



The US Environmental Protection Agency's Regional Vulnerability Assessment Program (ReVA)

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ReVA: the Approach

ReVA's Integrated Assessment Framework Helps Organize Research Knowledge and Tools to Respond to Client Needs

- **Data acquisition / preparation** (*existing data*)
 - **Extrapolation / interpolation**
 - **Model development / forecasting** (*many separate models*)
 - **Synthesis** (*many methods to address data issues and assessment questions*)
 - **Scenario Analysis**
 - **Visualization/Communication/Access to Information**
- EDT

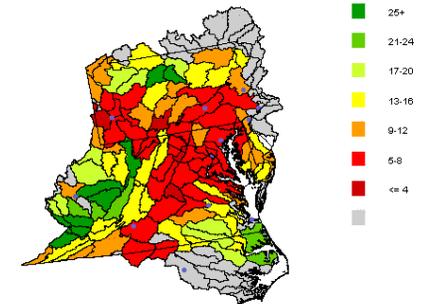
EDT = ReVA's web-based Environmental Decision Toolkit

Integration of Spatial Data: the Method Used Matters!

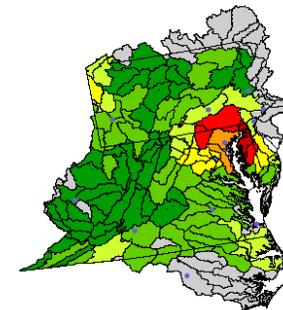
Is the method robust given the data being synthesized?

Method	Discontinuity	Skewness	Imbalance	Interdependency
Quantiles	Not sensitive	Not sensitive	Sensitive	Sensitive
Simple Sum	Not sensitive	Not sensitive	Sensitive	Sensitive
AHP	Not sensitive	Not sensitive	Not sensitive	Sensitive
PCA	Sensitive	Sensitive	Not sensitive	Not sensitive
State Space	Sensitive	Sensitive	Not sensitive	Not sensitive
Criticality	Not sensitive	Not sensitive	Sensitive	Sensitive
Overlay	Not sensitive	Not sensitive	Not sensitive	Not sensitive
Cluster	Not sensitive	Sensitive	Sensitive	Sensitive
SOM	Not sensitive	Sensitive	Sensitive	Sensitive

Best Quintile Counts



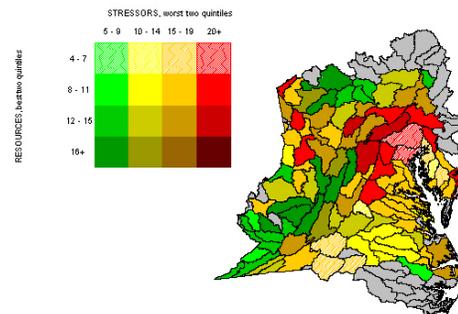
State Space



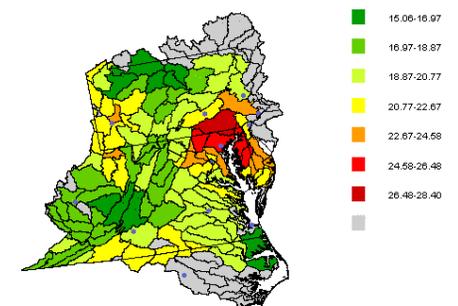
Is the method addressing the right question?

- Ranking Methods (*Condition*)
Quantiles, Sum of Ranks, AHP
- Distance from Reference Point (*Sustainability*)
PCA, State Space, Criticality
- Overlay of stressors/resources (*Value, vulnerability*)
- Grouping of Like Units (*Feasibility*)
Cluster Analysis, Self-Organizing Maps

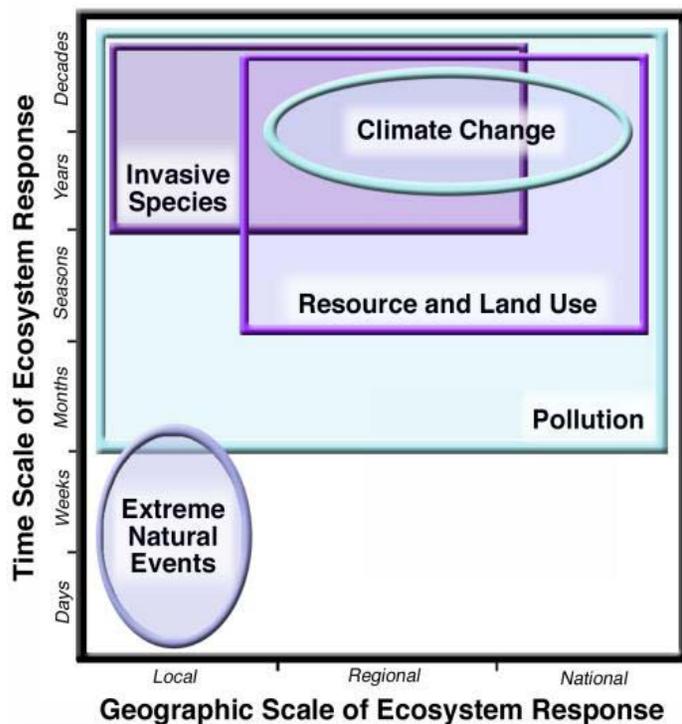
Stressor-Resource Overlay



Radar Area Summary



Future Scenarios: Projections of Major Drivers of Ecological Change (2020)



Despite compliance with environmental regulations, biological populations are declining.

Major drivers of change include:

- Land use change
- Resource extractions
- Pollution and pollutants
- Exotic invasive species
- Climate change

These drivers projected for the Mid-Atlantic Region

ReVA's Environmental Decision Toolkit (EDT)

- Web-based, integration and visualization
- Statistical application (S-PLUS), with mapped output
- Linked to ArcServe version for finer-resolution analysis
- Results as *relative* rankings within larger region
- Addresses multiple assessment questions
- Integration of data in subgroups (e.g. water, air) or subregions
- Weighting to reflect different values, perspectives
- Scalable (national to local)
- Data access, interoperable, webserviceable

ReVA Process

Descriptive Spatial Data

(Landscape metrics, census variables, species counts, etc.)

Spatial Model Output

(NPS estimates, air deposition estimates, invasive species, etc.)

Environmental Decision Toolkit

- Integration into Indices of Condition and Vulnerability
- Visualization from multiple perspectives
- Enabling Multiple Criteria Decision-Making
- Individual variables and Composite indices

Forecast Scenarios:

Drivers of Ecological Change (land use, exotic species, resource extraction, pollution and pollutants, climate change)

Alternative Management Scenarios (trade-off analyses)

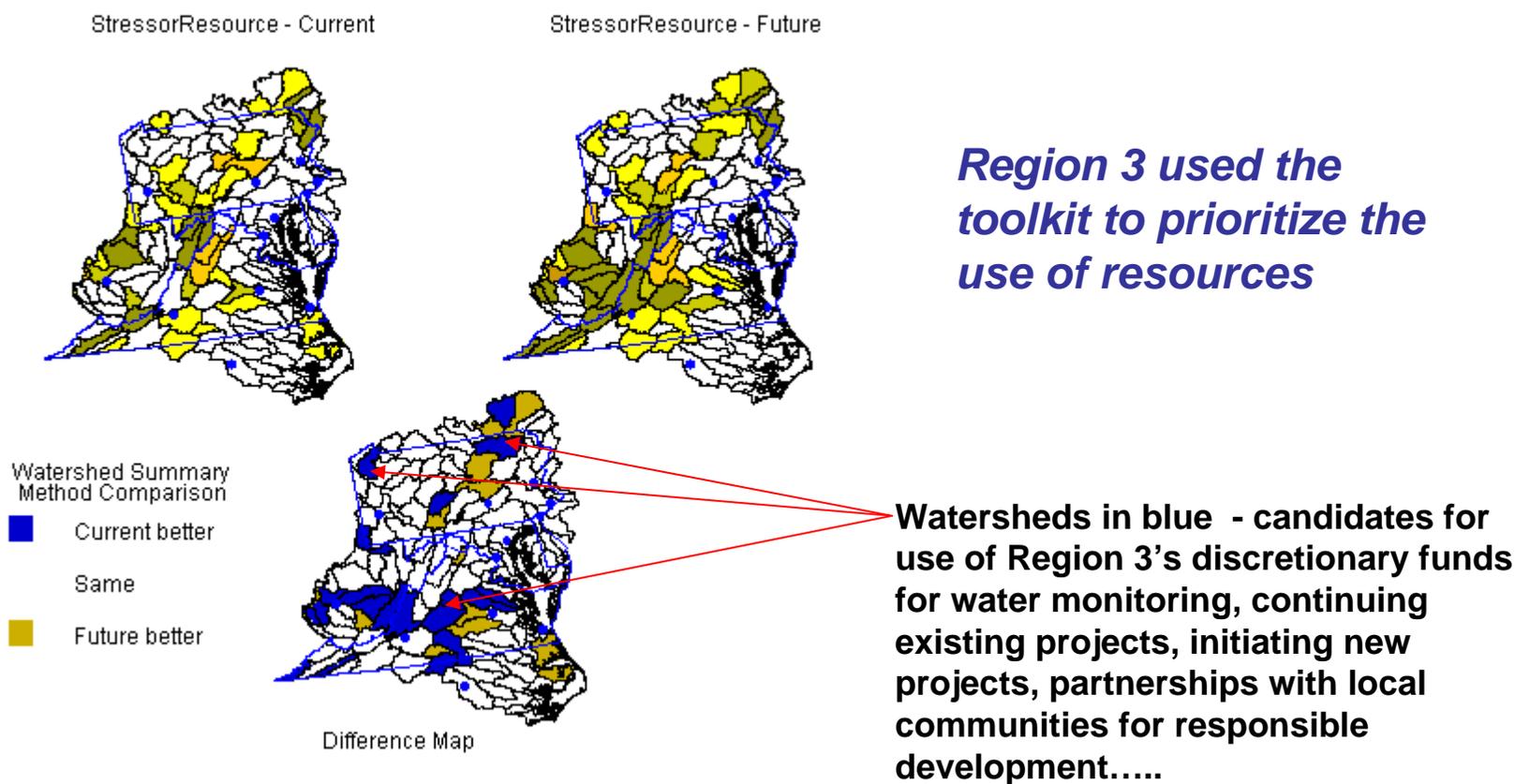
Descriptive Spatial Data

(Landscape metrics, population/demographic variables, etc.)

Spatial Model Output

(NPS estimates, air deposition estimates, invasive species, etc.)

Where will valued resources be subjected to additional stress?



Regional Growth Decision Tool

Sustainable Environment for Quality of Life (SEQL) study: 15-county area surrounding Charlotte, NC. Two alternative futures projected to 2030

[About the RGDT](#) |
 [How can I use the RGDT?](#) |
 [Use the RGDT](#) |
 [What is SEQL?](#) |
 [What is ReVA?](#)

[Home Page](#) >
 [Levels of Detail](#) >
 [Executive Summary](#) >
 SEQL Overview Map

View Scenario Maps

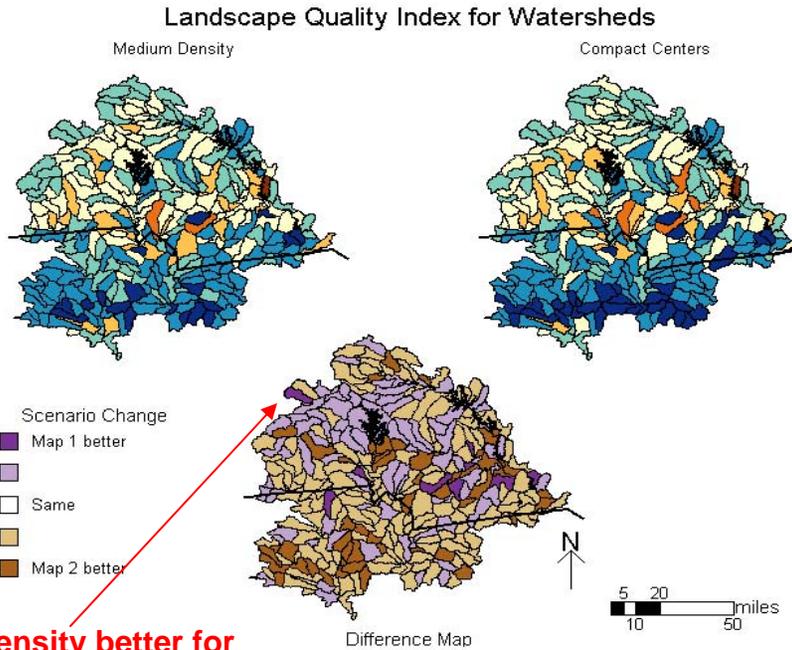
Select Layers to Display:

- County Lines
- Cities
- State Boundary
- Interstate Roads

Landscape Quality Index for Watersheds

Variables

- Percent any agricultural land
- Total agriculture land on steep slopes (9% slope)
- Percent barren landcover - natural
- Percent forest landcover
- Percent natural grass land cover
- Percentage of land that is edge forest class
- Road density
- Crop land cover along streams - 60 meters
- Forest land cover along streams - 60 meters
- Natural grass land cover along streams - 60 meters
- Percent shrub land cover
- Stream density
- Percent urban landcover
- Percent wetlands land cover



Trade-offs: Medium Density better for individual watershed; Compact Centers better for region

[Print File](#)

If you would like more detailed data, please go to the [Management Summary page](#).

SE Region – Air Toxics Policy Tool

Welcome to Region 4 EDT developed by ReVA

Hide introduction text

Welcome to the Southeastern Environmental Decision Toolkit (EDT). Here you can explore spatial data describing environmental conditions across EPA's Region 4, view assessment results on overall conditions and vulnerabilities for the region, create indices to represent certain perspectives or identify specific areas for management actions, and compare areas to a reference. The toolkit's interactive features allow users to zoom in to individual watersheds for detailed information as well as provide the regional context for strategic environmental decision-making and prioritization.

- Explore spatial data - the EDT will map the distribution of every individual spatial variable available within the associated database
- EPA Region 4 includes the states of Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee.
- Overall current conditions are mapped using 3 integration methods and all available variables.
- Overall vulnerabilities (e.g. where resources are currently threatened by existing stresses) are mapped using 2 integration method and all available variables.
- Users can create and save their own indices using a subset (e.g. all water-related) of weighted variables.
- Users can identify or create a reference watershed (e.g. where conditions are ideal) and compare other watersheds to this watershed.
- Using the dynamic map feature, users can zoom in to individual watersheds and look closer at what is happening there.
- Users interested in Ecosystem data should select HUCs as a reporting unit in the Reporting Unit selection menu at the top of the page. Users interested in Human Health data should select COUNTY.

Scattered throughout the EDT are information and metadata icons which are denoted by either an or an . Information icons are intended to give guidance on using features of the EDT. Metadata icons give information on EDT variables or methodology and at times link to FGDC (Federal Geographical Data Committee) metadata.

Are you interested in:

- [Exploring Current Data?](#)
- [Comparing Individual Variables?](#)
- [Examining Variable Information?](#)
- [Region 4 HAP's Analysis web site?](#)

Relative Vulnerability to Toxics for Region 4

Relative vulnerability to air toxics of water quality, available at the EDT tool and as a .png file.

Step 1: Variable: Relative toxicity of air toxics to amphibians

Step 2:

Relative vulnerability to air toxics of amphibians (unitless)

0 - 2.94
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6.8 - 10.65
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41.52 - 45.38
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1666.6 - 1670.46
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1678.18 - 1682.04
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1701.34 - 1705.2
1705.2 - 1709.06
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1716.78 - 1720.64
1720.64 - 1724.5
1724.5 - 1728.36
1728.36 - 1732.22
1732.22 - 1736.08
1736.08 - 1739.94
1739.94 - 1743.8
1743.8 - 1747.66
1747.66 - 1751.52
1751.52 - 1755.38
1755.38 - 1759.24
1759.24 - 1763.1
1763.1 - 1766.96
1766.96 - 1770.82
1770.82 - 1774.68
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1778.54 - 1782.4
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1797.84 - 1801.7
1801.7 - 1805.56
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180

National Environmental Assessment Toolkit (NEAT)

HAPs Local Scale
T & E Species
Proximity Analysis
HAPs Regional Scale
Assess Vulnerability
Sediment Concentrations
Tissue Concentrations
Deposition of NOx/SOx
Ambient Conditions
Changes since the Clean Air Act
Examine Trends
Variable Information
Data Download
Logout
[More information](#)
[See Metadata](#)

Select Geographic Area: US | Reporting Unit: HUC

Map with Ambient Conditions for Nation

The colored areas on the map correspond to the entire watershed, not the special area. The special area will be some subset of the entire watershed.

Step 1: CMAQ Variable: **Average deposition of ozone (CMAQ)**

Step 2: Special Area of Concern: **Square km of Federal Natural Areas from PAD database**

Step 3: **Make Map**

Average deposition of ozone (CMAQ) (kg/ha)

N=2108

Average deposition of ozone (CMAQ)

Average deposition of ozone (CMAQ)				
	Bottom 25%	25%-50%	50%-75%	Top 25%
Ranges (kg/ha)	3.4088-39.1707	39.1707-47.8046	47.8046-58.7317	58.7317-82.934
Area (km ²)	410565.365	410806.025	172455.016	129895.331

Air Quality Policy Support:

National Ambient Air Quality Standards Assessment (NAAQS) – what are impacts to protected areas?

STATS / GRAPHS
POWERED BY
Insightful

NEAT: Performance Measures

HAPs Local Scale
T & E Species
Proximity Analysis
HAPs Regional Scale
Assess Vulnerability
Sediment Concentrations
Tissue Concentrations
Deposition of NOx/SOx
Ambient Conditions
Changes since the Clean Air Act
Examine Trends
Variable Information
Data Download
Logout
[More information](#)
[See Metadata](#)

[Welcome](#) > [Changes since the Clean Air Act](#) > [Examine Trends](#)

Select Geographic Area: US | Reporting Unit: HUC

Display Pre/Post Maps CASTNet Variables for Nation

The variables on this page display the difference between a pre - CAA average of 3 years (89-91) and a post-CAA average of 3 years (2004-2006). The colored areas on the map correspond to the entire watershed, not the special area. The special area will be some subset of the entire watershed.

Step 1: Variable for first map: Sulfate Differences in Deposition - Pre and Post CAA (CASTNet)
 Step 2: Special Area of Concern: <None>
 Step 3: Make Map: Static Map | Dynamic Map

Sulfate Differences in Deposition - Pre and Post CAA (CASTNet) (kg/ha)

N=2108

	Post Better		0	Pre Better	
Tribal Land Pre/Post Ranges (kg/ha)	-9.7824--0.7348	-0.7348--0.0118	0	0.0151-0.3554	0.3554-1.7037
Tribal Land Area (km ²)	114763.442	111131.648	0	4870.297	2812.72
Natural Land (State) Pre/Post Ranges (kg/ha)	-16.4794--3.5219	-3.5219--0.0015	0	0.0062-0.3509	0.3509-3.1383
Natural Land (State) Area (km ²)	54002.585	36514.141	0	1593.163	4119.832
Natural Land (Private) Pre/Post Ranges (kg/ha)	-13.4904--0.9719	-0.9719--0.0015	0	0.0075-0.306	0.306-3.1383
Natural Land (Private) Area (km ²)	209799.646	595415.148	0	73425.088	81156.404
Industrial Land (Private) Pre/Post Ranges (kg/ha)	-8.3746--1.3528	-1.3528--0.1006	0	0.0181-0.094	0.094-0.1699
Industrial Land (Private) Area (km ²)	30545.488	1462.308	0	26.827	82.408
Forest Land (Private) Pre/Post Ranges (kg/ha)	-7.9049--5.1056	-5.1056--4.0761	0	NA-NA	NA-NA
Forest Land (Private) Area (km ²)	4170.785	10006.169	0	0	0
Geological Area Pre/Post Ranges (kg/ha)	-9.4267--1.2317	-1.2317--0.1042	0	0.2682-0.2682	0.2682-0.2682
Geological Area Area (km ²)	119.972	127.066	0	0	0.065
Natural Land (Federal) Pre/Post Ranges (kg/ha)	-16.4794--1.9859	-1.9859--0.0015	0	0.0062-0.315	0.315-3.1383
Natural Land (Federal) Area (km ²)	210289.526	710289.424	0	0.6709.208	106166.893

How effective has the Clean Air Act been in protecting valued ecosystems (e.g. protected areas)?



ORD Ecosystem Services Research New Directions 2009-2014

- **Vision**

A comprehensive theory and practice for quantifying ecosystem services, their value and their relationship to human well-being, is consistently incorporated into environmental decision making.

- **Goal**

Transform the way we understand and respond to environmental issues by making clear how our management choices affect the type, quality and magnitude of the services we receive from ecosystems.

ESRP Major Research Questions

Pollutant-Based Ecosystem Services Research

How does a regulated pollutant—nitrogen—affect, positively and negatively, the bundle of ecosystem services at multiple scales?

Ecosystem-Based Ecosystem Services Research

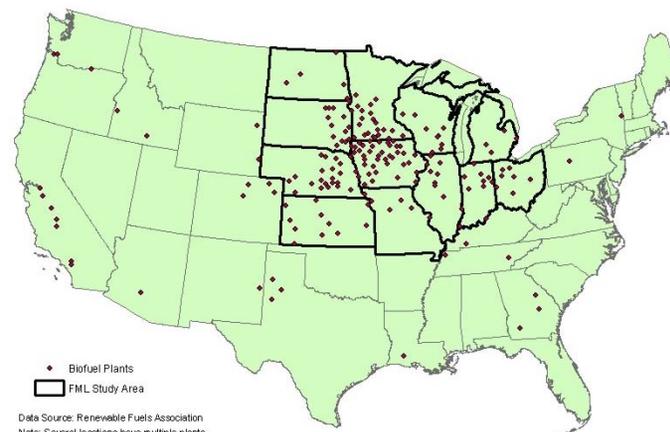
How does the bundle of ecosystem services provided by selected ecosystem types—wetlands and coral reefs—change under alternative management options at multiple scales?

Place-Based Ecosystem Services Research

How does the bundle of ecosystem services for all ecosystems within an “ecosystem service district” change under alternative management options?

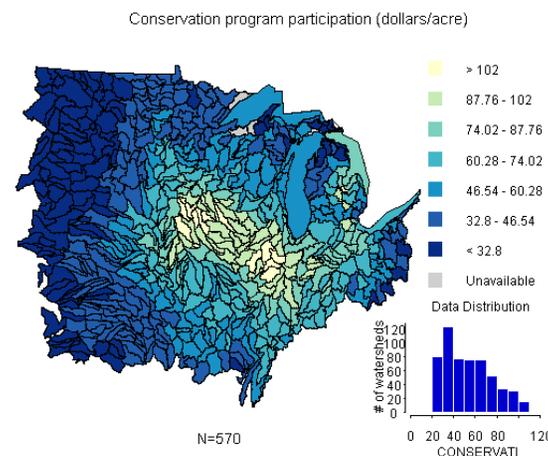
Change drivers of interest for Midwestern place-based study

- Biofuels
 - Potential for rapid, large-scale changes in land use or land management
 - Implicit trade-offs among ecosystem services
- Agricultural conservation practices
 - Existing area of large investment, uncertain benefit
 - Increasing interest in ecosystem service-based incentives and markets



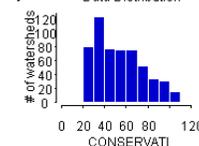
Data Source: Renewable Fuels Association
Note: Several locations have multiple plants

Locations of ethanol biorefineries and FML boundary



Conservation program participation (dollars/acre)

N=570



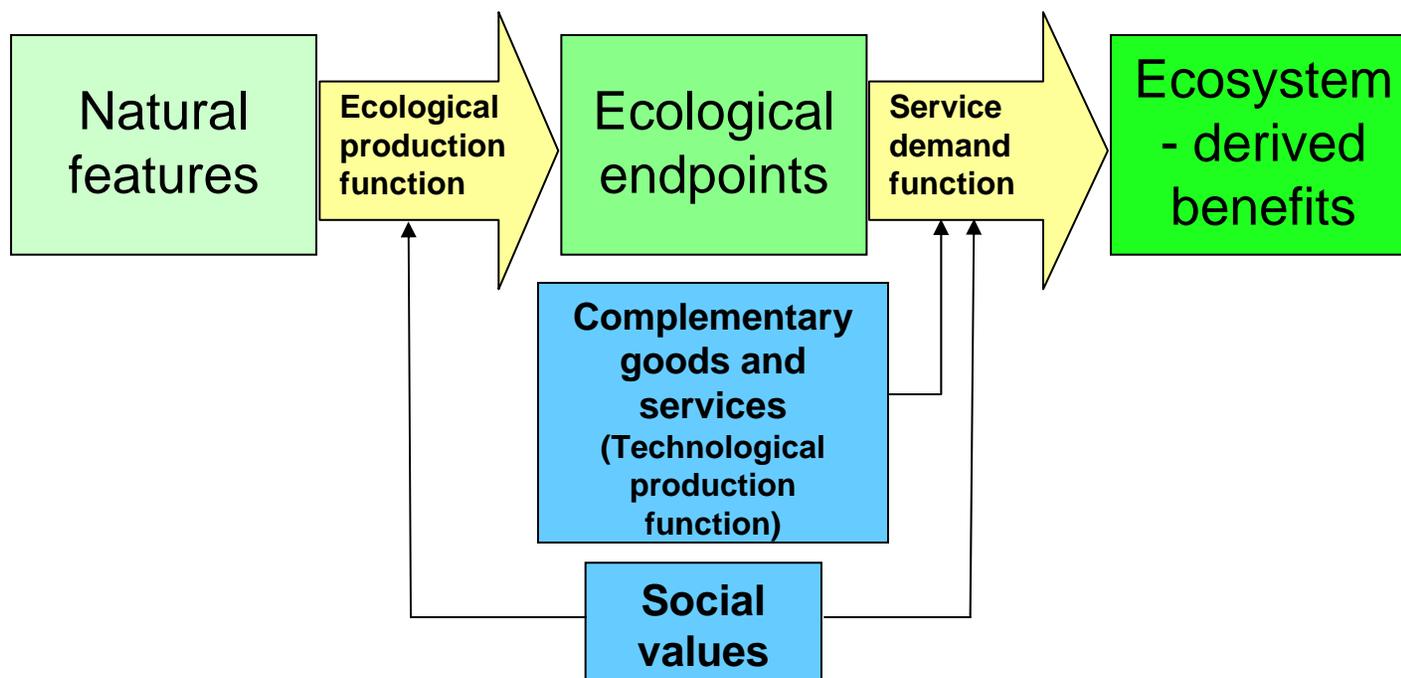
Problem statement

- How do structures, functions and processes of Midwestern ecosystems contribute to societal well-being?
- How can we quantify the ecological, technological, and service demand functions of the Midwest landscapes?
- How will today's land use decisions affect trade-offs of future ecosystem services? What land-use/land cover configurations afford the best combinations of ES based on society's values?
- What indicators of ecosystem service changes communicate the vulnerabilities and opportunities to decision-makers?
- How can we facilitate conservation and restoration of ecosystem services through existing or future market structures or policies?

Services of interest in FML Study (examples)

- ***Carbon storage***
- ***Water supply***
- ***Flood moderation***
- ***Water quality***
- ***Biodiversity***
- ***Air quality***
- ***Food production***
- ***Biofuel feedstock production***

Ecosystem Services Framework



Wainger and Boyd

Quantifying production functions is long-term research

Short-term analysis of ecosystem service endpoints

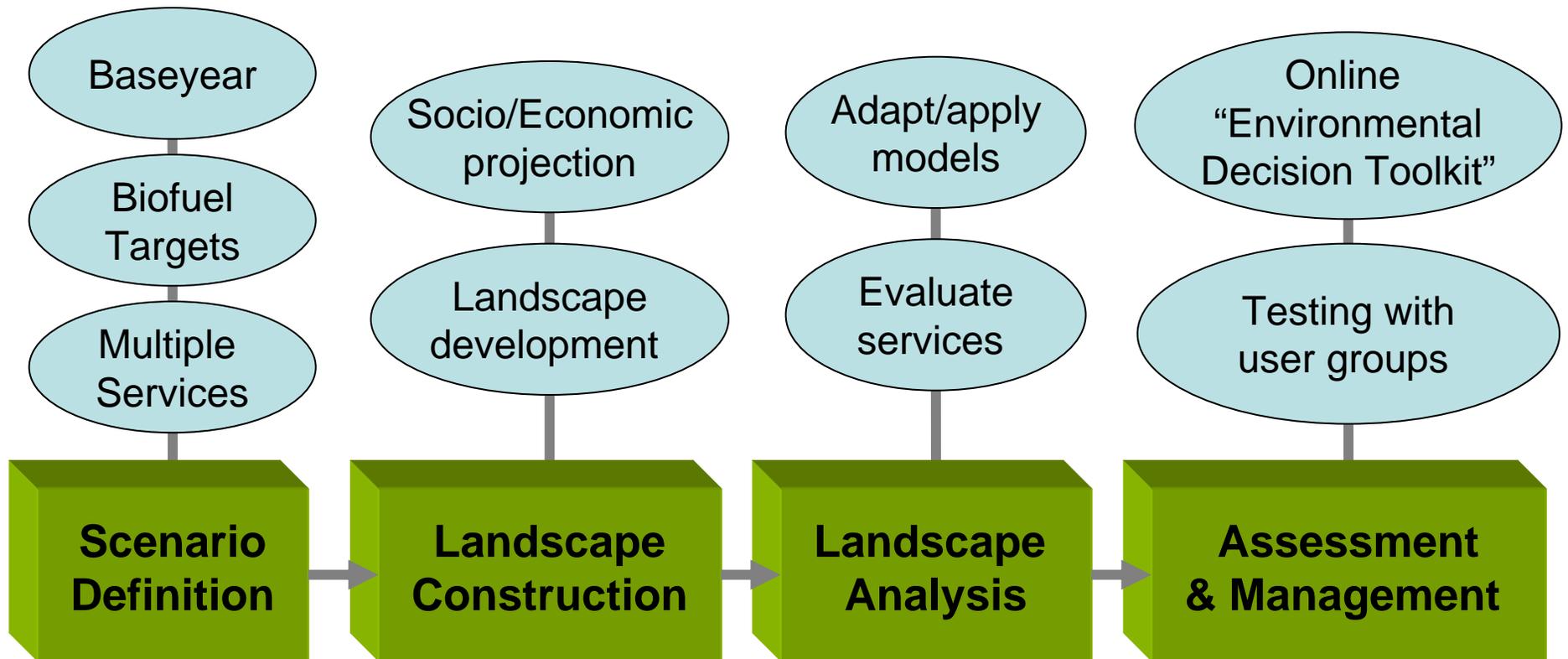
Supply and Demand Metrics

- Quality
- Quantity
- Vulnerability
 - Exposure
 - Ecological Resilience
 - Social Resilience

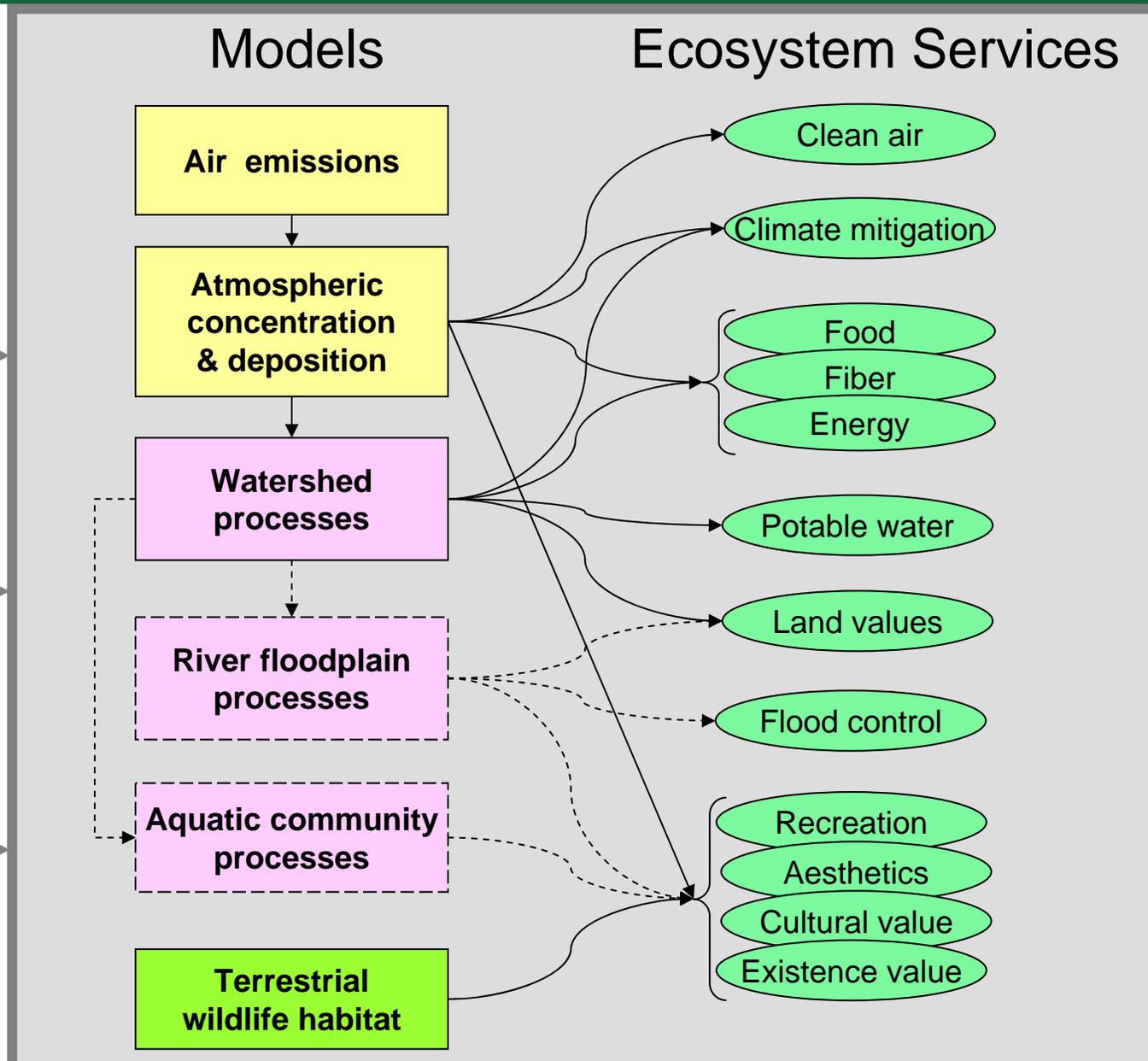
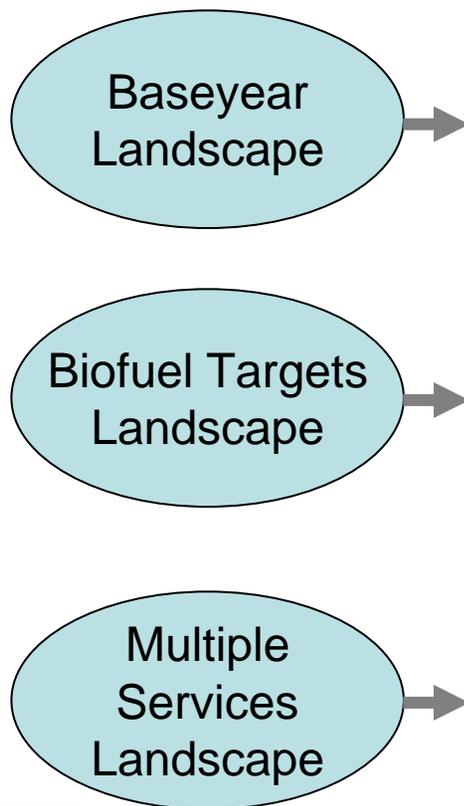
Interim Products:

- *Acquire regionally consistent, available data*
- *Clients (case studies) will help identify meaningful indicators through use of spatial data exploration tool (FML-EDT)*

Overview of alternative-futures research approach



Scenario Analysis



Biofuel Targets Scenario (2022)

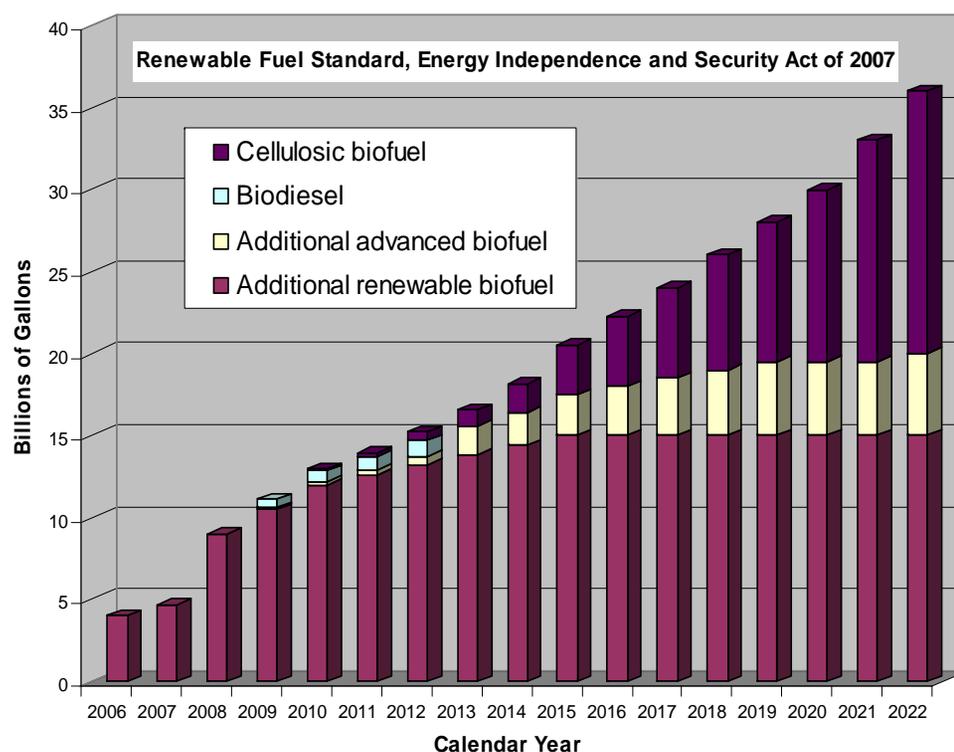
**Market Allocation (MARKAL)
econometric model (NRMRL)**

- Energy supply and demand

Sets conditions for:

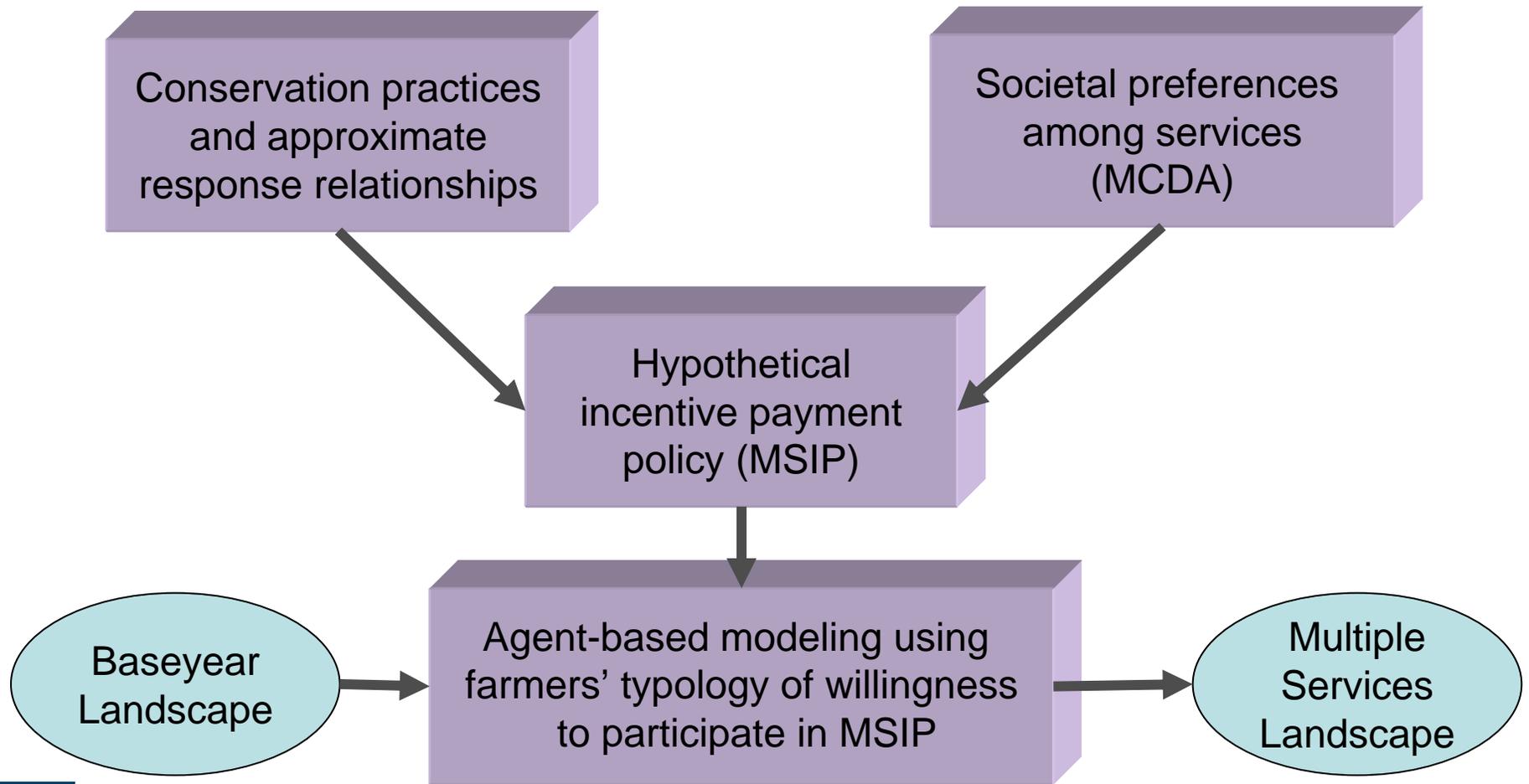
**Food and Agricultural Policy
Research Institute (FAPRI)
econometric model
(ISU/CARD)**

- Net returns (profits – costs) drivers
- Number of acres / region

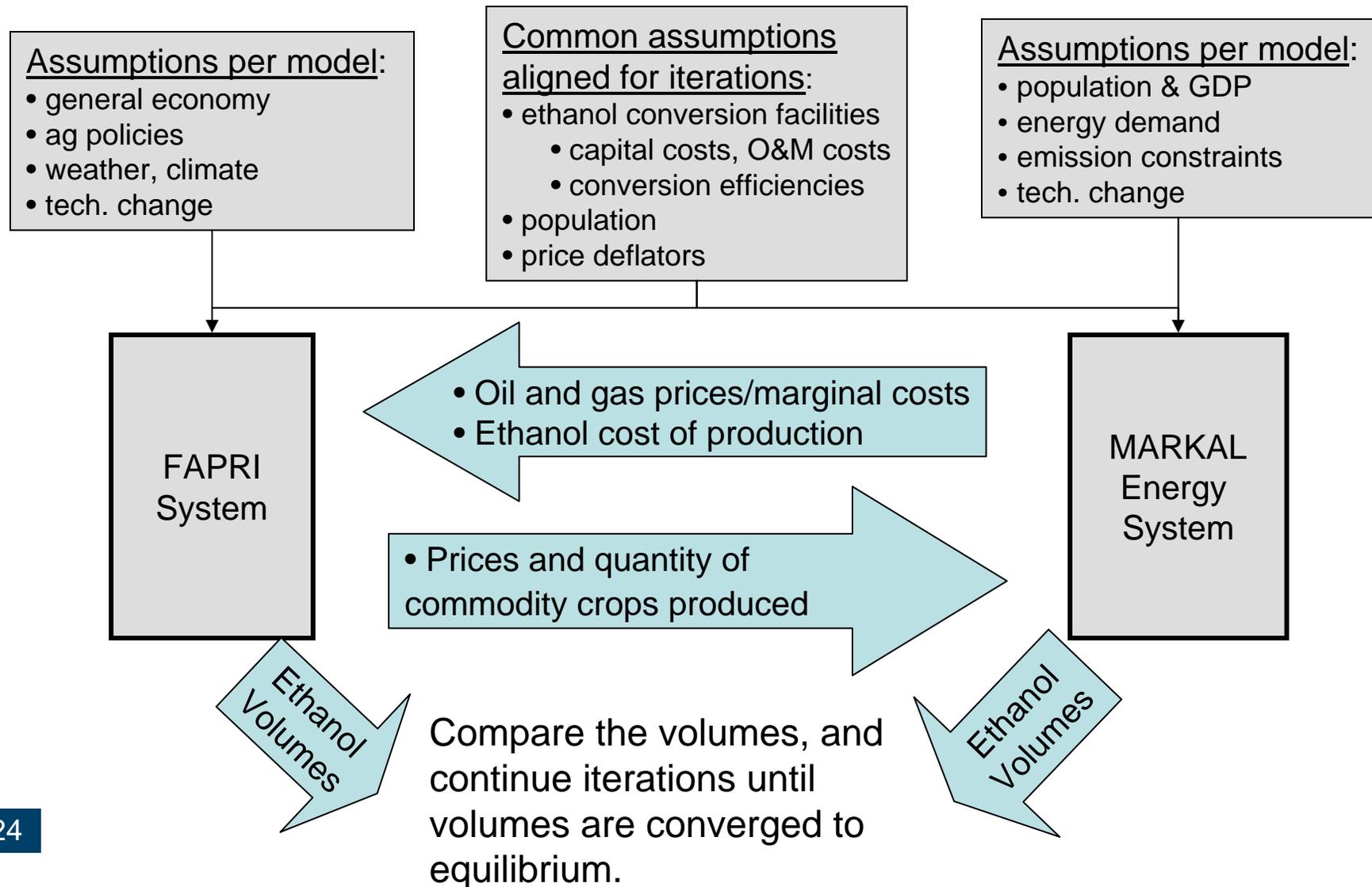


Results disaggregated using soils data, tillage practices, etc.

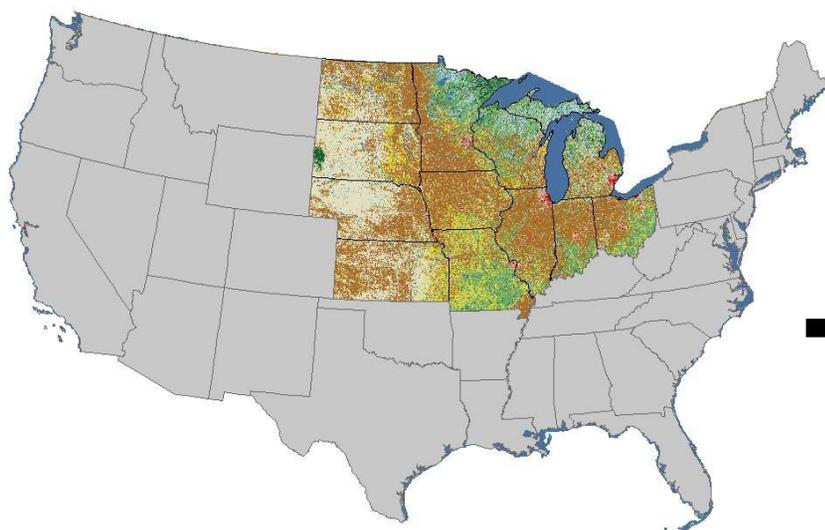
Multiple Services Scenario (2022)



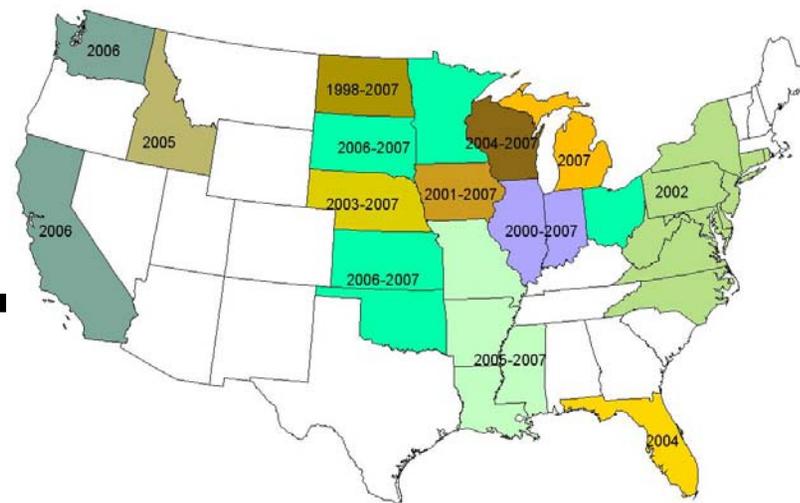
Capturing Energy and Agriculture Market Dynamics through EPA and Iowa State/CARD Interaction



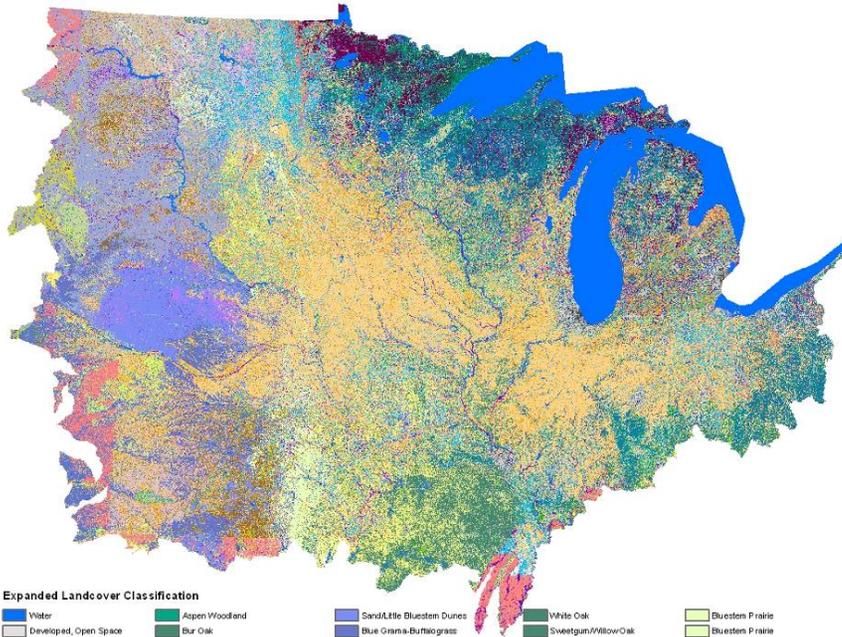
Base Year Scenario



NLCD 2001/2002



NASS Cropland Data Layers



Expanded Landcover Classification

Water	Aspen Woodland	Sand/Little Bluestem Dunes	White Oak	Bluestem Prairie
Developed, Open Space	Bur Oak	Blue Grama/Buffgrass	Sweetgum/Willow Oak	Bluestem Prairie
Developed, Low Intensity	White Dark Pine	Bluestem Prairie	Yellow Poplar/White/Red Oak	Bluestem Prairie
Developed, Medium Intensity	White Spruce	Saltbrush-Oreasewood	Deadwood Flatwood	Little Bluestem/Indiangrass/Wintergrass
Developed, High Intensity	Lumber Pine	Riparian Woodland	White Oak	Black Ash/Elm/Red Maple
Barren Land	Lodgepole Pine	Cottonwood/Willow	Swamp Chestnut/Cherrybark Oak	Willow/Water/Dian onleaf Oak
Undefined Deciduous Forest	Douglas Fir	Riparian	Live Oak	Jack Pine Swale
Undefined Evergreen Forest	Ponderosa Pine	Riparian	Aspen	Great Plains Riparian
Undefined Mixed Forest	Spruce Sup/Alpine Fir	Douglas Fir	White/Black/Red Oak	Floodplain Riverbirch/Sycamore
Undefined Shrub/Scrub	Bristlecone Pine	Shrubland	Grass/Shrub Balds	Riparian Riverbirch/Sycamore
Undefined Grassland/Herb.	Juniper/Pinyon Pine	Ponderosa Pine	Jack Pine	Floodplain Sweetgum/Willow Oak
Undefined Pasture Hay	Aspen	Introduced Woody Wetland	Longleaf Pine	Floodplain Sweetgum/Willow Oak
Undefined Crop	Red Alder	Introduced Upland Herbaceous	Virginia Pine	Floodplain Black Ash/Elm/Maple
Undefined Woody/Wetland	Black Sagebrush	Introduced Upland Herbaceous	Willow/Water/Dian onleaf Oak	Black Spruce/Tamarack/Peastland
Undefined Herbaceous Wetland	Saltbrush-Oreasewood	Introduced Upland Herbaceous	Red Pine	Swamp Riverbirch/Sycamore
Monsiature Corn	Black Sagebrush	Introduced Herbaceous Wetland Riparian	Missouri Glades	Coastal Plain Swamp
Monsiature Soybean	Big Sagebrush	Introduced Upland Tree	Post/Black Oak	Black Ash/Elm/Maple Swamp-Bog
Monsiature Wheat	Salt Desert Shrub	Recently Logged	Balsam Fir	Prairie Pothole Wetland
Monsiature Cotton	Sagebrush-Grass	Recently Logged	Henlock Yellow Birch	Viet Meadow/Prairie Marsh
Corn/Soy	Cholcherry-Serviceberry Rose	Ruderal Forest	Shortleaf Pine/Oak	Coastal Herbaceous Marsh
Corn/Wheat	Sandsage Prairie	Sand Shimmery Oak	Chestnut Oak	Appal. Shrub/Herbaceous Wetland
Corn/Other	Cholcherry-Serviceberry Rose	Big Sagebrush	Sugar Maple/Beech	Laurentian-Acadian Herbaceous Wetland
Corn/Fallow	Mesquite	Sugar Maple	Loblolly Pine-Hardwood	Bluestem Depressional Wetland
Soybean/Wheat	Ponderosa Pine	White/Black/Red Oak	Shortleaf Pine/Oak	Alkali/Cacaton-Tobosa Grass
Soybean/Other	Juniper/Pinyon Pine	White Oak	Chestnut Oak	Alkali/Cacaton-Tobosa Bottom land
Soybean/Fallow	Big Sagebrush/Buebunch/Wheatgrass	White Oak	Post/Black Oak	White Oak
Wheat/Other Crop	Big Sagebrush	Oak	Deadwood Shrubland	Shortleaf Pine/Oak
Wheat/Fallow	Big Sagebrush	Oak-Hickory	Bur Oak	Sweetgum/Willow Oak/River Flatwoods
Cotton/Other	Blue Gramma/Western Wheatgrass	White/Black/Red Oak	Pin Oak	Black Oak Bluff/Grassland
Misc Grain/Fallow	Gramma/Luteo-Threeswn	Post/Black Oak	Grass/Shrub Bald	Pin oak/Sweetgum/Wet Flatwood
Other Crop/Fallow	Gramma/Oaletta	White/Black/Red Oak	Glade	Ruderal Shrub/Forest
Alfalfa Hay	Rough Fescue-Idaho Fescue	Black Oak	Red Pine	Ruderal Mixed Forest
Alfalfa Hay/Other	Rough Fescue-Idaho Fescue	Post/Black Oak	White Cedar	Ruderal Mixed Forest
Fallow	Wheatgrass-Kuesten-Nelegrass	Sugar Maple/Beech/Yellow Birch	Lake Prairie	Managed Tree Plantation
Sparsely Vegetated	Tall Fescue	Sugar Maple/Basswood	Bluestem Prairie	Managed Tree Plantation
Sparsely Vegetated	Alpine Rangeland	Chestnut Oak	Bluegrass Savanna/Woodland	Introduced Wetland Vegetation
Sparsely Vegetated	Bluestem Gramma Prairie	Yellow Poplar/Hemlock	Little Bluestem/Post Oak	Modified/Managed Tallgrass
Aspen Forest/Pastland		Sugar Maple/Beech	Karst Plain Prairie	Modified/Managed Tallgrass

Enhanced Land Cover Data for FML– Combines the best of NLCD, NASS Crop Data Layer, and LANDFIRE using a set of rules

Includes crop type as well as rotation

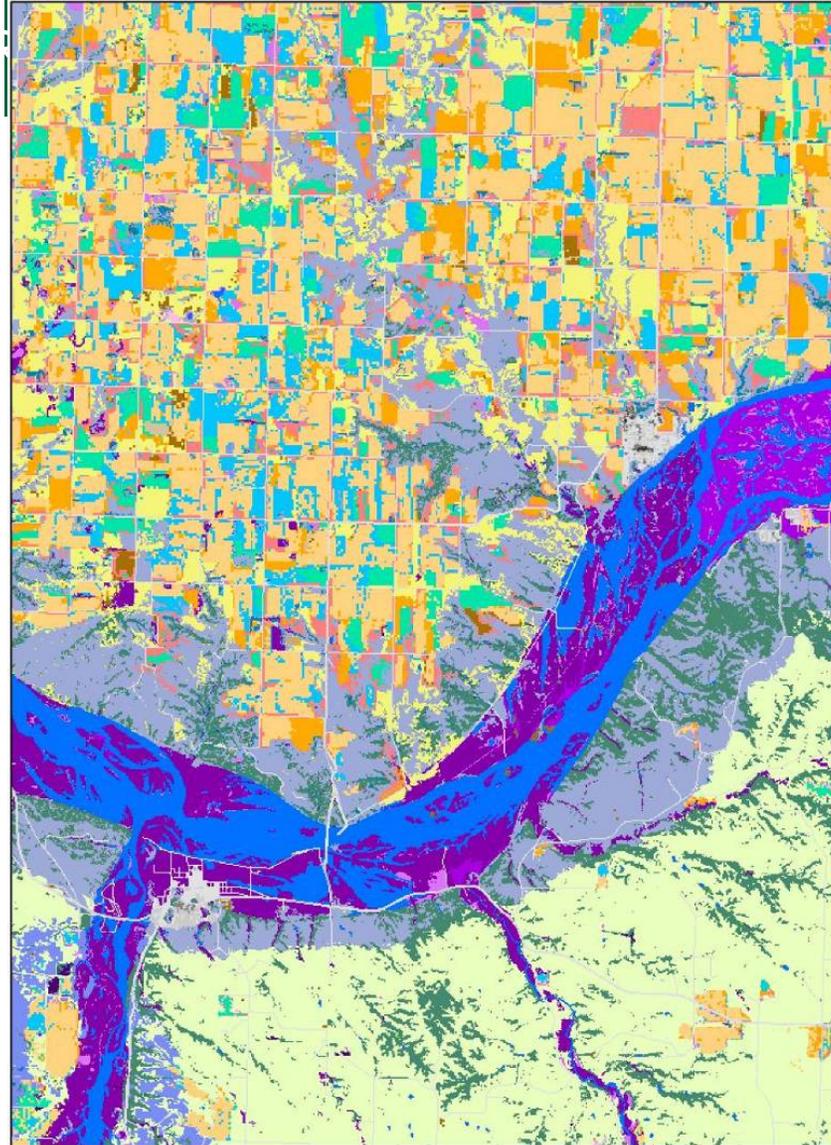
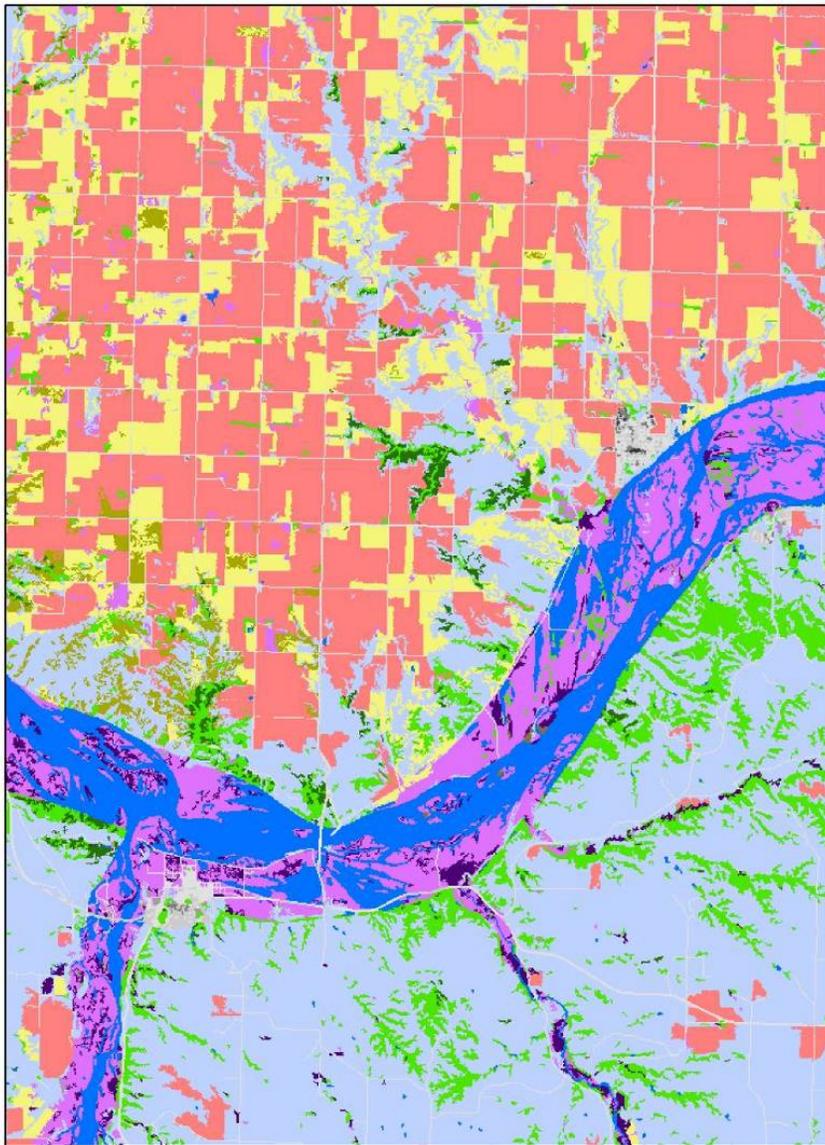
Implications for better estimation of nutrients and pesticides loads/export

Better assessment of crop yields

Megan Mehaffey

NLCD 2001

NLCD Expanded 2001



27

Pasture

Row crops

Corn monoculture

Pasture

Alfalfa/Hay

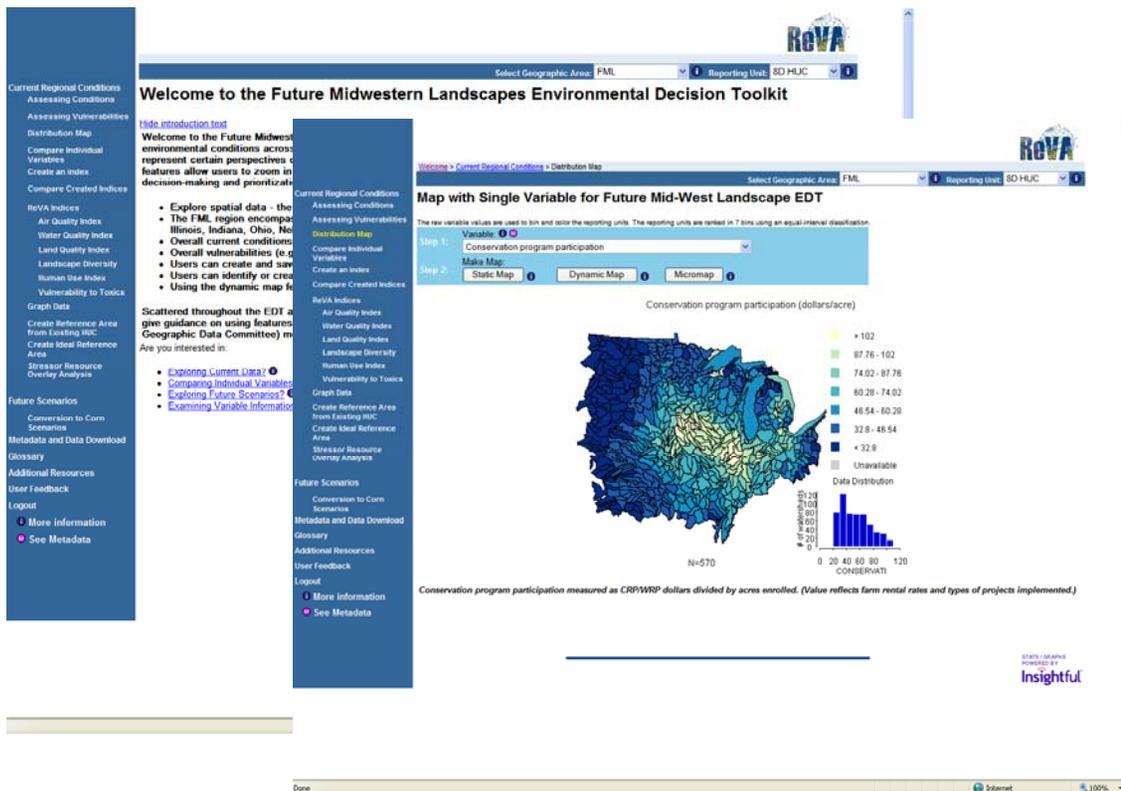
Soybean in rotation

Corn in rotation

27

Megan Mehaffey

The Future Midwestern Landscapes Environmental Decision Toolkit (FML-EDT)



- User-friendly tool for decision-makers
- Structured around ES themes to promote problem solving
- Reduce complex information into useable performance metrics
- Promote understanding of cause/effects resulting from policy choices

Future capability: Build an ecosystem service index (ESI) combining user-weighted values

Compare Individual Variables
Create an index
Compare Created Indices
ReVA Indices
Air Quality Index
Water Quality Index
Land Quality Index
Landscape Diversity
Human Use Index
Vulnerability to Toxics
Graph Data
Create Reference Area from Existing HUC
Create Ideal Reference Area
Stressor Resource Overlay Analysis
Future Scenarios
Conversion to Corn Scenarios
Metadata and Data Download
Glossary
Additional Resources
User Feedback
Logout
More information
See Metadata

Step 1:

- Clean Air
- Climate Mitigation
- Food Production
- Fiber Production
- Energy Production
- Potable Water
- Land Value
- Flood Control
- Wildlife-based Recreation
- Aesthetics
- Cultural Value
- Biodiversity Existence Value

Step 2:

Make Map
Static Map
Dynamic Map
<< Back

0 1 2 3 4 5 6 7 8 9 10

room for improvement

relatively good provision of services



ECOSYSTEM SERVICES RESEARCH PROGRAM

Assessing Existing & Baseline Future Conditions

Evaluating Opportunities for Action

Analysis Components

Nutrients / GOM / Great Lakes

Which watersheds are generating the most N and P to GOM?

Which watersheds are generating the most **controllable** N and P to GOM?

Establish model based on farm & landscape characteristics (e.g., areas with high fertilizer inputs, leaky soils/ geology, minimal conservation practices implemented)

Which watersheds are generating the most N and P to Great Lakes?

Which watersheds are generating the most **controllable** N and P to Great Lakes?

Establish model based on farm or urban & landscape characteristics

How can conservation practices be targeted to cost-effectively reduce N, P exports to major waterbodies?

Identify leakiness factors by watershed or sub-watershed location, loadings, attenuation characteristics, existing BMPs

Which stream reaches have ecological components vulnerable to nutrient pollution?

How can conservation practices be targeted to cost-effectively reduce N, P exports to vulnerable streams?

Identify where functions have high likelihood of being restorable. (ie, moderately impacted with high opportunities for cost-effective BMPs)

Where are the biggest changes in stream chemistry likely to occur if biofuel production increases?

What level of nutrient export might be generated with alternative management aimed at fulfilling multiple services?

Scenario Analysis - nutrient export indices

Water Quality for Drinking

Where are people exposed to health risks from nitrates in groundwater?

Where can practices be implemented to increase the safety of the groundwater supply?

Population exposed, % marginal farmland, restorable wetlands

Where are municipal surface water intakes (SWI) at risk for increased treatment requirements? (from development, nitrogen pollution, etc.)

Where could practices be targeted to protect SWIs?

% natural veg in surface water protection watershed (identify watersheds near thresholds?) vs. land conversion pressure

Recreational hunting

Where are recreational hunting options the most scarce?

Where are opportunities to cost-effectively increase recreational hunting opportunities?

e.g., Green ratio vs. population

Existence Values - Terrestrial habitats

Which habitats are vulnerable?

Which habitat patches are the most critical to preserve?

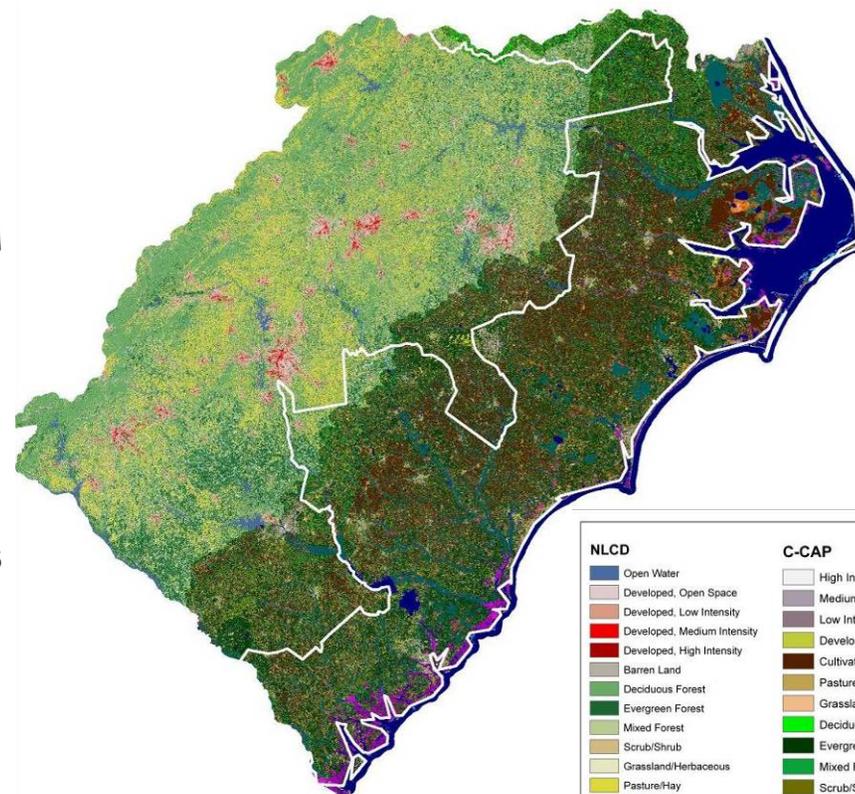
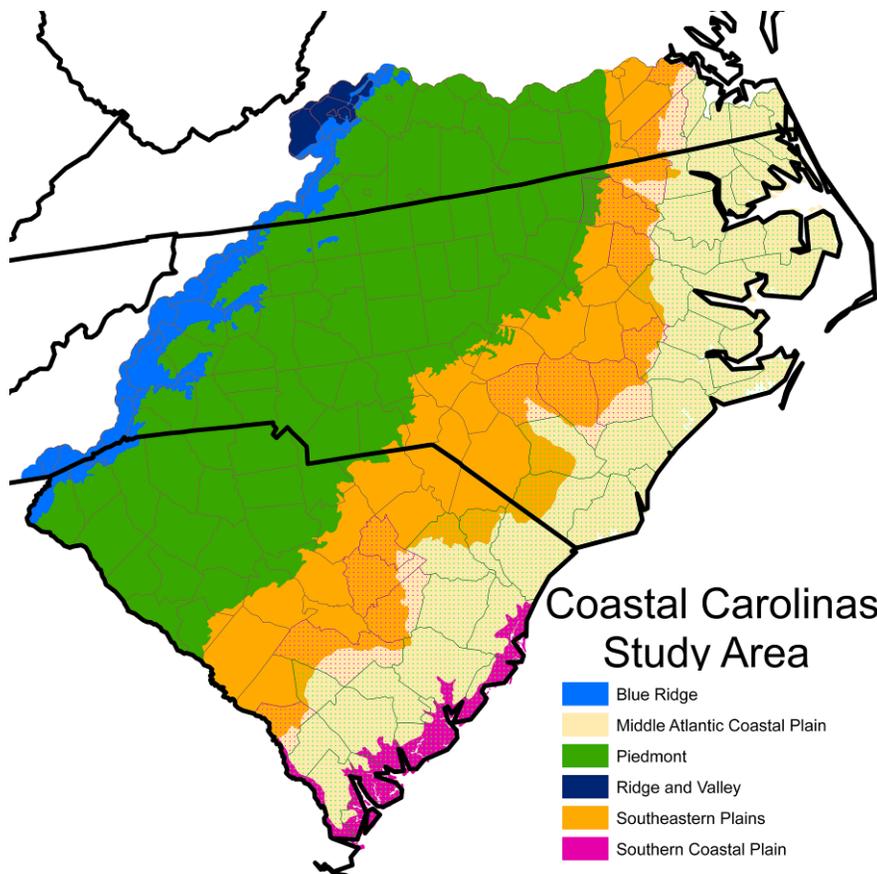
Documented, likely, and potential occurrences of rare species and natural communities combined with opportunities for green corridors, reduced fragmentation, etc. (e.g., something like FNAI)

Where are rare habitats experiencing the greatest stress?

Which areas are the most critical to restore to protect scarce habitat?

Land conversion potential; cumulative impacts of land conversion; x FNAI-like layer

The Coastal Carolinas Project



NLCD	C-CAP
Open Water	High Intensity Developed
Developed, Open Space	Medium Intensity Developed
Developed, Low Intensity	Low Intensity Developed
Developed, Medium Intensity	Developed Open Space
Developed, High Intensity	Cultivated
Barren Land	Pasture/Hay
Deciduous Forest	Grassland
Evergreen Forest	Deciduous Forest
Mixed Forest	Evergreen Forest
Scrub/Shrub	Mixed Forest
Grassland/Herbaceous	Scrub/Shrub
Pasture/Hay	Palustrine Forested Wetland
Cultivated Crops	Palustrine Scrub/Shrub Wetland
Woody Wetlands	Palustrine Emergent Wetland
Emergent Herbaceous Wetlands	Estuarine Forested Wetland
	Estuarine Scrub/Shrub Wetland
	Estuarine Emergent Wetland
	Unconsolidated Shore
	Bare Land
	Water
	Palustrine Aquatic Bed

Coastal Carolinas

The Coastal Carolinas Ecosystem Services Initiative is being developed to address a variety of issues related to impacts from global change and coastal development. The initiative will focus on:

- Mapping and quantifying coastal ecosystem services.
- Establishing the relationships between human land use, air, land, and aquatic processes, and coastal ecosystem services.
- Developing models and information to estimate how changing land use, sea level, and storm frequency and intensity may impact future coastal ecosystem services.
- Developing decision support tools which will help land use managers incorporate the full value of ecosystem services and the probable future impacts and costs of land use decisions.



Coastal Carolinas Alternative Futures

Sea Level Rise:

Slow (current rate)

Medium (1 m by 2100)

Fast (3 m by 2100)

Development Response:

Business as Usual



Adaptation in Place



Flee the Coast



	Slow (current rate)	Medium (1 m by 2100)	Fast (3 m by 2100)
Business as Usual	✓	✓	✓
Adaptation in Place	✓	✓	✓
Flee the Coast	✓	✓	✓

Models of Climate Change Effects:

**SLOSH?
SLAMM?**

Charleston Harbor

Mount Pleasant

Isle of Palms

Folly Beach

Physical process models - National Weather Service's Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model

Hurricane SLOSH Model

-  Water
-  Category I
-  Category II
-  Category III
-  Category IV
-  Category V



Questions?