MODELING OPTIONS FOR WETLANDS

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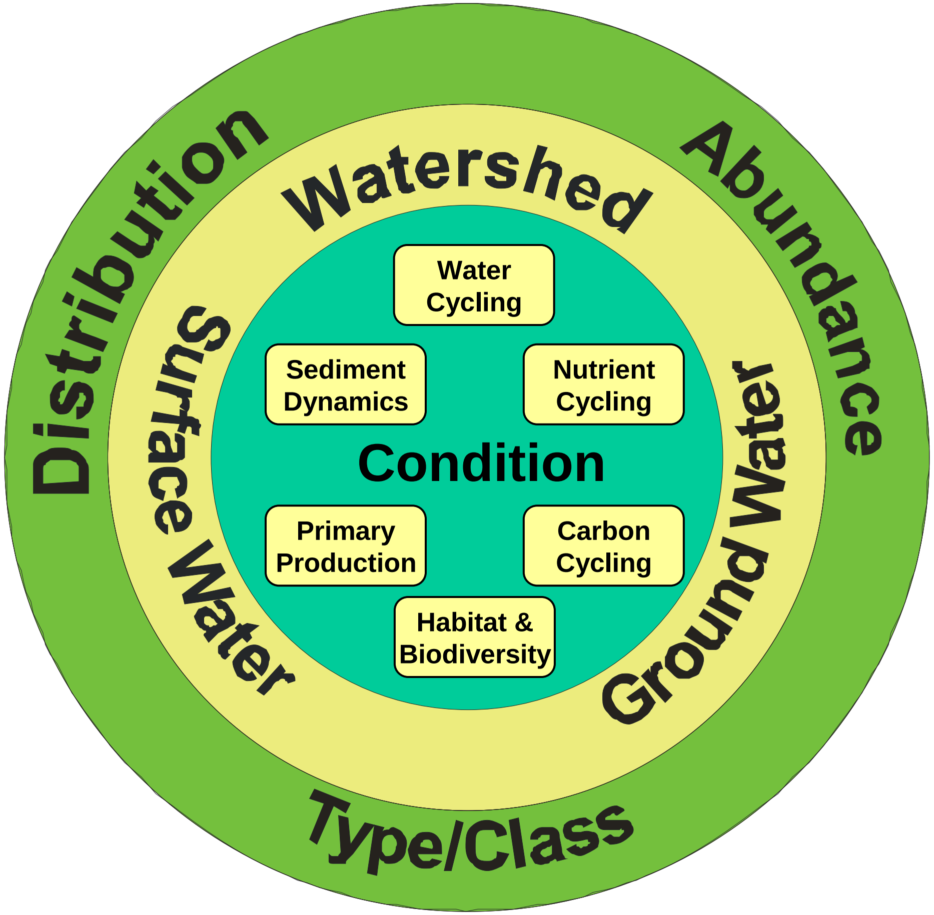
Charleston, SC Jan. 2009

Introduction

- Wetlands provide a disproportionately large number of ecosystem services to humans
- The ESRP recognizes modeling as an important tool for projecting how the provision of services changes under future scenarios
- The modeling of wetlands is underdeveloped relative to land and water ecosystems

Outline

- Model the wetland as a unit
  - DRAINMOD
  - REMM
  - STELLA model
  - SLAMM
- Imbed the wetland in a watershed and/or instream model




DRAINMOD - Home - Windows Internet Explorer
http://www.bae.ncsu.edu/soil_water/drainmod/index.html
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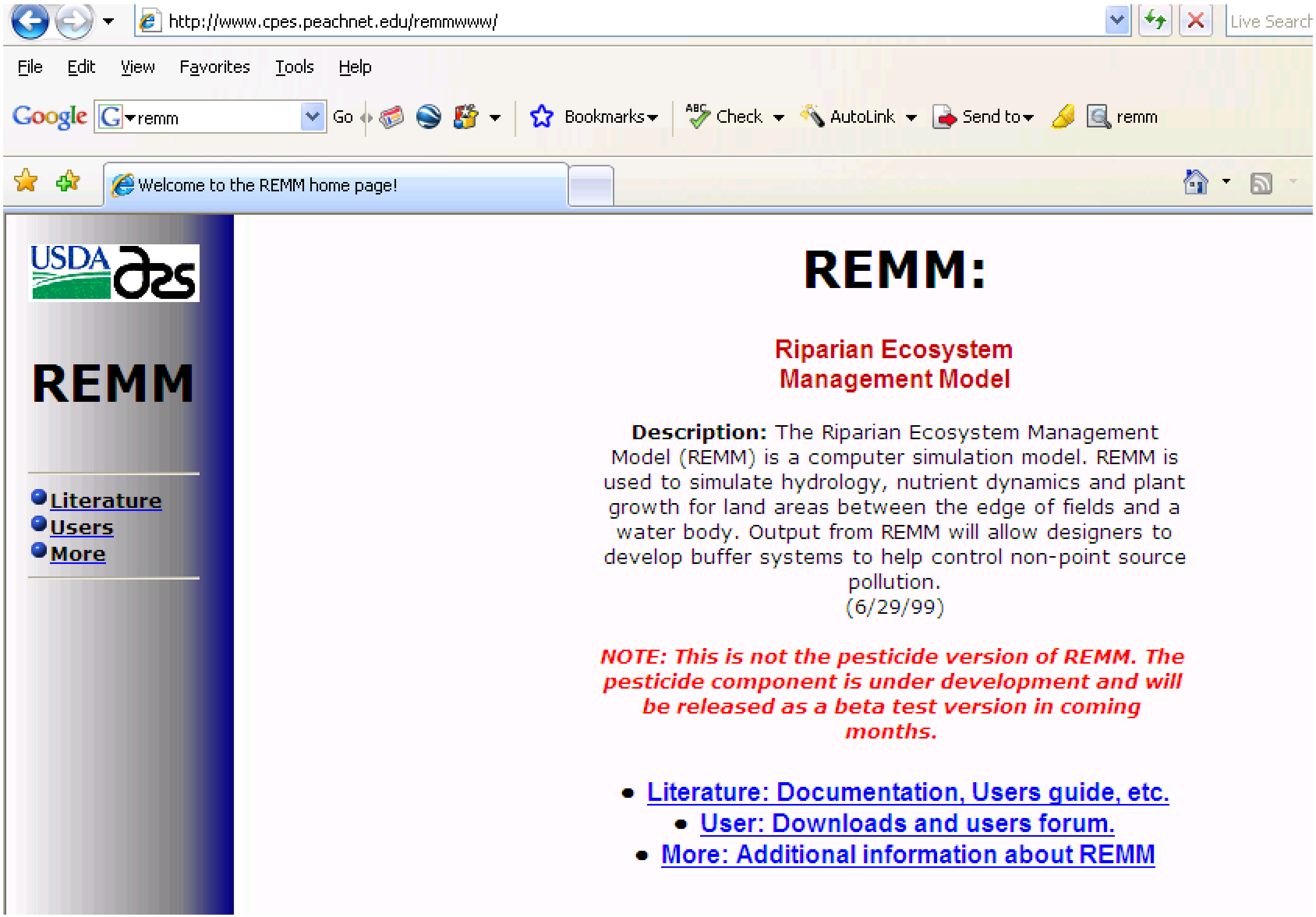
DRAINMOD
DRAINMOD is a computer simulation model developed by Dr.Wayne Skaggs at the Department of Biological & Agricultural Engineering, North Carolina State University, Raleigh, NC in 1980. The model simulates the hydrology of poorly drained, high water table soils on an hour-by-hour, day-by-day basis for long periods of climatological record (e.g. 50 years). The model predicts the effects of drainage and associated water management practices on water table depths, the soil water regime and crop yields. It has been used to analyze the hydrology of certain types of wetlands and to determine whether the wetland hydrologic criterion is satisfied for drained or partially drained sites. The model is also used to determine the hydraulic capacity of systems for land treatment of wastewater. The model has been successfully tested and applied in wide variety of geographical and soils conditions. In the last 20 years, the
DEPRESSION STORAGE
SOIL SURFACE
WATER TABLE
Local intranet
100%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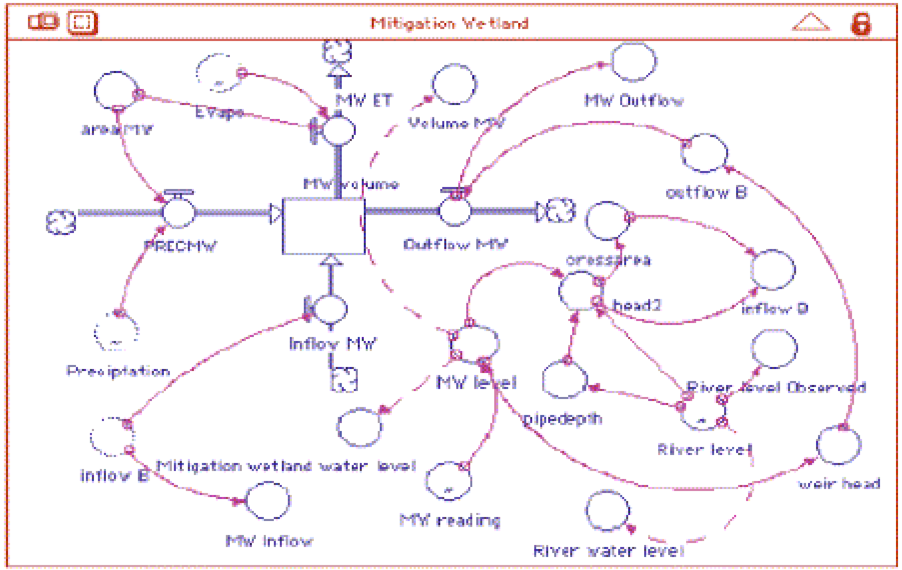
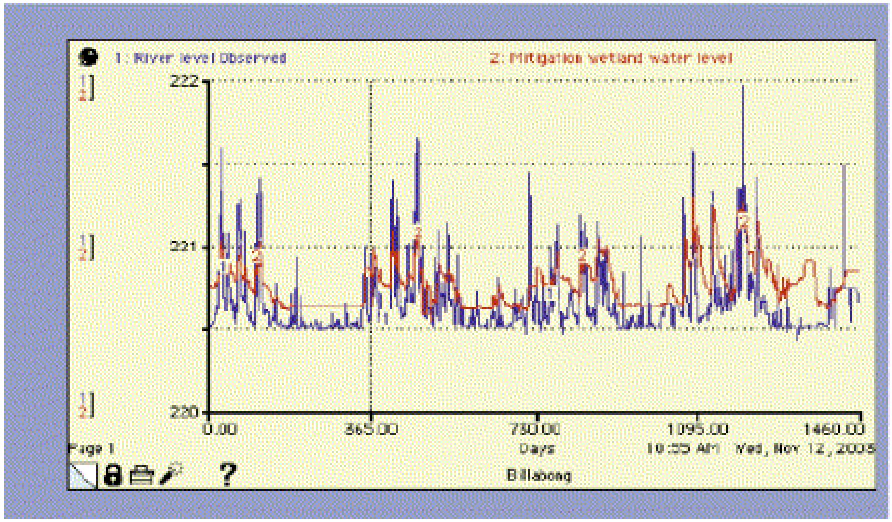
Riparian Ecosystem Management Model
Description: The Riparian Ecosystem Management Model (REMM) is a computer simulation model. REMM is used to simulate hydrology, nutrient dynamics and plant growth for land areas between the edge of fields and a water body. Output from REMM will allow designers to develop buffer systems to help control non-point source pollution.
(6/29/99)
NOTE: This is not the pesticide version of REMM. The pesticide component is under development and will be released as a beta test version in coming months.
Literature: Documentation, Users guide, etc.
User: Downloads and users forum.
More: Additional information about REMM

STELLA Model

a)



b)



- Zhang L., and WJ Mitsch, 2005. Modelling hydrological processes in created freshwater wetlands: an integrated system approach. Environmental Modelling & Software 20:935-946

- Structure of the dynamic simulation model
    - Daily precipitation (P)
    - evapotranspiration (ET)
    - Inflow (Si)
    - Surface outflow (So)
    - Groundwater outflow (Go)

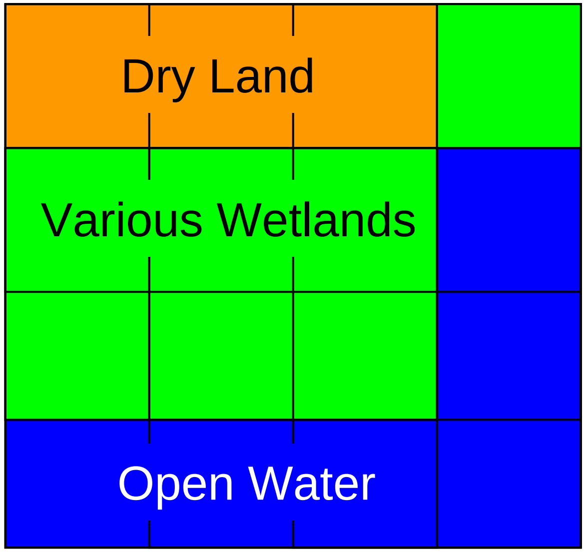
SLAMM - Sea Level Rise Affecting Marshes Model

- SLAMM simulates the dominant processes involved in wetland conversions and shoreline modifications during long-term sea level rise.
- A complex decision tree incorporating geometric and qualitative relationships is used to represent transfers among coastal classes.

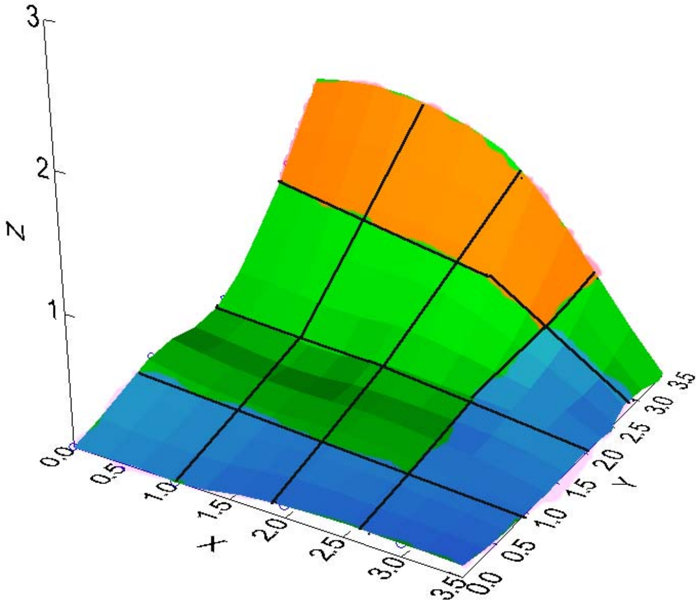
Jonathan Clough , Warren Pinnacle Consulting, Inc.
Dr. Christopher Craft, Indiana University

SLAMM Spatial and Temporal Scales

- Often 30m x 30m cells with elevation, slope, aspect, wetland type, multiple land-types
- Spatial Domain, variable, USGS Quad to Chesapeake Bay
  - Greater than 90 million cells may be run using hard-drive
- Model Processes, Calculated at each time-step assuming equilibration
- Results Time-step: Decadal to 200 year projections



2D Representation



3D Representation

SLAMM Model Processes

- Soil Inundation
- Erosion
- Overwash of Barrier Islands
- Soil Saturation
- Marsh Accretion

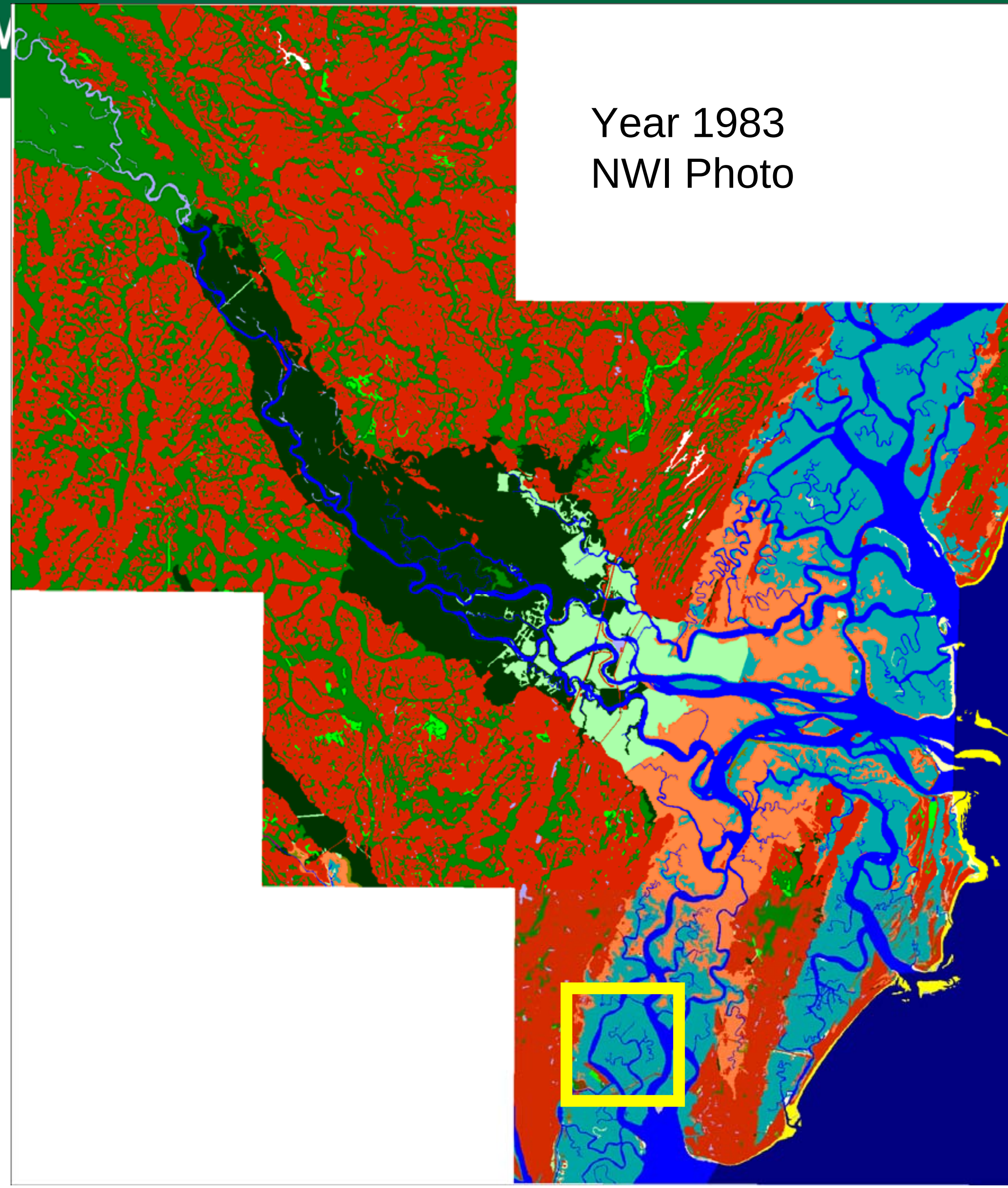
Fate of Wetland Cells

Adjust cell elevation based on SLR and Accretion

If cell is in defined estuary, determine type based on salinity

Otherwise, determine if cell has fallen below minimum elevation

If cell is exposed to water and meets maximum fetch, erode cell



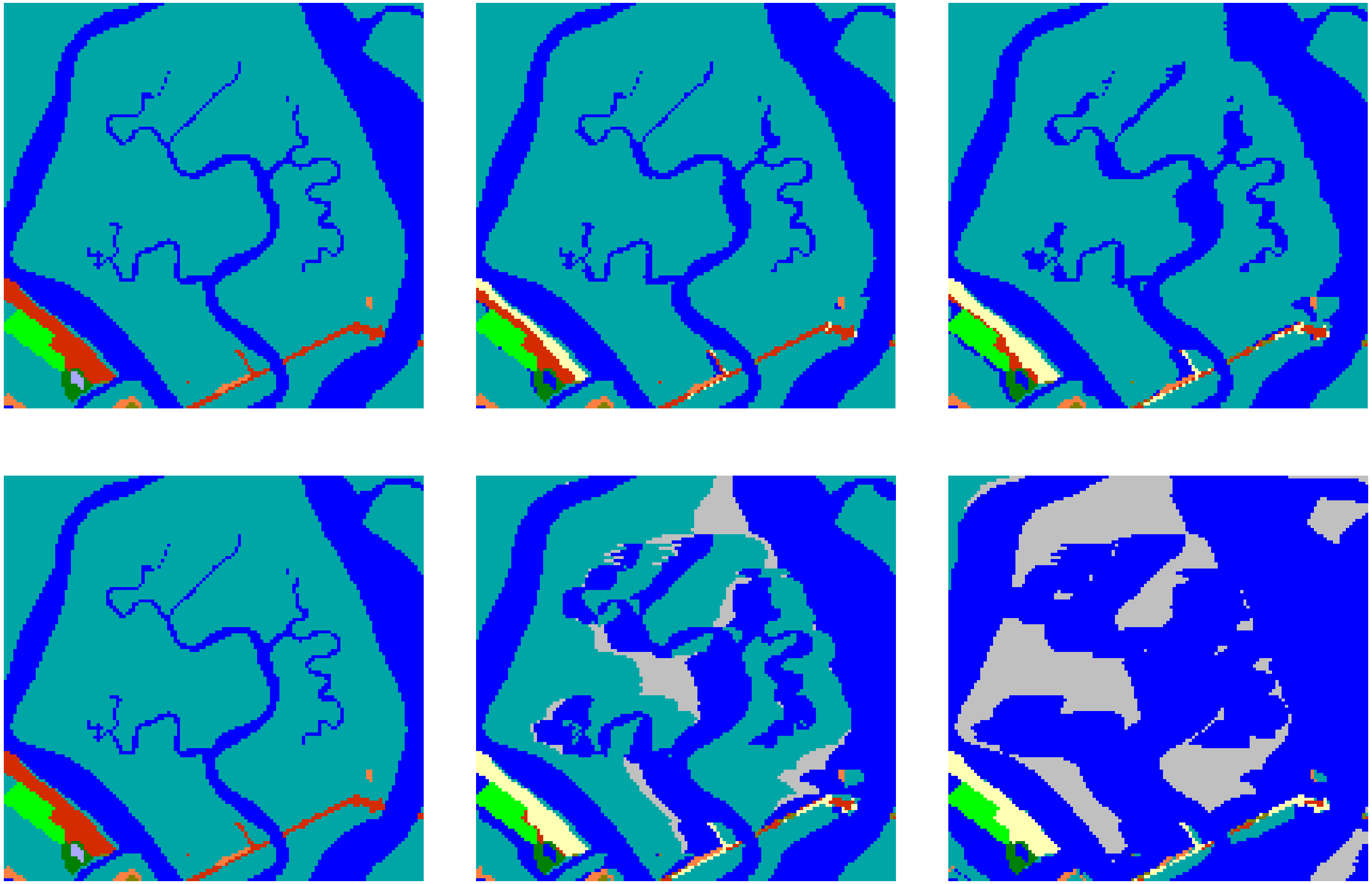
Altamaha River GA

SLAMM Model Results (land type)

1983 | 2050 | 2100

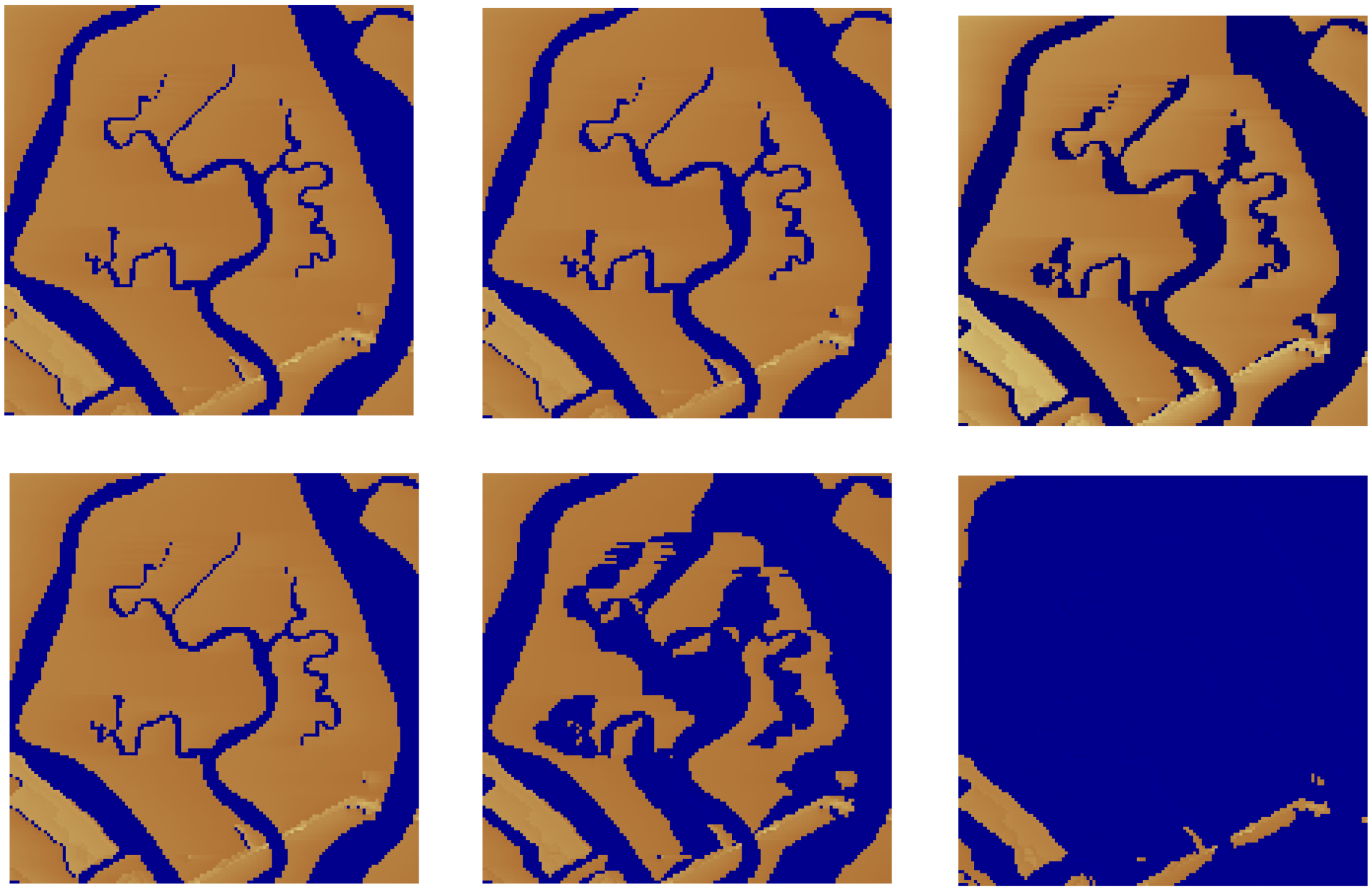
3 mm/yr

10 mm/yr



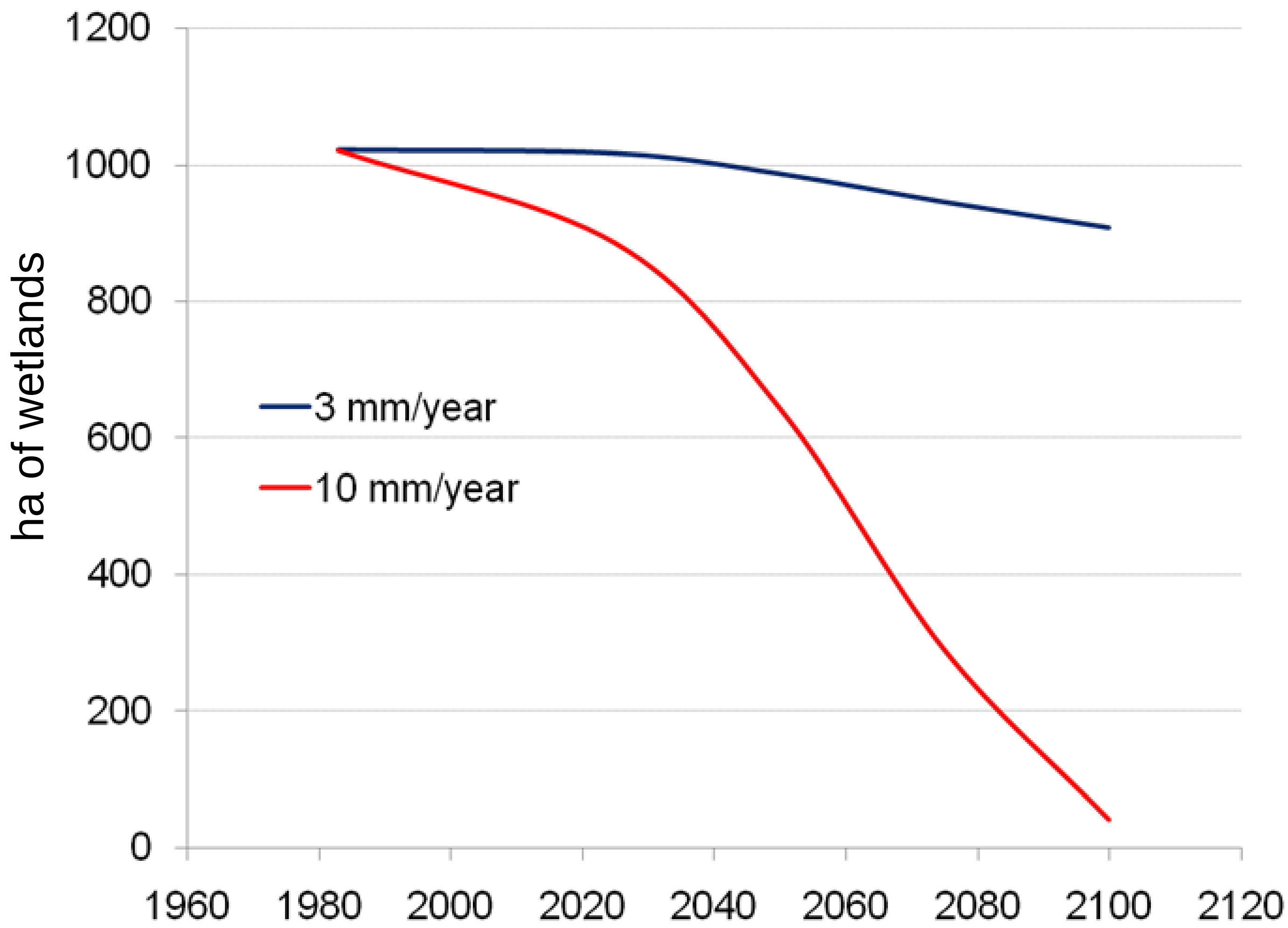
SLAMM Model Results (elevation)

	1983	2050	2100
3 mm/yr			
10 mm/yr			



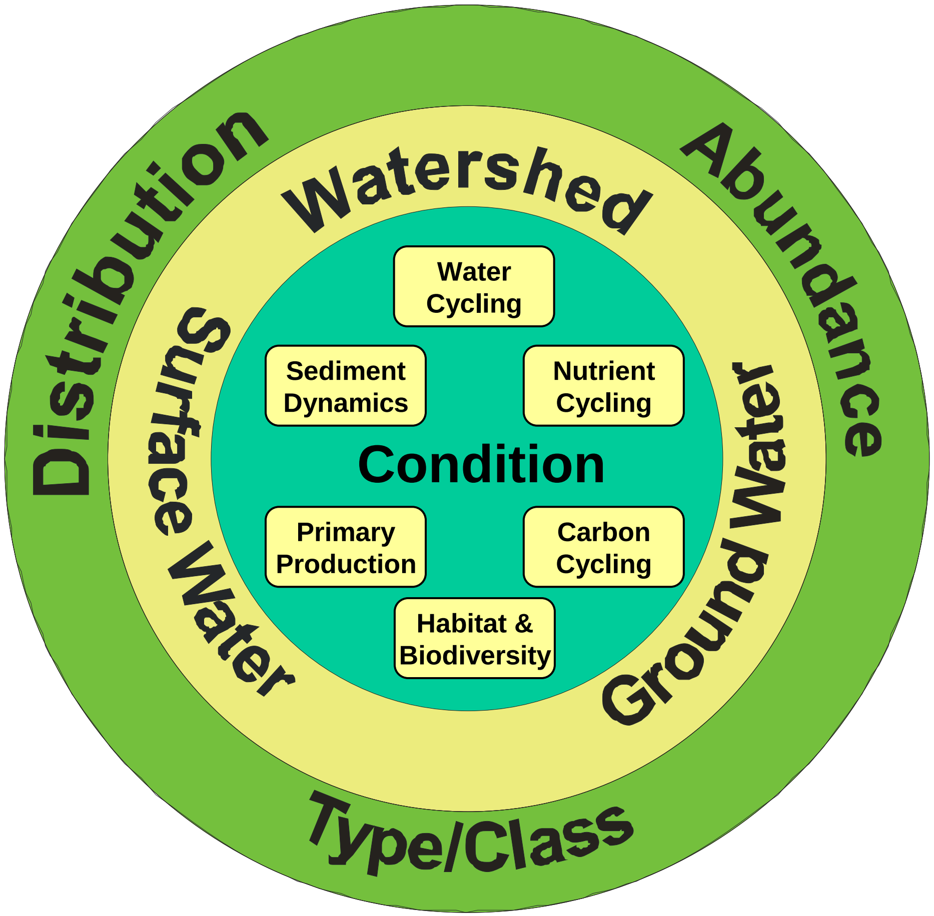
Blue color indicates land below MTL

SLAMM Model Results (wetland loss through time)

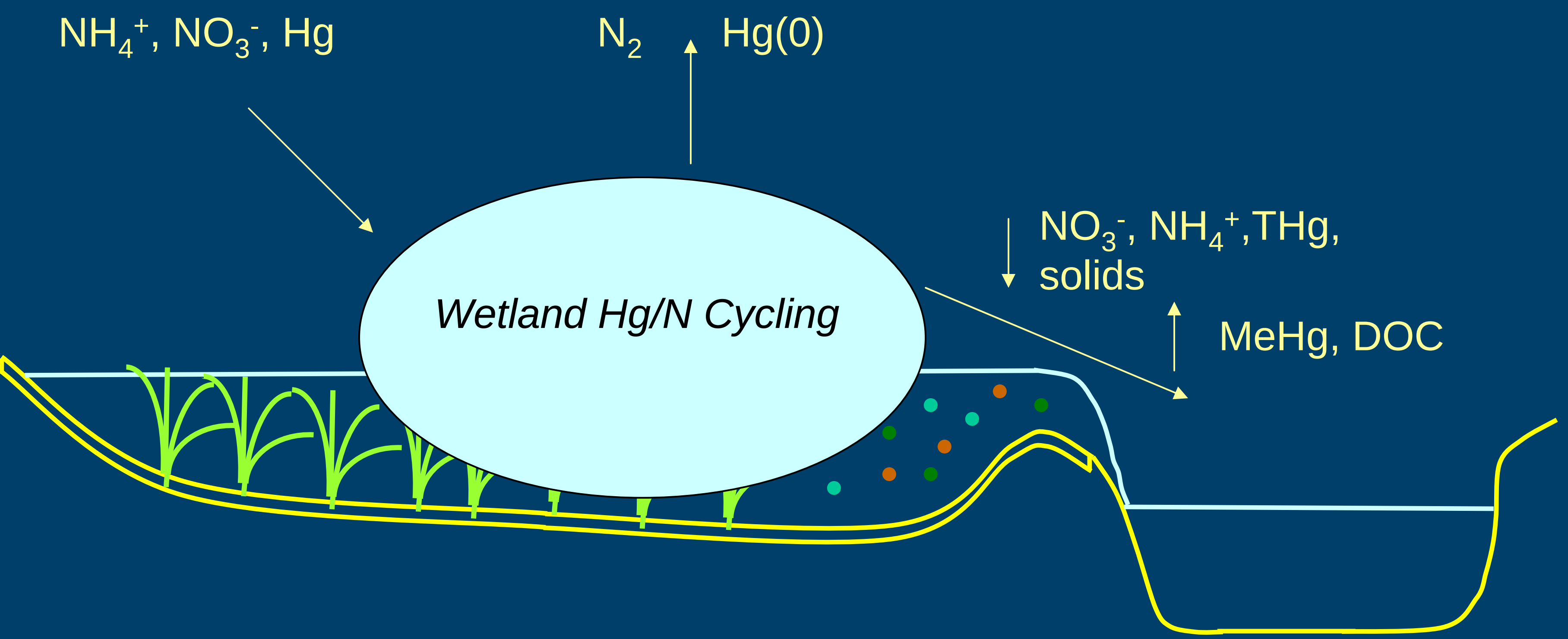


Outline

- Model the wetland as a unit
- Imbed the wetland in a watershed and/or instream model
  - GBMM
  - WASP



Modeling Watershed Wetlands Biogeochemistry (Hg, N) and Ecosystem Services: The N/Hg Challenge



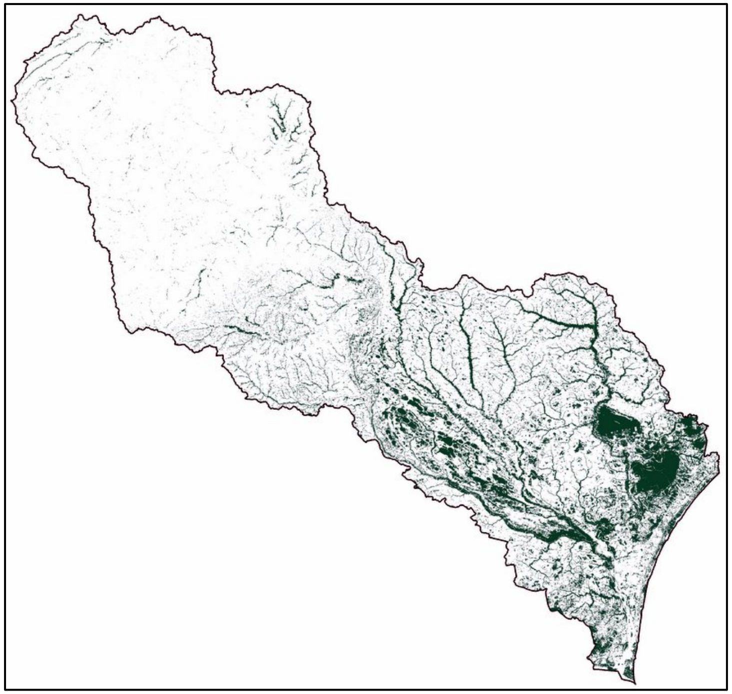
How do we model the effects of N loss but MeHg gain in wetlands within watersheds (in a spatially-explicit manner)?

Heather Golden, Chris Knightes, NERL/ERD

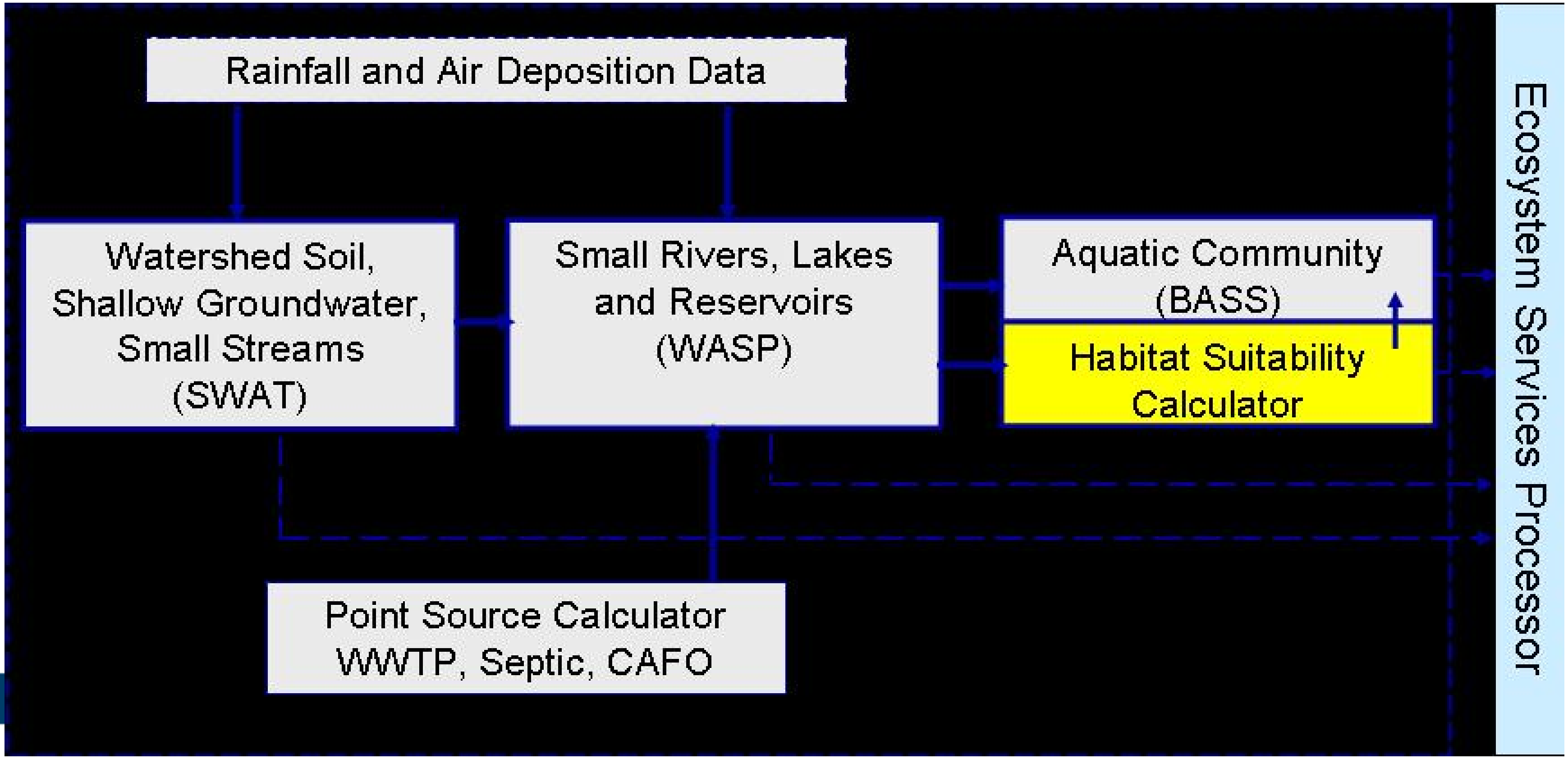
Grid Based Mercury Model (GBMM)

- Models daily water, sediment, and mercury (Hg) fluxes from watersheds using a spatially-explicit (ArcGIS grid cell) approach
- Models spatially-explicit layout of wetlands throughout watershed
- Future wetland capabilities:
  - *Wetland sub-module:* with mercury processing and transport to tributaries
  - *Nitrogen sub-module:* include nitrogen processes in wetlands
- GBMM is linked to WASP, being tested in Cape Fear

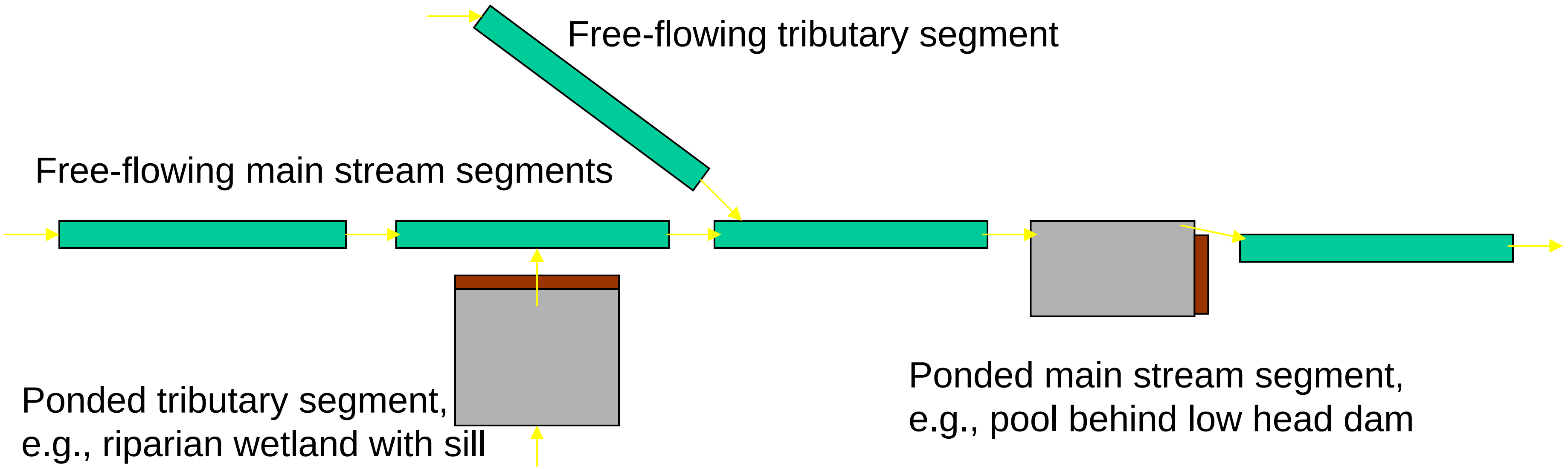
Wetlands in the Cape Fear River Basin



ERD Integrated Modeling Project



WASP Stream Network Hydrology

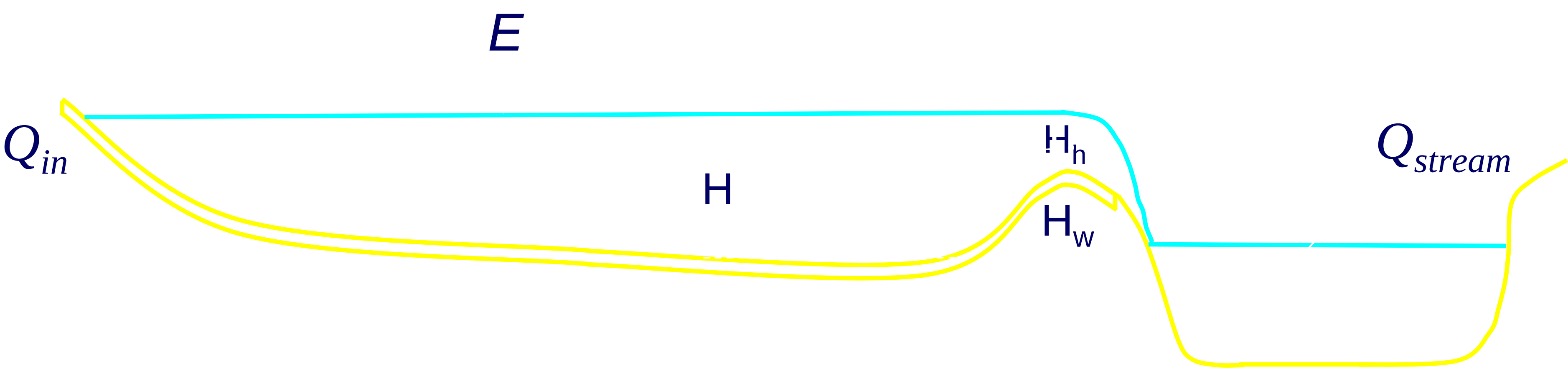


WASP internally calculates
flows, volumes, depths, widths in:
free-flowing reaches (kinematic wave equation) and
ponded reaches (weir overflow equation)

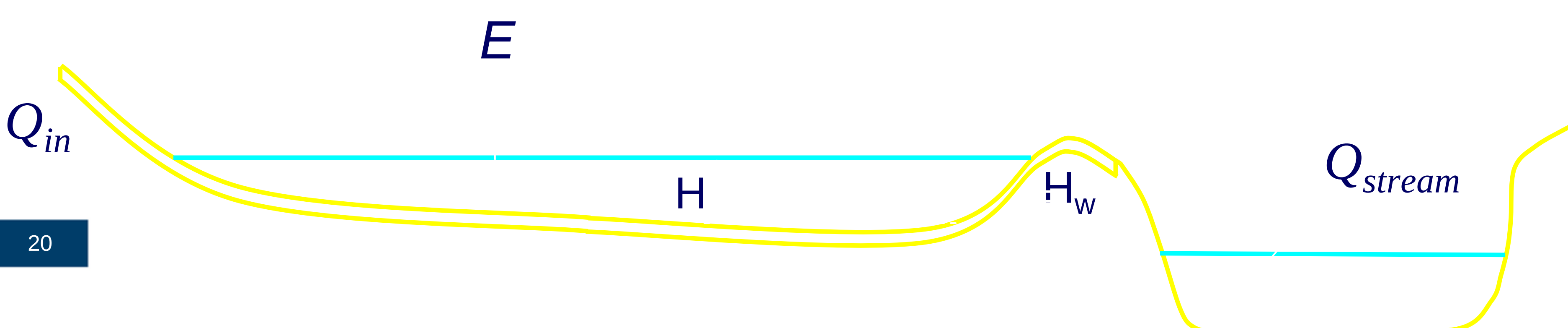
Bob Ambrose, NERL/ERD

Wetland Reach: Hydrology

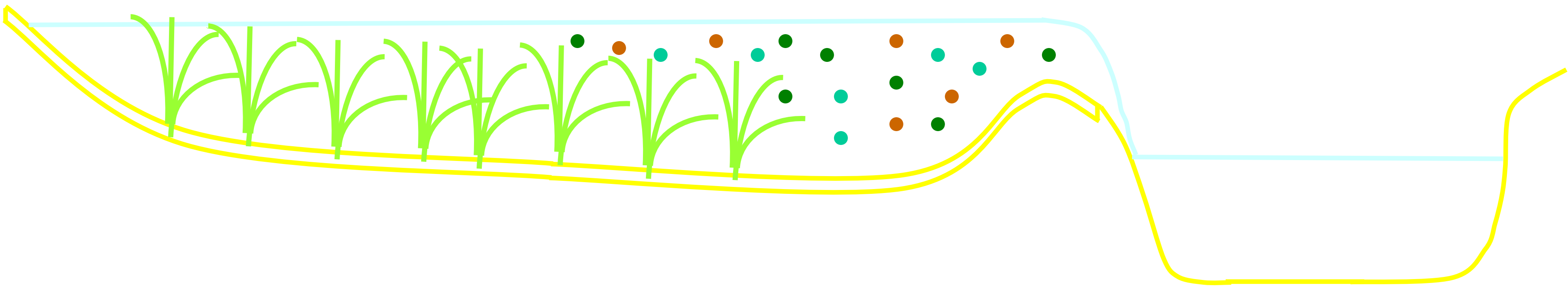
Wet conditions: overflow over sill:



Dry conditions: no outflow:



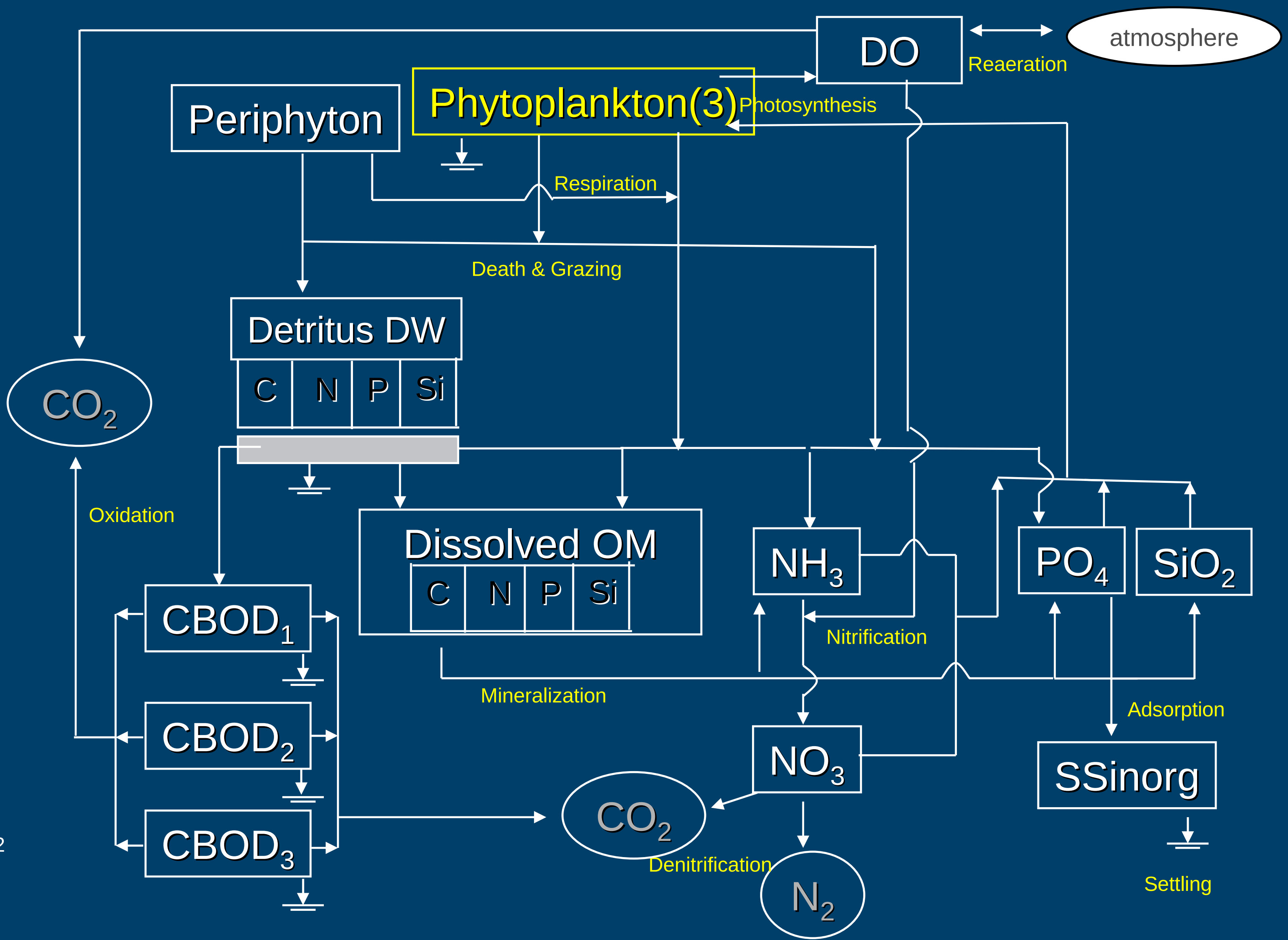
Wetland Reach: Biogeochemistry



- Water Quality Processes
  - Phytoplankton Kinetics
  - Periphyton Kinetics
  - No Macrophyte Kinetics
  - Phosphorus Cycling
  - Nitrogen Cycling
  - Silicon Cycling
  - Organic Carbon Production
  - Solids Production
  - Dissolved Oxygen Kinetics

- Mercury Cycling Processes
  - Partitioning (water column and sediment)
  - Volatilization of Hg0(aq) to Hg0(air)
  - Oxidation: Hg0 → HgII
  - Reduction: HgII → Hg0
  - Methylation: HgII → MeHg
  - Demethylation: MeHg → HgII
  - Photoreduction: MeHg → Hg0

WASP Water Quality Kinetics



Summary

- Can either simulate a single wetland as a unit or imbed the wetland in a watershed and/or instream model
- Modeling approaches will differ among
  - Coastal wetlands
  - Riparian wetlands
  - Isolated wetlands
- More model development is needed for ESRP