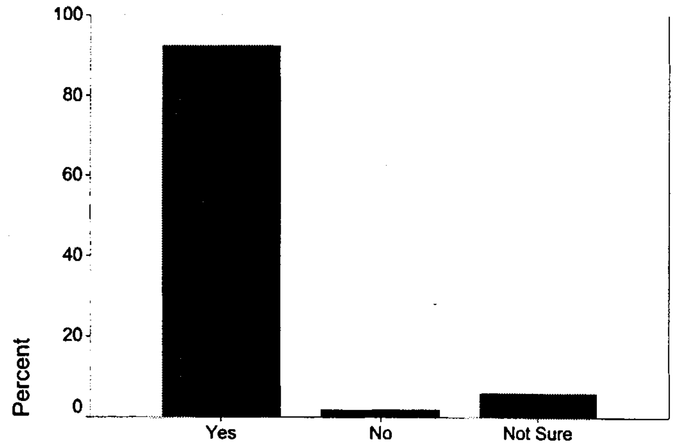

WORCESTER COUNTY, MD.
2000 BLOCK GROUPS
PREPARED BY THE DEPARTMENT OF PLANNING
PLANNING DATA SERVICES DIVISION, GIS SECTION

excluded. This seemed particularly important because of the extraordinary number of business phone numbers in the Ocean City area. We recognize that a listed sample misses unlisted residential phone numbers that would have been included in an RDD sample. Nevertheless, the listed sample helped in reaching phone numbers of permanent residents and second homeowners with minimal effort.

Telephone interviewing started on June 11, 2001 and finished on June 27, 2001. Eight interviewers were Salisbury University students: Jamie Bartlett, Jamie Birkett, Sondra Brown, Jessica Fyock, Sandy Gall, Cynthia Marrufo, Sharon Sullivan, and Dennis Urban. Two interviewers were non-students: Doreen Shekibula and Michael Wigfall. We almost always had two interviewers working during the day, Monday through Friday, from 11:00 A.M. till 5:00 P.M. Four to six interviewers were on duty during the evenings from 6:00 P.M. till 9:00 P.M., Monday through Friday. Average time to complete one interview was approximately15 minutes. All phone numbers in the sample were called four times. Respondents reported that the interview was worthwhile (Figure 75).

Figure 75

Was Interview Worthwhile?



Appendix C

Maryland Coastal Bays Questionnaire (June 2001) And Frequency Distribution for Reponses

Q-01. Which one of the following best describes you:

	Valid Percent	
1. I am a permanent resident of Worcester County and own or rent a house or apartment in the county.	90.0	
2. I own a second home in Worcester County, but it is not my primary residence.	10.0	
Total	100.0	N = 512 Missing = 0
3. I'm in Worcester County on vacation or working here during the summer and I'm not a permanent resident.		N = 332

Like Most About Maryland Coastal Bays

Q-02. First, I would like to ask you if there are any Maryland Coastal Bays' activities that you participate in and find enjoyable. For each activity I mention, please respond with a "High," "Medium," or "Low" to indicate your level of enjoyment. Or you can say "Don't Participate."

Q-02.1. Sailing	Valid Percent	
1. High	6.1	
2. Medium	3.1	
3. Low	8.0	
4. Don't Participate	82.8	
Total	100.0	N = 512; Missing = 1

Q-02.2. Motor boating		
1. High	26.0	
2. Medium	15.0	
3. Low	9.8	
4. Don't Participate	49.2	
Total	100.0	N = 512

Q-02.3. Swimming at the beaches		
1. High	42.7	
2. Medium	20.2	
3. Low	14.3	
4. Don't Participate	22.9	
Total	100.0	N = 512; Missing = 1

Q-02.4. Fishing

1. High	27.9	
2. Medium	18.6	
3. Low	13.9	
4. Don't Participate	39.6	
Total	100.0	N = 512

Q-02.5. Crabbing

1. High	17.2	
2. Medium	17.6	
3. Low	19.5	
4. Don't Participate	45.7	
Total	100.0	N = 512

Q-02.6. Jet skiing

1. High	6.3	
2. Medium	3.5	
3. Low	13.9	
4. Don't Participate	76.4	
Total	100.0	N = 512

Q-02.7. Bird watching

1. High	22.9	
2. Medium	20.9	
3. Low	18.9	
4. Don't Participate	37.3	
Total	100.0	N = 512

Q-02.8. Looking at the natural beauty of the bays

1. High	71.7	
2. Medium	19.5	
3. Low	4.1	
4. Don't Participate	4.7	
Total	100.0	N = 512

Q-02.9. Canoeing or kayaking

1. High	8.4	
2. Medium	10.2	
3. Low	15.6	
4. Don't Participate	65.8	
Total	100.0	N = 512

Responsibility for Protecting the Maryland Coastal Bays

Q-03. Overall, how would you rate the progress that has been made in recent years in preserving and protecting the quality of the Maryland Coastal Bays? Would you say there has been "A lot," of progress, "Some," or "Not Much"?

1. A lot	26.8	
2. Some	50.6	
3. Not Much	14.1	
4.Don't Know/No Opinion	8.6	
Total	100.0	N = 512

Q-04. Generally, would you say that the decisions made by state and local government officials show that they are interested in preserving and protecting the quality of the Maryland Coastal Bays: "Almost All of the Time," "Only Some of the Time," or "Never."

1. Almost All of the Time	31.4	
2. Only Some of the Time	59.0	
3. Never	3.5	
97. Don't Know/No opinion	6.1	
Total	100.0	N = 512

Q-05. In general terms, which one of the following three statements best reflects your belief?

1. People should be able to do what they want with their own land and determine for themselves how to protect the bays.	11.2	
2. Government officials should work with citizens to develop a plan to protect the bays.	67.7	
3. Government officials should use the best information available and adopt and enforce regulations that will protect the bays.	18.0	
4. Don't know/ No Opinion	3.1	
Total	100.0	N = 512 Missing = 1

Q-06. Generally speaking, which level of government do you think would do the best job in preserving and protecting the coastal bays? "Local," State," or "Federal"

(Interviewer instructions: county or town response should be coded as local.)

1. Local	54.9	
2. State	35.5	
3. Federal	9.6	
Total	100.0	N = 512 Missing = 53

Q-07. Based on your knowledge, are there any groups in Worcester County whose views on the Maryland Coastal Bays are consistently left out of the process of making decisions rather than being part of process? I'll identify a few groups and you tell me if you feel they are "part of the decision making process" or if they are "left out."

Q-07.1. Real estate developers

1. Left out of the decision making process.	15.9	
2. Part of the decision making process	54.1	
3. Don't Know/No opinion	30.0	
Total	100.0	N = 512; Missing = 4

Q-07.2. Watermen

1. Left out of the decision making process.	27.5	
2. Part of the decision making process	54.0	
3. Don't Know/No Opinion	18.5	
Total	100.0	

Q-07.3. Environmental groups

1. Left out of the decision making process.	8.9	
2. Part of the decision making process.	75.9	
3. Don't Know	15.2	
Total	100.0	N = 512; Missing = 5

Q-07.4. Farmers

1. Left out of the decision making process.	33.3	
2. Part of the decision making process	48.0	
3. Don't Know	18.7	
Total	100.0	N = 512; Missing = 4

Q-07.5. Recreational boaters and crabbers

1. Left out of the decision making process.	37.0	
2. Part of the decision making process	41.3	
3. Don't Know	21.7	
Total	100.0	N = 512; Missing = 4

Most Important Environmental Issue

Q-08. Now, I'd like to ask you about some activities that may be harmful to the Maryland Coastal Bays. Please tell me if you think the following activities are a "Big Problem," a "Little Problem," "Not a Problem," or if you've not heard about it you can say "Don't Know."

Q-08.1. Current rate of growth and development

1. Big Problem	58.0	
2. Little Problem	22.5	
3. Not a Problem	8.4	
97. Don't Know	11.1	
Total	100.0	N = 512

Q-08.2. Homeowners who fertilize their lawns

1. Big Problem	33.5	
2. Little Problem	37.6	
3. Not a Problem	17.0	
97. Don't Know	11.9	
Total	100.0	N = 512; Missing = 1

Q-08.3. Water front property owners who erect piers or bulkheads

1. Big Problem	18.0	
2. Little Problem	34.7	
3. Not a Problem	31.0	
4. Don't Know	16.3	
Total	100.0	N = 512; Missing = 2

Q-08.4. Water front property owners who have small vegetation buffers

1. Big Problem	4.5	
2. Little Problem	21.7	
3. Not a Problem	50.5	
97. Don't Know	23.3	
Total	100.0	N = 512; Missing = 1

Q-08.5. Destruction of underwater plants such as sea grass beds

1. Big Problem	59.3	
2. Little Problem	15.5	
3. Not a Problem	8.2	
4. Don't Know	17.0	
Total	100.0	N = 512; Missing = 1

Q-08.6. Run off from agricultural fields, including those with chicken houses

1. Big Problem	73.2	
2. Little Problem	13.5	
3. Not a Problem	6.1	
4. Don't Know	7.2	
Total	100.0	N = 512

Q-08.7. Homeowners with poorly maintained septic systems

1. Big Problem	60.5	
2. Little Problem	17.8	
3. Not a Problem	7.4	
4. Don't Know	14.3	N = 512; Missing = 0

Q-08.8. Storm water run off

1. Big Problem	32.8	
2. Little Problem	37.7	
3. Not a Problem	14.5	
97. Don't Know	15.0	
Total	100.0	N = 512

Q-08.9. Growth of non-native species (such as the Japanese green crab and phragmites, common marsh reed)

1. Big Problem	37.1	
2. Little Problem	18.6	
3. Not a Problem	7.8	
97. Don't Know	36.5	
Total	100.0	N = 512

Q-08.10. Sewage treatment plants operated by cities and towns

1. Big Problem	27.9	
2. Little Problem	26.6	
3. Not a Problem	22.3	
97. Don't Know	23.2	
Total	100.0	N = 512

Q-08.11. Recreational use of motorboats

1. Big Problem	31.1	
2. Little Problem	39.5	
3. Not a Problem	21.1	
97. Don't Know	8.4	
Total	100.0	N = 512

Q-08.12. Recreational use of jet skis

1. Big Problem	43.4	
2. Little Problem	30.5	
3. Not a Problem	17.4	
97. Don't Know	8.8	
Total	100.0	N = 512

Q-08.13. Chicken processing plants

1. Big Problem	55.4	
2. Little Problem	22.5	
3. Not a Problem	6.5	
97. Don't Know	15.7	
Total	100.0	N = 512

Q-09. Overall, how has growth and development in Worcester County during the last five years affected your life? Would you say it has had a positive effect, no effect, or a negative effect?

1. Positive Effect	(Continue to Q-09.1.)	32.3	
2. No Effect	(Go to Q-10)	36.2	
3. Negative Effect	(Go to Q-09.2)	28.8	
4. Don't Know		2.7	
Total		100.0	N = 512; Missing = 1

Q-09.1. What has been the main positive effect?
Open-ended question.

Q-09.2. What has been the main negative effect?
Open-ended question.

Knowledge and Evaluation of Maryland Coastal Bays Program

Q-10. My next question is this: Have you heard of a program in Worcester County called the Maryland Coastal Bays Program? "Yes," "No," or "Not Sure."

1. Yes	83.2	
2. No	13.3	
3. Not Sure	3.5	
Total	100.0	N = 512; Missing = 1

Q-11. Within the past year, did you hear about or perhaps even attend the following events that were sponsored by the Maryland Coastal Bays Program? You can answer "Yes," "No," or "Not Sure."

Q-11.1. Did you hear about the Canoe Cleanup at Assateague?

1. Yes (Continue to Q-11.1.A.)	57.5	
2. No (Go to Q-11.2)	40.9	
3. Not sure (Go to Q-11.2)	1.6	
Total	100.0	N = 512; Missing = 1

Q11.1.A. Did you attend this event?

1. Yes	7.8	
2. No	92.2	
Total	100.0	N = 512 Missing = 218

Q-11.2. Did you hear about the Earth Day boat trip?

1. Yes (Continue to Q-11.2.A.)	31.7	
2. No (Go to Q-11.3)	65.4	
3. Not sure (Go to Q-11.3)	2.9	
Total	100.0	N = 512; Missing = 1

Q-11.2.A. Did you attend this event?

1. Yes	5.6	
2. No	94.4	
Total	100.0	N = 512 Missing = 350

Q-11.3. Did you hear about the Isle of Wight cleanup?

1. Yes (Continue to Q-11.3.A.)	52.8	
2. No (Go to Q-11.4)	45.2	
3. Not sure (Go to Q-11.4)	2.0	
Total	100.0	N = 512; Missing = 1

Q-11.3.A. Did you attend this event?

1. Yes	7.0	
2. No	93.0	
Total	100.0	N = 512 Missing = 242

Q-11.4. Did you hear about Maryland Coast Day?

1. Yes (Continue to Q-11.4.A.)	44.4	
2. No (Go to Q-11.5)	52.4	
3. Not sure (Go to Q-11.5)	3.1	
Total	100.0	N = 512; Missing = 1

Q-11.4.A. Did you attend this event?

1. Yes	16.7	
2. No	82.4	
Total	100.0	N = 512 Missing = 285

Q-11.5. Are you aware of monthly meetings of the Citizens' Advisory Committee of the Maryland Coastal Bays Program?

1. Yes (Continue to Q-11.5.A.)	26.0
2. No (Go to interviewer instructions for Q-12.1)	71.8
3. Not sure (Go to interviewer instructions forQ-12.1)	2.2
Total	100.0
	N = 512 Missing = 1

Q11.5.A. Did you ever attend one of these meetings?

1. Yes	15.0
2. No	83.5
3. Not sure	1.5
Total	100.0
	N = 512
	Missing = 379

(Interviewer instructions:

If the respondent answers "yes" to any part of Q-11, please go to Q-12.1

If the respondent answers "no" to all parts of Q-11, please go to Q-13.)

Q-12.1. How did your hear about the Maryland Coastal Bay activity (activities) that you just mentioned? Was it through television, radio, newsletter, newspaper articles, or conversations with neighbors or friends.

1. Television (Continue to Q-12.2)	12.1
2. Radio (Continue to Q-12.2)	2.5
3. Newsletters (Continue to Q-12.2)	10.8
4. Newspaper articles (Continue to Q-12.2)	49.2
5. Neighbors and friends (Continue to Q-12.2)	25.4
Total	100.0
	N = 512
	Missing = 114

Q-12.2. Is there any other way you have heard of the Coastal Bays activity (activities)?

1. Television	27.8
2. Radio	8.8
3. Newsletters	14.4
4. Newspaper articles	25.8
5. Neighbors and friends	23.2
Total	100.0
	N = 512
	Missing = 318

Q-13. How would you rate the Maryland Coastal Bays Program in providing leadership in working with different community groups to restore and protect the quality of the coastal bays? Are they doing an "Excellent," "Good," "Fair," or "Poor," job. Or are you "Not Sure?"

1. Excellent	13.4
2. Good	44.6
3. Fair	12.5
4. Poor	3.5
5. Not Sure	25.9
Total	100.0
	N = 512
	Missing = 57

Q-14. The goal of the Maryland Coastal Bays Program is to restore and protect the quality of Maryland's Coastal Bays. Do you think this goal is very important, somewhat important, or not important?

1. Very Important	85.8
2. Somewhat Important	13.2
3. Not Important	1.0
Total	100.0
	N = 512
	Missing = 11

Options for Protecting the Maryland Coastal Bays

Q-15. Frequently, there is disagreement over policies that would affect the Maryland Coastal Bays. For each proposal I read, please tell me if you 1. "Strongly Favor," 2. "Somewhat Favor," 3. "Somewhat Oppose," or 4. "Strongly Oppose."

Q-15.1. Protect habitat such as nesting and spawning areas

1. Strongly Favor	72.3
2. Somewhat Favor	21.2
3. Somewhat Oppose	2.0
4. Strongly Oppose	1.6
97. Don't Know/No opinion	3.0
Total	100.0
	N = 512
	Missing = 7

Q-15.2. Protect existing open spaces such as agricultural lands and forests

1. Strongly Favor	67.6
2. Somewhat Favor	24.3
3. Somewhat Oppose	3.0
4. Strongly Oppose	1.0
97. Don't Know/No opinion	4.2
Total	100.0
	N = 512
	Missing = 9

Q-15.3. Reduce the length of the season for fishing

1. Strongly Favor	13.3
2. Somewhat Favor	25.8
3. Somewhat Oppose	23.9
4. Strongly Oppose	15.7
97. Don't Know/No opinion	21.3
Total	100.0
	N = 512
	Missing = 9

Q-15.4. Reduce the length of the season for crabbing

1. Strongly Favor	19.1
2. Somewhat Favor	28.4
3. Somewhat Oppose	21.7
4. Strongly Oppose	12.3
97. Don't Know/No opinion	18.1
98. Refused to Answer	0.4
Total	100.0
	N = 512
	Missing = 9

Q-15.5. Dredge the coastal bays for better navigation

1. Strongly Favor	31.7
2. Somewhat Favor	25.5
3. Somewhat Oppose	13.3
4. Strongly Oppose	11.2
97. Don't Know/No opinion	18.3
Total	100.0
	N = 512
	Missing =10

Q-15.6. Reduce run off from agricultural land

1. Strongly Favor	59.3
2. Somewhat Favor	22.2
3. Somewhat Oppose	5.2
4. Strongly Oppose	5.0
97. Don't Know/No opinion	8.4
Total	100.0
	N = 512
	Missing =11

Q15.7. Protecting underwater plants such as sea grass beds

1. Strongly Favor	70.5
2. Somewhat Favor	21.8
3. Somewhat Oppose	2.4
4. Strongly Oppose	1.2
97. Don't Know/No opinion	4.2
Total	100.0
	N = 512
	Missing =11

Q-16. As you may know, one of the most controversial issues is the requirement that property owners plant a buffer of trees and shrubs along tidal wetlands or waterways that border their property. Would you say you "Strongly Favor," "Somewhat Favor," "Somewhat Oppose," or Strongly Oppose" the buffer requirement.

1. Strongly Favor (Continue to Q-16.A.)	50.2
2. Somewhat Favor (Continue to Q16.A.)	28.3
3. Somewhat Oppose (Continue to Q16.A)	5.2
4. Strongly Oppose (Continue to Q16.A)	4.6
97. Don't Know/No Opinion	11.6
Total	100.0
	N = 512
	Missing =14

(Interviewer instructions: Basically, a buffer of trees and shrubs refers to the land between the water and a homeowner's lawn.)

Q-16.A. What width do you favor for a buffer of trees and shrubs?

1. 0 feet	3.4
2. 25 feet	26.8
3. 50 feet	17.8
4. 75 feet	2.3
5. 100 feet	6.4
6. More than 100 feet	4.1
97. Don't Know/No opinion	39.1
Total	100.0
	N = 512
	Missing =75

Q-17. Do you "strongly agree," agree," disagree," or "strongly disagree," with this statement: Future growth and development in Worcester County should be concentrated in currently developed areas rather than in outlying and less populated agricultural areas.

1. Strongly agree	35.3
2. Agree	36.2
3. Disagree	22.0
4. Strongly disagree	6.5
Total	100.0
	N = 512
	Missing = 98

Tourism

Q-18. Do you prefer the "downtime" our resorts have in the winter or should there be more promotion of year-round tourism?

1. I prefer the "downtime"	54.2
2. I prefer more promotion of year-round tourism	38.4
3. Not sure	7.4
Total	100.0
	N = 512
	Missing = 23

Q-19. How important do you think it is to expand and promote ecotourism opportunities such as nature tours and bird watching? Do you think it is "Very Important," Somewhat Important," or "Not Important."

1. Very Important	44.9
2. Somewhat Important	46.3
3. Not Important	6.8
97. Don't Know/No opinion	2.0
Total	100.0
	N = 512
	Missing = 13

(Interviewer instructions: You might want to say at this point: Thanks for being so helpful, just a few more questions and we'll be finished.)

Individual Behavior

Q-20. Compared to five years ago, would you say that today you . . .

Q-20.1. Recycle cans, bottles, and newspapers

1. More	50.6
2. About the same	37.4
3. Less	12.0
Total	100.0
	N = 512
	Missing = 20

Q-20.2. Conserve water

1. More	45.2
2. About the same	52.6
3. Less	2.2
Total	100.0
	N = 512
	Missing = 23

Q-20.3. Dispose of motor oil and other chemicals properly	
1. More	44.0
2. About the same	53.7
3. Less	2.3
Total	100.0
	N = 512
	Missing = 76

Q-20.4. Littering	
1. More	12.0
2. About the same	54.0
3. Less	34.0
Total	100.0
	N = 512
	Missing = 45

Q-21. Does your residence have a septic system?	
1. Yes (Continue to Question Q-21.A.)	38.0
2. No (Go to Q-22)	59.2
97. Don't Know/No opinion (Go to Q-22)	2.8
Total	100.0
	N = 512
	Missing = 14

Q-21. A. Has it been pumped within the last 3 years?	
1. Yes	66.7
2. No	18.0
97. Don't Know/No opinion	15.3
Total	100.0
	N = 512
	Missing = 323

Q-22. Do you own or ever rent a jet ski?	
1. Yes (Continue to question Q-22.A.)	12.9
2. No (Go to Q-23)	86.9
97. Don't Know/No opinion (Go to Q-23)	0.2
Total	100.0
	N = 512
	Missing = 14

Q-22. A. How often do you use a jet ski?

1. Once or twice a month	60.8
2. Once a week	17.6
3. Two or more times a week	21.6
Total	100.0
	N = 512
	Missing = 461

Demographic Questions

Q-23. How long have you lived (or owned a second home) in Worcester County?

1. 0 – 5 years	23.9
2. 6 – 10 years	20.3
3. 11- 20 years	22.1
4. Over 20 years, but not all of my life	21.1
5. All of my life	12.5
Total	100.0
	N = 512
	Missing = 15

Q-24. Which of the following is nearest to your home?

1. Berlin	19.0
2. Bishopville	8.7
3. Girdletree	2.8
4. Newark	3.6
5. Ocean City	20.2
6. Ocean Pines	34.3
7. Public Landing	2.2
8. Snow Hill	2.4
9. Stockton	3.4
10. West Ocean City	3.4
Total	100.0
	N = 512
	Missing = 16

Q-25. Which age category are you in?

1. 18 – 24	9.1
2. 25 – 34	9.5
3. 35 – 44	12.7
4. 45 – 54	15.3
5. 55 – 64	25.6
6. 65 – 74	19.5
7. 75 and older	8.5
Total	100.0
	N = 512
	Missing = 15

Q-26. Which category best describes your race or ethnicity?

1. White	93.2
2. Black	5.7
3. Hispanic	0.4
4. Asian	0.2
5. Other	0.4
Total	100.0
	N = 512
	Missing = 25

Q-27. Sex (Interviewers: Do not ask, code based on respondent's voice)

1. Male	39.4
2. Female	60.6
Total	100.0
	N = 512
	Missing = 15

Q-28. Last question: Was participating in this interview a worthwhile experience?

1. Yes	92.3
2. No	1.8
3. Not sure	5.9
Total	100.0
	N = 512
	Missing = 20

Thanks . . .

Appendix D

Responses to Open-Ended Question on the Effects of Growth and Development

Main Positive Effect Q-09.1.

- For personal business
- Controls development in area
- Increase in services
- Diversity of people = better government processes, provides fresh perspective on local resources
- More people=more revenue
- No conclusion
- Local gov't does good job, issues are taken care of, good community, beautiful area
- Profit goes back into local development
- Easy access to stores
- Income and available services
- Better job opportunities due to growth
- Don't know
- Increase in real estate prices
- Beneficial to homeowners
- Limiting building on waterfront
- Gov't involved in protecting environment
- New amenities like libraries, YMCA
- Convenience
- Cleaning the air
- Increase in fish in past couple years
- Property values on rise
- More financial opportunities in area
- Improved quality of life
- Coastal area

Main Negative Effect Q-9.2.

- Too many Sunsation buildings are an eye sore, cut into small business owners profits, sell inappropriate products-need for more family oriented stores
- Bad for the environment and commercial crabbers
- Not enough growth
- Run off from golf courses is a problem that needs to be dealt with
- Traffic, noise, congestion, too many people, dirty streets, makes house dirty
- Too much tourism
- Growth and development
- Too crowded
- Too much waste
- Became legally blind 3 years ago
- High taxes
- Development of waterfront real estate
- Traffic
- More people in recreational activities cause pollution
- Too many people, too much growth

- Too much growth too fast causing environmental problems
- High cost of living has affected students/foreign students, lack of employment, force the "little guy" out, only wealthy/vacationers around
- Increased boating traffic, mean tourists
- Prices for real estate have increased
- Bay overused/under maintained
- Overpopulation

Coastal Bays Hard Clam Fishery Management Plan

Prepared by:
Maryland Department of Natural Resources
Coastal Bays Fishery Advisory Committee

February 2002

MARYLAND COASTAL BAYS

POLICY COMMITTEE

ENDORSEMENT STATEMENT

HARD CLAM FISHERY MANAGEMENT PLAN FOR MARYLAND'S COASTAL BAYS

We, the undersigned, endorse the 2002 Hard Clam Fishery Management Plan for Maryland's Coastal Bays. We agree to accept the 2001 Hard Clam Fishery Management Plan for Maryland's Coastal Bays as a guide to conserving the hard clam resource of the coastal bays, protecting its ecological and socio-economic value, and optimizing the long-term use of the resource. We further agree to support implementation, by the dates set forth in the Plan, the management actions recommended to assess the impact of *Hematodinium* (disease), conduct a comprehensive stock assessment, control crabbing effort and harvest rates, improve the quality of recreational crabbing, protect hard clam habitat, and implement effective enforcement.

We recognize that the 2002 Hard Clam Fishery Management Plan for Maryland's Coastal Bays is based on the science as we know it today, and not an endpoint. We recognize the need to commit long-term, stable, financial support and human resources to the task of managing the hard clam resource of the coastal bays and addressing important research needs. In addition, we ask the Maryland Department of Natural Resources to periodically review and update the Plan and report on progress made in achieving the Plan's management recommendations.

For Maryland Department of Natural Resources ______________________
Chuck Fox, Secretary

For Worcester County ______________________
John Bloxom, Commissioner

Louise Gulyas, Commissioner

Jeanne Lynch, Commissioner

James Purnell, Jr., Commissioner

Virgil Shockley, Commissioner

For Town of Ocean City

James Mathias, Mayor

For Town of Berlin

Rex Hailey, Mayor

For Ocean City Council

Rick Meehan, President

For U.S. Environmental Protection Agency

Donald Welsch, Region III Administrator

For Maryland Department of Agriculture

Hagner Mister, Secretary

For Maryland Department of the Environment

Jane Nishida, Secretary

For Maryland Department of Planning

Roy Kienitz, Director

For Assateague Island National Seashore

Mike Hill, Superintendent

For MCBP Scientific Technical Committee

Don Boesch, Chairperson

For Local Citizens

Jack Burbage

Carolyn Cummins

Edward Lee

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Mitch Tarnowki, Fisheries Service

TABLE OF CONTENTS

SECTION 1. EXECUTIVE SUMMARY 7

SECTION 2. GOAL AND OBJECTIVES 9

SECTION 3. BIOLOGICAL BACKGROUND 10
Life History 10
Ecological Role 11
Habitat Requirements 12
History of Hard Clam Fishery in the Maryland Coastal Bays 12

SECTION 4. MANAGEMENT STRATEGY 18
OBJECTIVE 1: Enhance and perpetuate hard clam stocks. 18
Problem 1.1: Mortality of Small Clams 18
OBJECTIVE 2: Manage for a viable commercial hard clam harvest to maintain an economically stable fishery. 18
Problem 2.1: Potential Economic Hardship to Commercial Clammers Caused by the "Boom and Bust" Nature of the Fishery 18
OBJECTIVE 3: Evaluate the feasibility of hard clam aquaculture opportunities. 19
Problem 3.1: Establishing Hard Clam Aquaculture 19
OBJECTIVE 4: Enhance and promote the recreational hard clam fishery. 19
Problem 4.1: Limited Access and Knowledge of Recreational Clamming Opportunities in Maryland's Coastal Bays 19
OBJECTIVE 5: Minimize conflicts between coastal bay user groups and commercial hard clam fishermen. 20
Problem 5.1: Conflict Between Recreational Fishermen and Commercial Clammers 20
OBJECTIVE 6: Minimize ecological impacts associated with the commercial and recreational hard clam fisheries. 21
Problem 6.1: Community Concern on the Ecological Effects of Commercial Hydraulic Clam Dredging 21
Problem 6.2: Direct Impact to Submerged Aquatic Vegetation (SAV) by Commercial Hydraulic Clam Dredging 22
Problem 6.3: Potential Impact to Overwintering Blue Crabs by Commercial Hydraulic Clam Dredging 23
OBJECTIVE 7: Protect, maintain and enhance important hard clam habitats. 23
Problem 7.1: Water Quality 23
Problem 7.2: Hard Bottom Habitat 23
Problem 7.3: Navigational Channel Dredging and Dredge Disposal 24
Problem 7.4: Growth of Noxious Algal Blooms 24

OBJECTIVE 8: Minimize the impacts of non-indigenous invasive species. 24
Problem 8.1: Green Crabs 24
OBJECTIVE 9: Implement fisheries dependent and independent monitoring programs to obtain sufficient and accurate data for managing hard clams. 25
Problem 9.1: Stock Assessment 25
Problem 9.2: Assessment of Bottom Enhancement Activities 25
Problem 9.3: Commercial Catch, Effort and Economic Data 25
Problem 9.4: Recreational Catch, Effort and Economic Data 25

References 26

Appendix I. A literature review of the ecological effects of hydraulic escalator dredging. 29

SECTION 1. EXECUTIVE SUMMARY

In July 1999, a Comprehensive and Conservation Management Plan was adopted for Maryland's coastal bays. This Plan distinguished Maryland's coastal bays as a separate, unique ecosystem from the Chesapeake Bay, and included a recommendation that the Maryland Department of Natural Resources (DNR) address fishery issues specific to Maryland's coastal bays. Fishery issues were divided into three categories: finfish, shellfish, and blue crabs. This document specifically addresses the issues related to hard clams, and sets forth management strategies for improving the management of hard clams in the coastal bays.

The goal of the Hard Clam Fishery Management Plan (FMP) for Maryland's Coastal Bays is to manage hard clams in Maryland's coastal bays in a manner which conserves the coastal bay stock, protects its ecological and socio-economic value, and optimizes the long-term use of the resource. To achieve this goal, the following objectives have been defined: 1) Enhance and perpetuate hard clam stocks; 2) Manage for an economically stable commercial hard clam fishery; 3) Evaluate the feasibility of hard clam aquaculture opportunities; 4) Enhance and promote the recreational hard clam fishery; 5) Minimize conflicts between coastal bay user groups and commercial hard clam fishermen; 6) Minimize ecological impacts associated with the commercial and recreational hard clam fisheries; 7) Protect, maintain and enhance important hard clam habitats; 8) Minimize the impacts of non-indigenous species; and 9) Implement fisheries dependent and independent monitoring programs to obtain sufficient and accurate data for managing hard clams.

A series of management strategies have been developed to address the objectives of this FMP. The most significant action is limiting the number of individuals into the commercial hard clam fishery by permit only based upon participation rates in the fishery from the 1990/91 through 2000/01 harvest seasons. This action addresses three objectives in the FMP: maintaining an economically stable commercial fishery; minimizing conflicts between coastal bay user groups and hydraulic clam dredgers, and minimizing potential ecological impacts from hydraulic clam dredging.

Other significant actions aimed at minimizing user group conflicts include: prohibiting commercial clamming in the area above the Ocean City Airport at Marker 13 northward to the Rt. 90 Bridge on Saturdays (Sunday is currently closed) from September 15 through October 15 and April 15 through May 31; and establishing noise level requirements for commercial fishing vessels that are consistent with those that have been in place for recreational vessels (90 decibels).

The FMP also includes a report on an extensive literature review on the ecological effects associated with hydraulic dredging. The findings of this review concludes that the ecological effects of hydraulic dredging may be largely mitigated by the physical dynamics of the coastal bays ecosystem as well as the characteristics of the benthic faunal community that has developed under such conditions. The direct impact to submerged aquatic vegetation (SAV) can be significant, but Maryland Law, established in 1998, prohibits the use of hydraulic clam dredges in SAV beds. Further, regulatory restrictions reduce the impact of this activity by prohibiting harvesting in vulnerable SAV and through a closed season during the warmer months when biological processes (growth, feeding, reproduction) are at their peak.

Another point of interest in the FMP, is that the primary limiting factor to the abundance of hard clams in Maryland's coastal bays appears to be the survival of small clams (< 6 mm) due to predation by blue crabs with additional predation pressure by oyster drills, whelks, mud crabs and other organisms. Protection of broodstock (adults) is provided indirectly through areas closed to commercial clamming due to Maryland Department of Environment restricted areas, protected SAV, and shoreline setback areas. These areas currently closed to commercial clamming consist of approximately 40 percent (26,725 acres) of Maryland's entire coastal bays. The amount and distribution of these area closures should provide adequate broodstock protection.

In summary, it appears that the removals (harvest) of hard clams is not the limiting factor to the abundance of hard clams in the coastal bays. Management efforts to increase the abundance of hard clams need to be focused on improving bottom habitat to reduce predation on small clams. Most importantly, the FMP addresses the significant conflicts between coastal bays user groups and commercial hydraulic clam dredgers, and the strong perception among the coastal bays community about the ecological impacts that clam dredging has to the coastal bays ecosystem.

SECTION 2. GOAL AND OBJECTIVES

The goal of the Maryland Coastal Bays Hard Clam Fishery Management Plan is to manage hard clams in Maryland's Coastal Bays in a manner which conserves the coastal bay stock, protects its ecological and socio-economic value, and optimizes the long-term use of the resource.

To achieve this goal, the following objectives must be met:

1) Enhance and perpetuate hard clam stocks;

2) Manage for an economically stable commercial hard clam fishery;

3) Evaluate the feasibility of hard clam aquaculture opportunities;

4) Enhance and promote the recreational hard clam fishery;

5) Minimize conflicts between coastal bay user groups and commercial hard clam fishermen;

6)Minimize ecological impacts associated with the commercial and recreational hard clam fisheries;

7) Protect, maintain and enhance important hard clam habitats.

8) Minimize the impacts of non-indigenous invasive species.

9) Implement fisheries dependent and independent monitoring programs to obtain sufficient and accurate data for managing hard clams.

SECTION 3. BIOLOGICAL BACKGROUND

Life History

The hard clam (*Mercenaria mercenaria*) is a bivalve that is found in the intertidal and subtidal areas of the Atlantic coast from the Gulf of St. Lawrence to Texas. It is most abundant from Massachusetts to Virginia (Stanley & DeWitt 1983). Hard clams are also referred to as quahog, little-neck clam, or cherrystone clam. Hard clam distribution within coastal areas is mainly determined by salinity. They can be found in areas with salinities as low as 12 ppt but are more common in salinities greater than 18 ppt. Adult hard clams live in a variety of substrates but prefer sandy, muddy bottoms (VMRC 1997). They are found in a range of depths from the intertidal zone to greater than 18 meters. Adults use their muscular foot to burrow into the substrate and although they are capable of moving laterally, generally remain in the same location throughout their lives. The depth within the substrate at which the adults are found varies depending on the type of substrate. They usually burrow deeper in sandy substrates (average 2 cm deep) than muddy substrates (average 1 cm deep) (Stanley 1970). Since adults move very little, hard clam areas are determined by juvenile settlement. In areas where adult populations have been removed, repopulation is dependent on the transport of larvae to the area and several years of growth (Stanley & DeWitt 1983).

Hard clams are protandrous, consecutive hermaphrodites, i.e., they start off life as males and approximately half will change to females (VMRC 1997). Sexual maturity appears to be a function of size. Definitive sexes are discernable around 30 mm (1.2 inches) which usually takes two to three years to reach (Stanley & DeWitt 1983). Since spawning is dependent on size, slow-growing individuals will be older when they reach sexual maturity. Peak reproduction usually occurs around 60 mm (2.4 inches). There are conflicting reports on whether fecundity decreases with age. Besides size, spawning is also dependent on temperature and food availability (Roegner & Mann 1991). Spawning often occurs in pulses and can extend over several months. In the mid-Atlantic region, spawning generally begins in May when the temperature rises above 20-23°C (Stanley & DeWitt 1983) and ends in October (Roegner &.Mann, 1991). The spawning period in Maryland has been reported to occur from the beginning of June through August (Sieling 1956). Hard clam fecundity (the number of eggs per individual) is high. Females can release between 1 and 24 million eggs per spawn, the number usually increasing with increasing clam size (Davis & Chanley 1956; Stanley & DeWitt 1983).

Hard clam eggs are pelagic and subject to the tides, currents, and winds. As the embryo develops, it goes through the usual development stages of bivalve molluscs; the free-swimming trochophore larval stage, the veliger larval stage, the pediveliger stage, and metamorphosis into a juvenile seed clam. During the larval stages, hard clams feed on dinoflagellates and other planktonic organisms. The duration of each of the larval stages is dependent on environmental conditions and can extend between 7 and 24 days (Roegner & Mann 1991). The distribution of clam spat set is the result of passive transport and active site selection. During the last larval stage, the pediveliger alternates between swimming and crawling on the bottom which allows it to test the bottom for optimal settling sites. Metamorphosis from the last larval stage to the juvenile seed clam is inhibited at salinities below 17 ppt and ensures that seed clams set in areas that are favorable for adults (Stanley & DeWitt 1983).

Years with low freshwater flows generally produce good clam sets (Hibbert, C.J. 1976). Seed clams prefer a bottom habitat with a few small rocks and shells and are more densely aggregated in sand rather than mud. Juvenile seed clams will move to their ultimate habitat after their first year. When they reach 10 mm in length, they assume the burrowing behavior of adults (Stanley & DeWitt 1983). The mortalities associated with spat and seed clams due to predation are high (VMRC 1997). Without some sort of cover such as oyster shells or stones, seed clams generally disappear (Stanley & DeWitt 1983). Entire clam sets have been eliminated due to predation. As a result, there is a poor relationship between the size of the stock and the number of young recruited into the adult population. Theoretically, a few adults can produce enough spat to sustain the population (Stanley & DeWitt 1983). In the Chesapeake Bay, the Virginia Marine Resources Commission has designated hard clam sanctuaries as a means to protect broodstock and increase hard clam reproductive potential. In the Maryland coastal bays, there are currently over 26,000 acres that are closed to commercial clamming due to Maryland Department of the Environment restricted areas, submerged aquatic vegetation, and shoreline buffer areas. These acres have the potential to also protect hard clam broodstock.

Ecological Role

Hard clams are suspension feeders, i.e., they filter plankton and microorganisms from the water column while they are buried in the bottom substrate. Therefore, the clams participate in benthic-pelagic coupling, that is, they facilitate the transfer and recycling of materials and energy between the water column and sediment through their filter-feeding, pseudofeces production, digestion, absorption, excretion and elimination processes (Grizzle et al. 2001). These transfers work both ways, for in addition to removing phytoplankton the clams release ammonia as a waste product back into the water column, where it is utilized by the microalgae. It is speculated that the filtering ability of the clams has the potential to decrease turbidity and microalgae concentrations, improving water quality. On the other hand, mesocosm experiments found that phytoplankton biomass was not reduced by clam filter-feeding at densities of 16 clams/m^2 (Grizzle et al. 2001).

The primary predator on juvenile hard clams is blue crabs with additional predation pressure by oyster drills, whelks and mud crabs. Other important predators include sea stars, cownose rays, horseshoe crabs, herring gulls, waterfowl, and finfish especially tautog, puffer, black drum and flounder (Roegner & Mann 1991). The intensity of predation is related to the size of a hard clam. Smaller clams have thinner shells making them more vulnerable to gastropods and other predators. Crabs are capable of crushing small clams and can seriously impact clams that are less than 6 cm by chipping away at the edges of their shells. As clams grow larger and their shell thickens, they are less vulnerable to predation (Kraeuter & Castagna 1980). Predation may account for the absence of small clams and explain the skewed size-frequency distributions of populations toward larger individuals (Roegner & Mann 1991). Shell aggregations are important habitat features for hard clams since they provide some protection from predators; seagrasses may also shelter young hard clams, depending on the type of predator involved (Peterson et al. 1984, Beal 2000). Natural mortality on larger, adult hard clams is low. There are a number of diseases that can affect hard clams but their occurrence is not well-documented. An unknown pathogen referred to as Quahog Parasite Unknown (QPX) has been found in hard clams under aquaculture conditions and there is some concern about its presence in the wild. The Virginia Institute of Marine Science (VIMS) initiated a study to examine the presence of QPX and it was found in Chincoteague Bay in 1996. The disease poses no human health risks. There also are some parasitic infestations of hard clams but their occurrence is also low.

Habitat Requirements

Temperature is the most important factor in hard clam growth and reproduction (Stanley & DeWitt 1983). In general, the early larval stages have a narrower temperature tolerance than adults. Optimum survival has been reported between 22 and 25°C for larvae and between 21 and 31°C for adults (Roegner & Mann 1991). Salinity also plays a role in survival and is most critical during the egg and larval stages. Optimum growth and survival to settlement and metamorphosis occurs around 26 - 27 ppt. Hard clams can withstand a range of pH levels (7.0-8.75) which are normally encountered in their habitats.

Hard clams exhibit a high tolerance to low levels (0.5 mg/L) of dissolved oxygen (DO) and can withstand short periods of anoxic conditions; adult clams can tolerate less than 1 mg/L for three weeks and still burrow (Stanley & DeWitt 1983). However, growth rates decrease when DO is consistently below 4 mg/L. Dissolved oxygen levels below 5 mg/L would be considered stressful for hard clams (Roegner & Mann 1991).

The amount of suspended material in the water column or turbidity can affect hard clams. Heavy sediment loads have negative effects on hard clam growth. Laboratory studies on the effects of high concentrations of silt on hard clams indicate decreased feeding rates and growth rates. Embryos exhibited normal development at silt loadings below 3000 mg/L and larvae tolerated silt concentrations of 4000 mg/L, although growth was depressed by 500 mg/L of clay (Stanley & DeWitt 1983).

History of Hard Clam Fishery in the Maryland Coastal Bays

The fortunes of the Maryland coastal bays shellfish industry, indeed, the very complexion of the ecosystem itself, has been dictated by catastrophic storms which have periodically ripped open and subsequently closed the inlets connecting these lagoons to the ocean. Aside from Chincoteague Inlet, these passages were ephemeral, lasting from a few months to several decades. The breaching of an inlet allowed oceanic water to flood into the bays, dramatically raising salinities. Conversely, when an inlet closed the bays gradually reverted to a more brackish regime. Salinity is one of the most important factors in the distribution of estuarine organisms, with each species limited by its tolerance range. For the hard clam *Mercenaria mercenaria* (Linnaeus), the lower salinity limit is about 15-20 ppt, as compared to oysters which can tolerate brackish water down to 5 ppt. Hence, as the inlets formed and closed, so did the clam population expand and contract. The only persistent population was in southern Chincoteague Bay, where the salinity remained consistently high enough for clams to survive.

The earliest harvesters of the hard clam in the coastal bays were the indigenous people belonging to subgroups of the Nanticocke tribe (Truitt & Les Callette, 1977). The native Americans gathered the clams by feeling for them with their feet, or treading in clammer's parlance. In addition to being items of food, the clams were highly valued as a source of purple shell for making wampum beads, the common currency of exchange among tribes all along the Atlantic coast.

Little has been recorded concerning clamming activities during the colonial period through the 19th century, save to say that they were harvested most likely on a sustenance basis rather than for commercial trade. During the colonial period there was a substantial connection between Sinepuxent Bay and the Atlantic known as Sinepuxent Inlet, which probably allowed clams to inhabit most of the coastal bays system.

During the 1860's and 1870's Chincoteague Bay had a second inlet at Green Run large enough to let ocean going ships to pass through (Truitt & Les Callette, 1977), which should have resulted in an abundance of clams. However, Ingersoll (1887) in his treatise on commercial shellfishing in the United States, dismissed clamming in this region as too trivial to mention. Consumer preferences in general during this period and the particular socioeconomics of this region would have limited commercial clamming. Oysters were the primary source of inexpensive protein to the rapidly burgeoning populations in the cities along the eastern seaboard, and even into the hinterlands, thanks to the railroads.[1] Clam consumption was a distant second, increasing in the summer months when oysters were out of season. However, most of the harvesters in the Chincoteague region were farmers who worked part time at shellfishing, generally in the colder months when they were not farming (Earll, 1887). The oyster trade was extremely lucrative for them, since Chincoteague oysters, with their distinctive salty flavor, were particularly prized in the high end markets of New York and Philadelphia, with some even shipped to Europe (Ingersoll, 1881). It seems likely, then, that the Chincoteague baymen were tending their crops during the peak demand for clams. Most of the commercial hard clam harvesting during this time was on the Chesapeake side in Pocomoke and Tangier Sounds (Ingersoll, 1887). Nevertheless, one record indicated that 40,000 lbs.[2] of hard clams valued at $2,000 were landed in the coastal bays during 1880 (Earll, 1887).

In the 1890's hard clams, in particular the smaller littlenecks, became fashionable delicacies (Mackenzie, 1997a). Landings from the coastal bays were fairly respectable, with over 100,000 lbs. of meats being reported (Murphy, 1960). By this time, however, Green Run Inlet had closed and the resulting decline in salinity undoubtedly caused the hard clam population to contract back to the southern part of Chincoteague Bay. Catches steadily declined so that within ten years the figure had dropped to less than a third of the early 1890's and by 1908 only 8,400 lbs. were caught (Murphy, 1960).

Over the years there was talk of constructing a new inlet expressly to improve conditions for growing shellfish. At least two schemes were approved by the state legislature, which would have leased large tracts of bay bottom to the construction companies upon completion of the inlet. Little beyond the paperwork was accomplished, however, and depressed salinities persisted in the coastal

[1] The shipments of oysters from all sources to New York City alone were enough to provide every family with an oyster meal twice per week (MacKenzie, 1997).

[2] It is uncertain whether this figure represents whole clams in their shells or just meat weight (likely the former).

bays for almost 40 years, until a winter storm in 1920 cut a passage through Assateague Island about three miles below Ocean City. Within a few years hard clam landings shot up (landings were110,000 lbs. in 1925), with harvesters earning up to $30-35 per day, a very good living by contemporary accounts (Md. Fish, 1931; Conserv. Dept., 1933). This inlet closed up in 1929, and clams were subsequently added to the list of stocks that crashed that year[3].

The benefits to the seafood industry of a second inlet was not lost upon state conservation officials, scientists[4], and most importantly, legislators. In 1931, the Maryland General Assembly set aside $500,000, with the federal government contributing another $250,000, to construct a permanent inlet in the vicinity of Ocean City. The specific intent was to provide a port for ocean going fishing vessels and to improve conditions for growing and harvesting shellfish, both clams and oysters, as well as blue crabs (Cons. Dept. 1931, 1933). In addition, access to the ocean for recreational and charter fishing boats was viewed as a boon to tourism in the area. Also in 1931, a law was passed requiring commercial clammers to obtain a license (LoM 1931, Ch. 431). The law was to become effective when $125,000 of bonds for the new inlet were sold, essentially linking the sale of licenses to the benefits the inlet would provide to the hard clam industry.

Before work began, however, a terrible storm[5] tore open a new inlet just south of Ocean City in August, 1933. Since the money for an inlet had already been allocated, the Army Corp of Engineers was able to begin stabilizing it almost immediately. Salinities quickly rose in the lagoons, allowing hard clams to flourish, with populations expanding throughout the coastal bays system.

After an initial jump in 1936, hard clam landings steadily climbed through the next decade and a half, peaking in the late 1940's, after which a long decline set in. The number of clamming licenses paralleled the harvests, reaching highs ranging between 162 and 189 between 1942 and 1947 before dropping off. During this period harvesting was primarily by hand tongs, hand rakes or treading, the latter two methods being confined to shallower waters. Clamming by these methods was legal all year round. The breakdown for commercial gears for the period 1944-48 was as follows: tongs - 41%, rakes - 45%, treading - 13%, dredges - 1% (Sieling, 1956). The dredges, which were similar to oyster dredges but with longer teeth, came into more widespread use during the winter of 1952-53 (Wells, 1957). By 1955, dredges and the Shinnecock rake, which had been legalized that year (LoM 1955, Ch.707), accounted for 40% of the commercial harvest even though there were seasonal restrictions imposed on them (Sieling, 1956). These gear allowed for more efficient harvesting, particularly in deeper waters. As a result, harvests began to climb again, soon surpassing the post-war peak (Murphy, 1960; Boynton, 1970). At some point during the mid- 1950's dredges were declared illegal. During this period approximately 100 clammers held commercial licenses, of which an initial 25 Shinnecock rake

[3] Actually, landings held through 1930, when 81,000 lbs. were reported, then fell precipitously the following year to 2,000 lbs. (Murphy, 1960).

[4] Most notably Dr. R. Truitt, head of the recently established Chesapeake Biological Laboratory and a native son of Boxiron, Md. near Chincoteague Bay.

[5] The storm was extremely destructive both along the coast and in the Chesapeake region (Cons. Dept., 1933).

licenses were issued, later declining to about 14 (Md. Bd. Nat. Res. 1958). A 1956 study estimated that recreational clamming took about as much if not more than commercial harvesting (Sieling 1960).

During the 1960-61 season the number of clamming licenses surged to an all time high of 215, almost tripling the harvest from the previous season. Interestingly, only 6 Shinnecock rake licenses were issued that season. Handscrapes (small dredges) were again legalized in 1961 (LoM 1961, Ch. 338) and the number of combined Shinnecock rake/handscrape licenses climbed to 64, with the latter gear probably accounting for the increase. After a couple of more seasons with record harvests, commercial landings again sagged in the mid-1960's. The Board of Natural Resources, blaming overfishing as the primary culprit, argued for increased regulation of the industry, including the imposition of a minimum size limit, the establishment of broodstock sanctuaries, and the legalization of the hydraulic escalator dredge, which reputedly did much less damage to clams in the bottom, hence less wastage, than the Shinnecock rake or clam dredge (Md. Bd. Nat. Res. 1966, 1967). It was also mentioned that many clamming areas in Isle of Wight and Assawoman Bays had been dredged up and used as fill in the Ocean City Area, pointing to the need for information on the distribution and abundance of hard clam stocks (Md. Bd. Nat. Res. 1964).

Nineteen sixty-seven was a landmark year for hard clam management in the coastal bays. For the first time, a minimum size limit - one inch measured transversely - was imposed (LoM 1967, Ch. 404). In addition, the General Assembly granted the Dept. of Chesapeake Bay Affairs (successor to the Board of Natural Resources) regulatory authority over the hard clam fishery in matters of permissible harvest gears, quantity and size limits, and clamming areas. Using this authority, the Department allowed hydraulic dredging that same year with certain restrictions (Reg. No. 158, 15 Oct. 1967). Probably the most important of these was the imposition of a daily harvest limit (another first) of 100 bushels per boat (about 20,000 clams per boat-day), in recognition of the greater harvesting efficiency of the hydraulic dredge over previous methods. The following year this was further reduced to 8,000 clams per boat-day, primarily due to market concerns (Boynton, 1970). Allowance of this gear was codified into law the next year (LoM 1968, Ch.369).

It seemed almost inevitable that the hydraulic escalator dredge arrived at the coastal bays. This gear was developed in Maryland to harvest the untapped quantities of soft clams *Mya arenaria* (Linnaeus) from the subtidal waters of the Chesapeake. Initially, it was viewed with suspicion by many concerned about its impacts, resulting in it being banned from many areas, including the coastal bays (LoM 1953, Ch. 744). Eventually this gear became more accepted, though still with restrictions, both legislative and departmental. It was only a matter of time before seaside clammers started advocating its use. They found an ally in the Department, which viewed the gear as a boon to the sagging industry by boosting production while conserving the resource by reducing the number of broken and unusable clams (Md. Bd. Nat. Res. 1966, 1967). In addition, studies conducted in the Chesapeake concluded that the dredge had minimal impact except when it directly tore into oyster bars or grass beds (Manning, 1957). This further encouraged the Department to legalize hydraulic dredging in the coastal bays, where the old shell bars no longer supported oyster populations and seagrass beds were limited in extent since they were just beginning to return.

Predictably, with the introduction of the hydraulic dredge harvests jumped over the previous year. By the following season, 42 hydraulic dredges were licensed, as well as 7 Shinnecock rakes, 3 hand scrapes, 2 clam rakes, and 2 tongs (Boynton, 1970). The older gears rapidly disappeared, so that by the 1969-70 season only 2 clam rakers and 1 tonger were still active aside from 46 dredge boats. This boom lasted only four seasons before harvests started to slide precipitously, despite tighter regulation of the fishery and the new gear type that were supposed to advance the cause of conservation.

At face value, it would appear that the hydraulic dredge was too efficient for the fishery and the stocks were rapidly depleted. Delaware managers cited this decline when arguing against legalizing this gear some ten years later (DNREC, 1979). Certainly, harvests immediately following the introduction of the hydraulic dredge reversed a three year decline in catches. With the exception of the peak year of 1969, however, annual harvests were within the range of the Shinnecock rake and handscrape years.

The situation leading the precipitous drop in hard clam landings was complicated by external market factors. During this period, vast reserves of surf clams began to be exploited in the coastal waters of the Atlantic, flooding the market with a cheap, abundant, and consistently available product. Hard clams from the Maryland coastal bays were mostly of the larger chowder sizes (Drobeck et al., 1970), which, in addition to bringing the lowest prices, were the size most vulnerable to competition from surf clams for the large-scale chowder and clam strip trade.[6] The surf clam was superior for these purposes in terms of size and meat yield per clam (double that of hard clams). As a result, prices for hard clams (chowders) plummeted, from $2.00 per bag during the 1968-69 season to $1.20 in 1970-71 (J. Casey, MDNR, unpubl. data).

Nearby states with significant surf clam landings also experienced sharp drops in hard clam harvests during this period. In both Virginia and New Jersey, peak hard clam landings during the mid-1960's were followed by extended declines, although neither state allowed hydraulic escalator dredges for harvesting hard clams (Ford, 1997; MacKenzie, 1997b). Concomitantly, surf clam landings increased dramatically, more than doubling from 39.9 million pounds in 1968 to 82.3 million pounds in 1973; Virginia and New Jersey accounted for 79% of the surf clam landings that year. (In comparison, the highest hard clam harvest in Maryland was 759.8 *thousand* pounds in 1969). Chincoteague, Virginia became a major surf clam landing port, as did Ocean City, Maryland.

Due to this loss of market and the inability of the resource to make up the difference in prices, many clammers abandoned the hard clam fishery, with some undoubtedly entering the lucrative surf clam fishery out of Ocean City and Chincoteague. The number of hydraulic dredge licenses declined from 46 in 1969 to 23 only three years later; by 1975 only 11 dredge licenses were issued (Brey, 1979).

The hard clam industry remained marginal for the next 20 years, to the point where MDNR ceased compiling catch records. Anecdotally, only about three boats were working in Chincoteague Bay and three to five boats in the upper bays through the 1980's and early 90's (Capt. G. Marshall, pers. comm.).

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[6] The aforementioned DNREC (1979) report ignored the economic situation in Maryland, even though this was plainly stated in a memo from W. Brey of the National Marine Fisheries Service Statistics Branch and included as App. C of the report: "In 1970 the surf clam made inroads on the hard clam market. Due to the fact that almost all of the Maryland hard clams are of the chowder size they were competing with the surf clam. Demand for the chowder size hard clam declined because it could not compete price-wise."

During this period MDNR initiated some innovative projects in an attempt to enhance the fishery. The most ambitious of these was seeding commercial and recreational areas with hatchery reared hard clams. Between 1972 and 1977, over four million seed clams were planted throughout the coastal bays (Casey 1972, 1974, 1978). Unfortunately, mortality rates were extremely high due to predation (J. Casey, MDNR, pers. comm.), despite several plantings on relic oyster bars where it was hoped that existing shell would provide cover to the young clams (Casey, 1974). Another project planted surf clam shell in Chincoteague Bay to provide a refuge for naturally setting clams (Scott, 1981). Although successful in enhancing recruitment,[7] financial and logistical constraints limited this project to only two plantings (R. Scott, MDNR, pers. comm.).

In the mid-1990's successful hard clam recruitment, particularly in Isle of Wight and Sinepuxent Bays, in combination with a scarcity of softshell clams in Chesapeake Bay, led to a resurgence of clamming activity in the coastal bays. Landings rose gradually at first, then jumped abruptly in the 1998-99 season when approximately 25 boats were working. Although landings were well below the heyday of the 1960's, the value of the catch was close to record breaking, especially since a large percentage of the population was of prime littleneck size. Harvest totals for the following season were almost identical, then declined during the 2000-01 season as the number of boats dropped to about 16. The focus of harvesting shifted from the upper bays to Chincoteague Bay, which had experienced good hard clam recruitment in recent years.

During this period the most significant legislation regulating the hard clam fishery since the legalization of the hydraulic escalator dredge went into effect, making it illegal to use a hydraulic clam rig in seagrass beds. In addition to protecting the seagrasses, this restriction results in a *de facto* sanctuary for clams within the grassbeds. Since the seagrass beds had considerably expanded over the past decade, this effectively eliminated approximately one-third of the coastal bays from clamming. Combined with the seagrass beds, restrictions in shoreline set-backs, poor water quality areas, privately leased bottom, and a recreation-only clamming area bring to a total an estimated 40% of the coastal bays that is off-limits to commercial clamming. The law provides for annual redelineations of the seagrass closures, so that as the grassbeds expand clamming areas will continue to contract.

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[7] Many years later, the shell was still enhancing recruitment. The 1996 Hard Clam Survey found numerous small clams on these plantings, whereas the adjacent unshelled areas had few if any (M. Tarnowski, unpubl. data).

SECTION 4. MANAGEMENT STRATEGY

OBJECTIVE 1: Enhance and perpetuate hard clam stocks.

Problem 1.1: Mortality of Small Clams - The primary limiting factor to the abundance of hard clams in the coastal bays appears to be the survival of small clams (< 6 mm.) due to predation by blue crabs with additional predation pressure by oyster drills, whelks, mud crabs and other organisms. Protection of broodstock is provided indirectly through areas that are closed to commercial clamming due to Maryland Department of the Environment restricted areas, submerged aquatic vegetation, and shoreline setback areas. These areas currently closed to commercial clamming consist of approximately 40 percent (26,725 acres) of Maryland's coastal bays. The amount and distribution of these area closures should provide adequate broodstock protection. Management efforts to increase the abundance of hard clams should focus on minimizing predation of small clams.

Action 1.1.1: Investigate the importance of habitat closures (MDE restricted areas, SAV closures, and shoreline setback areas) to recognize their benefits as hard clam broodstock protection areas.

Implementation: Ongoing

Actions 1.1.2: Develop an action plan for improving hard bottom habitat (i.e shell or other suitable substrate) to reduce predation on small clams. The action plan will include the identification of:

a) Planting materials and sources;
b) Enhancement areas; and
c) Funding sources (i.e. improved reporting of commercial hard clam harvest will increase funding generated through the shellfish tax which could be used towards bottom enhancement activities).

Implementation: Initiate in 2002

OBJECTIVE 2: Manage for a viable commercial hard clam harvest to maintain an economically stable fishery.

Problem 2.1: Potential Economic Hardship to Commercial Clammers Caused by the "Boom and Bust" Nature of the Fishery - Commercial clammers have been satisfied with the economics of the coastal bays hard clam fishery, but are concerned that the economics of the fishery may become jeopardized if the number of commercial clammers exceeds levels experienced during the 1990s.

Action 2.1.1: DNR will limit the number of individuals into the commercial hard clam fishery by permit only based upon those individuals who have landed at least 100 bags of hard clams (as documented by DNR dealer reports) in Maryland's coastal bays in at least 2 years between the 1990/91 and 2000/01 seasons. Using this criteria, a total of 22 individuals would qualify for this permit. This permit should be transferable with a license, or to an individual who purchases a clam rig from an individual who meets the criteria stated above, and relinquishes their permit to the new clam rig owner. DNR will evaluate this action within 3 years to determine if the desired outcomes are being achieved. This action is consistent with actions 5.1.2 and 6.1.3.

Implementation: 2002

Action 2.1.2: DNR will develop a plan (i.e. reporting requirement from commercial clammers) to improve the collection of catch, effort and economic data from the commercial hard clam fishery to assist managers in evaluating the impacts of future management decisions.

Implementation: 2002

OBJECTIVE 3: Evaluate the feasibility of hard clam aquaculture opportunities.

Problem 3.1: Establishing Hard Clam Aquaculture - The hard clam aquaculture industry is expanding in most Atlantic coast states, but while there appears to be potential for production from Maryland's coastal bays few have made a serious effort. The process for obtaining a aquaculture permit in Maryland is complicated and time consuming, and few pilot studies have been conducted to determine the feasibility and economic potential of hard clam aquaculture in Maryland's coastal bays.

Action 3.1.1: Evaluate the legal, institutional and economic incentives and barriers to private aquaculture at the local, state, and federal level in Maryland.

Implementation: 2002

Action 3.1.2: Identify problems with the permitting process, and make recommendations to specific agencies to solve those problems.

Implementation: Initiate in 2001

Action 3.1.3: Simplify the application process, and designate a single point contact at DNR to assist potential applicants with aquaculture permits, questions related to the regulatory requirement, guidance through the permitting process and fulfilling of regulatory obligations, tracking permit applications, and coordinating state agency permitting activities to aquaculture permits.

Implementation: Ongoing

Action 3.1.4: DNR will evaluate the feasibility of hard clam aquaculture in Maryland's coastal bays by:

a) Identifying potential areas and size of area for hard clam aquaculture;
b) Initiating and providing funding for pilot hard clam aquaculture studies;
c) Investigating the economic impact of hard clam aquaculture; and
d) Assessing the ecological impacts associated with hard clam aquaculture.

Implementation: Initiate in 2002

OBJECTIVE 4: Enhance and promote the recreational hard clam fishery.

Problem 4.1: Limited Access and Knowledge of Recreational Clamming Opportunities in Maryland's Coastal Bays - Approximately 23,000 acres (total area closed to commercial clamming minus areas closed due to water quality and oyster leases) of bottom habitat in Maryland's coastal bays can be considered as recreational only clamming areas because of areas unavailable to commercial clamming. These areas are relatively evenly distributed throughout the coastal bays and are suitable for recreational clamming. Few people, however, currently participate in this activity because of limited access to these areas. A water-use assessment survey conducted in 2000 indicated that 6% of boaters actively engage in recreational clamming, and 17% go recreational clamming some time in Maryland's coastal bays. An additional 18% of those interviewed indicated that they would go clamming in Maryland's coastal bays if they had more opportunities or knew of more areas to go clamming (J. Falk, University of DE, personal communication).

Action 4.1.1: DNR will develop and distribute a public outreach brochure illustrating recreational clamming areas, access points, methods and harvest restrictions.

Implementation: 2002

Action 4.1.2: DNR will work with the Town of Ocean City and Worcester County to improve access to recreational clamming areas.

Implementation: Initiate in 2002

Action 4.1.3: DNR will investigate the feasibility of planting seed to establish and/or enhance areas for recreational clamming, and if feasible, develop a seeding strategy.

Implementation: Initiate in 2002

Problem 4.2: Recreational Catch Limits - The recreational catch limit for hard clams is currently 1 bushel per person per day. Those is Virginia and Delaware are 250 and 100, respectively. Reducing the recreational catch limit may appear to be contradictory of this objective, but those involved in the development of this fishery management plan have indicated that the current 1 bushel catch limit is excessive, and reducing it will be in the best long-term interest of recreational clammers.

Action 4.2.1: DNR will reduce the recreational catch limit for hard clams from 1 bushel to 250 hard clams per person per day.

Implementation: 2002

OBJECTIVE 5: Minimize conflicts between coastal bay user groups and commercial hard clam fishermen.

Problem 5.1: Conflict Between Recreational Fishermen and Commercial Clammers - There is a social conflict between recreational fishermen and commercial hydraulic clam dredgers. The satisfaction of recreational fishermen targeting finfish (i.e. summer flounder, seatrout, striped bass) in the early fall and late spring is affected by the turbidity plumes generated from the disturbance of bottom substrate by hydraulic dredging activity. Recreational fishing activity during the late fall and early spring is concentrated in the northern bays and is highest on weekend days. Commercial clamming is prohibited on Sundays during the open season of September 15 through May 31, but Saturdays are currently open at which time this conflict is most significant.

Action 5.1.1: DNR will prohibit commercial clamming in the area between the Ocean City

Airport at Marker 13 northward to the Rt. 90 Bridge on Saturdays (Sundays currently closed) between September 15 through October 15, and April 15 through May 31.

Implementation: 2002

Action 5.1.2: DNR will limit the number of individuals into the commercial hard clam fishery by permit only based upon those individuals who have landed at least 100 bags of hard clams (as documented by DNR dealer reports) in Maryland's coastal bays in at least 2 years between the 1990/91 and 2000/01 seasons. Using this criteria, a total of 22 individuals would qualify for this permit. This permit should be transferable with a license, or to an individual who purchases a clam rig from an individual who meets the criteria stated above, and relinquishes their permit to the new clam rig owner. DNR will evaluate this action within 3 years to determine if the desired outcomes are being achieved. This action is consistent with actions 2.1.2 and 6.1.3.

Implementation: 2002

Action 5.1.3: DNR will reduce the bycatch allowance of hard clams for recreational purposes in the hydraulic dredge fishery from 1 bushel to 250 hard clams per person per day.

Implementation: 2002

Problem 5.2: Conflict Between Shoreline Property Owners and Commercial Clammers - The noise generated from hydraulic clam dredgers working close to shore during the morning has resulted in complaints from shoreline property owners. Complaints are related to commercial clammers working close to shore, in legal areas, just outside of the shoreline setback area, and those individuals who obtain written permission to clam within the setback area.

Action 5.2.1: DNR will establish a maximum noise level limit for commercial vessels consistent with the recreational limit.

Implementation: 2002

Action 5.2.2: DNR will increase the shoreline setback distance for which a person may not catch hard clams with a hydraulic dredge in front of federal or state-owned property from 150 to 300 feet.

Implementation: 2002

Action 5.2.3: DNR's Natural Resource Police will monitor the causes of reported noise complaints to facilitate future management decisions related to this issue.

Action 5.2.4: DNR will investigate the impacts of prohibiting or restricting the written permission provision that allows an individual to catch hard shell clams with a hydraulic dredge within the shoreline setback restriction of 300 feet.

Implementation: 2002.

OBJECTIVE 6: Minimize ecological impacts associated with the commercial and recreational hard clam fisheries.

Problem 6.1: Community Concern on the Ecological Effects of Commercial Hydraulic Clam Dredging -There is a strong public perception in Maryland's coastal bays community that commercial hydraulic clam dredging has a significant detrimental impact to the ecology of the coastal bays. In response to this concern, DNR conducted a literature review of the ecological effects of hydraulic dredging (Appendix I). The results of this literature review concluded that the ecological effects of hydraulic escalator dredging may be largely mitigated by the physical dynamics of the coastal bays ecosystem as well as the characteristics of the benthic faunal community that has developed under such conditions. Regulatory restrictions further reduce the impact of this activity by prohibiting harvesting in vulnerable seagrass beds and through a closed season during the warmer months when biological processes such as feeding, growth, reproduction, and recruitment are at their peak. Outreach efforts are now necessary to inform the public on the results of this literature review, and the actions DNR has taken to minimize the ecological impacts of hydraulic clam dredging.

Action 6.1.1: DNR and Maryland's Coastal Bays Program will educate the public on the ecological effects of hydraulic clam dredging and the importance of the commercial hard clam fishery to the coastal bays community.

Implementation: 2002

Action 6.1.2: DNR will encourage studies to evaluate the ecological impacts of hydraulic clam dredging in Maryland coastal bays.

Implementation: Initiate 2002

Action 6.1.3: DNR will limit the number of individuals into the commercial hard clam fishery by permit only based upon those individuals who have landed at least 100 bags of hard clams (as documented by DNR dealer reports) in Maryland's coastal bays in at least 2 years between the 1990/91 and 2000/01 seasons. Using this criteria, a total of 22 individuals would qualify for this permit. This permit should be transferable with a license, or to an individual who purchases a clam rig from an individual who meets the criteria stated above, and relinquishes their permit to the new clam rig owner. DNR will evaluate this action within 3 years to determine if the desired outcomes are being achieved. This action is consistent with actions 2.1.2 and 5.1.2.

Implementation: 2002

Problem 6.2: Direct Impact to Submerged Aquatic Vegetation (SAV) by Commercial Hydraulic Clam Dredging - The direct impact of the hydraulic escalator dredge on SAV beds is significant. Dredging uproots plants, leaving behind trenches that may persist for lengthy periods of time due to the energy dampening and sediment stabilizing effects of SAV beds. In 1998, Maryland Law §4-1006.1 was established prohibiting the use of hydraulic clam dredges in SAV beds, and requiring the State to delineate existing SAV beds as necessary to maintain this protection over time as SAV beds change in size/shape. Since the early 1990s, SAV beds in Maryland's coastal bays have tripled in acreage despite an increase in harvesting activity during this same period.

Action 6.1.1: DNR will continue to prohibit the use of hydraulic clam dredges in SAV beds, and delineate existing SAV beds as necessary to maintain this protection over time.

Action 6.1.1a: The Maryland Coastal Bays Fishery Advisory Committee shall become the local group to develop and provide recommendations to DNR regarding the delineation of SAV closure areas to harvest from hydraulic clam dredging.

Action 6.1.1b: DNR will continue to foster the support among legislators to make recommended changes in the SAV law which would benefit all stakeholder groups by making the delineation and enforcement process more manageable, and the closure areas consistent over a longer period of time.

Implementation: 6.1.1 - Ongoing; 6.1.1a - 2001; and 6.1.1b - Ongoing

Action 6.1.2: DNR and the National Park Service will investigate the feasibility and funding options for using Global Positioning System (GPS) units to improve the ability for clammers to comply with SAV closure areas and offset the maintenance cost associated with using buoys to identify SAV closure areas.

Implementation: 2002

Problem 6.3: Potential Impact to Overwintering Blue Crabs by Commercial Hydraulic Clam Dredging - There is concern that hydraulic clam dredging activity may have a negative impact on overwintering blue crabs, but data is unavailable to assess this concern.

Action 6.2.1: DNR will evaluate the need to restrict hydraulic dredging in important female blue crab overwintering areas by:

a) Delineating female blue crab overwintering areas;

b) Determining the significance or contribution of these overwintering crabs to the coastal bays blue crab population;

c) Determining the magnitude of overwintering blue crab bycatch in the hydraulic clam dredge fishery; and

d) Assessing the impact of dredging activity on overwintering female blue crabs.

Implementation: a) Ongoing; b) Dependent on funding; c) Dependent upon funding; and d) Dependent on funding.

OBJECTIVE 7: Protect, maintain and enhance important hard clam habitats.

Problem 7.1: Water Quality - In spite of the state's effort to balance economic growth with environmental protection, population growth has resulted in increased land disturbing activities in the coastal areas. This has caused a closure of more than 2,500 acres shellfish growing areas due to fecal coliform contamination.

Action 7.1.1: Develop strategies to restore water quality in areas closed to harvesting hard clams because of pollution.

Implementation: Ongoing

Problem 7.2: Hard Bottom Habitat - The quantity and quality of hard bottom habitat is essential to minimizing predation of small hard clams which is a limiting factor to their abundance.

Action: 7.2.1: Develop an action plan for improving hard bottom habitat (i.e shell or other suitable substrate) to reduce predation on small clams. The action plan will include the identification of:

a) Planting materials and sources;
b) Enhancement areas; and
c) Funding sources.

Implementation: Initiate in 2002

<u>Problem 7.3: Navigational Channel Dredging and Dredge Disposal</u> - Dredging activities can impact hard clam populations, and should be coordinated in a manner to minimize any such impacts.

Action 7.3.1: The MD Coastal Bays Navigation and Dredging Advisory Group (NADAG) will seek comments from DNR's Shellfish Program on the potential impacts of proposed dredging activities on hard clams.

Implementation: Ongoing

<u>Problem 7.4: Growth of Noxious Algal Blooms</u> - In recent years, noxious algal blooms such as brown tides have become more prominent in Maryland's coastal bays. Factors attributing to noxious algal blooms are currently unknown. Research suggests that brown tides may affect growth and reproduction of hard clams.

Action 7.4.1: DNR and MCBP will identify potential funding sources to support the following research and monitoring activities:

1) Assess the potential impact that noxious algal blooms have on hard clam populations; and
2) Identify factors which might contribute to noxious algal blooms.

Implementation: Ongoing

- -

OBJECTIVE 8: Minimize the impacts of non-indigenous invasive species.

<u>Problem 8.1: Green Crabs</u> - The green crab (*Carcinus macnas*) first appeared in the Ocean City inlet and has since expanded its range north and south in the coastal bays. Green crabs prey upon bivalves and other crab species. The effect that green crabs have on the hard clam population in the coastal bays is speculative at this time.

Action 8.1.1: DNR with the advice of Maryland's Coastal Bays Fishery Advisory Committee will implement measures to minimize the impact of green crabs and Japanese shore crab on the hard clam population in Maryland's coastal bays, and coordinate this effort with Delaware and Virginia.

Implementation: 2002

Action 8.1.2: DNR will continue to work with Maryland's Non-indigenous Species Task Force to examine invasive species issues, and develop an Aquatic Nuisance Species plan to become eligible for Federal funding.

Implementation: Ongoing

- -

OBJECTIVE 9: Implement fisheries dependent and independent monitoring programs to obtain sufficient and accurate data for managing hard clams.

Problem 9.1: Stock Assessment - Assessments of the coastal bays hard clam stock historically have been sporadic with many years between surveys. Since 1993, DNR's shellfish program has been conducting population surveys on an annual basis.

> **Action 9.1.1** - DNR will continue to survey the hard clam resource on annual basis in Maryland's coastal bays to facilitate management decisions.
>
> > **Implementation:** Ongoing

Problem 9.2: Assessment of Bottom Enhancement Activities - Bottom enhancement activities need to be assessed to determine if these efforts are improving clam recruitment.

> **Action 9.2.1:** Design and implement a program to monitor the efficacy of bottom enhancement activities.
>
> > **Implementation:** Dependent on funding.

Problem 9.3: Commercial Catch, Effort and Economic Data - The present system does not provide adequate reporting of harvest information. Improving the commercial reporting system for hard clams will facilitate management and generate additional funding through the shellfish tax for bottom enhancement activities. Catch information is currently obtained through dealer reports that are believed to be under-reporting the harvest.

> **Action 9.3.1** - DNR will establish, implement and evaluate a commercial reporting program to obtain accurate catch, effort and economic data from anyone harvesting hard clams in Maryland's coastal bays. This action is consistent with action 2.1.2.
>
> > **Implementation:** 2002

Problem 9.4: Recreational Catch, Effort and Economic Data - There is no information on harvest, effort, and economic impact of recreational clamming in the coastal bays.

> **Action 9.4.1:** DNR will facilitate the design and implementation of a recreational clamming survey in Maryland's coastal bays.
>
> > **Implementation:** Dependent upon funding.

References

Beal, B.F. 2000. The importance of temporal and spatial replication of field experiments: effects of seagrass cover on the growth and survival of cultured juveniles of the soft-shell clam, *Mya arenaria*, and hard clam, *Mercenaria mercenaria.* 20th Milford Aquaculture Seminar (abstract).

Boynton, W. 1970. The commercial fisheries of Chincoteague Bay - past, present, and future. *In*: Assateague Ecological Studies, Part I: Environmental Information. Nat. Res. Inst. Univ. Md. Contrib. no. 446.

Brey, W.E. 1979. Appendix C. National Marine Fisheries Service clam landings for Maryland. *In*: DNREC, Shellfisheries Management Plan for: Indian River, Indian River Bay, and Rehoboth Bay.

Casey, J. 1972. Experimental seed clam planting in Maryland's oceanside bays begun. Commer. Fish. News. 5(6): 4.

Casey, J. 1974. Hard clam planting program by DNR continues in Maryland's oceanside bays. Commer. Fish. News. 7(3): 2.

Casey, J. 1978. DNR continues hard clam repletion program. Commer. Fish. News. 11(1): 3.

Conservation Department of the State of Maryland. 1931. Ninth Annual Report, p. 23-25.

Conservation Department of the State of Maryland. 1933. Eleventh Annual Report, p.18-21.

Davis, H. C. and P.E. Chanley. 1956. Spawning and egg production of oysters and clams. Proc. Natl. Shellf. Asoc. 46:40-58

Delaware Department of Natural Resources and Environmental Control (DNREC). 1979. Shellfisheries Management Plan for: Indian River, Indian River Bay, and Rehoboth Bay.

Drobeck, K., H. Hidu, J.M. Odell and W. Boynton.1970. Chincoteague and Sinepuxent Bay benthos. *In*: Assateague Ecological Studies, Part I: Environmental Information. Nat. Res. Inst. Univ. Md. Contrib. no. 446.

Earll, R.E. 1887. Maryland and its fisheries. *In*: G.B. Goode (ed.), The Fisheries and Fishery Industries of the United States. Sec. II. p. 424-426. Gov. Print. Off., Wash.

Ford, S.E. 1997. History and present status of molluscan shellfisheries from Barnegat Bay to Delaware Bay. *In*: C.L. Mackenzie, Jr., V.G. Burrell, Jr., A. Rosenfield, and W.L. Hobart (eds.). The history, present condition, and future of the molluscan fisheries of North and Central America and Europe, Vol.

1, Atlantic and Gulf Coasts. U.S. Dept. Commer., NOAA Tech. Rep. 127, p. 119-140.

Grizzle, R.E., V.M. Bricelj, and S.E. Shumway. 2001. Physiological ecology of *Mercenaria mercenaria*. In: Biology of the Hard Clam. J.N. Kraeuter and M. Castagna (eds.). Elsevier, Amsterdam. 751 pp.

Hibbert, C.J. 1976. Biomass and production of a bivalve community on an intertidal mud-flat. J. Exp. Mar. Biol. Ecol 25(3): 249-261.

Ingersoll, E. 1881. The oyster industry. *In*: G.B. Goode (ed.), The History and Present Condition of the Fishery Industries. Gov. Print. Off., Wash., 251 pp.

Ingersoll, E. 1887. The oyster, scallop, clam, mussel, and abalone industries. *In*: G.B. Goode (ed.), The Fisheries and Fishery Industries of the United States. Sec. II. p. 507-626. Gov. Print. Off., Wash.

Kraeuter, J. and M. Castagna. 1980. Effects of large predators on the field culture of the hard clam, *Mercenaria mercenaria*. Fish. Bull. Vol. 78 (2): 538-541.

Mackenzie, C.L. Jr.1997a. The U.S. molluscan fisheries from Massachusetts Bay through Raritan Bay, N.Y. and N.J. *In*: C.L. Mackenzie, Jr., V.G. Burrell, Jr., A. Rosenfield, and W.L. Hobart (eds.). The history, present condition, and future of the molluscan fisheries of North and Central America and Europe, Vol. 1, Atlantic and Gulf Coasts. U.S. Dept. Commer., NOAA Tech. Rep. 127, p. 87-117.

Mackenzie, C.L. Jr.1997b. The molluscan fisheries if Chesapeake Bay. *In*: C.L. Mackenzie, Jr., V.G. Burrell, Jr., A. Rosenfield, and W.L. Hobart (eds.). The history, present condition, and future of the molluscan fisheries of North and Central America and Europe, Vol. 1, Atlantic and Gulf Coasts. U.S. Dept. Commer., NOAA Tech. Rep. 127, p. 141-169.

Manning, J.H. 1957. The Maryland soft-shell clam industry and its effects on tidewater resources. Md. Dep. Res. Educ. Resour. Study Rep. 11. 25 p.

Maryland Board of Natural Resources. 1958. Fifteenth Annual Report, p. 39.

Maryland Board of Natural Resources. 1966. Twenty-third Annual Report, p. 40.

Maryland Board of Natural Resources. 1967. Twenty-fourth Annual Report, p. 35.

Maryland Fisheries. 1931. Salting the bays of Worcester County. 9: 10-11.

Murphy, G.L. 1960. Commercial fisheries catch statistics of major species landed in Worcester County, Maryland. Md. Dept. Res. & Edu., CBL, Ref. No. 60-5.

Peterson, C.H., H.C. Summerson, and P.B. Duncan. 1984. The influence of seagrass cover on population structure and individual growth rate of a suspension-feeding bivalve. *Mercenaria mercenaria*. J. Mar. Res., 42: 123-138.

Roegner, G.C. and R. Mann. 1991. Hard clam, *Mercenaria mercenaria*. In: Habitat Requirements for Chesapeake Bay Living Resources, eds. S.L. Funderburk, J. A. Mihursky, S.J. Jordan, and D. Riley. Living Resources Subcommittee, Chesapeake Bay Program.

Scott, R. 1981. Shell planted on public bottom in Chincoteague Bay to aid hard clam set. Tidewater Fish. News, 14(5): 2-3.

Sieling, F.W. 1956. The harshell clam fishery in Maryland waters. Md. Tidewater News. Vol. 12 (10), Suppl. No. 9. 2 pp.

Stanley, J.G. and R. DeWitt. 1983. Species Profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) - Hard Clam. U.S. Fish Wildl. Serv. FWS/OBS-82/11.18. U. S. Army Corps of Engineers, TR EL-82-4. 19 pp.

Stanley, S.M. 1970. Relation of Shell Form to Life Habits of the Bivalvia (Mollusca). Geol. Soc. Amer., Mem. 125. 296 pp.

Truitt, R.V. & M.G. Les Callette. 1977. Worcester County, Maryland's Arcadia. Wo. Co. Hist. Soc., Snow Hill, Md. 579 pp.

Virginia Marine Resources Commission (VMRC). 1997. Virginia Fisheries Management Plan, Hard Clam.

Wells, H.W. 1957. Abundance of the hard clam, *Mercenaria mercenaria*, in relation to environmental factors. Ecology 38: 123-128.

Appendix I. A literature review of the ecological effects of hydraulic escalator dredging.

A LITERATURE REVIEW
of
THE ECOLOGICAL EFFECTS of HYDRAULIC ESCALATOR DREDGING

REPORT TO THE
COASTAL BAYS FISHERIES ADVISORY COMMITTEE

Prepared by
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Maryland Department of Natural Resources
Fisheries Service
Shellfish Program

September, 2001

TABLE OF CONTENTS

EXECUTIVE SUMMARY ii

INTRODUCTION 1

I. EFFECTS ON SUBSTRATE

Dredge Tracks 1

Sedimentation 3

Turbidity Plumes 3

Bottom Composition 5

Cultch 6

Substrate Contaminants 6

II. BIOLOGICAL EFFECTS

Clams

Market Clams 7

Juvenile Clams 8

Settlement and Recruitment 8

Other Benthic Fauna

Potential Impacts 9

Response to Disturbance 10

Submerged Aquatic Vegetation

Direct Impacts 14

Indirect Impacts 14

III. THE COASTAL BAYS ECOSYSTEM

Physical Environment 15

Benthic Faunal Community 16

Limitations on the Fishery

Time Restrictions 17

Area Restrictions 17

CONCLUSIONS 17

TABLES 18

LITERATURE CITED 21

EXECUTIVE SUMMARY

At the request of the Coastal Bays Fishery Advisory Committee, MDNR Shellfish Program staff undertook a literature review on the ecological effects of the hydraulic escalator dredge. In order to accommodate a wider range of studies, the review was expanded to include not only the hydraulic escalator dredge but other comparable fishing gear and natural disturbances of similar or larger scale. Because of the sheer volume of material on the subject of ecosystem disturbances, this review is by no means exhaustive. Nonetheless, the papers are a fair representation of this topic that can be applied to the Maryland coastal bays.

As the hydraulic dredge moves along, the hydraulic jets cut into the bottom, leaving behind a trench. The width of the cut generally conforms to the width of the dredge; in Maryland the water manifold across the leading edge of the dredge cannot exceed 36 in. The depth of the track is largely determined by the target species. Since hard clams live close to the surface of the substrate, a coastal bays hydraulic escalator dredge is typically set to cut 2.5 - 4 in. below the bay bottom, leaving behind a trench four to eight inches deep. Prop wash in shallow water can scour out deeper trenches. The tracks have been reported to persist anywhere from a few hours to three years, depending on the erosional characteristics of the site; the majority of the studies found that the tracks disappeared within one to two months. Because of the shallow nature of the Maryland coastal bays, wind events can readily disturb the bottom, resulting in short persistence times for dredge tracks. The primary exception is in vegetation beds, where trenches were noticeable for at least a year due to the energy dampening and sediment stabilizing effects of the seagrasses.

The amount of incidental sedimentation outside of the dredge track depends on the type of substrate being worked as well as currents and depth of cut. The maximum distance of detectable deposits resulting from hydraulic dredging was 75 ft. from independent studies in Maryland and Virginia. Another study in Maryland found negligible sedimentation at 15 ft. from a dredging site.

The silt/clay particles stirred up by the hydraulic dredge remain in suspension the longest, resulting in a turbidity plume. Hence, the total amount of suspended solids in the plume and its duration depends on substrate composition, while the distance and direction the plume travels is a function of water currents. The depth of the cut will also affect sediment loadings. In an extreme case, suspended solids measured at the conveyor belt of a dredge working in a silt/clay mud flat dropped by an order of magnitude within a distance of 200 ft., although a plume was still visible. Values at the dredge were about 30% higher than background silt loadings; at 200 ft. plume concentrations were well below maximum background levels. Other studies have shown that natural environmental factors such as wind and tidal-induced events can produce background particle loadings that equal or exceed levels resulting from dredging.

The winnowing of sediments by the dredge can leave the track with a lower silt/clay content, depending on the initial sediment makeup. Changes in sediment composition in the coastal bays due to clam dredging likely are insignificant compared to natural processes. This system is a high energy, erosion/deposition environment, resulting in the addition of both silt/clays and sand into the bays. Biological processes also play a factor, with previously sandy bottoms in seagrass beds accumulating a surface covering of fine particles and organic detritus. Thus, as seagrasses expand there is a net loss of surficial sand substrate.

The effect of hydraulic dredging on cultch (shell or other hard fragments that provide habitat for epibenthic organisms) depends on the environment and circumstances in which it occurs. Exposed cultch located immediately downcurrent from dredging can be buried by a layer of displaced sediment. The distance the cultch will be affected is influenced by sediment type and currents. On the other hand, there is evidence that the hydraulic escalator dredge can expose previously buried shell, leaving it accessible to organisms.

Toxic contaminants in the sediment such as heavy metals and hydrocarbon compounds, if resuspended, can be concentrated by filter-feeding organisms. One study concluded that in areas of low initial concentrations contaminant resupension from hydraulic escalator dredging is not a problem. Aside from the relatively low contaminant levels in the Maryland coastal bays, there are other ameliorating factors concerning this issue. Clam dredging only superficially penetrates the substrate compared to activities such as channel dredging and sand borrows. Contaminant accumulation is unlikely to build up in clamming areas due to naturally occurring surficial sediment disturbances such as storms and bioturbation. In addition, since biological activity is lowest during the winter months when much of the clamming takes place, potential bioaccumulations of contaminants through filtration is minimal.

In contrast to a conventional dredge which forces its way into the bottom, the hydraulic escalator dredge uses jets of water to cut through the substrate, suspending animals and floating them onto the conveyor belt. As a result of this jetting action the majority of the catch is largely undamaged. Mortalities of the fragile softshell clam averaged 5% due to a hydraulic dredge, compared with a 50% mortality associated with hand digging. Juvenile clams were no more prone to incidental damage from the hydraulic dredge than the adults. Hard clams, because of their thick and heavy shell, are even less susceptible to breakage, with about one in 2,000 clams damaged by the hydraulic escalator dredge. One of the rationales for legalizing this gear in the coastal bays was that it would reduce incidental clam mortalities compared with the conventional dredges in use at the time. Both juvenile and adult hard clams have the ability to dig through the thin overburden of sediment cast by the dredge. Hydraulic dredging does not seem to have a negative impact on clam recruitment, but whether settlement and recruitment is enhanced by tilling the substrate with the hydraulic harvester is uncertain.

Predatory species such as crabs and fish may benefit from exposure of prey items by dredging. However, much of the clamming season occurs during the colder months when predators are either inactive or have left the area.

Benthic faunal communities in high disturbance areas such as coastal ecosystems readily recover and persist in the face of environmental perturbations, whether acute or chronic. Recovery of community parameters such as abundance, diversity, structure, and function is usually on the order of months, largely depending on the reproductive cycles of the constituent species. A study evaluating four years of intensive dredging within a confined (1 km^2) area found no effect on the functioning and production of the zoobenthic community, despite a decrease in overall biomass due to the harvesting of two comparatively large, slow growing target species.

The direct impact of dredging on seagrass beds is catastrophic, with plants completely uprooted in the process. Vegetative recolonization can be slow, on the order of two years or more. Repeated dredging within a bed can greatly restrict or completely inhibit recovery. Dredge tracks, which persist for longer periods in rooted vegetation, can be subjected to disturbances which may suppress seed germination, further delaying recovery.

The impact of turbidity plumes on seagrasses is less clear. The possibility of localized effects on the grass beds is reduced by a number of factors. Most of the seagrass beds are located adjacent to sandy areas which produce less of a plume due to fewer silt/clay particles; even plumes in siltier substrate can be expected to be largely dissipated within 100 meters. Wind, the primary agent of water movement in Chincoteague Bay, does not always direct the plumes towards the seagrass beds. In addition, during the course of a season clammers move around to different areas and are not necessarily in close proximity to the seagrass beds. Despite an increase in harvesting activity over the past few years, seagrass acreage in the Maryland coastal bays has tripled during this same period. Whether the rate or extent of seagrass increase was indirectly affected by clam dredging is unknown.

In summary, the ecological effects of hydraulic escalator dredging may be largely mitigated by the physical dynamics of the coastal bays ecosystem as well as the characteristics of the benthic faunal community that has developed under such conditions. Regulatory restrictions further reduce the impact of this activity through a closed season during the warmer months when biological processes such as feeding, respiration, growth, reproduction, and recruitment are at their peak and by prohibiting harvesting in vulnerable seagrass beds. If concerns regarding these issues still persist among resource management and user groups, they can be properly addressed only through directed studies.

INTRODUCTION

Since its introduction in the early 1950's, the hydraulic escalator dredge has been met with reactions ranging from vociferous opposition to healthy scepticism and cautious acceptance to enthusiastic embrace. As a result, a number of studies on the impact of this device have been conducted over the years in Maryland, where it was invented, as well as other regions. The earliest studies investigated its effect on softshell clam and neighboring oyster populations, including physical alterations to the habitat. Later research attempted to take a more comprehensive approach, looking at various ecosystem components such the benthic faunal community and seagrasses.

At the request of the Coastal Bays Fishery Advisory Committee, MDNR Shellfish Program staff undertook a literature review on the ecological effects of the hydraulic escalator dredge. Since many of these studies were narrowly focused, the review was expanded to accommodate a wider range of impacts, including other comparable fishing gear and natural disturbances of similar or larger scale. Because of the sheer volume of material on the subject of ecosystem disturbances, this review is by no means exhaustive. Nonetheless, the papers are a fair representation of this topic that can be applied to the Maryland coastal bays.

I. EFFECTS ON SUBSTRATE

Dredge Tracks

As the hydraulic dredge moves along, the hydraulic jets cut into the bottom, leaving behind a trench. The width of the cut generally conforms to the width of the dredge; in Maryland the water manifold across the leading edge of the dredge cannot exceed 36 in. (COMAR 08.02.02.03). The depth of the track is largely determined by the target species. Softshell clams in Chesapeake Bay live deep in the substrate; consequently dredges are set to cut between 18 in. and 24 in. below the surface of the bay floor (Glude, 1954). On the other hand, hardshell clams, with their shorter siphons and heavier shells, live close to the substrate surface. Typically, a coastal bays hydraulic escalator dredge is set to cut 2.5 - 4 in. below the bay bottom.

The trench is partially backfilled by heavier sediment particles coming almost immediately out of suspension as well as clumps of sediment deposited off the end of the escalator belt. The degree of backfilling is determined primarily by sediment characteristics. Fine sediments tend to remain in suspension longer and may be carried away from the track by currents. At the same time, sediments with high clay content tend to stay clumped so that they are redeposited off the belt. Although propeller wash can assist in filling in the trench (Glude, 1954), in very shallow water prop wash can actually scour out the backfill, deepening and widening the track (Manning, 1957; MacPhail, 1961; Godcharles, 1971). This can be remedied by use of a simple prop guard or shield (MacPail, 1961). The drawback is that it reduces boat speed by about 15%.

The length of time required for the dredge tracks to fill in is highly variable, depending on location as well as the original depth of the trench. Factors that affect track persistence include sediment type, depth, wind and tidal currents, vegetation, and whether an area is subtidal or intertidal.

Sandy bottoms appear to recover quickly, often on the order of days. Glude (1954), using the recently developed SCUBA, observed an area of coarse sand in the Miles R. (Maryland) which had been extensively clammed. The bottom appeared fairly uniform with wave produced ripples and an occasional depression 4 - 10 in. deep. Nowhere were deep furrows or holes found. He does not comment on how recently clamming activity had taken place in the area. In Virginia, Haven (1970), using a hard-clam hydraulic dredge on sandy bottom, observed trenches up to 4 - 6 in. deep; these filled in within one to two months. Godcharles (1971) found that sand in high energy areas recovered almost immediately (one day). Other sand trenches lasted one week with no evidence whatsoever after three months; they had firmed up over that period of time. Caddy (1973), citing another study, states that clamming tracks last several days; no details are provided. The track of a hydraulic dredge 4 ft. wide and 9 in. deep through silty sand was difficult to recognize after 24 hours (Meyer et al., 1981). Hall et al. (1990), using a suction dredge on sandy bottom at a depth of 7 m. (23 ft.), saw no evidence of dredging after 40 days, despite the initial presence of holes 3.5 m wide and 0.6 m deep (11.5 ft. by 2 ft.). The intervening period was characterized by stormy conditions which stirred the bottom. Eleftheriou and Robertson (1992), dragging a scallop dredge on sand in depths less than 10 m (33 ft.), observed that although furrows were evident initially (1.2 m/4 ft. wide by 0.04 m/1.5 in. deep), they were eliminated shortly after the four days of experimental dredging had ended. They concluded that track persistence depended on wave action and tidal condition; the experiment site was characterized as a high energy embayment.

Dredge tracks persist longer in bottoms with lower potential for erosion. These include both fine, consolidated sediments and coarser grained substrates such as gravel, some intertidal flats, established vegetation beds, and probably most importantly, areas with low energy regimes including deeper regions removed from wave action.

Fine, consolidated sediments in low energy systems allow tracks to persist, as in the Lagoon of Venice, where tracks originally 9 ft. wide and 4 in. deep in a silt bottom were still evident two months later[8] (Pranovi & Giovanardi, 1994). The extent of recovery over this period was not described. In comparison, Manning (1957) found that tracks in a firm, muddy bottom had filled in from an average of 5 in. to an average of 3 in. deep four to six days after dredging. These were obliterated in a relatively short period of time (no specifics provided) but some of the tracks remained soft after four months. The difference is that a strong tidal current (up to 1 kn.) existed at the Manning study site. Tracks through coarse sediments such as gravel (1 cm diameter) can also persist for extended periods, particularly in low current environments, although no time estimate was provided (Caddy 1973).

Dredging in an intertidal setting may increase track persistence. Hydraulic escalator dredge tracks through an intertidal flat of compact mud in Maine were noticeable for up to one and a half years, while cuts in an intertidal silty sand flat in Washington were observed for up to three years (Kyte & Chew, 1975). Kyte and Chew (1975) speculate that intertidal flats are more compact and stable than comparable subtidal habitats due to draining and drying when the tide is out, resulting in much more persistant cuts. However, they do not comment on the energy regimes of these study sites. In contrast, Beukema (1992) noted that dredge tracks through an intertidal sand flat in Holland comparable to those of a Maryland clam dredge were erased in a matter of days by tidal currents.

[8] These may also have been in *Zostera* beds (see paragraph below on vegetation beds).

Established vegetation beds can stabilize the substrate and dampen the effect of waves and currents, allowing dredge tracks to remain longer. Godcharles (1971) observed evidence of trenching in submerged aquatic vegetation (*Thallassia*) from one to ten months. The most long-lived track he recorded, 11 months, was through a cover of *Caulerpa*[9], a macroalga that establishes persistent, non-transient beds by means of rhizomes which maintained the shape of the trench. This was also in shallow water where the prop wash scoured the bottom, so that some of the trenches were up to 18 in. deep. Although at most of Godcharles' sites the substrate within the trench hardened to pre-dredging consistency inside of a month, some spots in the vegetation beds remained soft for over 500 days.

Sedimentation

Immediately after suspension by the water jets of the dredge, the heaviest material such as pebbles, coarse sand, and shell fragments settle out, followed by progressively smaller particles from medium to fine and very fine sand, and finally the silts and clays. Thus the amount of incidental sedimentation outside of the dredge track depends on the type of substrate being worked as well as currents.

From an experiment in which an escalator dredge worked on a section of muddy creek bottom for nine hours, Manning (1957) estimated that sedimentation was not detectable beyond 75 ft. downstream of the dredged area. All dredging was done on ebb tide with currents approaching 1 kn. The boat ran aground several times, displacing additional sediments by prop wash. Intermediate distances downcurrent of the dredged area had sediment deposits of about 1.2 in. at 25 ft. and 0.6 in. at 50 ft. Haven (1970), testing a hydraulic escalator dredge in Virginia, concurred that deposition of sediments is negligible 75 ft. downcurrent from dredging. In comparison, Drobeck and Johnston (1982), repeating the Manning study but in sandy substrate, found sedimentation greatly reduced. Sediment accumulation was approximately ⅛ in. at 15 ft. downcurrent of the dredging zone. In addition to the difference in substrate type, Manning's Cox Creek site was considerably more narrow and shallow than the later experimental site in the Patuxent River, which had maximum currents of 0.27 kn.

Black and Parry (1999) are in agreement with the above studies. A 10 ft. wide scallop dredge towed at 6 kn over fine sand and muddy fine sand bottoms deposited 2 mm (0.08 in.) of sediment within a few meters of the dredge; at 20 m (66 ft.) deposition was negligible (0.1 mm/0.004 in.).

Turbidity Plumes

The silt/clay particles stirred up by the hydraulic dredge remain in suspension the longest, resulting in a transient turbidity plume. Thus, the total amount of suspended solids in the plume and its duration depends on substrate composition, while the distance and direction the plume travels is a function of water currents. The depth of the cut, hence the volume of displaced sediments, will also affect the concentration of suspended particles.

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[9] *Thallasia* (turtlegrass) is replaced by *Zostera* (eelgrass) in more northern areas, including Maryland. *Caulerpa* or equivalent rhizomatous macroalgae species that establish stable beds are not found in the coastal bays; most of the species there are drift macroalgae or those attaching to structure, particularly seagrasses, and are usually transient.

Values as high as 584 mg/l of suspended solids were recorded at the conveyor belt of a dredge working in a silt/clay mud flat (Kyte & Chew, 1975). This value rapidly dropped to 89 mg/l at a distance of 61 m (200 ft.) from the dredge, although a plume was still visible. Background silt loadings at the site varied from 4 to 441 mg/l.

Using a 10 ft. wide scallop dredge, Black and Parry (1999) conducted a detailed analysis of plume dynamics. They found particle concentrations in a sediment plume to be 2-3 orders of magnitude higher (2000 - 5000 mg/l) than background levels in the first 20 sec. after dredging. This quickly dropped so that after 9 min. suspended sediment concentrations were equivalent to values during a large storm, and after 30 min. sediment loadings had dropped 98%, bringing them back to natural background levels. After one hour particle concentrations were extremely low (10 mg/l or 0.2% of initial values); by this time the plume had moved 350 m. Plume sediments beyond 50 m of the dredge were entirely silts and clays. These values were for a muddy sand (30% mud) bottom; plumes in sandier areas dropped out more rapidly. The authors concluded that low concentrations of suspended fine grain particles (silt and clay) may be present for several hours but that suspended sediment concentrations more than 100 m (328 ft) from a dredge are insignificant and would not induce far-field effects.

Ruffin (1995) studied the effects of softshell clam dredging on turbidity in the Chester River, Maryland. Although there are key differences between this system and the coastal bays in geomorphology, hydrodynamics, energy input, substrate composition, and clamming methodology (eg. dredging depth), this is the only study to have looked at the plumes resulting from this activity in terms of light attenuation and persistence. The greatest increase in turbidity was found in shallow water with fine-grained sediments. The plumes dissipated rapidly at first as the larger particles settled out. Estimates of time to return to background levels were much higher than those of Black and Parry (1999), averaging 2.9 hours for turbidity and 4.8 hours for light attenuation; generally, values approached background levels much sooner than these averages (i.e. plume dissipation was exponential rather than linear, except in the shallowest areas). Eulerian (fixed location) time-series in shallow water were even longer, taking up to 22 hours for the light attenuation coefficient to return to background levels. Plumes in shallows persisted longer than in deeper areas. Based on aerial photos, the plume area was extremely variable among boats and river systems, averaging 8 ha/boat in the Chester River and 4.5 ha/boat in the Wye River.

Natural environmental factors can produce background particle loadings that equal or exceed levels resulting from dredging. A study in Washington found values of 32 to 54 mg/l in the vicinity of a hydraulic escalator dredge, while a nearby river mouth produced levels of 39 to 63 mg/l (Kyte & Chew, 1975). Light transmission varied from 4 to 80 percent at the dredge and 2 to 65 percent at the river mouth. The investigators concluded that the effects of the clam harvester on water quality were minor compared to the river. Drobeck and Johnston (1982) arrived at a similar conclusion, stating that wind and tidal-induced events may have a more profound effect on the total suspended sediment load at their experiment site in the Patuxent River than does dredging. Control values ranged from 51 to 101 mg/l in the three days before the dredging experiment; average levels for these control days were 89.7 mg/l, 81.0 mg/l, and 68.15 mg/l. The mid-impact zone immediately prior to dredging had levels between 37 and 75 mg/l, averaging 55.2 mg/l, while during dredging these ranged between 37.5 and

112 mg/l with an average of 64.4 mg/l. Bioturbation, the reworking of sediment by benthic fauna, can also elevate turbidity, with values as high as 35 mg/l within 3 m of the bottom reported by Rhoads (1973).

Bottom Composition

The winnowing of sediments by the dredge can leave the track with a lower silt/clay content, depending on the initial sediment makeup. In relatively homogenous, muddy sediments there was no detectable difference in sediment composition after dredging (Kyte & Chew, 1975). Sandier areas showed varying degrees of change and recovery, depending on the heterogeneity of the substrate and the energy regime of the area. Immediately after dredging, Haven (1970) reported a decline of fines in a predominantly sand bottom; no change in bottom composition was detected beyond 75 ft. Recovery time was not investigated. Godcharles (1971) found that two of six stations showed measurable losses of silt/clay particles after dredging. One station recovered to pre-dredging proportions but the changes persisted at the second station over a one year monitoring period. Pfitzenmeyer (1972) did not observe a loss of fines from a low silt/clay content bottom in Chesapeake Bay. Also, organic carbon content was not significantly different after dredging. Working in a high energy area with a predominantly sand bottom, Eleftheriou and Robertson (1992) found no change in sediment grades or organic carbon content after a scallop dredge had been dragged through the same track up to 25 times. In Washington, reduced levels of silt/clay particles and organic carbon persisted for several months (Kyte & Chew 1975). Details such as degree of change and length of time were not provided.

In certain situations, long-term intensive harvesting may result in a shift in bottom composition. In the Lagoon of Venice, a "moderate/low energy" ecosystem in Italy, clamming is concentrated in a relatively confined portion of the lagoon (~18 km^2 /7 mi^2) using large (9 ft. wide) hydraulic dredges (Pranovi & Giovanardi, 1994). Despite the fact that it was prohibited by law, this activity had markedly increased in the five to ten years prior to this study. Experimental dredging did not significantly affect particle size immediately before and after the treatment, both in clamming areas and non-clamming areas. However, the results of a sediment study conducted in the clamming areas a few years before clamming intensified showed a significant shift to sandier substrate over the intervening period. No such change had occurred in the non-clamming area.

Rice et al. (1989), found a slight but statistically higher amounts of very fine sand, silt, and clay in non-clamming areas when compared to clamming areas in Rhode Island, but there was no difference in the total organic carbon between the two sites. The non-clamming areas had been closed since the 1930's. The authors noted that clamming activity, using tongs and bullrakes, stirs up the sediments.

Changes in sediment composition in the coastal bays due to clam dredging likely are insignificant compared to natural processes. This system is a high energy, erosion/deposition environment, resulting in the addition of both silt/clays and sand into the bays (Bartburger & Biggs, 1970; Boynton & Nagy, 1993). Biological processes also play a factor, with previously sandy bottoms in seagrass beds accumulating a surface covering of fine particles and detritus sometimes ankle deep (pers. observ.). Thus, as seagrasses expand there is a net loss of sandy substrate.

Cultch

The effect of hydraulic dredging on cultch (shell or other hard fragments that provide habitat for epibenthic organisms) depends on the environment and circumstances in which it occurs. Exposed cultch located immediately downcurrent from dredging can be buried by a layer of displaced sediment (Manning, 1957; Drobeck & Johnston, 1982). The distance the cultch will be affected is influenced by sediment type and currents.

On the other hand, evidence suggests that the hydraulic escalator dredge can retrieve previously buried shell, leaving it accessible to organisms. The Canadian Department of Fisheries demonstrated the dredge's ability to clean oyster bars (MacPhail 1961). As a result of escalator dredging, Haven (1970) reported surface shell covering 20% of what had been bare sand bottom. Godcharles (1971) noted that buried shell had been dredged up and redeposited in and alongside the dredge track, leaving it exposed on the bottom. In contrast, although Drobeck and Johnston (1982) observed oyster shell on the escalator belt, there was no evidence of this shell at the substrate surface; only softshell clam shells were seen. Presumably the heavier oyster shell had been reburied in the deeper track of the softshell clam dredge.

Apparently, cultch skimmed with a shallow dredge setting from a thick shell base would be less likely to get reburied because there is no sediment involved save what had been on the shells. A hydraulic escalator dredge recently was used to clean relict oyster bars in the seaside bays of Virginia (J. Wesson, VMRC, pers.com.). This year, MDNR will experiment with this technique to retrieve buried shell in Chesapeake Bay.

Chincoteague Bay has relatively little in the way of exposed cultch. Most of the old oyster bars have long been buried to varying degrees through natural sedimentation (Sieling, 1960; Tarnowski, 1997). Although the hydraulic escalator dredge can bring up lightly buried shell, whether this shell remains exposed when returned to the bottom is unknown. The more deeply buried shell probably would not be exposed through routine dredging operation.

Substrate Contaminants

Toxic contaminants in the sediment such as heavy metals and hydrocarbon compounds, if resuspended, can be concentrated by filter-feeding organisms. After conducting an elemental analysis of the silt/clay fraction at their experiment site, Drobeck & Johnston (1982) concluded that in areas of low initial concentrations contaminant resupension is not a problem as the fine particles are diluted in distribution.

The Maryland coastal bays have generally low levels of substrate contaminants (EPA 1996). Of the 45 compounds and elements tested, none exceeded effects-range medium (ER-M) values in the bays proper, using the stringent Long and Morgan thresholds[10]. It should be noted that only one sample each was taken in Assawoman and Sinepuxent Bays (exclusive of the dead- end canals), while four samples were obtained from Chincoteague Bay. Effects-range low (ER-L) values were barely exceeded for at most three contaminants at these sites. These were nickel, arsenic, and DDT as shown

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[10]The U.S. EPA (1996) used these particular thresholds because values were available for most of the contaminants tested. According to their report, this method is more conservative than other means of determining contaminant thresholds, such as the EPA Sediment Quality Criteria. When applied to this study, the standard EPA criteria and other alternative approaches reduced the apparent number and geographic extent of exceedences.

in Table 1a for the "remaining Maryland" sites (specific sites were not characterized in the report; values were lumped into either artificial lagoons, St. Martin River or remaining Maryland). Three other compounds listed by the MCBP (1997) report as potential problems in the combined Delaware-Maryland coastal bays system were below thresholds in the Maryland bays proper (Table 1b), as were the remaining contaminants tested for by the EPA (1996). In contrast, more contaminants were found with higher concentrations in the dead-end canals due to their poor flushing characteristics and proximity to sources.

Aside from the relatively low contaminant levels in the Maryland coastal bays, there are other amelioratory factors concerning this issue. Contaminant accumulation is unlikely to build up in clamming areas due to naturally occurring surficial sediment disturbances such as storms and bioturbation (Rhoads, 1973; Kraeuter & Fegley, 1994). Furthermore, clam dredging only superficially penetrates the substrate compared to activities such as channel dredging and sand borrows. In addition, since biological activity is lowest during the winter months when much of the clamming takes place, potential bioaccumulations of contaminants through filtration is minimal.

II. BIOLOGICAL EFFECTS

Clams

Market Clams

A towed, non-hydraulic dredge captures the targeted species by mechanically forcing its way through the bottom; towed Shinnecock or bull rakes function in a similar fashion. In comparison, the hydraulic dredge use jets of water to cut through the substrate; the leading edge or knife of the dredge collects the objects suspended by the jets but generally is not forced through the bottom. Also, the conveyor system helps reduce incidental damage. A non-conveyor dredge, as it begins to fill, drops in efficiency so that animals are cast aside rather than gathered into the dredge (Meyer et al. 1981). Those animals are often left damaged or exposed to predators. In addition, more fragile species can be crushed as the dredge travels along the bottom accumulating its catch; some dredges can collect hundreds or even thousands of pounds of shellfish. The conveyor belt of the hydraulic escalator dredge prevents the catch from accumulating by continuously moving animals and debris away from the head of the dredge, keeping them spread out and reducing the possibility of them being damaged.

The hydraulic escalator dredge was developed in Maryland originally to harvest subtidal populations of softshell clams (*Mya arenaria*), which as the name implies have thin, fragile shells. As a result, most of the early research concerning impacts from this device focused on softshell clams as well as neighboring oyster bars.

In New England and eastern Canada, digging softshell clams manually results in non-catch mortalities of about 50%, contributing to the decline of the populations in these areas during the 1950's (MacPhail, 1961; Kyte & Chew, 1975). In contrast, softshell clam mortalities due to the hydraulic escalator dredge averaged about 5% with 10% as an extreme (Medcof 1961). Kyte and Chew (1975) offer a slightly higher average of 9.6% which they attributed to operator inexperience and the extremely compact nature of the substrate. Incidental mortalities of clams left in the bottom was almost non-existent since the harvester is over 95% efficient (MacPhail 1961).

Hard clams, because of their thick and heavy shell, are even less prone to breakage. In Virginia, Austin and Haven (1981) found about one in 2,000 clams were damaged by the hydraulic escalator dredge. One of the rationales for legalizing this gear in the coastal bays was that it would reduce incidental mortalities compared with the conventional dredges in use at the time (Md. Bd. Nat. Res., 1967).

Juvenile Clams

The effect of the hydraulic escalator dredge on juvenile softshell clams has been systematically studied (Medcof, 1961; Haven, 1970; Pfitzenmeyer, 1972; Kyte & Chew, 1975). As with adults, mortalities attributable to this gear are slight. Small clams either slip through the belt or are carried off the end of it; most of the clams are redeposited back in the track or immediately adjacent to it (Medcof, 1961). The juveniles can readily reburrow because of the softened sediment in the track (Medcof, 1961; Pfitzenmeyer & Drobeck, 1967). However, redigging times are variable and in the interim the small clams are vulnerable to predation. Kyte and Chew (1975) suggest that mortalities of softshell clams in Maine were probably higher than the breakage rate due to the inability of the clams to reburrow into the hard, compact sediments of an intertidal flat, leaving them as prey to gulls. Highly motile predators such as crabs and fish have been observed moving into dredge tracks within an hour of dredging (Caddy, 1973). Hard clam juveniles, possessing stout shells that they can close tightly, are less vulnerable than softshell clams of comparable size, which have thin shells that gape. Nevertheless, predation of redeposited hard clam juveniles can possibly be a problem during the warmer months. As temperatures cool predation drops off; predators are either inactive or leave the area during the colder months when most clamming takes place. Blue crabs, one of the most important predators of hard clams, stop feeding when water temperatures drop below 10°C (Van Heukelem, 1991). In Maryland, Drobeck and Johnston (1982) did not consider predation to be a serious factor by mid-October. Haven (1970) states that predators become active around the beginning of May in Virginia.

Hard clams, both juveniles and adults, have the ability to dig through the thin overburden of sediment cast by the dredge, since they can escape burial in 10 - 85 cm of native sediment (Kranz, 1974; Maurer et al., 1980). Young clams can dig out of sediment depths at least five times their shell height (approximately seven times their length) (Stanley & DeWitt, 1983). Burrowing takes place even at winter temperatures and burial survival is enhanced during this period (Maurer et al. 1980).

Suspended sediments can reduce filtration and growth in hard clams (Roegner & Mann, 1992). Sediment plumes from dredging are ephemeral, however, quickly subsiding after operations cease for the day (Black & Parry 1999), particularly in the sandy substrate where clams are more abundant and where harvesters would more likely be working (Wells, 1957; Drobeck et al., 1970). The eggs and larvae of hard clams are sensitive to high levels of suspended sediments, but these stages occur when the clamming season is closed (Stanley & DeWitt, 1982; Roegner & Mann, 1992).

Settlement and Recruitment

Hydraulic dredging does not seem to have a negative impact on clam recruitment. In Maryland, softshell clam harvest areas consistently produced clams on annual to triannual cycles (Manning, 1957; MacPhail, 1961). Despite being confined to a relatively small area, the Venetian Lagoon clamming fishery continued and expanded in intensity over a period of years (Pranovi & Giovanardi, 1994), suggesting continued recruitment in this region.

Whether settlement and recruitment is enhanced by tilling the substrate with the hydraulic harvester is unclear. Beginning in the early 1900's, bottom cultivation was carried on in Massachusetts to enhance bivalve settlement (Rice et al. 1989). Neither Haven (1970) in Virginia nor Pfitzenmeyer (1972) in Maryland found increased settlement of softshell clams as a result of hydraulic dredging. Pfitzenmeyer did find enhanced survival and recruitment of juveniles in dredged areas, but Haven found no differences between worked and unworked areas. Ten months after dredging in a Maine intertidal flat, softshell clam populations within the dredge tracks had increased several-fold over predredging levels (Kyte & Chew, 1975). In a study of Rhode Island hard clam populations, settlement and recruitment in a clamming area occurred at a significantly higher rate than in areas closed to clamming (Rice et al. 1989). The investigators suggest that the higher clam densities in the closed areas (190 clams/m^2) may have inhibited settlement; alternatively, the reduction of the silt/clay fraction in the sediment due to clamming activity may enhance setting rates, since hard clams prefer sandier substrates. On the other hand, low and irregular settlement is characteristics of hard clam populations in Georgia regardless if the area is harvested or not (Walker, 1987).

Other Benthic Fauna

Potential Impacts

The potential effects of the hydraulic harvesters on the benthic fauna are essentially the same as for clams. No systematic studies have been found that evaluate the direct mechanical effect of this type of dredge on incidental species. Anecdotally, because of the way it works the hydraulic escalator dredge would appear to do little damage to the bycatch, including such soft bodied animals as polychaetes and nemertean worms (Manning, 1959; Godcharles, 1970), although some percentage of the smaller, more delicate forms may get caught in the machinery (pers. observ.). Drobeck and Johnston (1982) surmised that the majority of the small animals washed through the dredge unharmed. It has even been suggested using this gear as a collection device for benthic fauna, providing the receptacle for the animals contained water to cushion the fall off the end of the belt (Manning, 1959; Godcharles, 1970). In contrast, gears that are forced into the bottom, such as scallop dredges, can kill or damage epifaunal and large infaunal organisms, sometimes in large numbers (Caddy, 1973; Eleftheriou & Robertson, 1992).

This is not to say that benthic populations are unaffected within and immediately adjacent to the dredge tracks, but to what degree is uncertain. An experiment in Maine found temporary declines in the infauna that quickly recovered, although no details were provided (Kyte & Chew, 1975). Animals can be displaced from the trench by the hydraulic jets or removed and redeposited outside of it by the conveyor. Some of these are probably lost to predation or damaged by the dredge. The relative importance of each possible fate is undetermined, although predation declines during the colder months (see above). No lasting effects of hydraulic escalator dredging on the benthic community have been observed (see *Response to Disturbance* section).

Regarding sedimentation, presumably most of the infaunal species can dig their way out of the light sediment covering (McCauley et al. 1977; Maurer et al., 1980; Beukema, 1995). However, filtering may be temporarily disrupted. Godcharles (1971) found no evidence of mass mortalities due to sedimentation from dredging. Motile epifauna should not be affected by sedimentation, but non-motile species could be buried. Dredging related oyster mortalities due to smothering were 100% at a distance of up to 25 ft. for adults and 75 ft. for spat (Manning, 1957; Drobeck & Johnston, 1982)[11]. One of the most conspicuous sessile epifaunal forms in Chincoteague Bay that could be impacted by sedimentation are sponges; however, these generally occur in the seagrass meadows. Much of other sessile epifauna are associated with hard substrate which would not be affected by clamming (eg. riprap, pilings, etc.), except perhaps on some of the remnant oyster shell bars.

Predators such as crabs and fish are undoubtedly sources of mortality to animals returned to the bottom. Manning (1957) reported crabs and several fish species attracted to areas of active dredging, but specifics were not given. Caddy (1973) directly observed predators, especially winter flounder but also sculpin and rock crabs, attracted to scallop dredge tracks within one hour of dredging at densities up to 30 times those outside the tracks. Similarly, Eleftheriou and Robertson (1992) noted congregations of fish, primarily pleuronectids, gadoids, and gobies, feeding in scallop dredge tracks, as well as seastars and a large variety of crustaceans. Meyer et al. (1981) categorized two types of predators of surf clams exposed by a hydraulic dredge: scavengers such as lady crabs, rock crabs, and spot feeding on damaged clams and those that preyed on undamaged clams including seastars, horseshoe crabs, and moon snails. Caddy (1973) estimated that the large scale scallop fishery on Georges Bank could have substantially benefitted bottom foraging fish populations.

Concern has been expressed about the possible impact of hydraulic escalator dredging on overwintering blue crab populations in the coastal bays. It is generally believed that crabs remain buried and inactive during the winter, which might leave them vulnerable to smothering from dredging. The literature reviews on blue crabs make no mention of this issue, probably because adult crabs in the Chesapeake Bay overwinter in waters deeper than the operating limit of hydraulic escalator dredges. One study found that locomotor activity in juvenile blue crabs ceased when water temperatures dropped to 5.5°C (Van Heukelem, 1991). However, another study has shown that at low temperatures crabs are still capable of some activity and mentioned that Truitt found overwintering females moving about in schools in the lower Chesapeake (Van Heukelem, 1991).

Response to Disturbance

The primary question concerning the benthic community is how it responds to disturbance. Few studies have been directed toward evaluating the effect of the Maryland hydraulic escalator dredge on the benthic faunal community. In Florida, Godcharles (1971) discovered no lasting impacts on the benthic populations. Using three gear types (benthic corer, trynet trawl, hydraulic escalator dredge) to sample both infauna and epifauna from 5,200 ft.^{2} plots, all but one vegetation station (from benthic core samples) showed little difference between control and experimental dredging sites. Based on the benthic core data, it appeared that recovery was slowest in some of the vegetated areas, which were completely stripped of plants by the dredge. No faunal differences between control and experimental plots, including the vegetated stations, were evident at any time in the trynet samples, which captured

[11] No subtidal oyster populations currently exist in the coastal bays (Tarnowski, 1997).

mostly the larger epibenthic species. Because stations had varying intervals between the experimental dredging and the final evaluation sampling with the benthic corer, the time course of infaunal recovery is unclear, with a maximum of thirteen months possible. The only definitive estimate was given as within eight months at one station. Similar results were observed in South Carolina, although no details were provided (Kyte & Chew, 1975). A study in Maine found temporary declines initially but full recovery within ten months (Kyte & Chew, 1975). Closer to the coastal bays, a study in the Patuxent River, Maryland reported rapid reestablishment of the benthic infauna, with no significant differences between the dredged and impact zones and the control area within five months of experimental dredging (Drobeck & Johnston, 1982). The general conclusion of these studies was that the benthic infaunal community was capable of recovery in a relatively short period of time.

Because of the limited number of studies involving the hydraulic escalator dredge, the present review was expanded to include the impacts of comparable gears, as well as larger scale natural and anthropogenic disturbances (Tables 2, 3). A variety of coastal habitats from around the world were included. Surrogates were sought which produce similar or greater disruptions to the benthos, including larger hydraulic (non-escalator) dredges, suction dredges, clam "kicking", scallop dredges, oyster shell dredges, channel dredging, dredge spoil dumping, pollution, and natural perturbations. The scale of the impacts ranged from experimental plots to a square mile dredge spoil site to entire estuaries (Table 2). The common thread of these studies is that they attempted to measure the response of the benthic faunal community to disturbance.

With few exceptions recovery was rapid, in most cases on the order of months (Table 3). This resiliency of the benthos is characteristic of shallow-water coastal and estuarine systems, which are subjected to continual disturbances (Turner et al., 1995). Studies with multiple locations showed that recovery times could vary due to differences in habitat (Godcharles, 1971; Kyte & Chew 1975; Pranovi and Giovanardi,1994; Thrush et al. 1995), community (Kyte & Chew 1975; Beukema, 1995; Thrush et al. 1995), and time of year (Hall & Harding, 1997).

Recovery time was largely tied to the reproductive cycle of the constituent species. Disturbances that disrupt the this cycle (elimination of spawners and/or offspring, inhibition of gametogenesis, interference with settlement, etc.) can delay re-establishment until the next spawning period. One community took 11-13 months to recover from a red tide outbreak occurring during the height of the reproductive season (Simon & Dauer, 1977). In temperate climates, the majority of the species reproduce during the warmer months. These usually have planktonic larvae which can travel some distance to recolonize areas. Some repopulation also takes place through active migration and passive transport of post-metamorphosed juveniles and adults from outside the disturbed area, as well as through the re-establishment of animals originally displaced within the affected zone.

During the recovery process, a successional pattern has been observed (Thistle, 1981). Community parameters including total numbers of individuals and species rebound quickest, often exceeding levels in comparable control locations. These species may be characterized as "opportunistic" species which are adapted to rapidly exploiting disturbed habitat. During the course of succession, the opportunists are then replaced by more established species of the community, leading to the re-establishment of species structure and hierarchy. Biomass is the parameter slowest to recover, since it is dependent on the growth rates of newly settled individuals or the immigration of adults into the disturbed zone. Small-scale (subsystem) disturbances create a spatial and temporal mosaic of successional states, allowing certain species to persist in a community where they were competively inferior (McCall, 1977; Thistle, 1981). This results in an increase in diversity within the community.

The few studies where recovery was incomplete can be divided into two classes. The first of these includes those where studies were conducted for a relatively short time period. Pranovi and Giovanardi (1994) looked at the impact of hydraulic dredging in commercial clamming and non-clamming areas of the Venice Lagoon in Italy over a two month period. By the end of this interval, the benthic community in the clamming area had essentially recovered save for biomass[12], which is consistent with the successional process given the brief time period that had elapsed. Within the non-clamming area, no statistical differences were detected immediately after dredging. However, after two months several community parameters (number of individuals, number of species, biomass) within the experimental plot had fallen significantly below levels in the control plot, although diversity indices were similar. The authors partly attributed these results to macroalgae (*Ulva*) accumulation in some segments of the dredge track of the non-clamming station. This station was within a seagrass bed, a habitat where tracks persist longer and macroalgae tends to accumulate, which could explain why the clamming station was not similarly affected. The actual interval for recovery at the non-clamming station is unknown since the study ended after two months.

Thrush et al. (1995), using a scallop dredge, also found differences in recovery between two sites, with neither location fully restored after three months (the length of the study). These were believed to be related to differences in initial community composition and environmental characteristics. Hall and Harding (1997), investigating the effects of two types of suction dredges, considered recovery essentially complete after 56 days despite some small but statistically significant differences. Also, recovery processes varied between the two gears, which they felt was probably due to the different times of year the experiments were conducted (the location was the same). They concluded that recovery was rapid and the overall effect on the infaunal community was low.

The second class of impact studies involved large-scale, tributary/ecosystem-wide disruptions where recovery was incomplete after two years. Dean and Haskin (1964) followed the recovery of an entire estuary from decades of pollution after a massive abatement project was completed. This study extended from the mouth of the Raritan River to its fresh water reaches, a distance of 20 km. The abatement resulted in rapid recolonization within six months. After 2.5 years the distribution of species number and abundance along the length of the study area showed a classic V-curve, suggesting re-establishment of the benthic community in terms of these parameters. However, interannual variations in species composition and structure might have been an indication that the community had not yet stabilized, although this could be the result of natural variability in these populations. The extent of the impact precluded establishing proper reference stations for comparison. Boesch et al. (1976) studied the effects of Tropical Storm Agnes on the benthos of several Virginia estuaries. At a 10 m deep mud site in the lower York River, salinity stratification due to the storm resulted in intermittent hypoxic conditions for over a month, devastating the benthic community. The community had not returned to pre-Agnes conditions after two years, although this may have also been affected by unusual

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[12] Biomass was measured as wet weight, including shells.

environmental conditions during this period. In contrast, a nearby 3 m deep station was impacted for a much shorter period of time by fresh water (but not hypoxia) and was largely recovered after five months.

Although most of the studies concluded that the disturbances caused no long-term effects on the benthic faunal community, two papers expressed reservations. Both were concerned with the effects of chronic fishing disturbance on benthic habitat. Pranovi and Giovanardi (1994) showed a significant change of bottom composition in areas of the Venetian Lagoon which had been intensively dredged for a number of years. They felt that the shift to sandier substrate would modify the community to the detriment of species associated with finer particles, which is generally found in the remainder of the lagoon. Unfortunately, although control sites existed for both fished and unfished areas, the respective community structures were not statistically compared. The potential impact of dredging on seagrass colonization in the dredging areas was also discussed as seagrasses were common around the clamming grounds (for further discussion on seagrass impacts see Submerged Aquatic Vegetation section below). The authors' objections to dredging essentially was that dredging may result in a habitat distinctly different from its surrounding environment. In contrast, Thrush et al. (1995) were concerned about the homogenisation of bottom characteristics due to long-term, large scale scallop dredging. They argued that habitat heterogeneity is important to the diversity, stability, and functioning of ecosystems. The authors also commented on the possible impact to community structure by removing larger, longer-lived sedentary species. Their conclusions were more cautionary than dire, suggesting ways to better predict potential large-scale impacts.

Most of the studies in Table looked at the effects of one time, acute perturbations. Beukema (1995) had an opportunity to investigate a chronic, intensive disturbance over an extended time period when a lugworm (*Arenicola marina*) dredge began harvesting at one of his long-term benthic monitoring sites in the Dutch Wadden Sea. This activity continued for four years within a 1 km^2 sandy intertidal area. The dredge created tracks similar to a Maryland hydraulic escalator dredge, and in fact softshell clams (*Mya arenaria*) were a secondary target species for harvest. At the end of the four year dredging period total biomass had declined. This was to be expected since the two target species accounted for almost 80% of the biomass. In addition to removal through harvesting, many of the non-harvested softshell clams were subjected predation and breakage by the dredge. Because *Arenicola* and *Mya* are slower growing, long-lived species, biomass recovery took about five years. With one exception, the remaining non-target species showed no negative effects from dredging. One polychaete worm species was adversely impacted but rapidly recovered after dredging ceased. On the other hand, the population of a small clam species, *Macoma balthica*, an important constituent of the biomass, was enhanced during the dredging period. The author concluded that even though the benthic community biomass structure took an extended period to recover, "the functioning of the community appeared to be hardly affected". This is because the biomass decline was primarily confined to the removal of a relatively low number of larger animals with low production:biomass ratios, whereas the remaining species were responsible for the bulk of benthic faunal production.

Submerged Aquatic Vegetation

One of the major concerns about the hydraulic escalator dredge is its impact on seagrass beds. Maryland law currently prohibits this gear in designated submerged aquatic vegetation areas.

Direct Impacts

The direct impact of dredging in seagrasses is catastrophic. Dredging uproots plants, leaving behind trenches that may persist for lengthy periods of time (Godcharles, 1971; Peterson et al., 1987). Recovery by vegetative propagation is slow, on the order of two years or more (Godcharles, 1971; Peterson et al., 1987). Restoration is facilitated by natural reseeding, but may be limited by disturbances within the track. The cuts may trap drift macroalgae (Pranovi & Giovanardi, 1994) which commonly accumulate in seagrass beds, possibly suppressing seed germination. Also, stingrays utilize the open spaces through the seagrass beds created by the dredge and can be very disruptive to the bottom by digging pits (J. Orth, pers.com.). Repeated harvesting within a vegetation bed can greatly restrict or completely inhibit recovery (Manning, 1957).

Burial also adversely affects seagrasses, suppressing the ability of the leaves to function and diminishing the plant's activities. The shoots and leaves of some SAV species can become buried by just a few centimeters of sediment (Stephan et al. 2000). In sand substrates, measurable quantities of displaced sediment can be expected at least within 15 ft. of the dredge[13] (Drobeck & Johnston, 1982). The seagrass area closure largely mitigates this concern, except perhaps for plants within the sedimentation zone if boats are working along the closure boundary.

Indirect Impacts

The indirect effects of hydraulic escalator dredging, specifically turbidity plumes, on seagrasses is less clear. Ruffin (1995) states that light attenuation was great enough to potentially inhibit the growth of redhead grass (based on inference rather than direct observation) in the shallower portions of the Chester River where the proportion silts and clays was higher, depending on how often the plants were shaded. Shading was a function of winds, tide, bottom type, and the location of the clam boats, all of which were variable. Since this study was essentially a "snap-shot" on a daily time-frame, the author suggested that long-term research on this issue was needed. In contrast, Black & Parry (1999) concluded that for sand substrates, suspended particles drop out over relatively short distances, with far-field effects on seagrasses unlikely beyond 100 m of the dredge.

The possibility of localized plume effects on the Maryland coastal seagrass beds is reduced by a number of factors. Since most of the seagrass meadows in the coastal bays are located adjacent to sandy areas (Bartberger & Biggs, 1970; Orth et al., 1993) which produce less of a plume due to fewer silt/clay particles, the effect of plumes would be expected to be less in the coastal bays than in the muddier tributaries of the Chesapeake. Also, the hard clam dredge displaces less sediment than the deeper cutting softshell clam dredge. Wind, the primary agent of water movement in Chincoteague Bay, may not always direct the plumes towards the seagrass beds. Seasonal wind patterns tend to blow from the cooler ocean to the warmer land during the spring and summer, keeping the plumes away from the

[13] Drobeck and Johnston (1982) measured displaced sediment accumulations of 0.3 cm at 15 ft.

majority of the beds, which are located along Assateague Island[14]. In addition, during the course of a season clamming activities shift around to different areas and are not necessarily in close proximity to the seagrass beds.

The Atlantic States Marine Fisheries Commission defines impacts of "significant concern" as those "that result in loss of SAV-habitat", which is considered to be meadows or patches of SAV but not individual plants (Stephan et al., 2000). Despite an increase in harvesting activity over the past few years, seagrass acreage in the Maryland coastal bays has nearly tripled during this same period (Orth et al., 1993, 2000). Whether the rate or extent of seagrass increase was indirectly affected by clam dredging is unknown.

III. THE COASTAL BAYS ECOSYSTEM

Although all of the aforementioned studies were conducted outside of the Maryland coastal bays, they or at least portions of them have some applicability to the situation in this region. Three factors are of importance in assessing the potential impact of the hydraulic escalator dredge on the coastal bays ecosystem: the physical environment, the characteristics of the benthic faunal community that has developed in this environment, and the nature of the fishery.

Physical Environment

The coastal bays are a physically dynamic environment (Truitt, 1968; Bartberger & Biggs, 1970). Although tidal currents can be strong in the vicinity of the inlets, wind is the main agent of disturbance in this system. Sustained winds of 20 mph or greater were recorded on 33 days during the year 2000 at the Assateague Island weather station; gusts of 20 mph or greater occurred on 236 days (NPS, unpubl. data). McCall (1977) found that a 25 kn wind in Long Island Sound was capable of disturbing the sea floor as deep as 66 ft. Depths in the coastal bays average 4 ft. and seldom exceed 8 ft. Winds capable of disturbing the bottom vary in intensity and duration from summer afternoon on-shore breezes and squalls to three days of hard westerlies and winter nor'easters up to the occasional hurricane (Truitt, 1968). Waves pound along the western shore, eroding away the banks, while storm overwashes and Aeolian transport deposit fine sand from Assateague Island into the bays. The net result is a very active system geologically speaking, so much so that the bays and their barrier islands are actually migrating westward (Bartberger & Biggs, 1970). From this perspective the effect on the physical environment of hydraulic escalator dredging at its current scale is negligible and in most cases is probably erased in relatively short order. The primary exception is in seagrass beds, where the energy dampening effect of the plants and sediment stabilization by the root/rhizome system allow physical disturbances to persist for longer periods.

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[14] For the year 2000, daily average wind directions at the Assateague I. weather station (National Park Service, unpubl. data) were calculated for 12 hr. periods corresponding with clamming activity. The longitudinal axis of Chincoteague Bay was taken to run 34°/214°T. Winds blowing from east of or along this line (from 34° up to 214°T) were assumed to be keeping turbidity plumes away from the major seagrass beds. During March-May and September (2nd half) winds blew from east of this axis 68% of the days, shifting to 48% in October and 27% in November.

Two other parameters of the physical environment need to be considered, not because they directly interact with clam dredging but for their role in defining the benthic and pelagic communities. On an annual basis water temperatures can vary from -2 °C (28 °F) to as high as 35 °C (95 °F). Owing to the shallowness of the bays, water temperatures are heavily influenced by air temperatures and can fluctuate sharply over a short period of time. The waters of Chincoteague Bay can approach hypersaline (higher than seawater) conditions during very dry summers[15]. These extremes in temperature and salinity create a harsh environment, restricting organisms to those that can tolerate or are adapted to changing conditions.

Benthic Faunal Community

The Maryland coastal bays belong to a highly changeable system, with extremes in conditions including both regular, seasonal fluctuations and unpredictable, sometimes catastrophic disruptions. Historically, as inlets were created by storms and filled in again, salinity regimes in the bays rose and fell. It is within this set of conditions that the benthic faunal community has developed over the past seven decades. The environment of the upper bays was very different prior to the stabilization of the Ocean City inlet in 1933[16]. These were so brackish that oysters occasionally suffered mortality from freshets as far south as the upper portion of Chincoteague Bay and oysters did not inhabit the bays above South Point (Grave, 1912).

Natural physical disturbance is recognized as a structuring force in many communities (Thistle, 1981). Since communities can become established in dynamic, naturally disturbed environments such as the Maryland coastal lagoons, they are necessarily adapted to accommodate disruption. Adaptation to disturbance allows a particular suite of organisms to form a community within the boundaries of their habitat requirements while excluding other, less tolerant species. Barring some fundamental, long-term change that deleteriously alters the environment of the constituent species (eg. salinity regime, disease, etc.), these communities are characterized by their resilience and persistence in the face of disturbance (Turner et al., 1995).

Many of the species that presently inhabit the coastal bays can rapidly exploit new habitats resulting from disruptions. In one documented example, hard clams, which require higher salinities, were not found in the brackish water bays above Chincoteague Bay during the early twentieth century. Then, a winter storm in 1920 created an inlet below Ocean City, elevating the salinity and allowing hard clams to quickly recolonize Sinepuxent Bay. Within five years this population had flourished to the extent that harvesters could make a decent living ($35/day), with hundreds of thousands to nearly two million clams harvested annually (Md. Conserv. Dept., 1929;1931). This inlet subsequently filled in during the late 1920's and the hard clam population disappeared as the salinity once again declined.

Limitations on the Fishery

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[15] Low salinity has not been much of an factor as it is in riverine estuaries since the stabilization of the Ocean City inlet, but prior to 1933 it was probably the major influence in species distribution in the coastal bays (Grave, 1912).

[16] Except for the 1920's, which was a period of higher salinities (see below).

Time Restrictions

Regulatory restrictions pertaining to time may mitigate possible negative impacts. The most important of these is the seasonal restriction. The prohibition on hydraulic escalator dredging for hard clams from June through the first half of September is during the period of peak biological activity, including feeding, respiration, and reproduction, and when the most vulnerable stages in the life cycles of many species occur. Predators are most active and abundant during this time. It should be noted that some of these biological processes are ongoing during the season (eg. eelgrass has its highest growth rates in the spring and fall), but decline with lower water temperatures while others may cease altogether (eg. larvae production). Also, during the season clamming activity is limited by time of day restrictions, Sunday closures, and daily catch limits. Non-regulatory factors such as weather, mechanical failure, market prices, and catch per unit effort may also reduce fishing time.

Area Restrictions

The most significant legislative action in recent years to govern the hard clam fishery is the closing of the seagrass beds to hydraulic escalator dredging. To protect the seagrass beds and its associated faunal community, dredging is restricted from approximately 25% of the coastal bays. This has also created a *de facto* hard clam broodstock sanctuary which may ultimately benefit the fishery. Other restricted areas include shoreline buffers, pollution closures in the St. Martin River and smaller areas, and a handful of leased grounds. In addition, factors including weather and clam densities can compel boats to work different areas, so that effort does not remain concentrated in one location for an extended period of time.

CONCLUSIONS

With the closure of seagrass beds to dredging, three basic biological issues regarding the hydraulic escalator dredge remain: 1) the impact of transient turbidity plumes on seagrass populations, 2) the effect of dredging on benthic populations and communities and 3) concern about overwintering blue crabs. Little or no information exists about the crabs that overwinter in the coastal bays, including overwintering areas, the size of this population, the contribution and significance of these crabs to the overall coastal bays population, and the actual impact of hydraulic escalator dredging on overwintering crabs, so that no conclusions can be made regarding this issue. As for seagrasses, the physical attributes (seasonal wind patterns, current regimes, sediment composition) of the coastal bays and the nature of clamming operations reduce the individual probabilities of plume impacts. Lastly, a review of the literature indicates that, in most instances, impacts on the benthic fauna are local and relatively short term. However, although an attempt was made to look at a variety of disturbances, locations, habitats, and scales, the fact remains that none of the studies were conducted in the Maryland coastal bays. Thus, conclusions can be drawn only through the extrapolation of findings from other areas.

Based on these studies, it would appear that the ecological effects of hydraulic escalator dredging is largely mitigated by the physical dynamics of the coastal bays ecosystem as well as the characteristics of the benthic faunal community that has developed under such conditions. Regulatory restrictions further reduce the impact of this activity by prohibiting harvesting in vulnerable seagrass beds and through a closed season during the warmer months when biological processes such as feeding, respiration, growth, reproduction, and recruitment are at their peak. If there are still concerns regarding these issues among resource management and user groups, they can be properly addressed only through directed studies.

TABLES

Table 1a. Substrate contaminant levels exceeding Long and Morgan effects-range low thresholds in the mainstem coastal bays of Maryland (EPA, 1996).

Contaminant	Highest Level	Median Level	ER-L	ER-M
Nickel	24.1 ppm	17.4 ppm	20.9 ppm	51.6 ppm
Arsenic	12.1 ppm	8.4 ppm	8.2 ppm	70.0 ppm
DDT	2.06 ppb	1.08 ppb	1.58 ppb	46.1 ppb

Table 1b. Substrate contaminant levels below Long and Morgan effects-range low thresholds in the Maryland mainstem coastal bays, but which exceeded these thresholds in other areas of Maryland and Delaware (EPA, 1996) and were of concern in the MCBP (1997) report. The remaining 39 analyzed contaminants of the EPA study were also below ER-L levels in the Maryland mainstem coastal bays.

Contaminant	Highest Level	Median Level	ER-L
Dieldrin	0 ppb	0 ppb	0.02 ppb
Chlordane	0.49 ppb	0 ppb	0.5 ppb
Benzo(a)anthracene	14.2 ppb	0 ppb	261 ppb

Table 2. Extent and duration of natural and anthropogenic disturbances reviewed for this report. Not all of the studies mentioned in the text are included (see Table 3).

Impact	Study	Impact Size	Duration/Coverage
Hydraulic Escalator Dredge	Godcharles 1971	484 m^2/sta. x 6 sta.	4@100%;40%;50%
Hydraulic Escalator Dredge	Drobeck & Johnston 1982	11,250 ft^2	4.5 hrs.
Hydraulic Suction Dredge	Hall et al. 1990	5,000 m^2/sta. x 5 sta.	5 hrs./sta.
Hydraulic Suction Dredge	Hall & Harding 1997	7,850 m^2/plot x 10 plots	20 min./plot
Tractor Dredge	Hall & Harding 1997	225/900/2025 m^2/plot x 8	100 %
Mechanical Dredge	Beukema 1995	1 km^2	4 yrs.
Hydraulic Dredge	Pranovi & Giovanardi 1994	1 track x 2 sta.	?
Prop Wash Kicking	Peterson et al. 1990	1,225 m^2/sta. x 6 sta.	39-230 min./sta.
Scallop Dredge	Thrush et al. 1995	700 m^2/sta. x 2 sta.	?
Oyster Shell Dredge	Connor & Simon 1979	2,500 m^2; 30,000 m^2	4 hrs.; 10 days
Dredge Spoil	Haskin et al. 1978	1 mi^2	2 mos.
Channel Dredging/Spoil Dump	McCauley et al. 1977	8,000 yd^3 x 2 areas	?
Red Tide	Simon & Dauer 1977	300,000 m^2	1-2 mos.?
Winds	Turner et al. 1995	9,000 m^2/sta. x 6 sta.	69 d/yr (winds>33 kn)
Pollution	Dean & Haskin 1964	~20 km^2 (Raritan estuary)	Decades
Hypoxia (TS Agnes)	Boesch et al. 1976	~65 km^2 (L.York estuary)	~6 wks

Table 3. Recovery times of coastal and estuarine benthic fauna to disturbance. The impact abbreviations can be interpreted from Table 2. ✓=recovered; ×=incomplete; ✓/×=mixed results from different sites; nd = not determined by end of study period.

Impact	Study	Study Area	Study Length	Time to Equilib.	# Indiv.	Species Number	Species Makeup	Biomass	Comm. Struct.
HED	Godcharles 1971	Fla.	500 d	<8 mo	✓	✓	✓		
HED	Kyte & Chew 1975	Me.		<10 mo	✓	✓	✓		
HED	Drobeck & Johns. 1982	Md.	11 mo	<5 mo	✓	✓	✓		✓
HSD	Hall et al. 1990	Scot.	40 d	<40 d	✓	✓	✓		✓
HS/TracD	Hall & Harding 1997	Scot.	56 d	56 d	✓/×	✓/×	✓		
MD	Beukema 1995	Neth.	13 yr	<6 mo	✓	✓	✓	×	×
HD	MacKenzie 1982	N.J.	6 mo	0-6 mo	✓	✓	✓		
HD	Pranovi & Giov. 1994	Ita.	2 mo	nd	✓/×	✓	✓/×	×	
Kicking	Peterson et al. 1990	N.C.	1 yr	<6 mo	✓	✓	✓		
ScDr	Thrush et al. 1995	N.Z.	3 mo	nd	✓/×	×			×
OyShDr	Connor & Simon 1979	Fla.	12 mo	6-12 mo	✓	✓	✓	✓	✓
Dr Spoil	Haskin et al. 1978	N.J.	16 mo	3 mo	✓	✓	✓		
ChannelDr	McCauley et al.1977	Ore.	56 d	28 d	✓	✓	✓		
Dr Spoil	" " " " "	"	56 d	14 d	✓	✓	✓		
Red Tide	Simon & Dauer 1977	Fla.	2 yr	11 mo	✓	✓	✓/×		✓/×
Storms	McCall 1977	Conn.	13/3 mo	3 mo	✓	✓	✓		✓
Winds	Turner et al. 1995	N.Z.	5.5 yr	NA	✓	✓	✓		✓
Pollution	Dean & Haskin 1964	N.J.	3 yr	nd	✓	✓	×		×
Hypoxia	Boesch et al. 1976	Vir.	2 yr	nd	✓	✓	×		×
Exp.Tray	Lu & Wu 2000	HongKong	15 mo	12 mo	✓	✓	✓		✓

LITERATURE CITED

Austin, H.M. and D.S. Haven. 1981. A report on the operation of a hydraulic escalator dredge on private ground on Hampton Flats, James River, during October 1980. Mar. Res. Rep. 81-3, VIMS, Gloucester Pt., Va. 41 p.

Bartberger, C.E. and R.B. Biggs. 1970. Sedimentation in Chincoteague Bay. *In*: Assateague Ecological Studies. Nat. Res. Inst., U. Md. NRI Contrib. No. 446, p. 70-89.

Beukema, J.J. 1995. Long-term effects of mechanical harvesting og lugworms Arenicola marina on the zoobenthic community of a tidal flat in the Wadden Sea. Neth. J. Sea Res. 33: 219-227.

Black, K.P. and G.D. Parry. 1999. Entrainment, dispersal, and settlement of scallop dredge sediment plumes: field measurements and numerical modelling. Can. J. Fish. Aquat. Sci. 56: 2271-2281.

Boynton, W. and J. Hagy. 1993. Maryland's Coastal Bays: An Assessment of Aquatic Ecosystems, Pollutant Loadings, and Management Options. Final Rep. to MDE. UMCEES Ref. No. 93-053 CBL. Solomons, Md.

Caddy, J.F. 1973. Underwater observations on tracks of dredges and trawls and some effects of dredging on a scallop ground. J. Fish. Res. Bd. Can. 30: 173-180.

Conner, W.G. and J.L. Simon. 1979. The effects of oyster shell dredging on an estuarine benthic community. Est. Coast. Mar. Sci. 9: 749-758.

Dean, D. and H.H. Haskin. 1964. Benthic repopulation of the Raritan River estuary following pollution abatement. Limnol. Oceanogr. 9: 551-563.

Drobeck, K.G. and M.L. Johnston. 1982. Environmental impact of hydraulic escalator dredging on oyster communities. Final Rep. to MDNR. UMCEES Ref. No. 82-5 CBL. Solomons, Md. 97 p.

Drobeck, K., H. Hidu, J.M. Odell and W. Boynton. 1970. Chincoteague and Sinepuxent Bay Benthos. *In*: Assateague Ecological Studies. Nat. Res. Inst., U. Md. NRI Contrib. No. 446, p. 173-241.

Eleftheriou, A. and M.R. Robertson. 1992. The effects of experimental scallop dredging on the fauna and physical environment of a shallow sandy community. Neth. J. Sea Res. 30: 289-299.

Hall, S.J., D.J. Basford and M.R. Robertson. 1990. The impact of hydraulic dredging for razor clams *Ensis* sp. on an infaunal community. Neth. J. Sea Res. 27: 119-125.

Haskin, H.H., R.C. Murray, S. Pollock, and C. Van Dover. 1978. The effects of overboard spoil disposal from the Cape May ferry terminal on the biota of lower Delaware Bay. Center Coast. Envir. Studies, Rutgers Univ. 77 p. and apps.

Haven, D.S. 1970. A study of the hard and soft clam resources of Virginia. U.S. Fish Wildl. Serv., Comm. Fish. Resources Devel. Act, Final Contract Report. 69 p.

Glude, J.B. 1954. Observations on the effect of Maryland soft-clam dredge on the bottom. U.S. Fish Wildl. Serv. 4 p. [Unpublished manuscript].

Godcharles, M.F. 1971. A study of the effects of a hydraulic clam dredge on benthic communities in estuarine areas. Fla. Dep. Nat. Res. Tech. Ser. 64. 51 p.

Grave, C. 1912. Fourth Report of the Shell Fish Commission of MD., p. 242-246.

Kraeuter, J.N. and S.R. Fegley. 1994. Vertical disturbance of sediments by horseshoe crabs (*Limulus polyphemus*) during their spawning season. Estuaries 17: 288-294.

Kranz, P.M. 1974. The anastrophic burial of bivalves and its paleoecological significance. J. Geol. 82: 237-265.

Kyte, M.A. and K.K. Chew. 1975. A review of the hydraulic escalator shellfish harvester and its known effects in relation to the soft-shell clam, *Mya arenaria*. Washington Sea Grant Program WSG 75-2. U. Wash. 30 p.

MacKenzie, C.L. 1982. Compatability of invertebrate populations and commercial fishing for ocean quahogs. N. Amer. J. Fish. Man. 2: 270-275.

MacPhail, J.S. 1961. A hydraulic escalator shellfish harvester. Bull. Fish. Res. Board Can. 128. 24 p.

Manning, J.H. 1957. The Maryland soft-shell clam industry and its effects on tidewater resources. Md. Dep. Res. Educ. Resour. Study Rep. 11. 25 p.

Manning, J.H. 1959. Commercial and biological uses of the Maryland soft clam dredge. Proc. Gulf and Caribb. Fish. Inst., 12th Sess. Pp. 61-67.

Maryland Board of Natural Resources. 1967. Twenty-Fourth Annual Report, p. 35.

Maryland Coastal Bays Program. 1997. Today's Treasure for Tomorrow: An Environmental Report on Maryland's Coastal Bays. Md. Dept. Nat. Res., MCBP 97-02. 36 p.

Maryland Conservation Department. 1929. Seventh Annual Report.

Maryland Conservation Department. 1931. Maryland Fisheries 9: 10-11.

Maurer, D., R.T. Keck, J.C. Tinsman, and W.A. Leathem. 1980. Vertical migration and mortality of benthos in dredged material-Part I: Mollusca. Mar. Environ. Res. 4: 299-319.

McCall, P.L. Community patterns and adaptive strategies of the infaunal benthos of Long Island Sound. J. Mar. Res. 35: 221-266.

McCauley, J.E., R.A. Parr, and D.R. Hancock. 1977. Benthic infauna and maintenance dredging: a case study. Water Res. 11: 233-242.

Medcof, J.C. 1961. Effects of hydraulic escalator harvesters on undersized soft-shell clams. Proc. Nat. Shellfish. Assoc. 50: 151-161.

Meyer, T.L., R.A. Cooper, and K.J. Pecci. 1981. The performance and environmental effects of a hydraulic clam dredge. Mar. Fish. Rev. 43(9): 14-22.

Orth, R.J., J.F. Nowak, G.F. Anderson & J.R. Whiting. 1993. Distribution of submerged aquatic vegetation in the Chesapeake Bay and tributaries and Chincoteague Bay - 1992. Final Rept. to U.S. EPA, Ches. Bay Prog. Office, Annapolis, Md. 277 p.

Peterson, C.H., H.C. Summerson, and S.R. Fegley. Ecological consequences of mechanical harvesting of clams. Fish. Bull. 85: 281-298.

Pfitzenmeyer, H.T. 1972. The effects of the Maryland hydraulic clam dredge on populations of the soft-shell clam, Mya arenaria. Final contract rep. Bur. Comm. Fish. (cited in Kyte & Chew, 1975).

Pfitzenmeyer, H.T. and K.G. Drobeck 1967. Some factors influencing reburrowing activity of soft-shell clams, *Mya arenaria*. Ches. Sci. 8: 193-199.

Pranovi, F. and O. Giovanardi. 1994. The impact of hydraulic dredging for short-necked clams, *Tapes* spp., on an infaunal community in the lagoon of Venice. Sci. Mar. 58: 345-353.

Rhoads, D.C. 1973. The influence of deposit-feeding benthos on water turbidity and nutrient recycling. Amer. J. Sci. 273: 1-22.

Rice, M.A., C. Hickox, and I. Zehra. 1989. Effects of intensive fishing effort on the population structure of quahogs, *Mercenaria mercenaria* (Linnaeus 1758), in Narragansett Bay. J. Shellfish Res. 8: 345-354.

Roegner, G.C. and R. Mann. 1992. Hard Clam *Mercenaria mercenaria*. *In*: Funderburk, S.L., S.J. Jordan, J.A. Mihursky, ansd D. Riley, eds. Habitat Requirements for Chesapeake Bay Living Resources. Chesapeake Research Consortium, Solomons, Md. p. 5.1-5.17.

Ruffin, K.K. 1995. The effects of hydraulic clam dredging on nearshore turbidity and light attenuation in Chesapeake Bay, Maryland. MS Thesis, Univ. Md. 97 p.

Sieling, F.W. 1960. The Resources of Worcester County Coastal Waters. Md. Dep. Res. Ed. Ref. No. 60-10.

Simon, J.L. and D.M. Dauer. 1977. Reestablishment of a benthic community following natural defaunation. *In*: Coull, B.C. (ed.) Ecology of Marine Benthos. Univ. South Carolina Press, Columbia. P. 139-154.

Stanley, J.G. and R. DeWitt. 1983. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic) - Hard Clam. U.S. Fish Wildl. Ser. FWS/OBS-82/11.18. Washington, D.C. 19 p.

Stephan, C.D., R.L. Peuser, M.S. Fonseca. 2000. Evaluating fishing gear impacts to submerged aquatic vegetation and determining mitigation strategies. Atlantic States Mar. Fish. Comm. workshop report. Wash., D.C. 35 p.

Tarnowski, M.L. 1997. Oyster populations in Chincoteague Bay. *In*: Homer, M.L., M.L. Tarnowski, R. Bussell, and C. Rice. Coastal Bays Shellfish Inventory. Final Rept. to Coast. Zone Manage. Prog., MDNR. Contract No. 14-96-134-CZM010. Annapolis, Md. p. 140-151.

Thistle, D. 1981. Natural physical disturbances and communities of marine soft bottoms. Mar. Ecol. Prog. Ser. 6: 223-228.

Thrush, S.F., J.E. Hewitt, V.J. Cummings, P.K. Dayton. 1995. The impact of habitat disturbance by scallop dredging on marine benthic communities: what can be predicted from the results of experiments? Mar. Ecol. Prog. Ser. 129: 141-150.

Truitt, R.V. 1968. High Winds...High Tides. A Chronicle of Maryland's Coastal Hurricanes. Nat. Res. Inst., Univ. Md. Ed. Ser. No. 77. 35 p.

Turner, S.J., S.F. Thrush, R.D. Pridmore, J.E. Hewitt, V.J. Cummings, M. Maskery. 1995. Are soft-sediment communities stable? An example from a windy harbor. Mar. Ecol. Prog. Ser. 120: 219-230.

U.S. EPA, 1996. Assessment of the Ecological Condition of the Delaware and Maryland Coastal

Bays. EPA/620/R-96/004. U.S. Environ. Protect. Agency, Ofc. Res. & Develop., Wash., D.C. 78 p. & append.

Van Heukelem, W.F. 1991. Blue Crab *Callinectes sapidus*. *In*: Funderburk, S.L., S.J. Jordan, J.A. Mihursky, ansd D. Riley, eds. Habitat Requirements for Chesapeake Bay Living Resources. Chesapeake Research Consortium, Solomons, Md. p. 6.1- 6.24.

Walker, R.L. 1987. Hard Clam, *Mercenaria mercenaria* (Linné), populations of coastal Georgia. Univ. Georgia Sea Grant College Program, Grant #04-7-158-4126. [Unpublished manuscript]

Wells, H.W. 1957. Abundance of the hard clam, *Mercenaria mercenaria*, in relation to environmental factors. Ecology 38: 123-128.

RECREATIONAL CRAB FACTS

CRAB SEASON: April 1 to December 31

MINIMUM SIZE: Hard – 5 inches; Soft – 4 inches; Peeler – 3 1/2 inches (measure from tip to tip of spikes)

LICENSE REQUIREMENT: None

IT SHALL BE LAWFUL:

1. **To crab** in the Coastal Bay's of Maryland's Atlantic Ocean and their tributaries using:
   a. not more than 600 feet of baited trotline, with a float of the same color, size, and shape attached to each end; or
   b. not more than two (2) 600 foot trotlines if two (2) or more persons are in the boat; or
   c. dip nets and any number of handlines; and
   d. not more than ten (10) or a combination of ten (10) collapsible crab traps or crab net rings per person from docks, piers, bridges, boats or shorelines; or
   e. not more than twenty-five (25) or a combination of twenty-five (25) collapsible crab traps or crab net rings, if two or more persons are in the boat.
2. **For waterfront property owners** to set a maximum of two (2) crab pots at their property:
   a. attached by rope or line to the property or a privately owned pier or dock; or
   b. attached to a pole in front of their property, not more than one hundred (100) yards from the shore and marked with a sign not less than six (6) inches in height indicating the owner's name and address; and
   c. are required by law to have one (1) 2 5/16-inches cull ring on a side panel of the upper compartment and one (1) 2 5/16-inches cull ring on the lower compartment; and
   d. are required by law to have a "turtle reduction device" attached to each entrance or funnel in the lower chamber constructed of wire or plastic, rectangle in shape with dimension not larger than 1 3/4-inches by 4 3/4-inches.

Time Restriction: None

Daily Catch Limit: One (1) bushel hard crabs per person, but not more than two (2) bushels if two (2) or more persons are on a boat.

KNOW THE RULES

You could be fined up to $500 for a size or creel limit violation!

CATCH A POACHER

"Poaching" deprives the public of the opportunity to use and enjoy Maryland's natural resources. Preserving our natural resources for our present and future enjoyment is everyone's responsibility.

REWARD

Citizens who report illegal activities to the Natural Resources Police will receive cash rewards for the information leading to the arrest and conviction of a violator. Be specific in the description of individuals. When possible, give name, addresses and vehicle descriptions. The anonymity of the information/caller is guaranteed.

REPORT A POACHER
CALL TOLL FREE 1-800-635-6124

FOR MORE INFORMATION PLEASE CONTACT
Maryland Department of Natural Resources
Fisheries Service
Tawes State Office Building
580 Taylor Avenue • Annapolis, MD 21401
1-800-688-FINS • 410-260-8265

DNR GENERAL INFORMATION
1-877-620-8DNR
Fisheries Service Extension 8265
www.dnr.state.md.us

Parris N. Glendening, Governor
Kathleen Kennedy Townsend, Lt. Governor
J. Charles Fox, Secretary, DNR
Karen M. White, Deputy Secretary, DNR

For a natural Resource Emergency or Assistance, Telephone 410-260-8888, twenty-four hours a day.

Natural Resource Police (Coastal Bays) 410-548-7070

This document is available in alternative format upon request from a qualified individual with a disability.

The facilities and services of the Maryland Department of Natural Resources are available to all without regard to race, color, religion, sex, age, sexual orientation, national origin, physical or mental disability.

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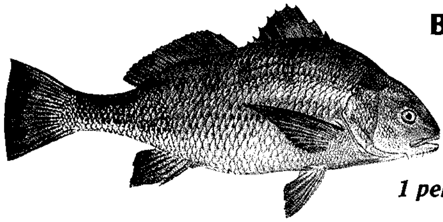
Recreational Fishing and Crabbing Regulations for Maryland's Coastal Bays, its Tributaries and Atlantic Ocean

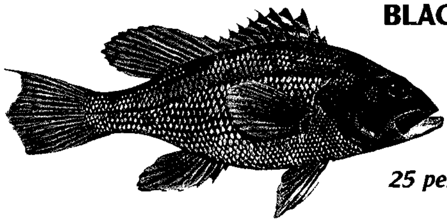
410-213-BAYS

LEGAL SIZE OF CERTAIN FISH



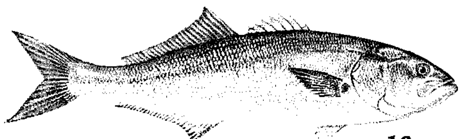
BLACK DRUM
16" minimum

Creel Limit –
1 per person per day



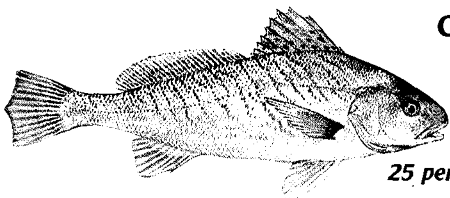
BLACK SEA BASS
11 ½" minimum

Creel Limit –
25 per person per day



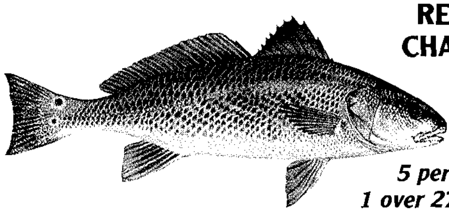
BLUEFISH
8" minimum

Creel Limit –
10 per person per day



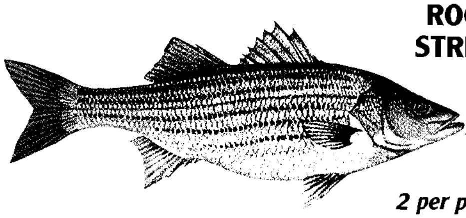
CROAKER OR HARDHEAD
9" minimum

Creel Limit –
25 per person per day



RED DRUM OR CHANNEL BASS
18" minimum

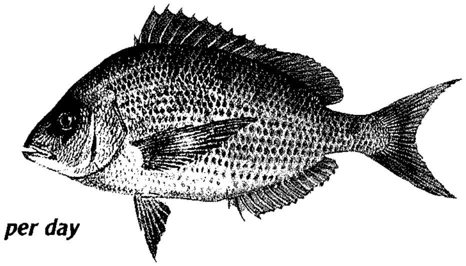
Creel Limit –
5 per person per day
1 over 27" in possession



ROCKFISH OR STRIPED BASS
28" minimum

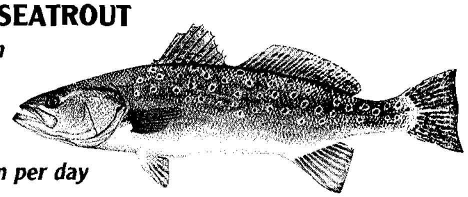
Creel Limit –
2 per person per day

SCUP OR PORGY
8" minimum



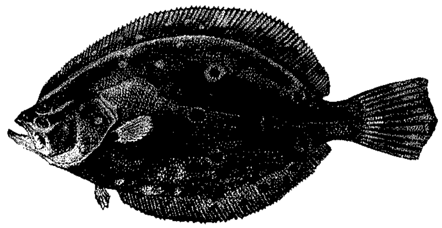
Creel Limit –
50 per person per day

SPOTTED SEATROUT
14" minimum



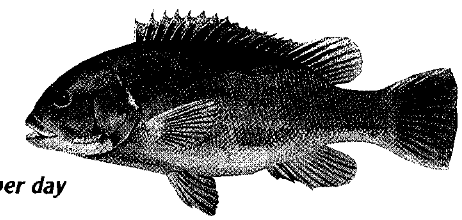
Creel Limit –
10 per person per day

SUMMER FLOUNDER
Closed Season:
July 25 –
August 11
17" minimum



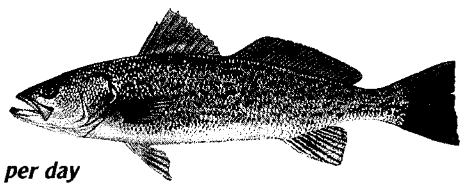
Creel Limit –
8 per person per day

TAUTOG
14" minimum



Creel Limit –
5 per person per day

WEAKFISH
14" minimum



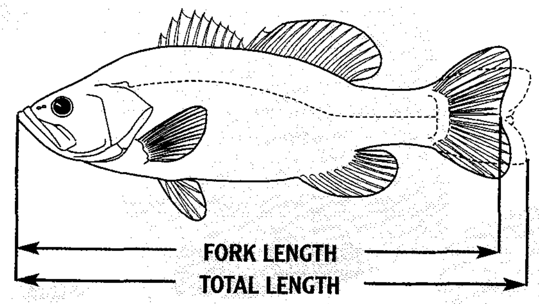
Creel Limit –
10 per person per day

IT SHALL BE LAWFUL:

1. during specific seasons established by the Department, to take or shoot with a speargun and spear in tidal waters of this state between June 15 and December 31 of each year, carp, garfish, skate, bull fish, shark, oyster toads, or swelling toads (blowfish), American eel, sea lamprey, stingrays or other ray fish.
2. to snag or use bow and arrows to obtain carp, garfish, skate, bull fish, shark, oyster toads, swelling toads (blowfish), stingrays or other ray fish ONLY.
3. to use a seine up to 50 feet in length and five feet wide to obtain bait minnows.
4. to use a cast net.
5. to keep any size white perch if caught by hook and line.
6. to use an "umbrella rig" that has no more than two (2) hooks or two (2) sets of hooks.
7. The noncommercial daily catch limit for hard-shell clams is one (1) bushel per person and must be 7/8" thick.

IT SHALL BE UNLAWFUL:

1. to have in one's possession aboard any boat on the tidal waters of Maryland any striped bass **CUT UP** or **FILLET**.
2. to catch pike or pickerel from March 15 to April 30 in the tidal waters of Maryland.
3. to have in one's possession American shad or hickory shad.
4. to use more than two (2) hooks or two (2) sets of hooks for each rod or line. Artificial lures or plugs with multiple hooks are considered one (1) set of hooks.
5. to cull striped bass.



Fish with a minimum size requirement should be measured from the tip of the nose to the end of the tail or caudal fin as indicated above.
Fish should be placed on a flat surface with a measuring device beneath its body to get an accurate measurement.

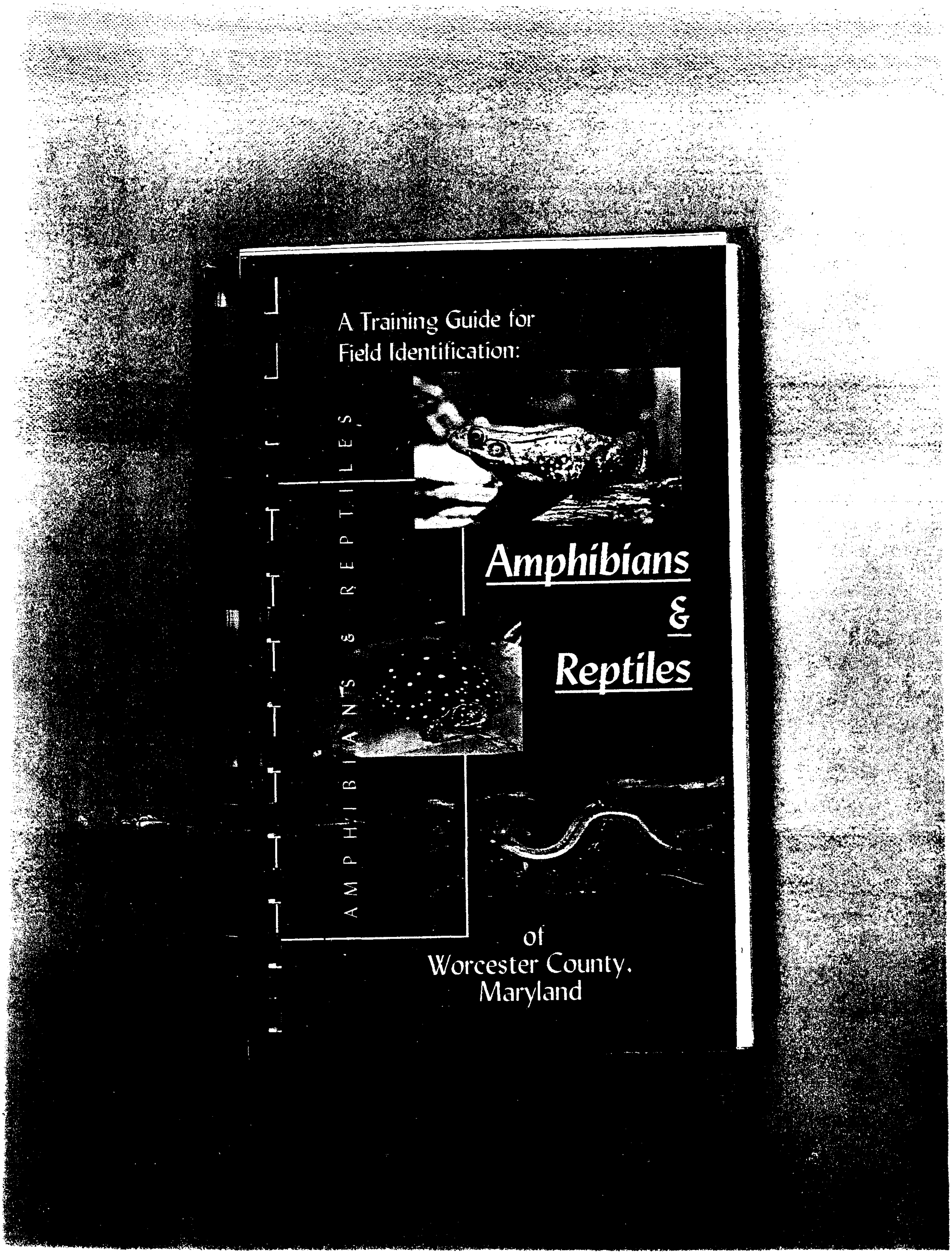

A Training Guide for
Field Identification:
AMPHIBIANS & REPTILES
Amphibians
&
Reptiles
of
Worcester County,
Maryland

Table of Contents

Worcester County Map	iv
Checklist	1
Illustrations	11
Amphibians	
Salamanders	16
Frogs and Toads	23
Reptiles	
Turtles	40
Lizards	54
Snakes	59
Other Potential Species	78
References	84
Photo Credits	85
Contact Information	86
Notes-Journal Pages	88
Key	93