Modeling Hg in streams using the WASP modeling framework

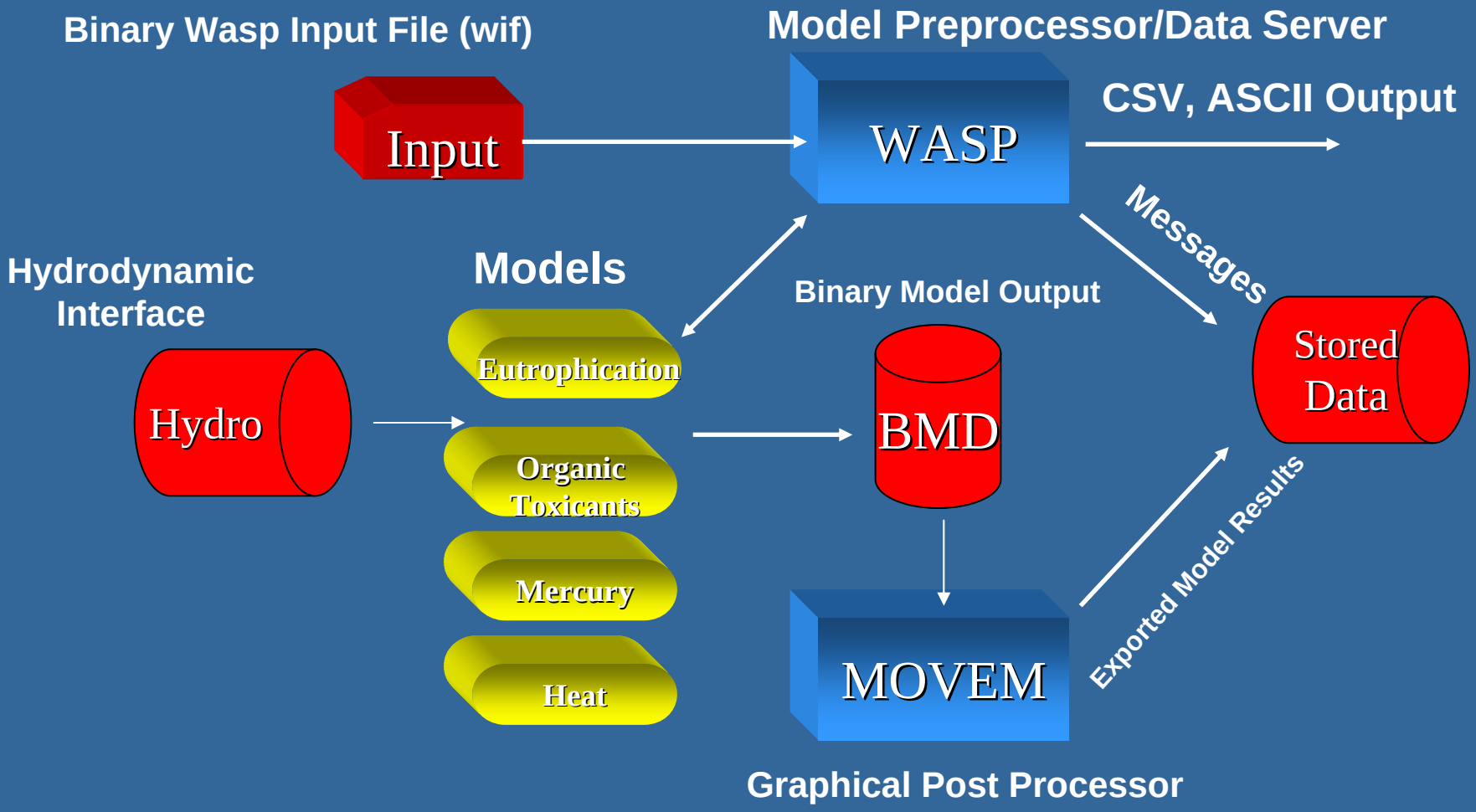
Christopher D. Knightes

Mercury in Streams Ecosystems Team Meeting

Troy, NY

3-6 May 2010

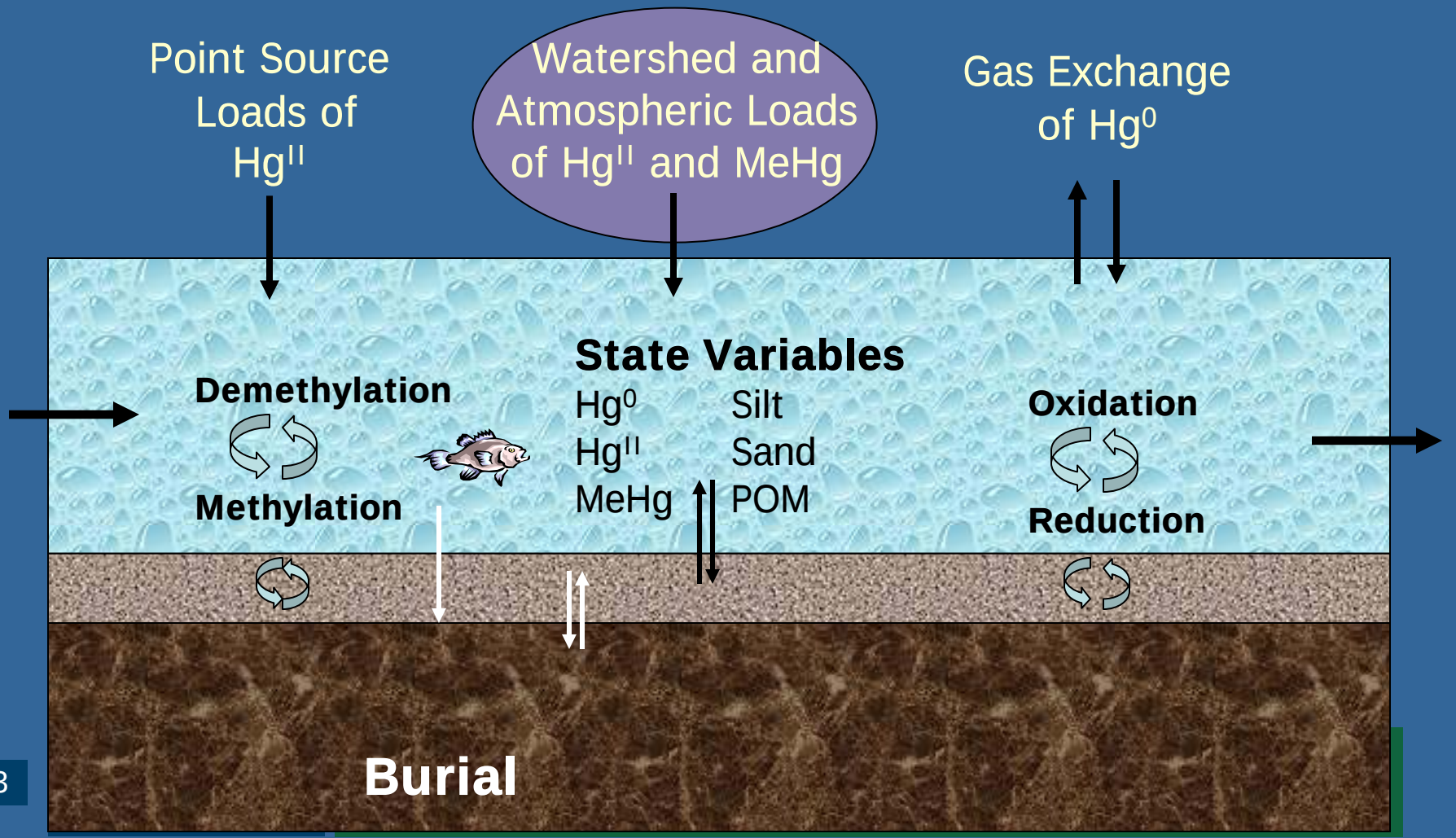
WASP Modeling Framework



EPA

ECOSYSTEMS SERVICES RESEARCH PROGRAM

WASP Hg Module



After EPA WASP 7 course.

WASP Advantages

- Network Flexibility
  - Applicable to most water body types at some level of complexity
  - 0D, 1D, 2D, 3D including branching
- Most Water Quality Problems
  - Conventional Water Quality: DO, nutrients, eutrophication, heat
  - Toxicants: organics, metals, mercury-specific module
- Separation of Processes
  - Transport (Advection, Exchange/Dispersion, Solids)
  - Kinetics
- External Links to Models and Spreadsheets
- Has internal, simple hydrodynamic modeling approaches for water routing
  - Dams and impoundments
  - Tidal influence and reverse flows

WASP Limitations

- Does not handle some variables and processes:
  - Segment drying (mudflats, flood plains)
  - Metals speciation reactions (special module, META4),
    - Calculations done outside WASP and then transferred in
  - Currently limited to 3 chemical species and 3 solids types
- Potentially large external hydrodynamic files
  - Forces WASP delineation and time steps
- Separate eutrophication and toxicant fate modules
- Cannot readily be run in batch mode
  - Requires manual calibration and parameter estimation and sensitivity and uncertainty analysis
- Introduction of new algorithms and processes can be slow and limited to the current WASP architecture.

WASP Limitations

- Does not handle some variables and processes:
  - Segment drying (mudflats, flood plains)
  - Metals speciation reactions (special module, META4),
    - Calculations done outside WASP and then transferred in
  - Currently limited to 3 chemical species and 3 solids types
- Potentially large external hydrodynamic files
  - Forces WASP delineation and time steps
- Separate eutrophication and toxicant fate modules
- Cannot readily be run in batch mode

sWASP

FRAMES

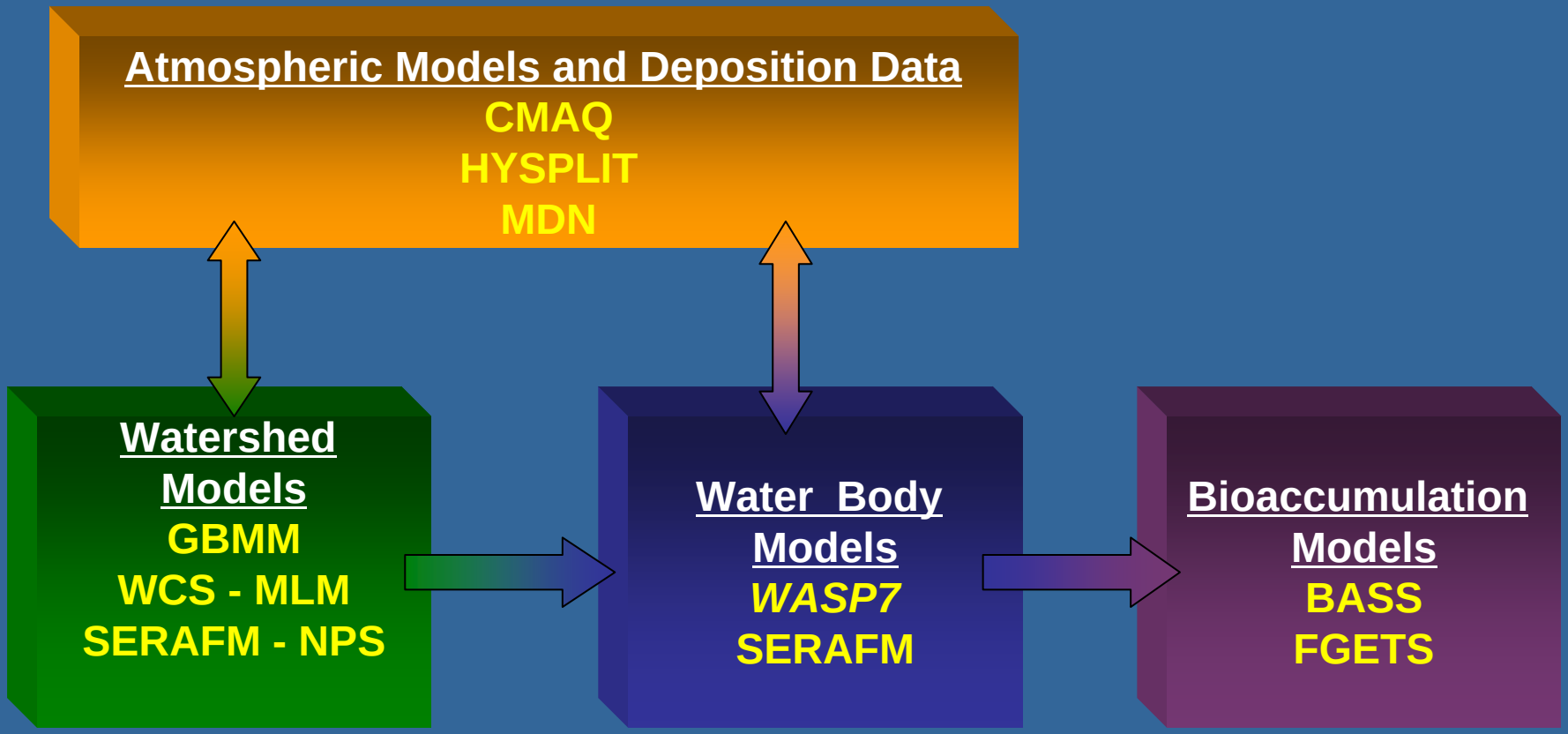
sWASP

  - Requires manual calibration and parameter estimation and sensitivity and uncertainty analysis

sWASP

Introduction of new algorithms and processes can be slow and limited to the current WASP architecture.

Multi-Media Hg Modeling Framework



EPA

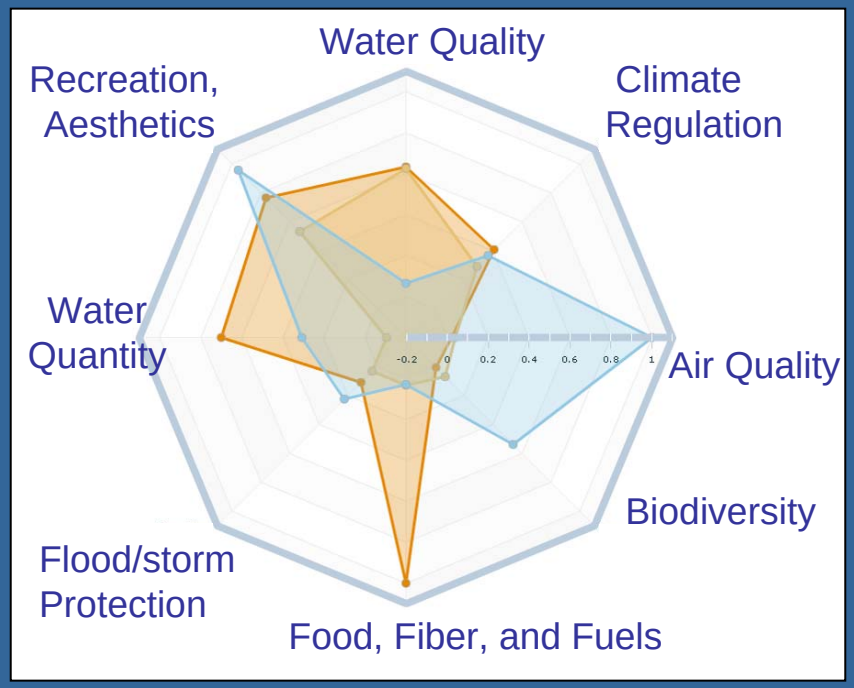
ECOSYSTEMS SERVICES RESEARCH PROGRAM

US EPA Ecosystem Services Research

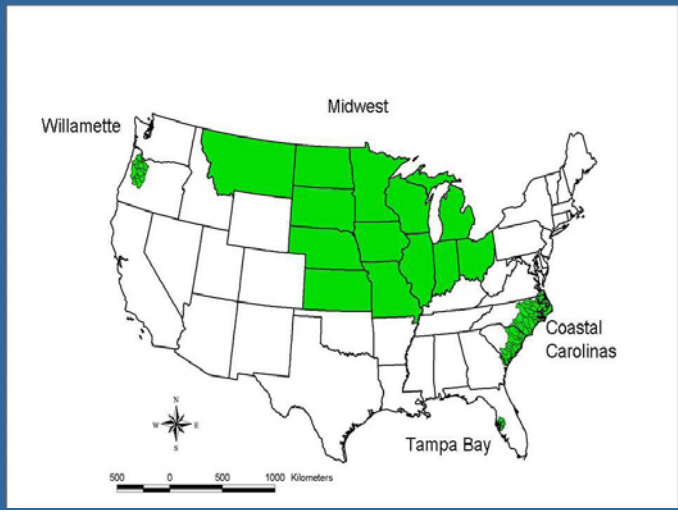
Incorporating ecosystem services into environmental decision making

Response of services to different scenarios

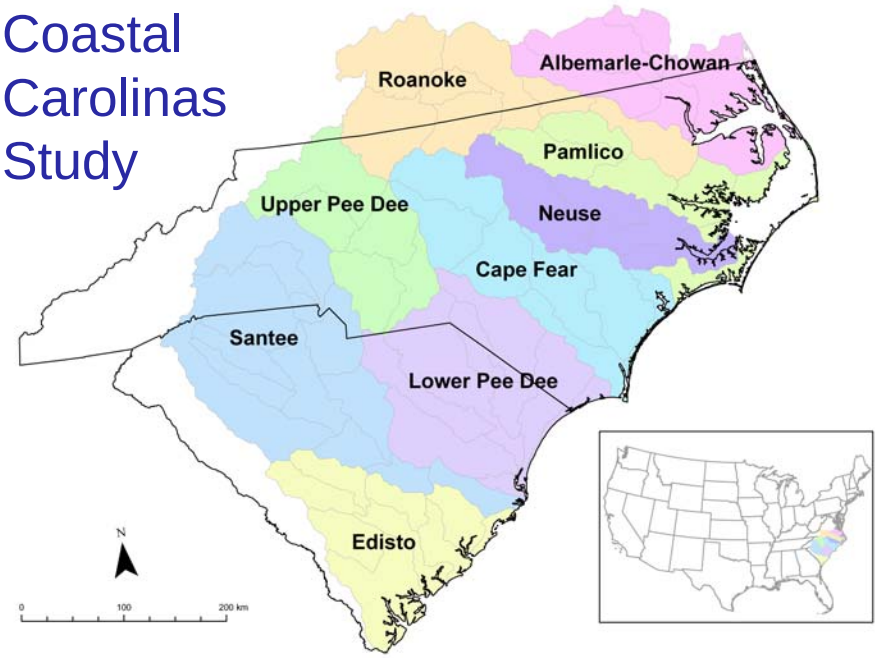
- land use change, climate change, management strategies



Place-Based Studies



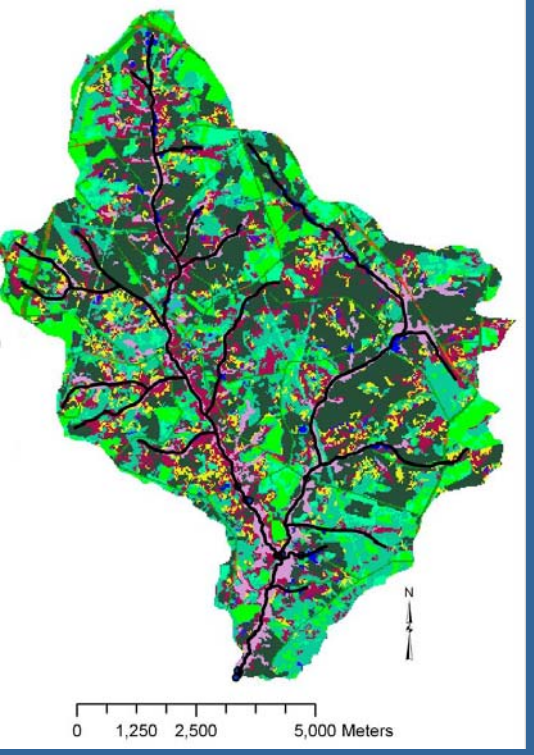
Coastal Carolinas Study

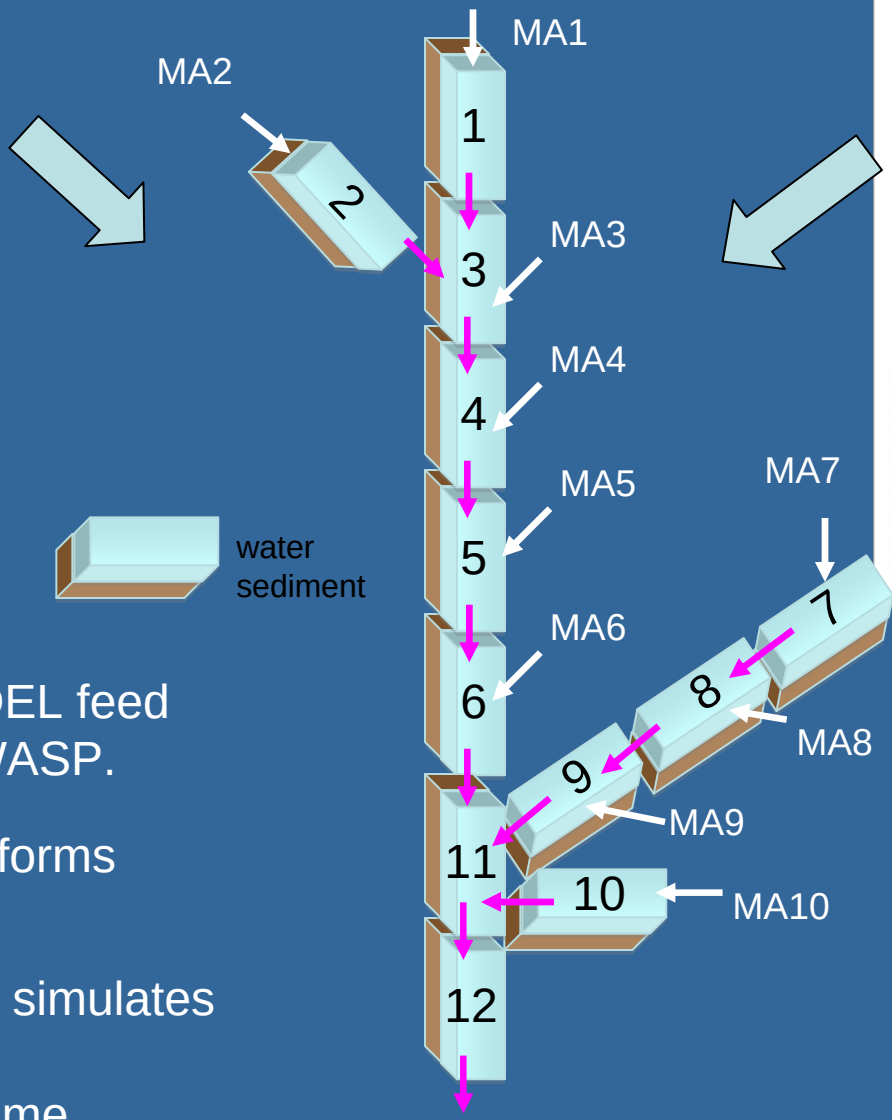


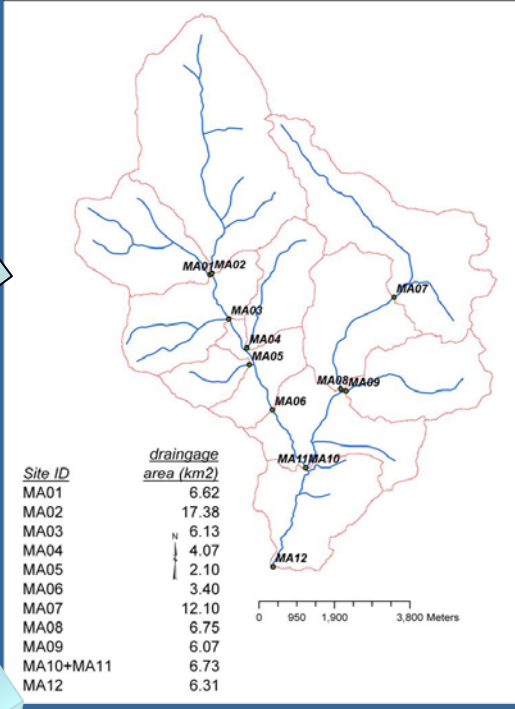
EPA

ECOSYSTEMS SI

McTier Creek WASP







Site ID	drainage area (km2)
MA01	6.62
MA02	17.38
MA03	6.13
MA04	4.07
MA05	2.10
MA06	3.40
MA07	12.10
MA08	6.75
MA09	6.07
MA10+MA11	6.73
MA12	6.31

1. GBMM and TOPMODEL feed information forward to WASP.

2. sWASP application informs WASP parameterization

3. *Each* WASP segment simulates Hg(II), Hg(0), MeHg and silt, sand, and POM vs time

4. dMeHg from WASP fed into BASS for bioaccumulation of MeHg for different trophic levels and fish species

EPA

ECOSYSTEMS SERVICES RESEARCH PROGRAM

McTier WASP Modeling

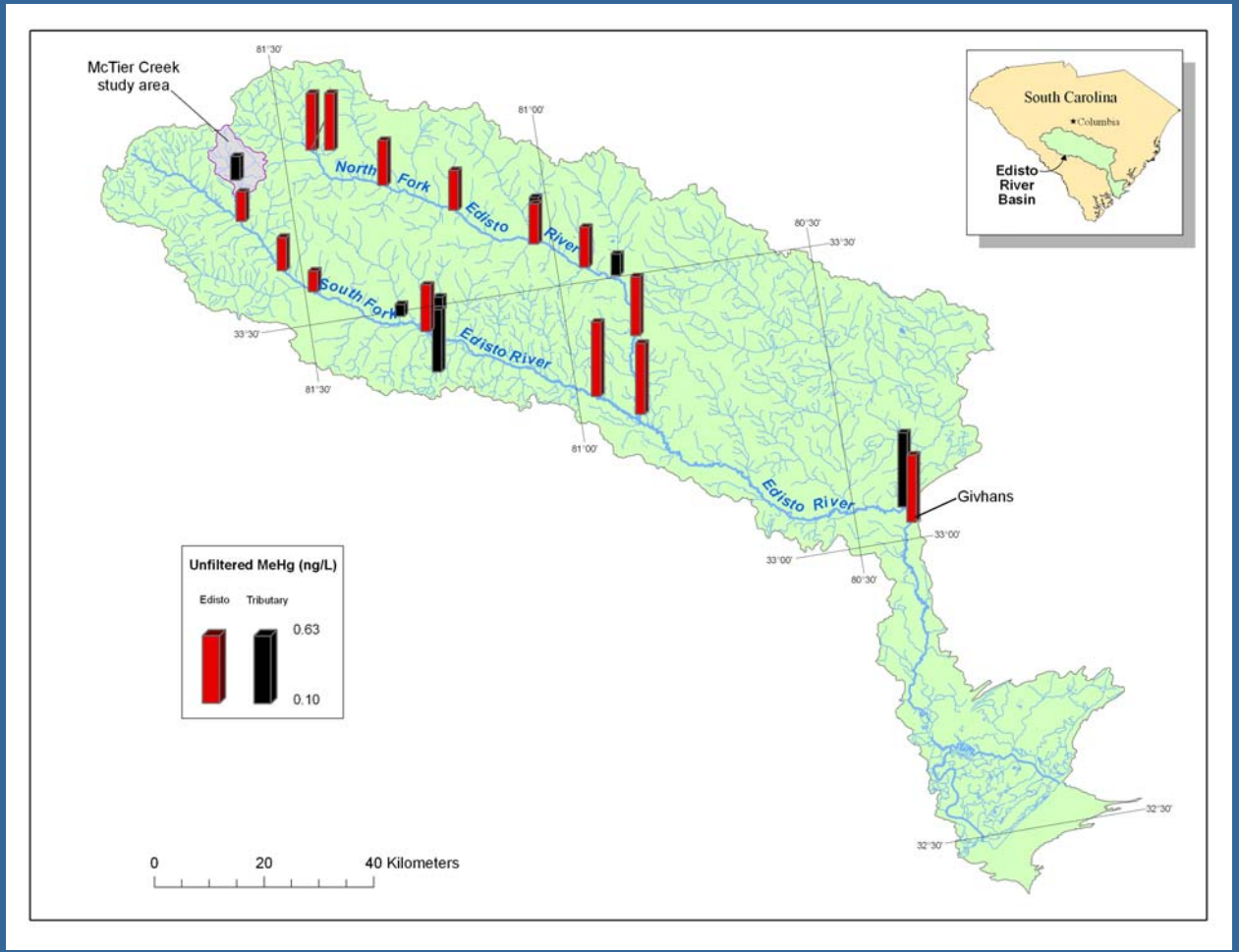
Publication Target -

WASP application:

- Focused Hg fate and transport Coastal Plain watershed and streams: ***McTier***
- Expanded to inform understanding of Hg cycling on regional scale: ***Edisto***

McTier Creek Area
~31 mi²

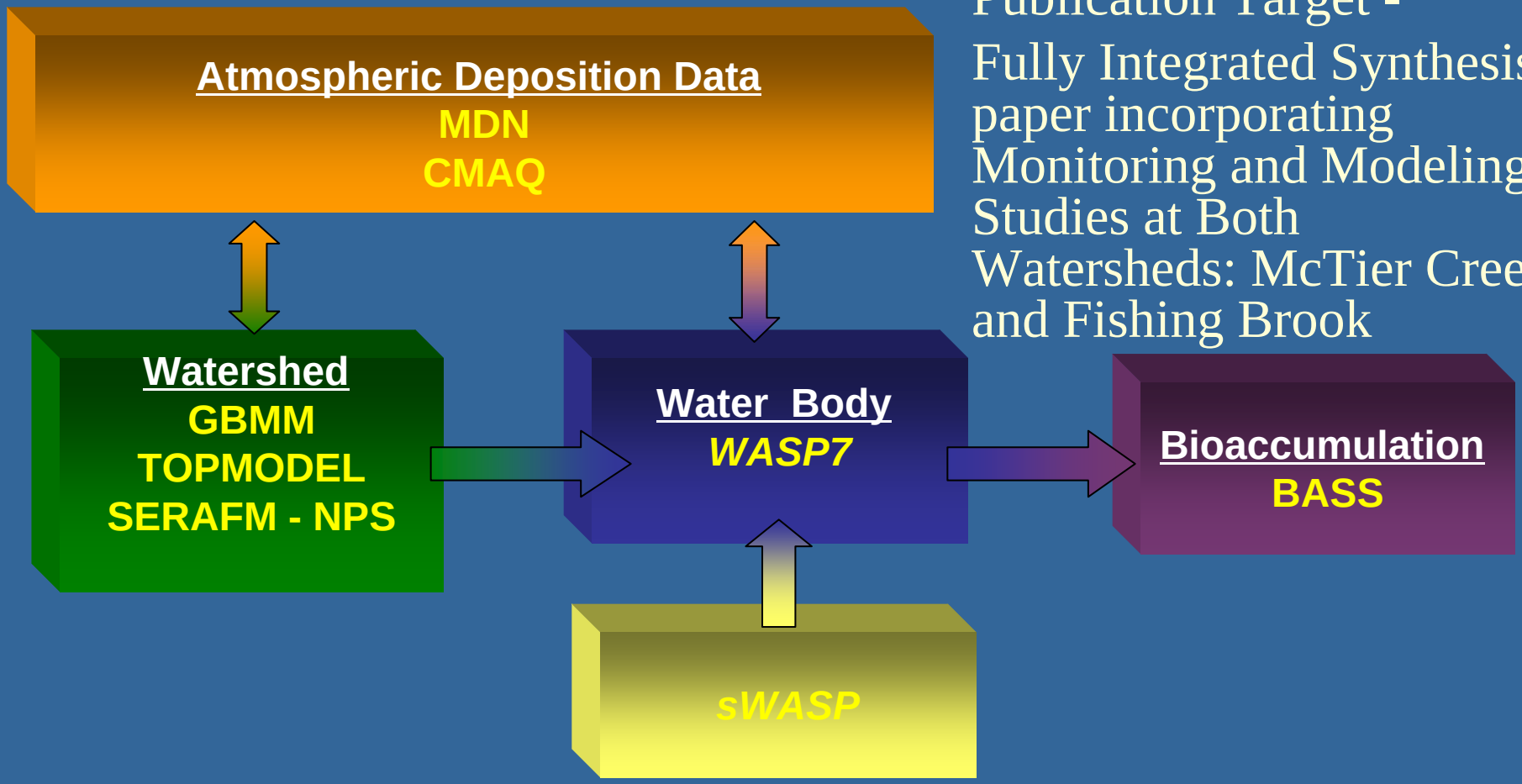
Edisto River @ Givhans
~2900 mi²



EPA

ECOSYSTEMS SERVICES RESEARCH PROGRAM

Fully Integrated Hg Modeling in Two Watersheds



Publication Target -

Fully Integrated Synthesis paper incorporating Monitoring and Modeling Studies at Both Watersheds: McTier Creek and Fishing Brook

EPA

ECOSYSTEMS SERVICES RESEARCH PROGRAM