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ECOSYSTEM SERVICES RESEARCH PROGRAM

BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

Wetland Ecosystem Services Program (ESRP-Wetlands)

SAB EPEC

July, 2009

Why Wetland Eco Services? Why Now? Why ESRP?

- Located between land and water, wetlands are buffers for human impacts on receiving waters
- Wetlands provide so many services that are taken for granted
- Wetlands continue to be degraded and lost
- EPA and Army Corps protect wetlands through the Clean Water Act
- EPA – Army Corps Wetland Compensatory Mitigation Rule (2008) – avoid, minimize, and compensate – recognizes the ecosystem benefits of wetlands
- Wetland protection and restoration programs are active throughout the US, by public and private agencies and organizations – if only we could document the benefits!

Wetland Loss in the United States

Dahl, T.E. 2006. Status and trends of wetlands in the conterminous United States 1998 to 2004.

Intertidal Vegetated	Lost	32,400 acres
Intertidal non-vegetated	Gain	5,900 acres
Freshwater Emergent	Lost	142,600 acres
Freshwater Forest	Gain	548,200 acres
Freshwater Shrub	Lost	900,800 acres
Ponds / nonvegetated	Gain	715,300 acres

Both Estuarine and Freshwater Wetland Losses were to Open Water types (open salt water and ponds)

"No Net Loss" policies obscure potential losses in services (e.g. as open water ponds replace vegetated wetlands

Overview of presentation:

Conceptual Framework for ESRP-Wetlands

Will highlight intersections of wetlands with:

- Mapping theme
- Place-based studies
- Reactive nitrogen theme
- Links to Office of Water assessments of wetland conditions (via probabilistic monitoring)

Uncertainties and challenges

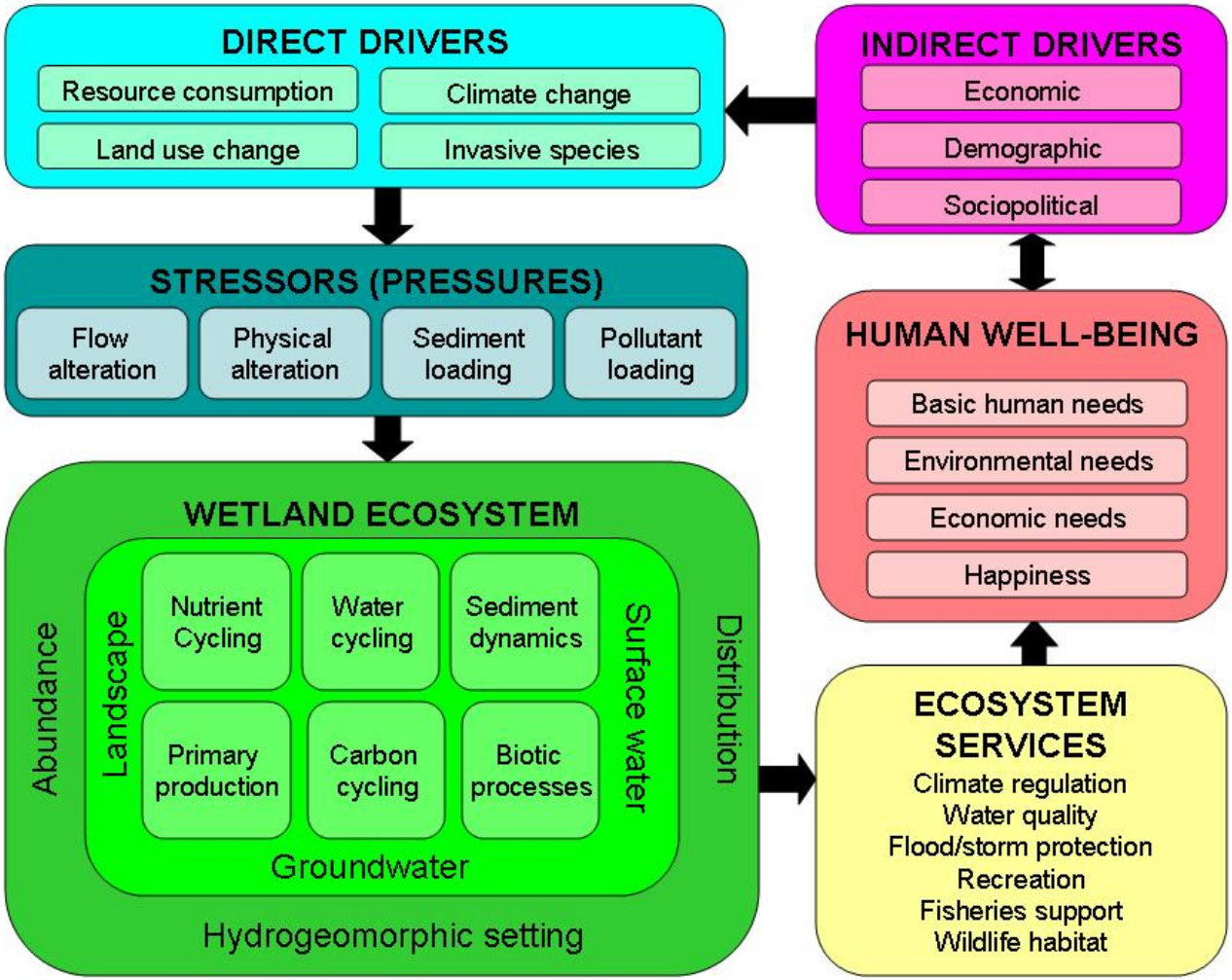
ESRP Organizational Matrix

Projects and Long term Goals →		LTG 3 Pollutant-Specific Studies: 6%	LTG 4 Ecosystem Specific Studies: 23%		LTG 5: Community Based Demonstration Projects: For National, Regional, State and Local Decisions 28%					Theme Leads
	Cross Program Themes and Research Objectives	Nitrogen (6%)	Wetlands (22%)	Coral Reefs (5%)	Willamette (11%)	Tampa Bay (4%)	Mid-West (4%)	Coastal Carolinas (8%)	Southwest (1%)	
Integration, Well-Being, Valuation, Decision Support, Outreach and Education LTG 1 9%	Ecosystem Services and Human Well-Being (3%)		*							Laura Jackson
	Valuation of Ecosystem Services		✓							Wayne Munns--Consultation Committee
	Decision Support (6%)		*							Ann Vega
	Outreach & Education to		*							Open
Inventory, Map, and Forecast Ecosystem Services at multiple scales LTG 2 31%	Landscape Characterization and Mapping (12%)		✓							Anne Neale
	Inventory and Monitoring of Services (14%)		✓							Mike McDonald
	Modeling (5%)		✓							Tom Fontaine--Consultation Committee
Pollutant Specific Studies LTG 3	Nitrogen (6%)		✓							Jana Compton
Eco-system Specific Studies LTG 4	Wetlands (22%)	✓	✓		✓	✓	✓	✓	*	Janet Keough
Project Area Leads	Rick Linthurst and Iris Goodman	Jana Compton	Janet Keough	Bill Fisher	David Hammer	Marc Russell	Randy Bruins/ Betsy Smith	Deborah Mangis	Nita Tallent-Halsell	Rick Linthurst and Iris Goodman
					Hal Walker: Place Based Coordinator					

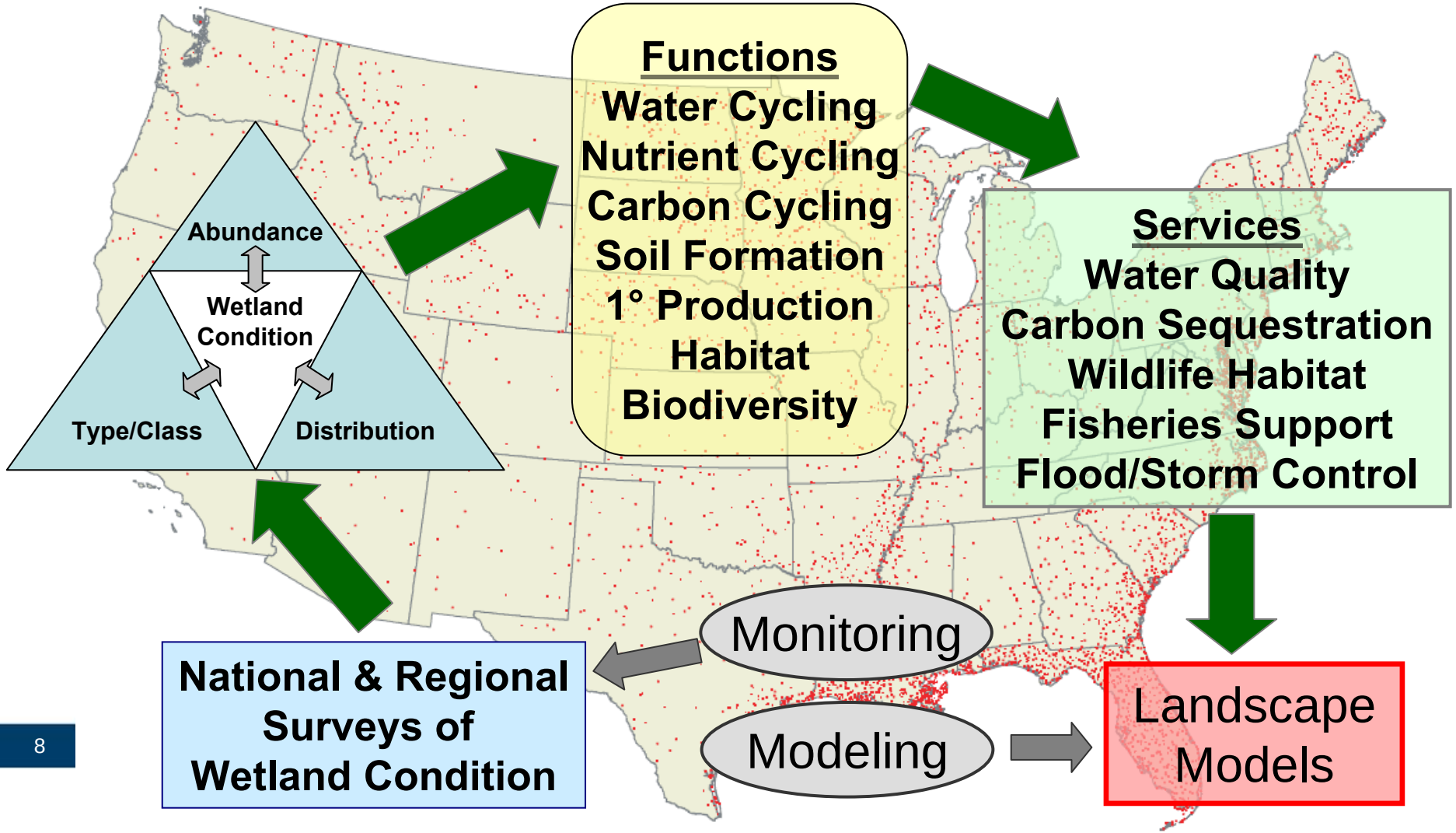
ESRP Wetland Team – ORD scientists and partners

- ORD Divisions – Duluth, Narragansett, Cincinnati, Las Vegas, Gulf Breeze, Corvallis, Ada, Athens
- STAR Grants
  - 2 new grants on relating wetland condition to ecosystem services
  - 1 new grant on relating the National Wetland Condition Assessment approach to eco services
- Special Governmental Employees – Dr. Marisa Mazzotta, Dr. Charles Vorosmarty
- OW Partners – OWOW Wetland Division (NWCA)

Conceptual Model for Wetland Services Relationships with Drivers, Stressors, and Human Well-Being



Wetland Ecosystem Service Roadmap



Examples of Eco Services Metrics

Ecosystem Service	Wetland Metrics
Carbon Storage	Carbon stocks in plants and soil / Carbon accretion to wetland soil; flux of GHG
Fisheries Support	Commercial / Recreational Fish or Shellfish Quantity / Fish – Shellfish Habitat Quality; Feedstock for C/R fisheries
Flood Control/Storm Surge Protection / Water Storage	Extent of Wetland Attenuation of Storm Surge or Flood, Water Volume Capacity of Wetlands
Water Quality Improvement	Reactive Nitrogen / Phosphorus Removal / Water Clarification; Pesticide Trapping
Wildlife Support	Birdwatching (Biodiversity) Opportunities / Wildlife Prey Abundance / Breeding Bird Community

General Categories of Wetlands in the ESRP Research Program

▪ Estuarine Intertidal Emergent	salt marsh
▪ Estuarine Intertidal Forested/Shrub	mangrove
▪ Estuarine Aquatic Bed	seagrass
▪ Estuarine Unconsolidated Shore	beaches/bars/tidal flats
▪ Palustrine Forested	forested swamp
▪ Palustrine Shrub	shrub swamp
▪ Palustrine Emergent	inland marsh/wet meadow
▪ Palustrine Aquatic Bed	floating/submerged vegetation

From Dahl, 2006. Status and Trends of Wetlands in the Conterminous United States 1998-2004

Consistent with the EPA OW National Wetland Condition Assessment Categories

These types comprise 98% of marine/estuarine wetlands and 94% of freshwater wetlands. Types not included Are marine intertidal and freshwater ponds.

THESE GENERAL TYPES VARY ACROSS ECOREGION, HYDROGEOMORPHIC SETTING, AREA, SALINITY-CONDUCTIVITY GRADIENT, SUCCESSIONAL STAGE

Wetland Categories x Services

Wetland Classes	Estuar Emerg	Estuar Shrub	Estuar Aquat	Estuar flat	Palust Forest	Palust Shrub	Palust Emerg	Palust Aq Bed
Carbon Storage	✓	✓			✓	✓	✓	✓
Fish Support	✓		✓	✓	✓	✓	✓	✓
Storm-Flood - Storage	✓	✓			✓	✓	✓	✓
Water Quality	✓	✓	✓	✓	✓	✓	✓	✓
Wildlife Support	✓	✓	✓	✓	✓	✓	✓	✓

✓ Regional and/or National Case Studies

We ultimately want to demonstrate:

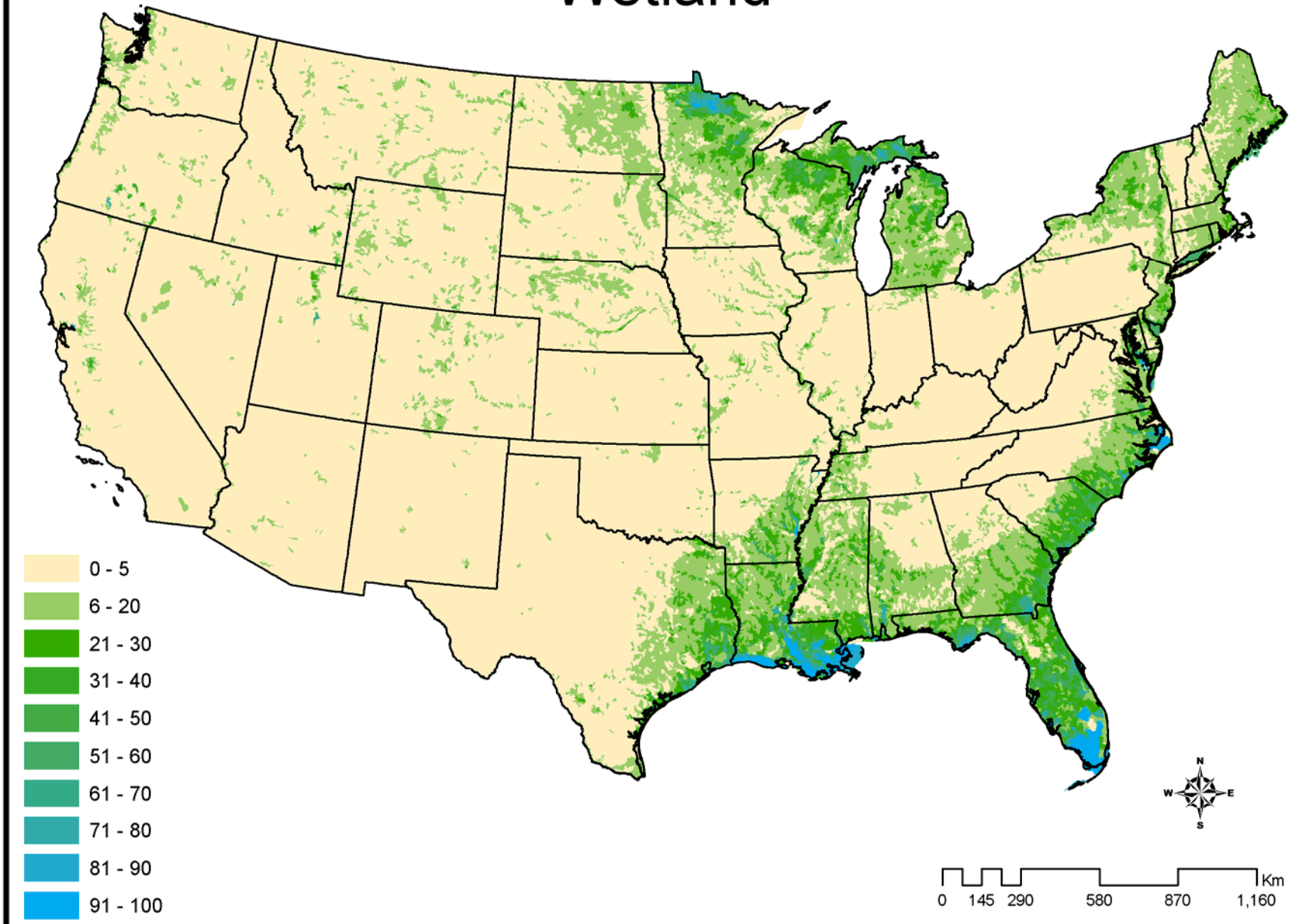
- The ability to use wetland condition indices (as monitored in the field) to estimate ecosystem service production functions
- The roles of location, pattern and connectivity of wetlands in delivery of multiple services
- Creation of wetland landscape profiles of services for most major classes of wetlands, over most of the conterminous U.S.
- Testing wetland landscape profiles for usefulness in predicting suites of wetland services at scales appropriate for decision-making

Status of ESRP Wetlands

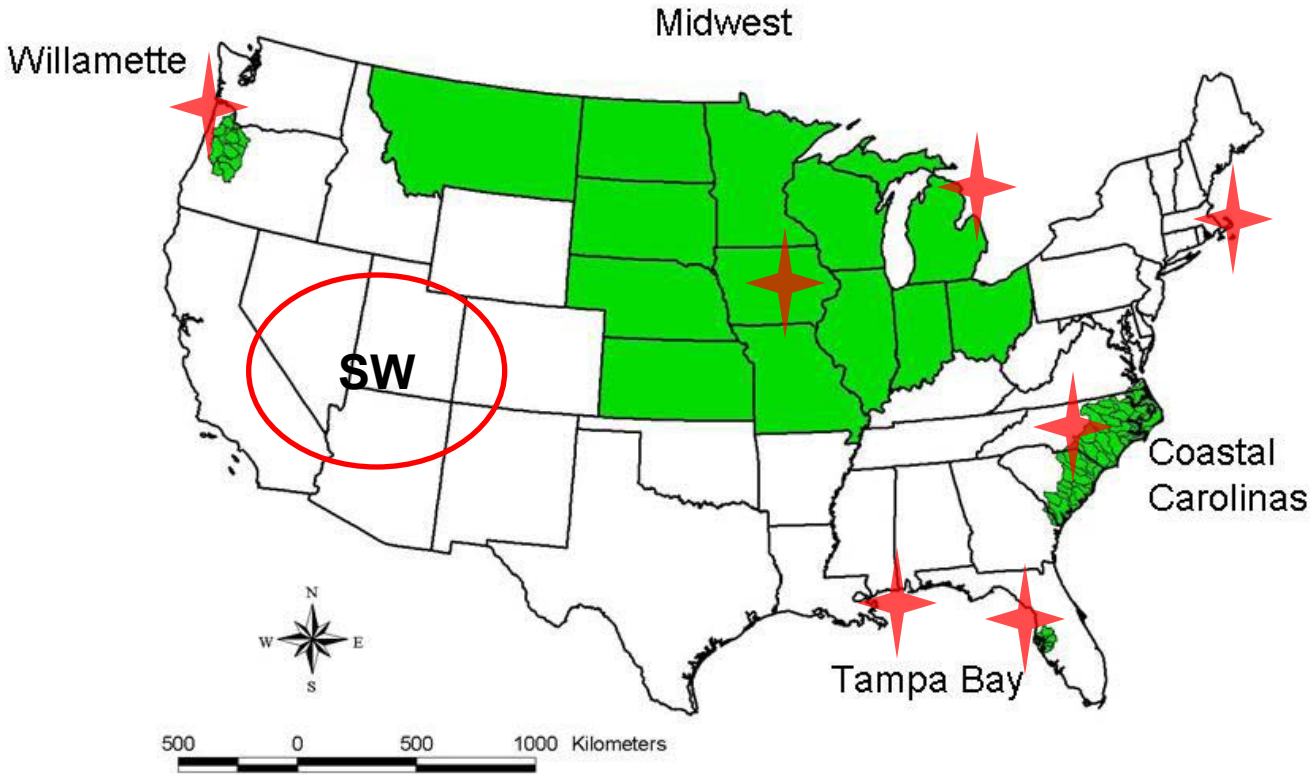
National Implementation Plan has been written, received peer review, now in revision

ORD Staff are gaining experience with ecosystem services science through literature reviews, seminars, and exploring existing data through meta analysis

Percentage WBD 12 Digit Hydrologic Units Wetland

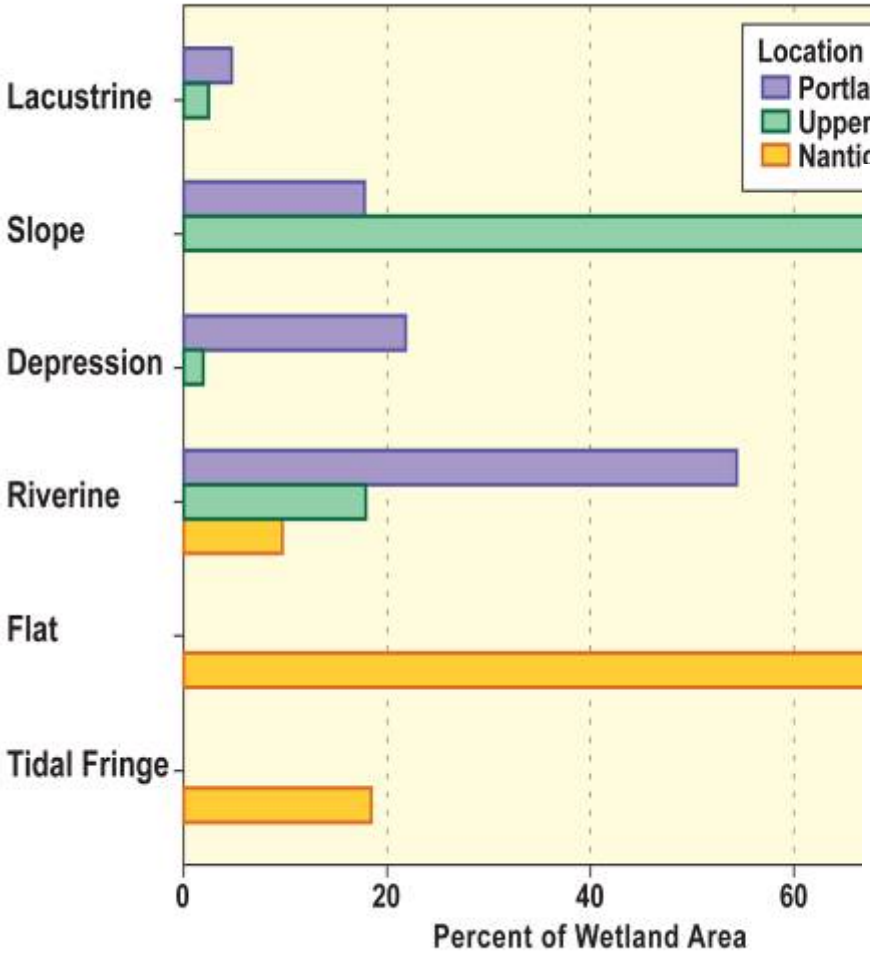


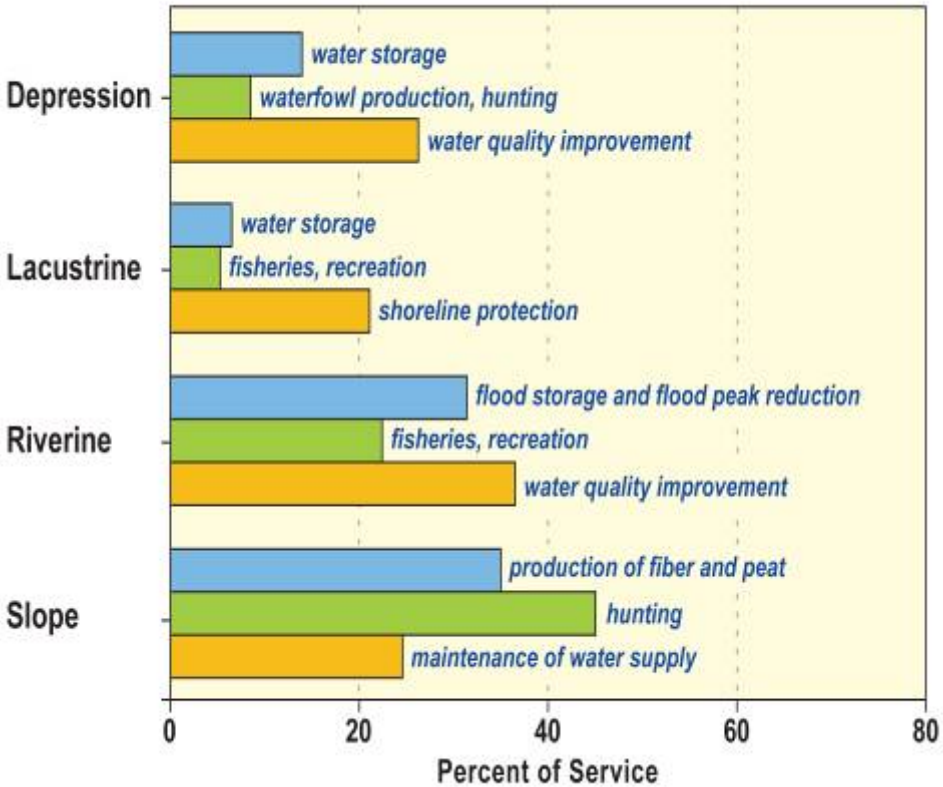
Place Based Studies – Wetland Efforts



Opportunity for coordinated site work: Standardization, Scaling, Applicability Testing, Collective Strength,….

Landscape Profiles





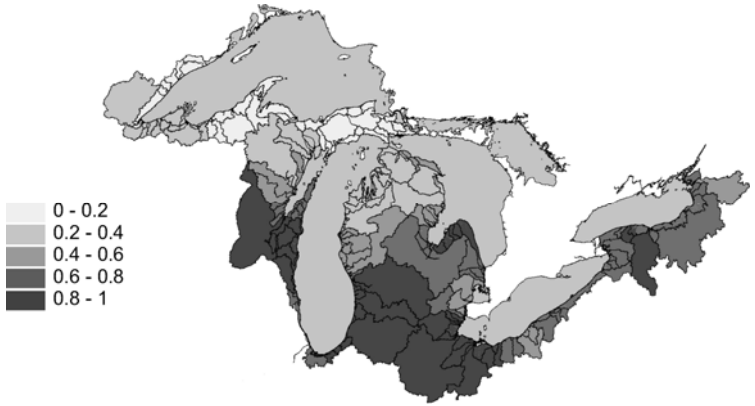
Modeling Services by Landscapes – Examples

Research Task	Methods (the "how")
Flood & Storm Surge Protection	Model storm surge vulnerability of coastal Louisiana & Carolinas from coastal wetland extent, tropical storm probabilities, and storm surge reduction coefficients. Develop models of wetland volume to determine capacity of wetlands to store water
Carbon sequestration	Apply soil organic carbon accumulation rates to wetlands in agricultural landscapes in the upper Midwest.
Water Quality & Nitrogen Cycling	Develop spatially-explicit nitrogen removal model for wetlands based on intensive datasets in specific places and literature.
Bundled wetland services	Develop landscape models of bundled wetland services (waterfowl production, carbon storage, water quality, habitat, recreation) in Mississippi River basin (or other basins)

Factors that regulate delivery of nutrients to Great Lakes Coastal wetlands

Anthropogenic activities in the Great Lakes basin

Agriculture

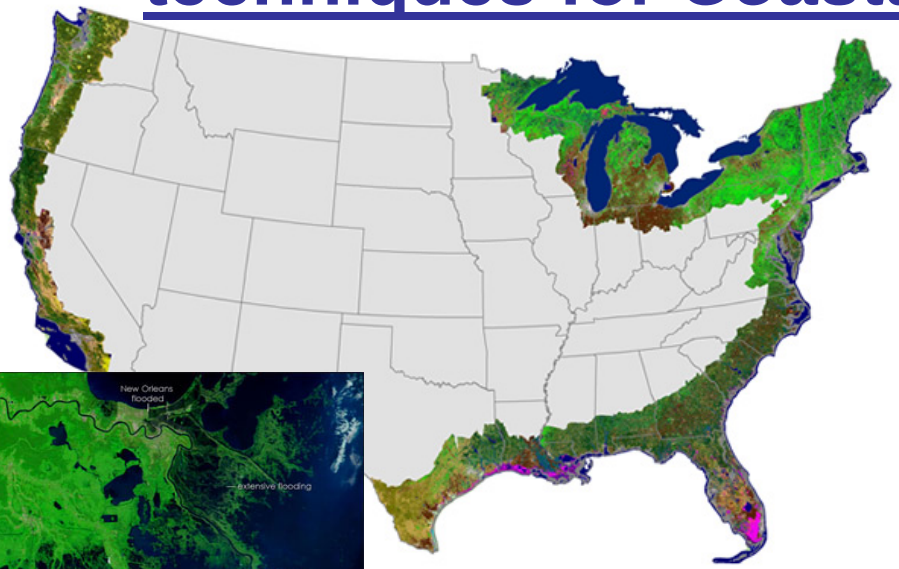


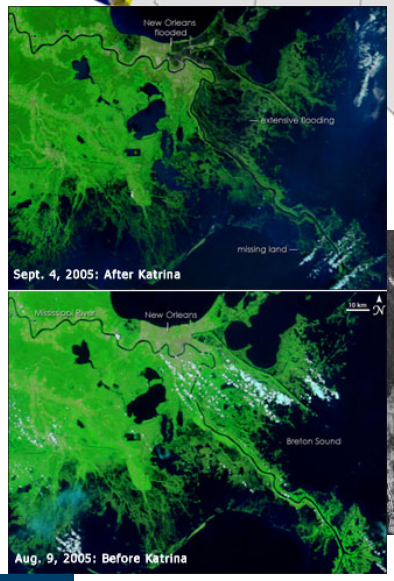
Human population

Point source pollution

Atmospheric deposition

Application of 'modified-traditional' mapping techniques for *Coastal Wetlands*





Storm Surge Protection

Sea Level Rise

Mapping/modeling of:

- (Presence/Extent/Condition)

  Coastal wetland change using multi-spectral satellite data (in addition to soil moisture indices, NWI, presence of hydric soils, and other variables)

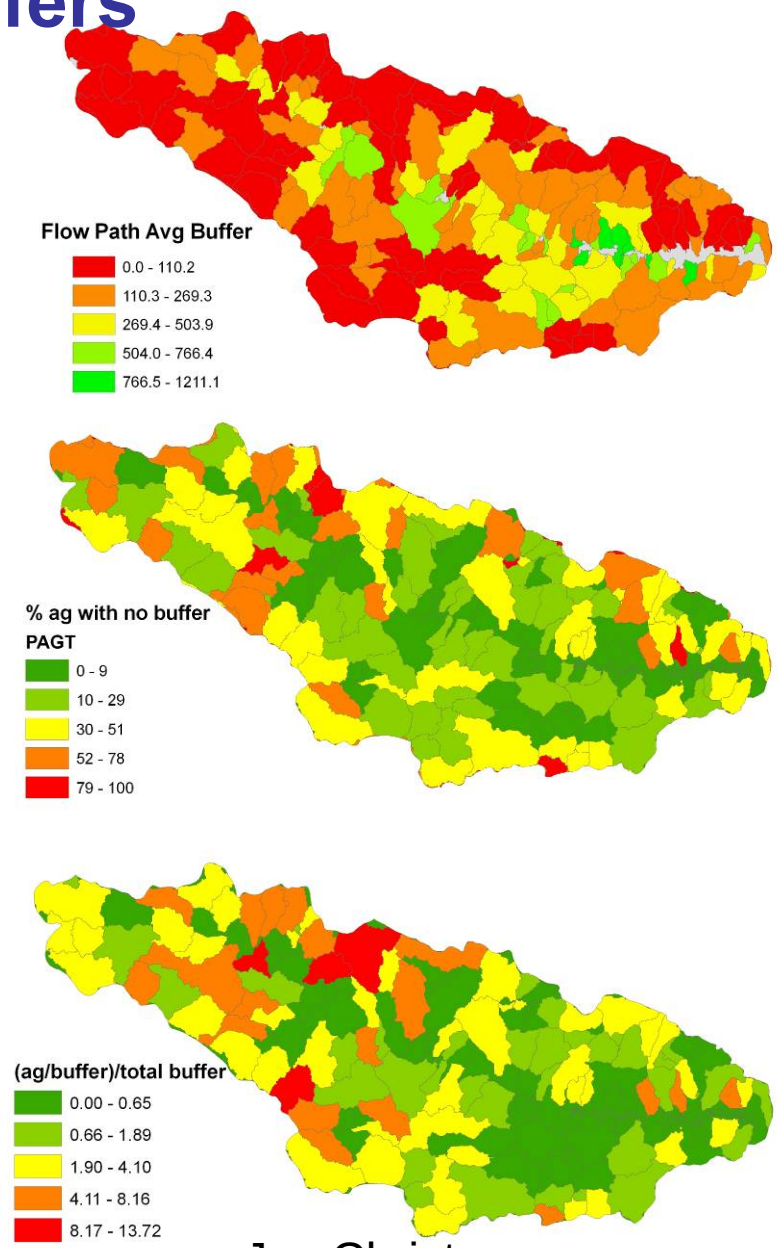
- (Ecosystem Services, including change)
  - Storm surge protection (SSP)
  - Wave energy and tidal energy attenuation, including analyses of sea level rise (SLR)
  - Production of commercially and recreationally important fish and birds
  - Pollutant accumulation/transformation
  - Provisioning of human recreational benefits and human aesthetic benefits

Ric Lopez

Water Quality -- Nutrient Attenuation/Removal by Riparian Buffers

Riparian metrics being tested

- Average Flow Path Buffer Width from Ag Cells (m)
  Based on Baker et al 2006
- % Ag draining to stream without passing through naturally vegetated buffer
- Sum of Ag/Buffer Ratio / total buffer length



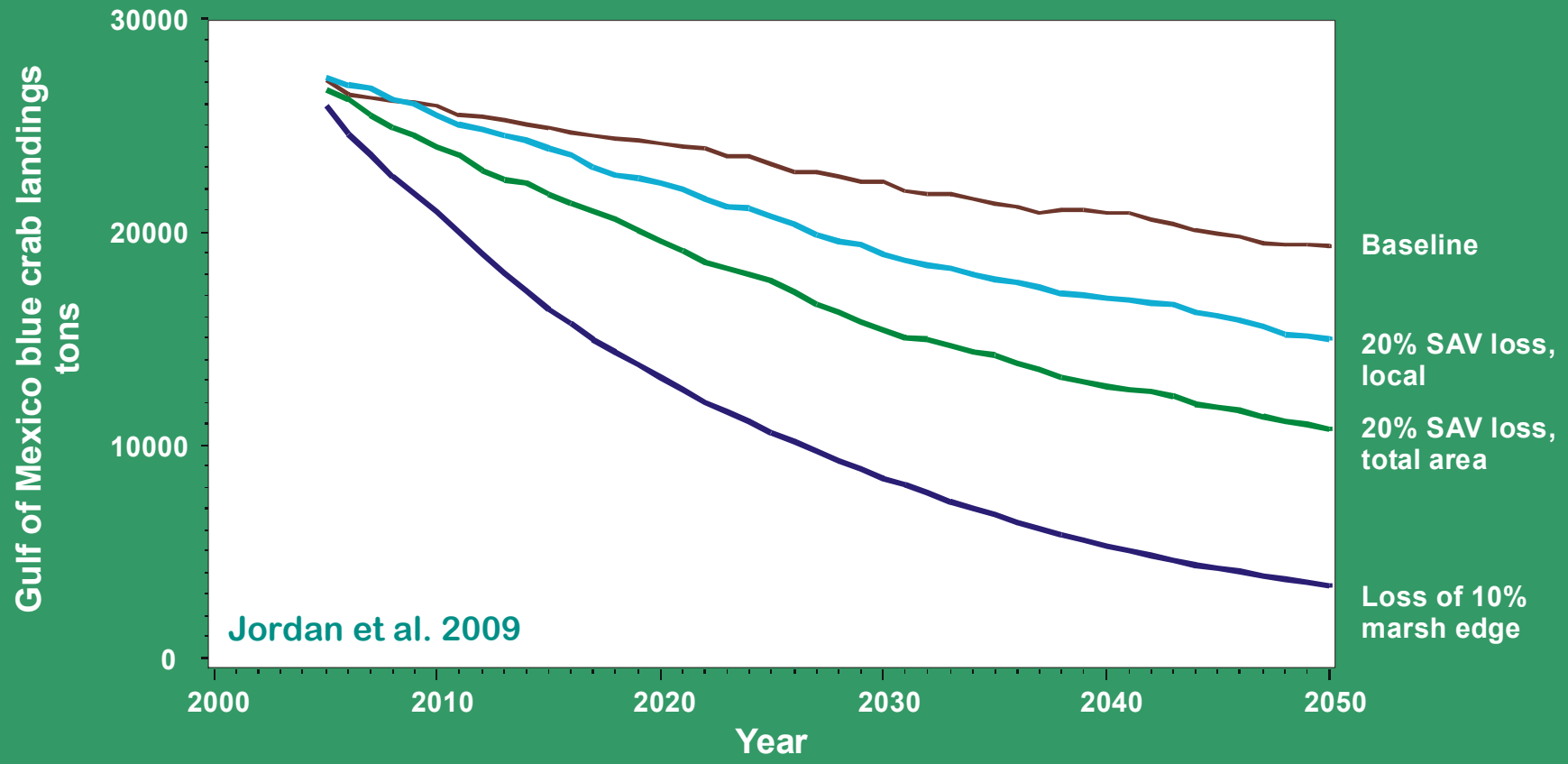
Jay Christensen

Candidate conservation practices for FML "Multiple Services" scenario

- Land retirement for conservation
- **Wetland restoration (interrupt tiles)**
- **Wetland creation (for water treatment)**
- Nutrient management (amount, timing)
- Reduced tillage (includes no-till)
- Winter cover
- Contouring and terracing
- **Riparian forest buffer**
- Grassed waterway
- Drainage water management (timing)
- **Flood-plain grassland**

Simulated effects of wetlands loss on fisheries

scaling from patch to estuary to region

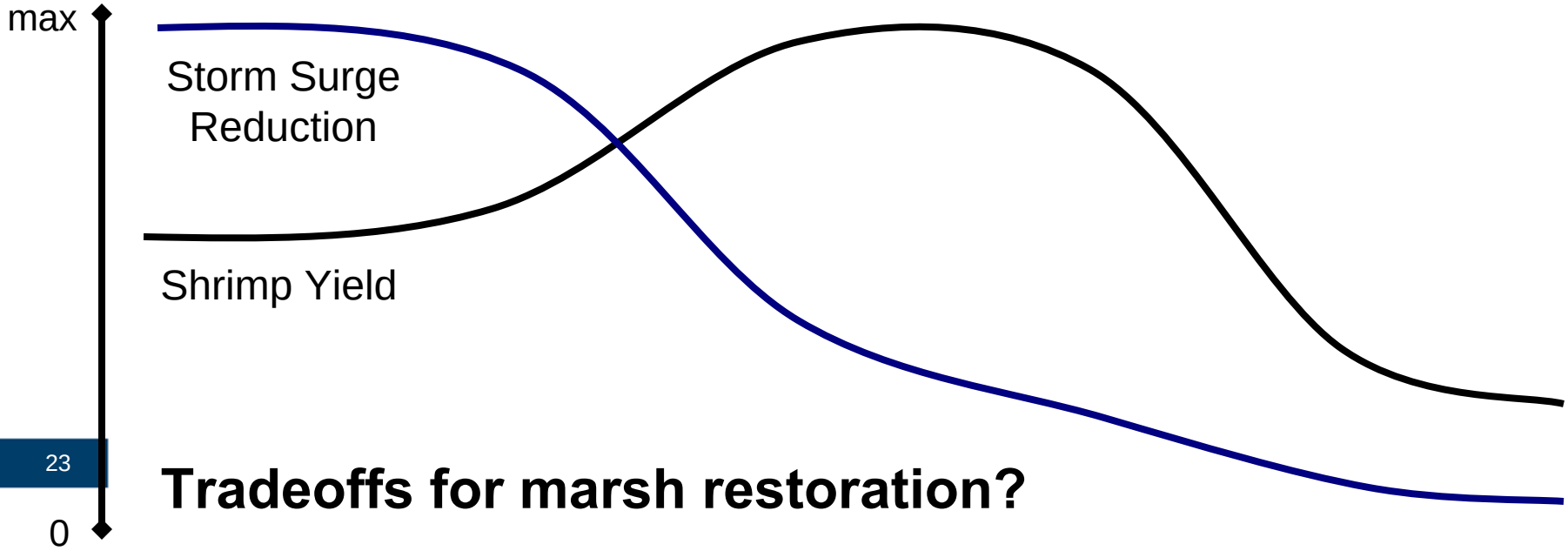


From S Jordan, ORD GED

Intact Marsh

Fragmented Marsh

Marsh Loss

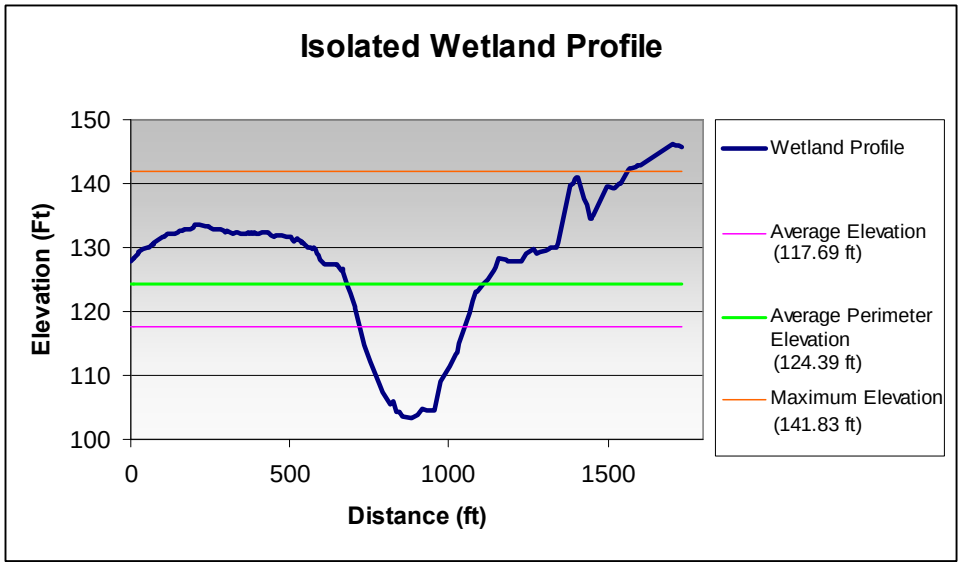


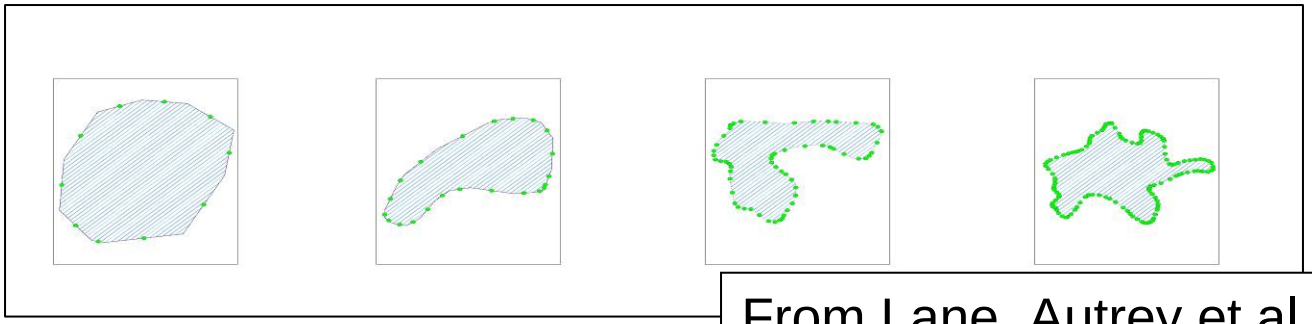
Tradeoffs for marsh restoration?

Isolated Wetland Water Storage Capacity

Identified 12,519 isolated wetlands in 2600 km^2 study area

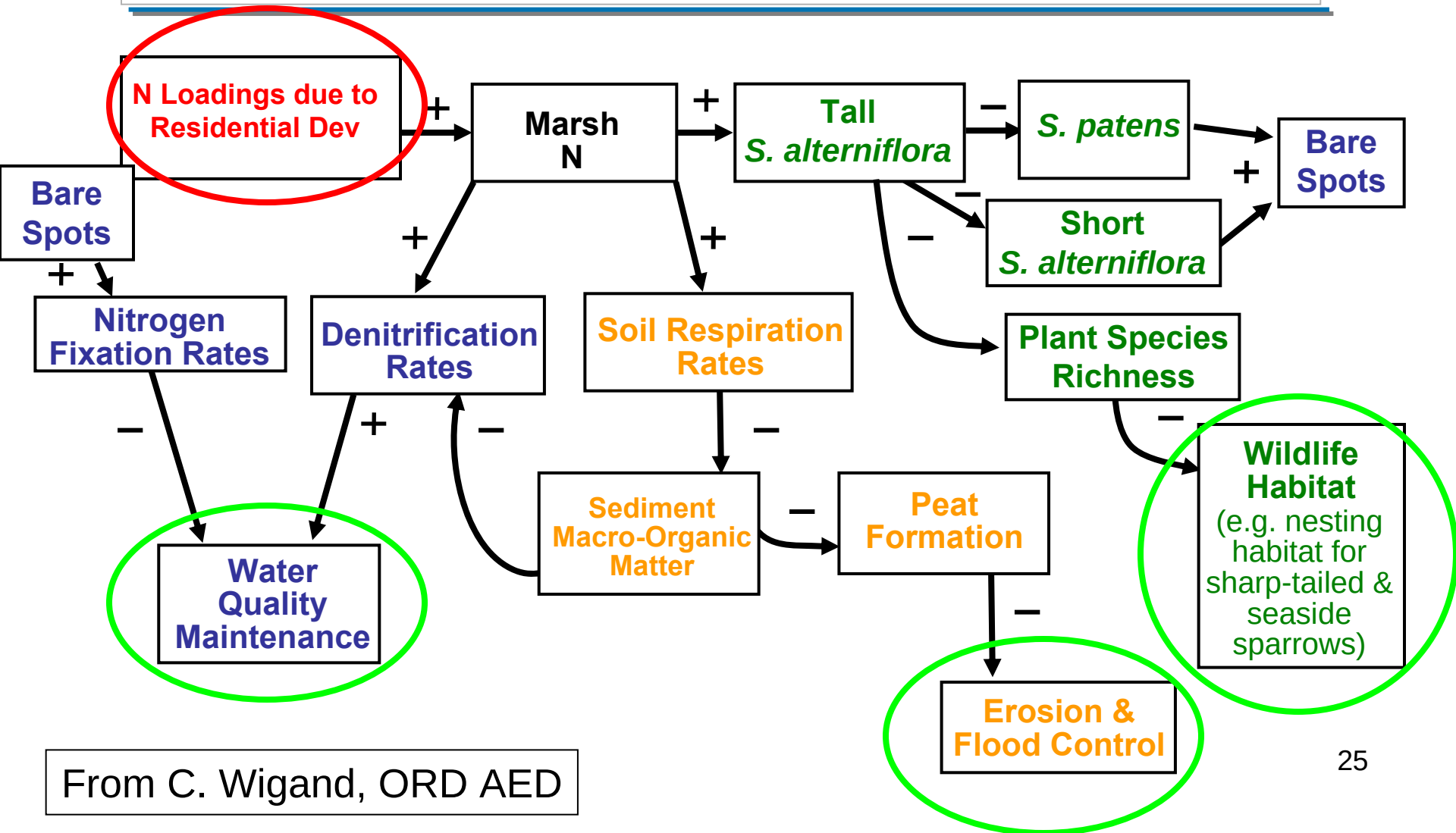
- Used LiDAR to ID bathymetric profile
- Isolated wetlands storage capacity of 43,000,000 m^3 of water





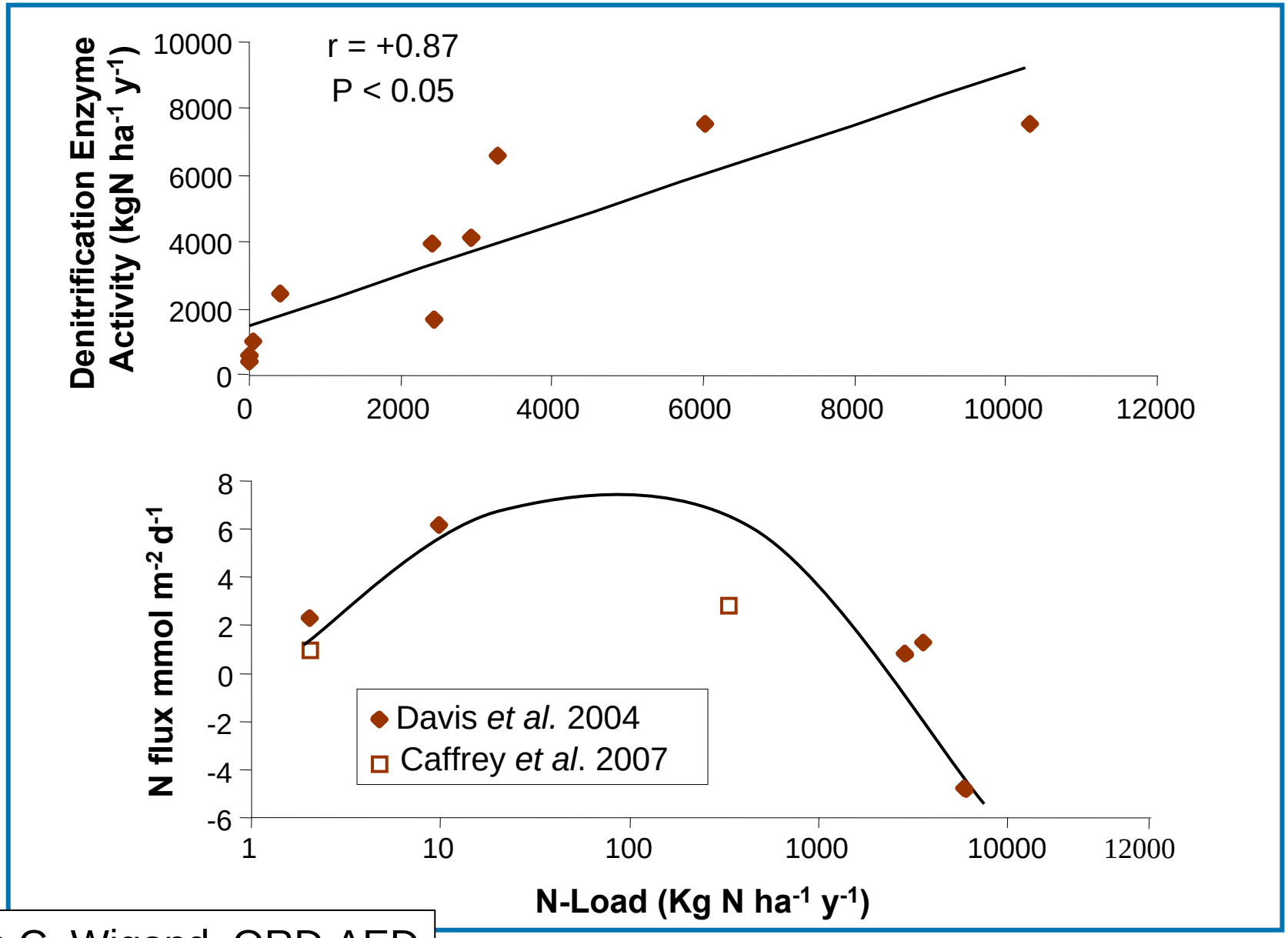
From Lane, Autrey et al

Mechanisms of Nitrogen Loading Effects on Marsh Structure, Function, and Delivery of Services in the Urbanized Northeast



From C. Wigand, ORD AED

High Marsh Denitrification Potential & Nitrogen Flux



From C. Wigand, ORD AED

Monitoring Ecosystem Services at a National Scale

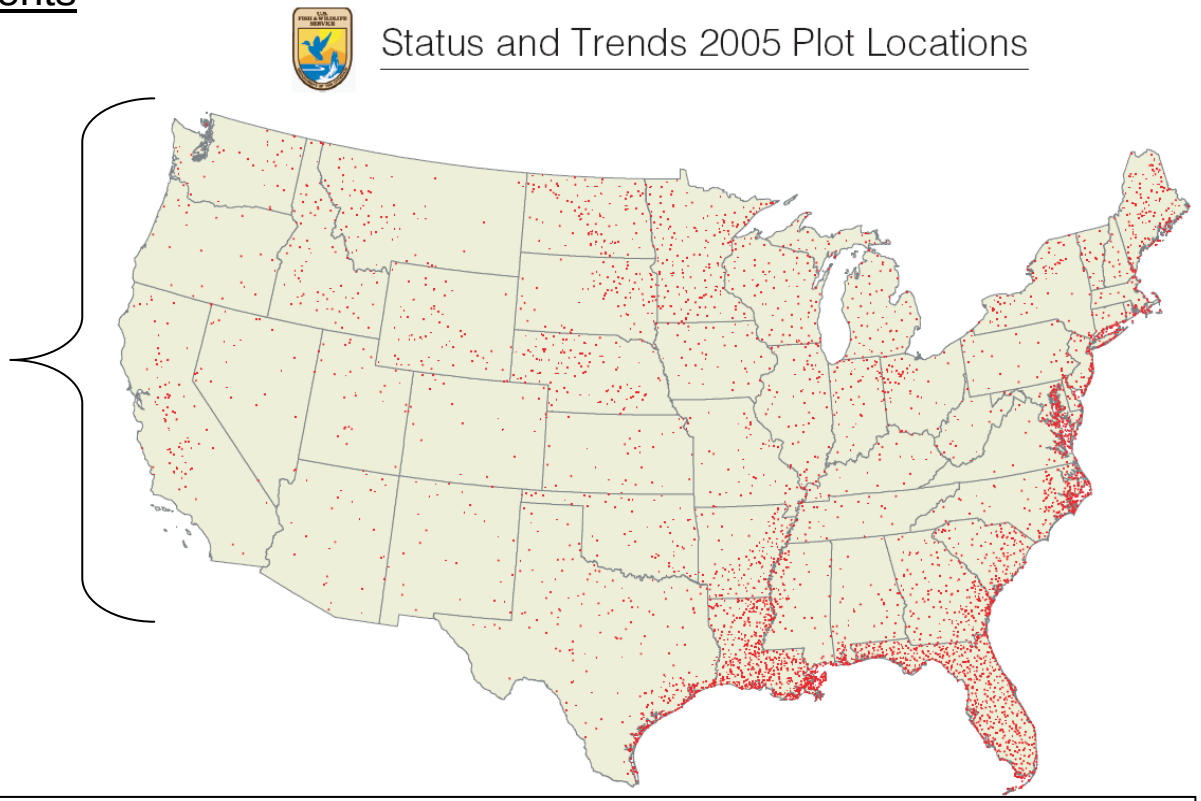
- Using the EPA National Wetlands Condition Assessment (OW-ORD Partnership) data to attempt estimates of services at a national scale
- National ES assessment would provide:
  - a baseline assessment of current services
  - unbiased and representative regional/national inventories
  - all vegetated wetlands of the U. S.
  - immediate link to Wetland Status and Trends efforts and associated policy and management

Sampling Frame
(Map for Selecting Sample Sites)

EPA is working in partnership with the U.S. Fish & Wildlife Service

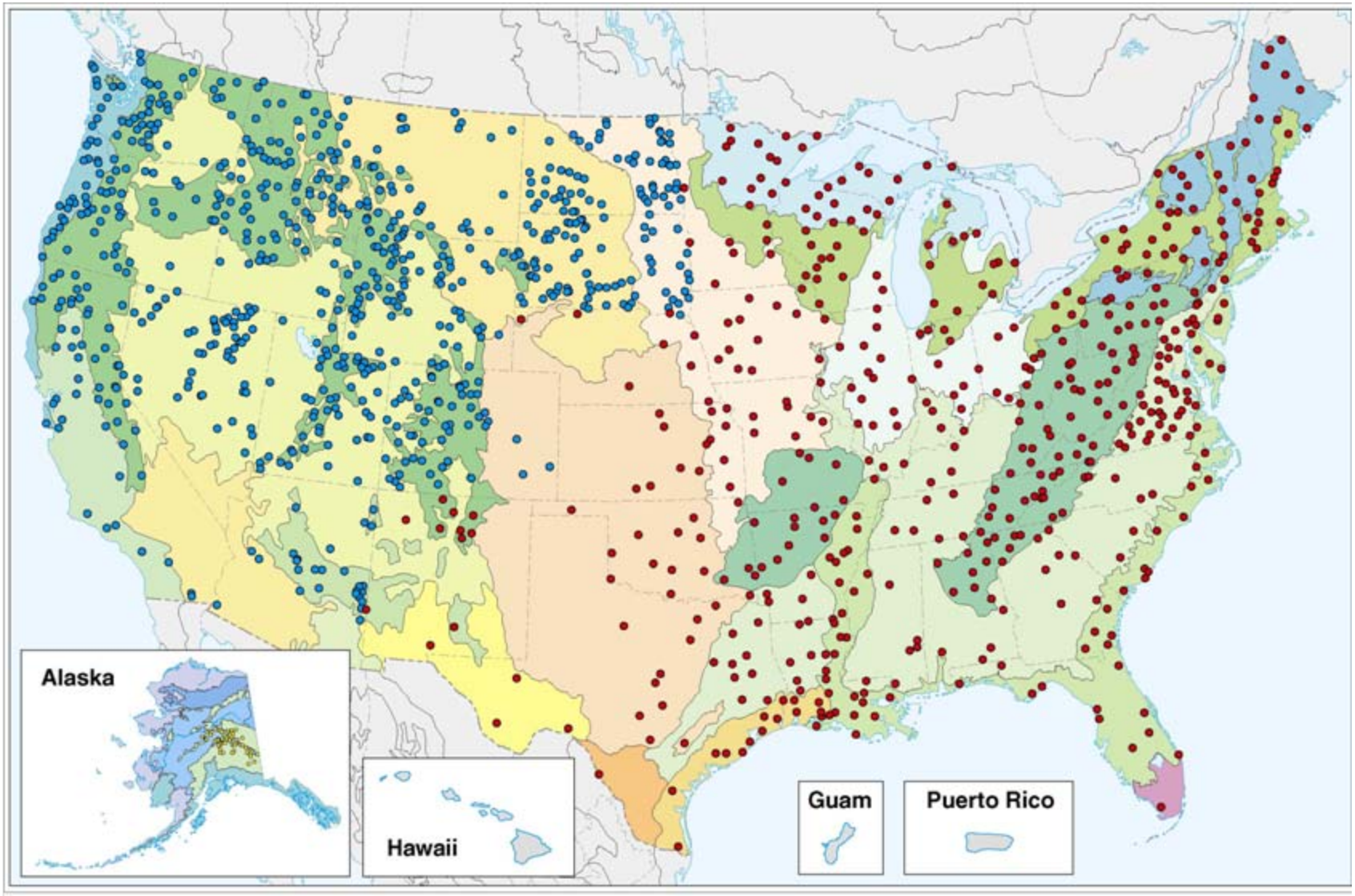
Status and Trends Enhancements

New Pacific Coast Plots

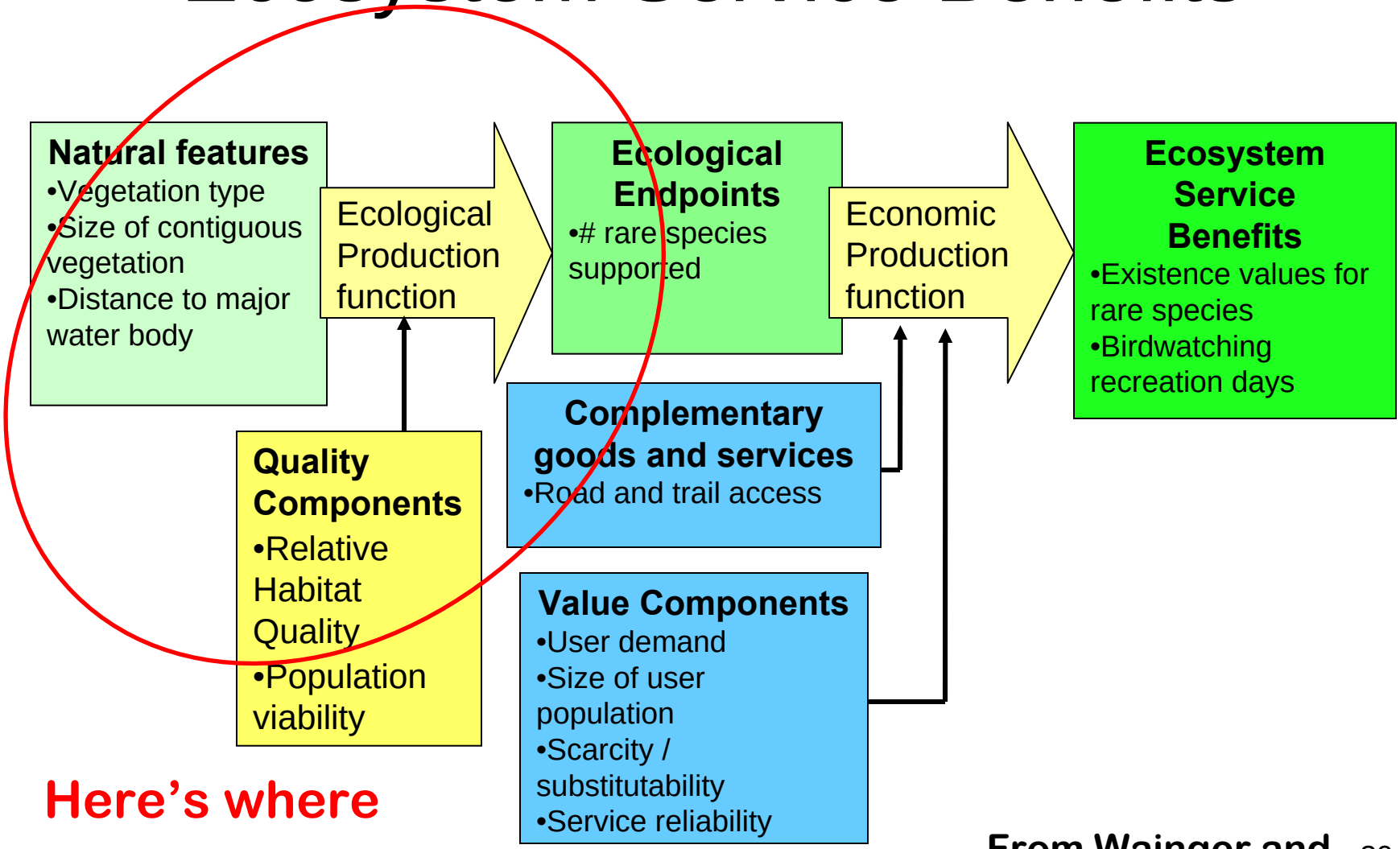


*** Each red dot is a 4 square mile plot that includes mapped wetlands, deepwater, and uplands.**

The Wetland Assessment Distribution
Will look a lot like Wadeable Streams Assessment



Example: Measurement of Ecosystem Service Benefits



Here's where We are at this point

From Wainger and Boyd

Central Scientific Uncertainties

Wetland Class → Function → Service Relationships

- Can ecosystem function/service be inferred from wetland type?
  - What are the natural moderating factors?
  - How does the magnitude of functions/services scale with
    - wetland size or shape?
    - location within a watershed or larger landscape / connectivity?
    - proximity to other habitat types?
  - What is the accuracy of estimating function/service at unmeasured sites?

Condition → Function → Service Relationships

- How does wetland condition affect ecosystem function/service?
  - Does the condition function/service relationship differ among wetland types?
  - What are the condition-response functions for key stressors?

Scientific Uncertainties

Nutrient, Sediment, Toxic Removal / Transformation

- **What types of mapped or monitored features can be used to estimate pollutant removal? For instance, Nitrogen removal, sediment trapping, etc.**
- **What are the most informative units of pollutant removal?**
- **(Net mT/ha/year? % loading removal/ha/year? Or?)**
- **What scale of estimation / mapping is feasible and appropriate for decision-making?**
- **Can we estimate these services for sites that are not measured?**

Challenges

- Demonstrating relationships between ecosystem services, ecosystem benefits and human values / well-being – do we have the capacity to make the translation of ecological data to social or economic information?
- Demonstrating the uncertainty associated with estimating wetland services at larger scales and translating these into estimates of benefits at those larger scales