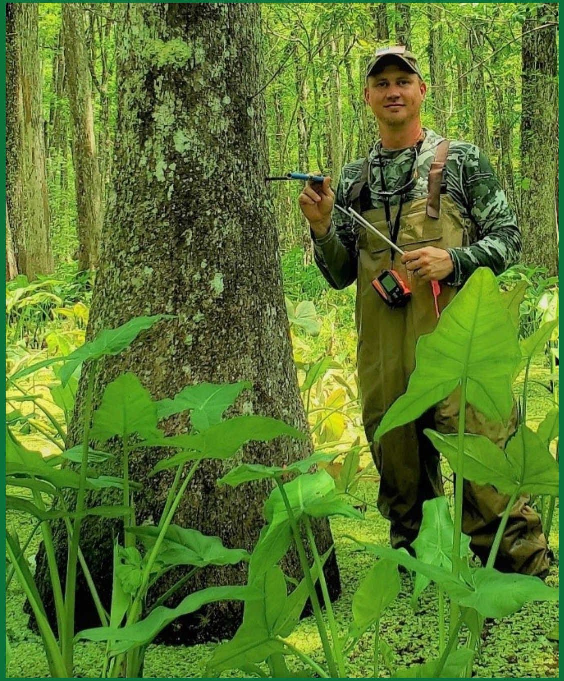
NNBF

International Guidelines on Natural and Nature-Based Features for Flood Risk Management

The Role of Vegetation to Maximize EWN® Success

Puerto Rico I May 2022

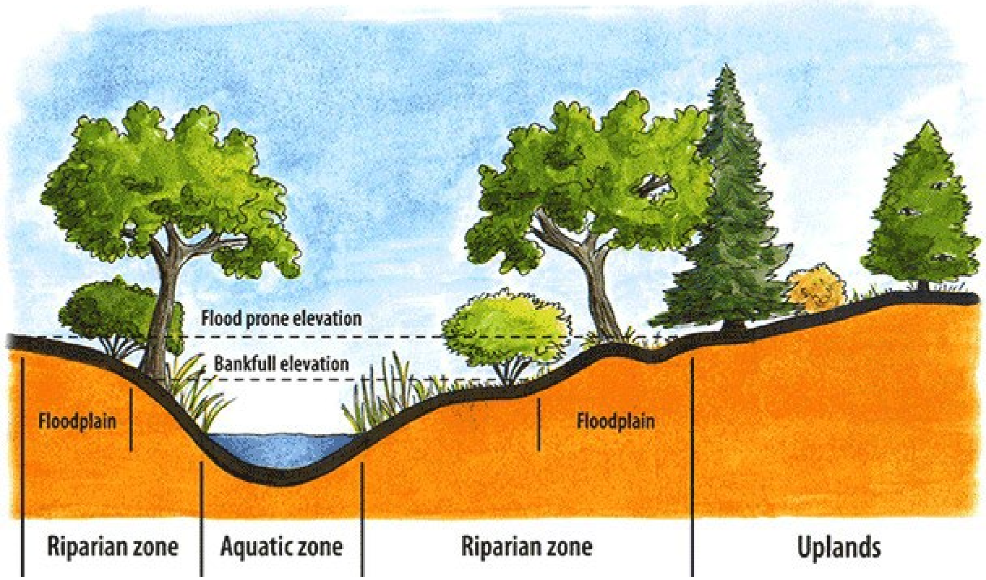


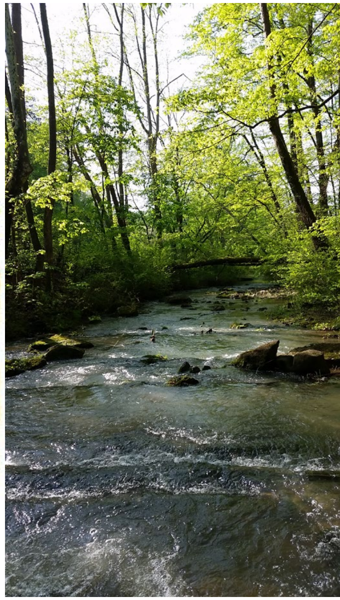
The Role of Vegetation to Maximize EWN® Success

Lead: Nathan R. Beane, US Army Corps of Engineers, PhD Research Forester

Importance of Vegetation

- Riparian Zone: “The Green Ribbon of Life”
  - Areas bordering streams, rivers, and lakes (lacustrine fringe)
  - Where aquatic and terrestrial environments converge
  - Increased plant and wildlife diversity
  - Linear nature of many riparian areas provides distinct travel corridors in otherwise fragmented landscapes





Source: https://slco.org/watershed/streams-101/the-riparian-zone/





Vegetation Importance to Aquatic Systems

- Vegetation in fluvial/floodplain ecosystems are the beginning of nutrient cycling
- Organic matter as food/energy source
- Filter nonpoint source pollution
- Downed dead wood provides structural complexity
- Importance to the water cycle/hydrological processes

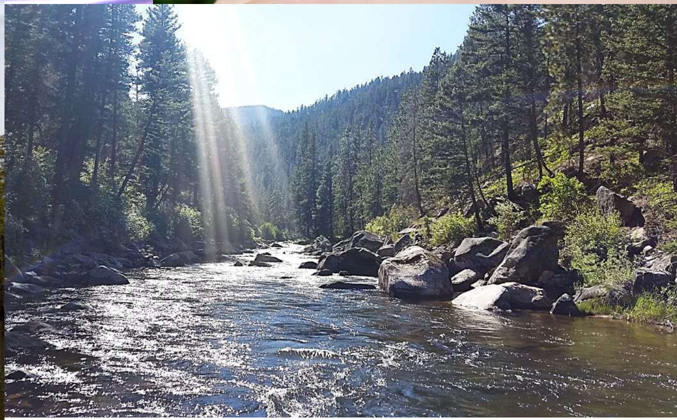


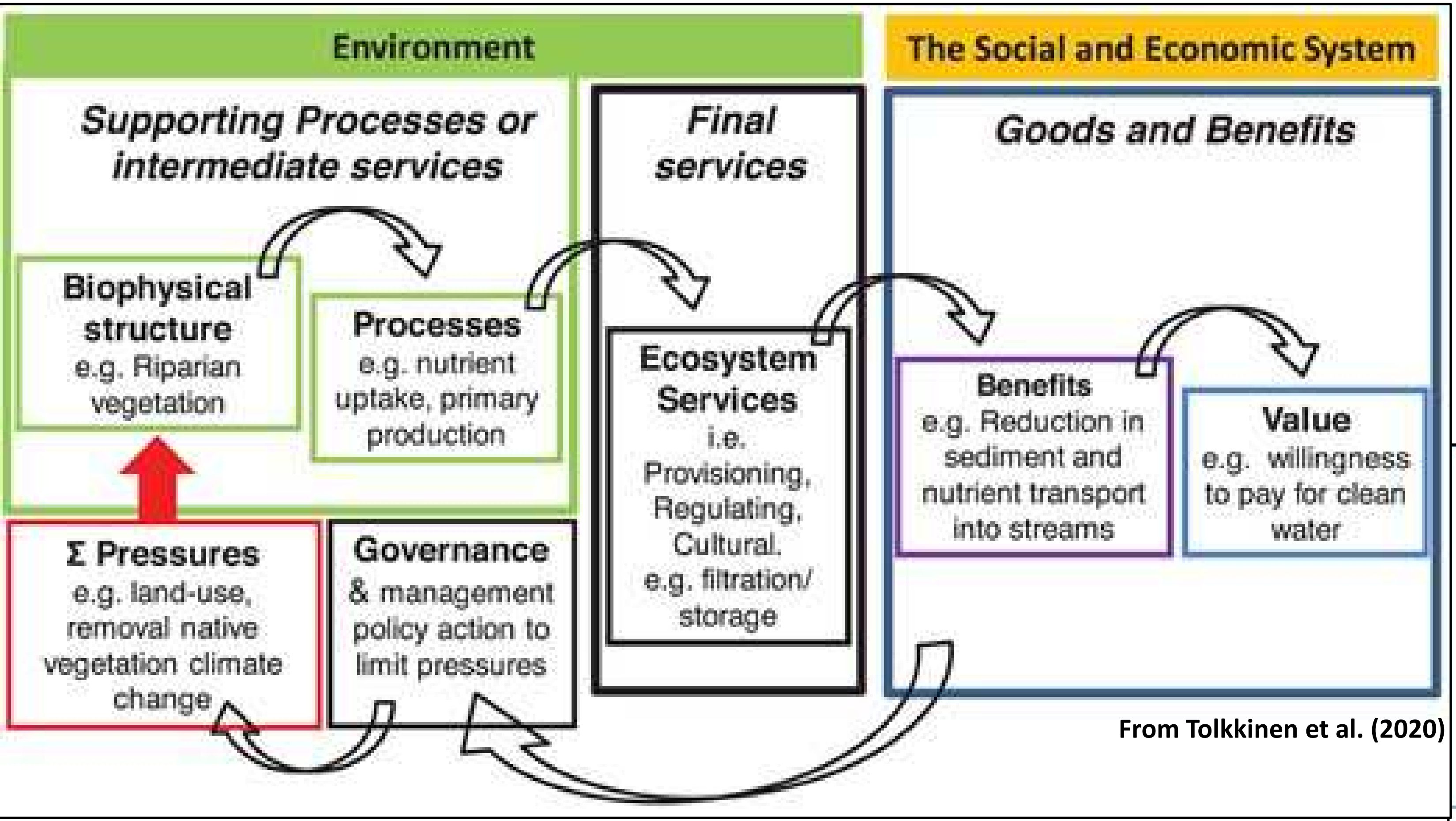
Vegetation Importance to Terrestrial Systems

- Ecosystem Services of Riparian Vegetation
  - Filtration of pollutants and chemical conditions of freshwaters
  - Carbon sequestration
  - Erosion control
  - Flow regulation
  - Pollination and seed dispersal
  - Pest control
  - Regulation of microclimate
  - Fire effects mitigation
  - Cultural services/value
    - Recreation
    - Aesthetics

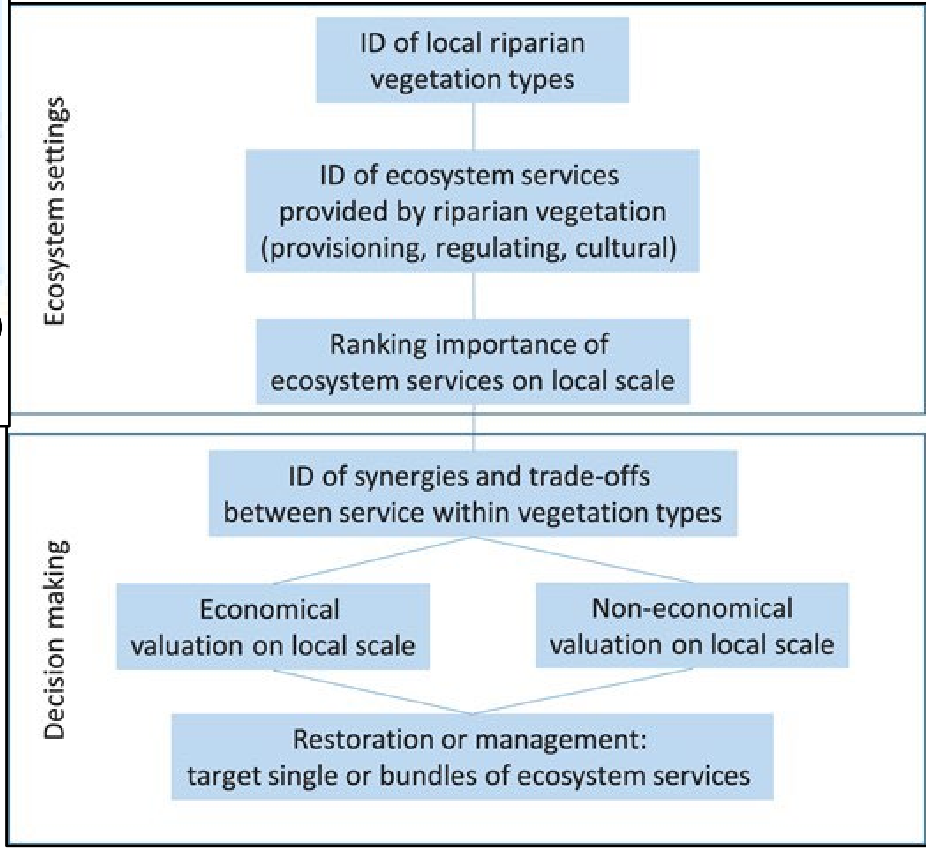






From Tolkkinen et al. (2020)

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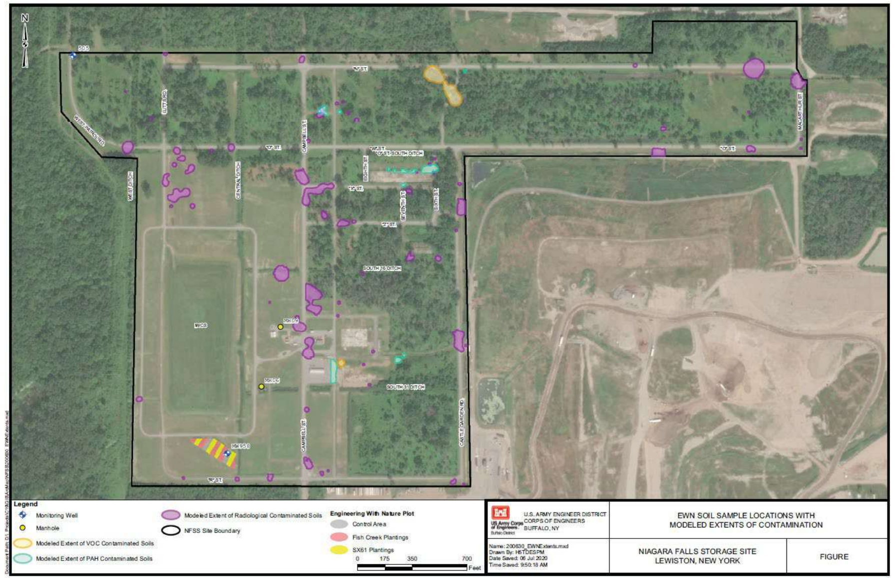
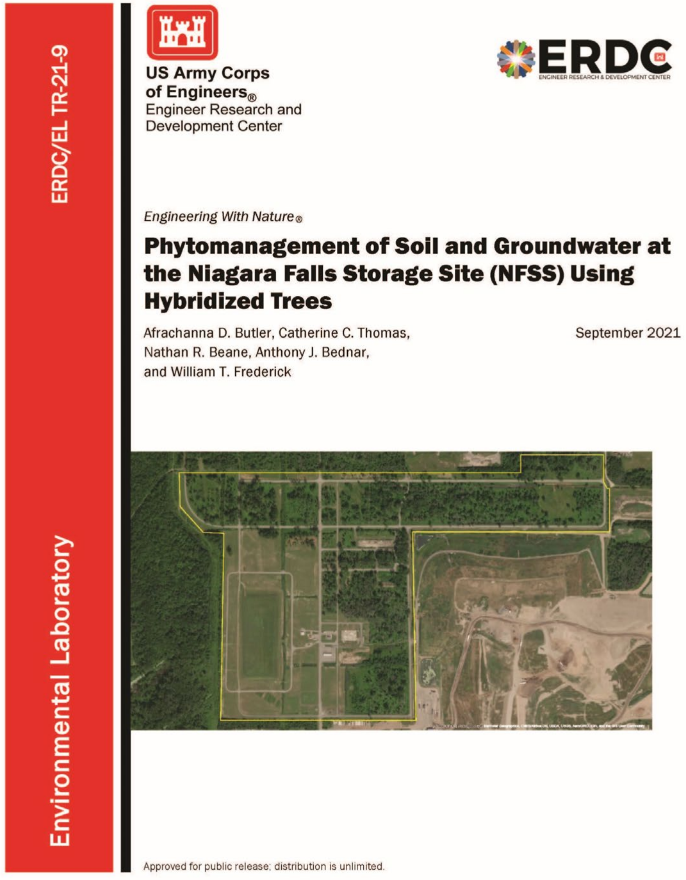
Case Study—Niagara Falls Storage Site, New York

- Phytomanagement of soil and groundwater
  - Storage area for radioactive residues and uranium (U) ore processing
  - Test plots established to examine growth performance along a U-impacted sanitary sewer line
  - No significant uptake or translocation into aboveground biomass
  - Favorable species for contaminant stabilization via subsurface dewatering.

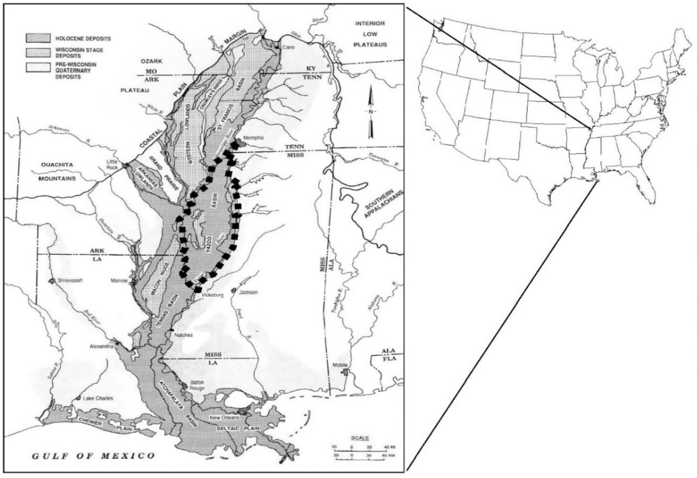




Case Study—Lower Mississippi River Alluvial Valley

Restoring Bottomland Hardwood Forests

- Restoration area >12,000 hectares
- Stand ages range from 5-26 years
- Wetland functional assessments across a restoration chronosequence
- Rapid metrics derived to evaluate restoration success at varying stages of forest succession



Wetland function	Description	Assessment Equation
Detain floodwater	Ability to store, convey, and reduce the velocity of floodwaters	$= V_{FREQ} \times \left[\frac{(V_{LOG} + V_{GVC} + V_{SSD} + V_{TDEN})}{4}\right]$
Detain precipitation	Capacity to prevent or slow runoff of rainfall to streams	$= \frac{(V_{POND} + V_{OHOR})}{2}$
Cycle Nutrients	Ability to convert nutrients between organic and inorganic pools via biogeochemical processes	$= \frac{\left[\frac{(V_{TBA} + V_{SSD} + V_{GVC})}{3} + \frac{(V_{OHOR} + V_{AHOR} + V_{WD} + V_{SNAG})}{4}\right]}{2}$
Export organic carbon	Capacity to export dissolved organic carbon to downstream systems	$= V_{FREQ} \times \frac{\left[\frac{(V_{OHOR} + V_{WD} + V_{SNAG})}{3}\right] + \left[\frac{V_{TBA} + V_{SSD} + V_{GVC}}{3}\right]}{2}$
Remove elements and compounds	Ability to remove or immobilize nutrients, metals, or other materials related to plant growth and improve water quality	$= V_{FREQ} \times \left[\frac{(V_{CEC} + V_{OHOR} + V_{AHOR})}{3}\right]$
Maintain plant communities	Capacity to support environmental conditions to develop and maintain characteristic plant communities	$= \left\langle \left\{ \frac{\left[\frac{(V_{TBA} + V_{TDENS})}{2} + V_{COMP}\right]}{2} \right\} \times \left[\frac{(V_{SOIL} + V_{POND})}{2}\right] \right\rangle^{1/2}$
Provide fish and wildlife habitat	Ability to support the fish and wildlife species that utilize wetlalnds during a portion of their life cycle.	$= \left\{\left[\frac{(V_{FREQ} + V_{POND})}{2}\right] \times \left[\frac{(V_{TCOMP} + V_{SNAG} + V_{TBA})}{3}\right] \times \left[\frac{(V_{LOG} + V_{OHOR})}{2}\right] \times \left[\frac{(V_{TRACT} + V_{CONNECT} + V_{CORE})}{3}\right]\right\}^{1/4}$

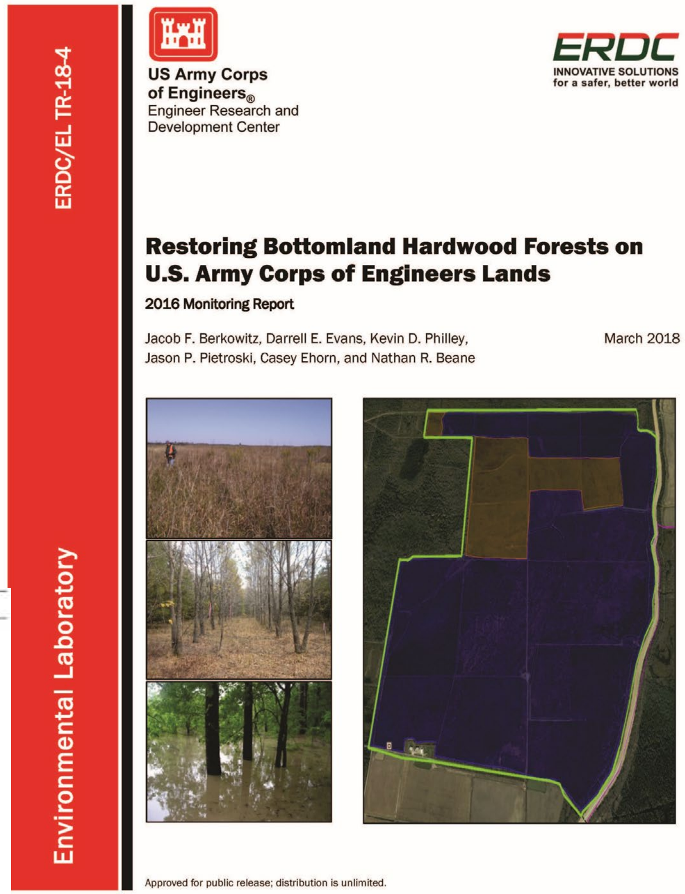
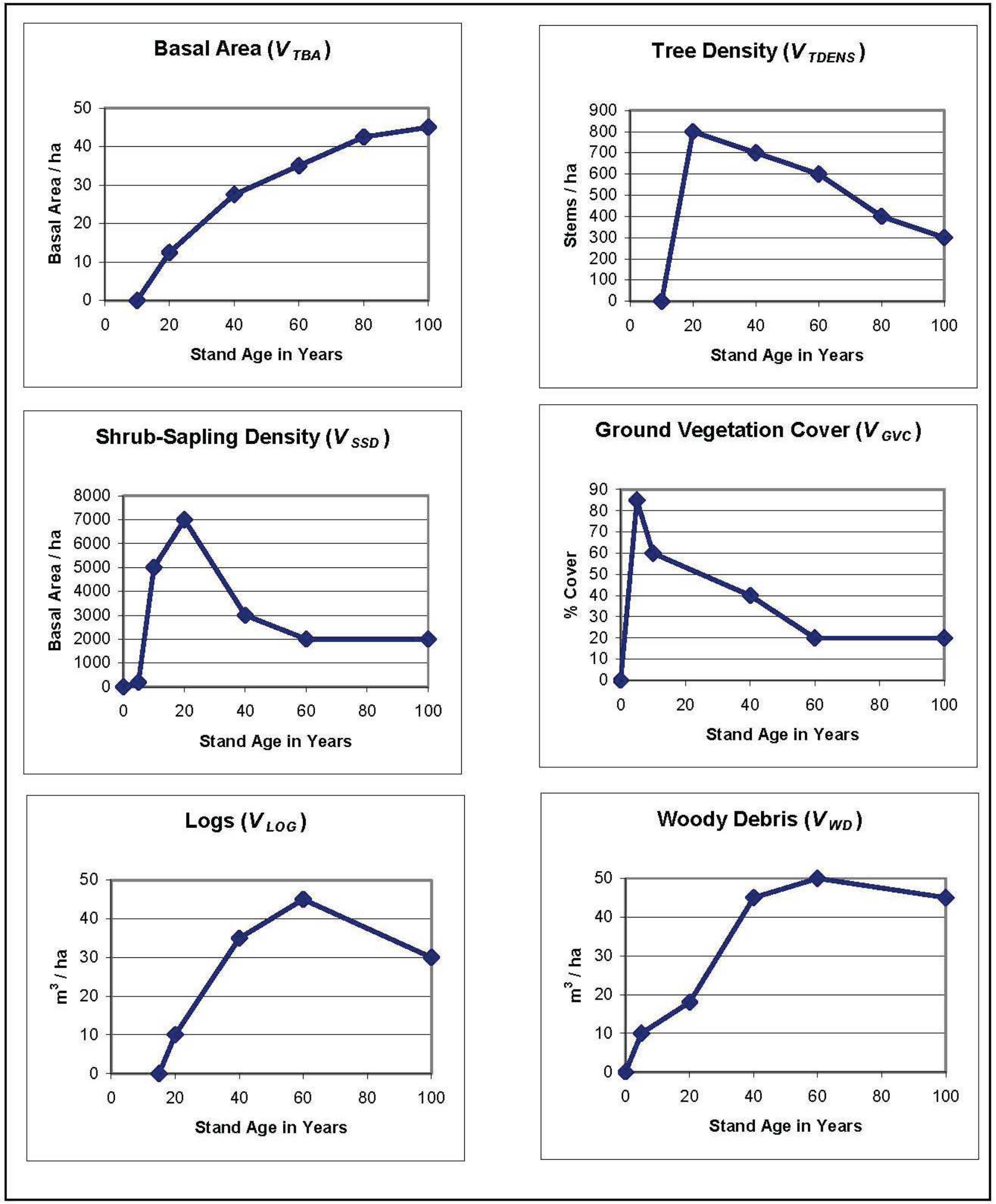


Table 3. Summary of rapid assessment variables, description, and sampling technique.

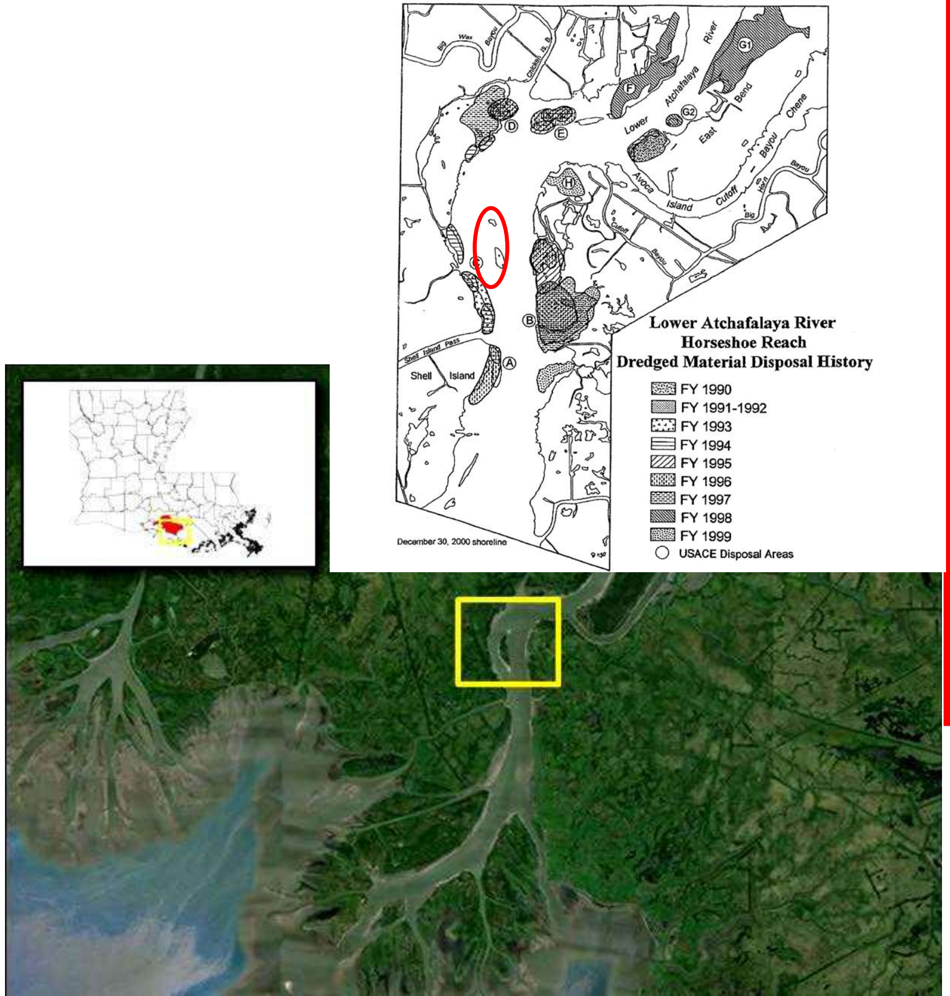
Rapid assessment variable	Description	Sampling technique
Core area	Portion of wetland lying within 100m buffer	Measured from aerial photo/GIS layer
Habitat connections	Proportion of the wetland perimeter connected to suitable habitat	Measured from aerial photo/GIS layer
Wetland tract	Contiguous wetland area adjacent to the wetland	Measured from aerial photo/GIS layer
Flood frequency	Frequency of overbank or backwater flooding	Measured from flood frequency map/stream gauge data
Cation exchange capacity	Cation exchange capacity change due to soil disturbance	Estimated based on soil type
Soil integrity	Proportion of the wetland exhibiting altered soils	Estimated based on amount of soil disturbance visible
Micro-depressional ponding	Percentage of small topographic depressions and vernal pool features	Estimated based on percent of depressions within sample area
Tree basal area	Basal area per hectare; proportional to tree biomass	Measured DBH of all trees > 7.6 cm in diameter within circular 0.04 ha plot
Tree density	Number of trees per ha	Count of all trees > 7.6 cm in diameter within circular 0.04 ha plot
Snag density	Density of standing dead woody stems	Count of all snags > 7.6 cm in diameter within circular 0.04 ha plot
Tree composition	Species composition of the tallest stratum	Percent concurrence with measured tree quality index within the uppermost stratum
Woody debris biomass	Volume of woody debris biomass per ha	Count of nonliving stems along a 3.7 m transect
Log biomass	Volume of log biomass per ha	Count of logs along a 15 m transect
Shrub-sapling density	Density of saplings and shrubs per ha	Count of all woody stems within two 0.004 ha plots
Ground vegetation cover	Percent cover of herbaceous and woody vegetation	Visually estimated percentage of ground covered with herbaceous and woody vegetation within four 1 m^2 plots
O horizon biomass	Mass of organic matter in the O horizon	Measured O horizon thickness
A horizon biomass	Mass of organic matter in the A horizon	Measured A horizon thickness

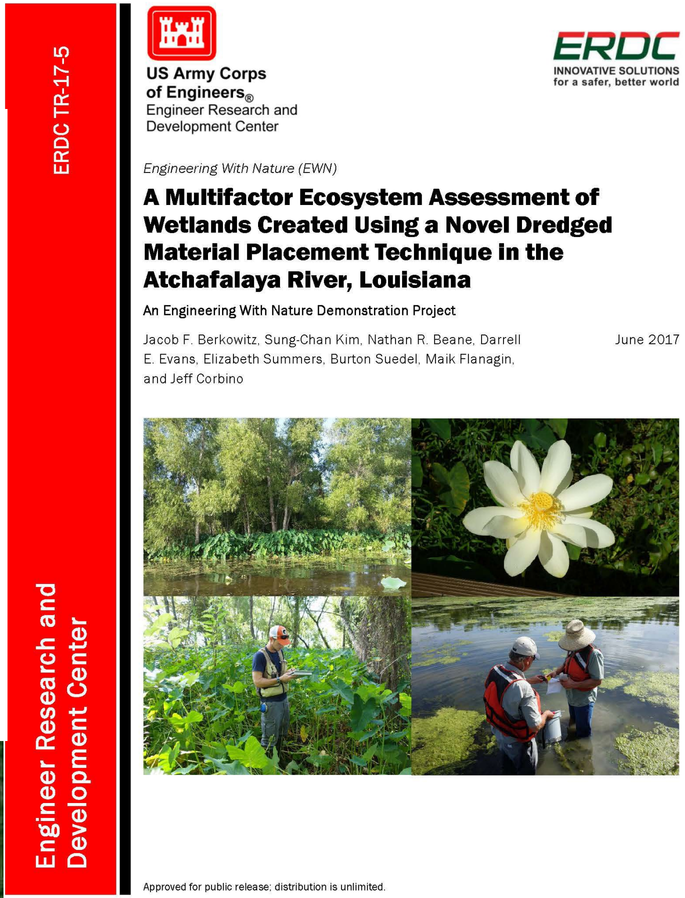


Case Study—Atchafalaya River, Louisiana

Multifactor Ecosystem Assessment of Wetlands

- Included evaluations of:
    - Geomorphic evolution
    - Ecosystem classification and distribution
    - Floral communities
    - Avian communities
    - Aquatic invertebrates
    - Soils and biogeochemical activity
    - Hydrodynamics and sediment transport





Case Study—Atchafalaya River, Louisiana

Multifactor Ecosystem Assessment of Wetlands

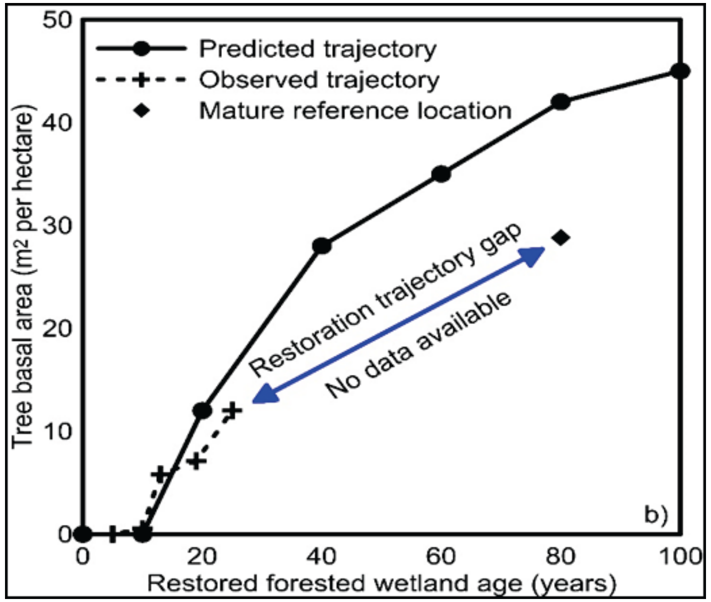
- Strategic placement of dredged material in areas that mimic natural processes
  - Created a 35-ha island supported by dredged material
  - Wetlands created provide nutrient cycling functions, including nitrogen removal, to improve water quality
  - Important habitat for migratory waterfowl and forest songbirds, including nesting sites
  - Enhanced invertebrate communities that sustain recreational and commercial fisheries, including shrimp.

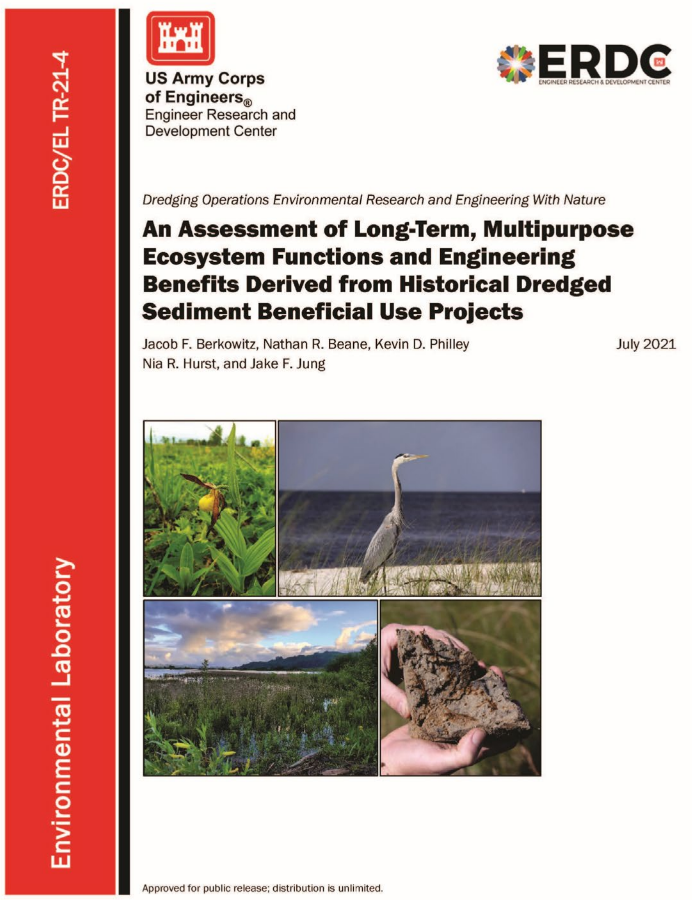




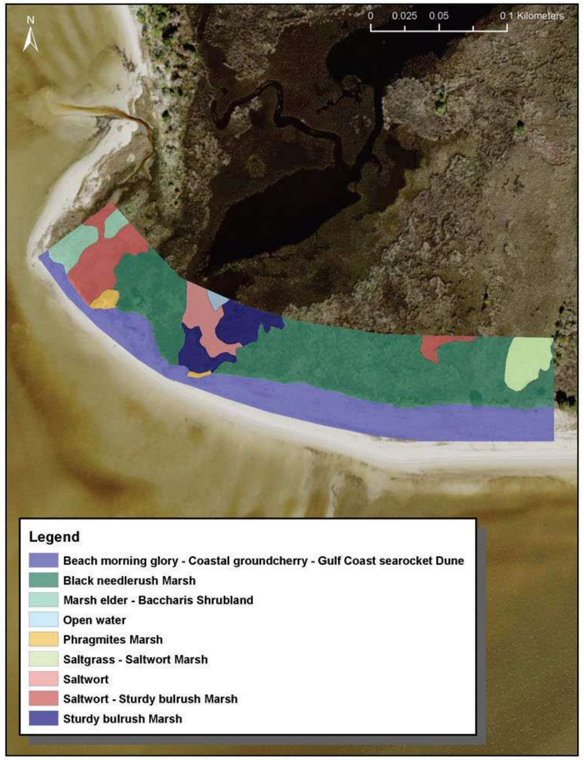

Case Study—Historical Dredged Material Projects

- Evaluated long-term benefits of innovative dredged material management
  - Revisited 6 historic habitat improvement projects
  - Documented long term trajectory of these projects
  - Compared project outcomes with natural (reference) conditions
  - Determined level of success in accordance with EWN initiatives

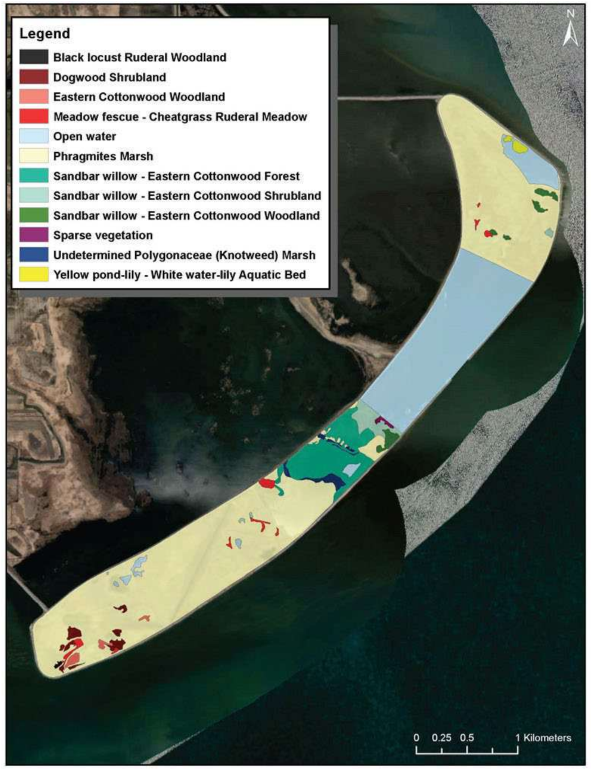




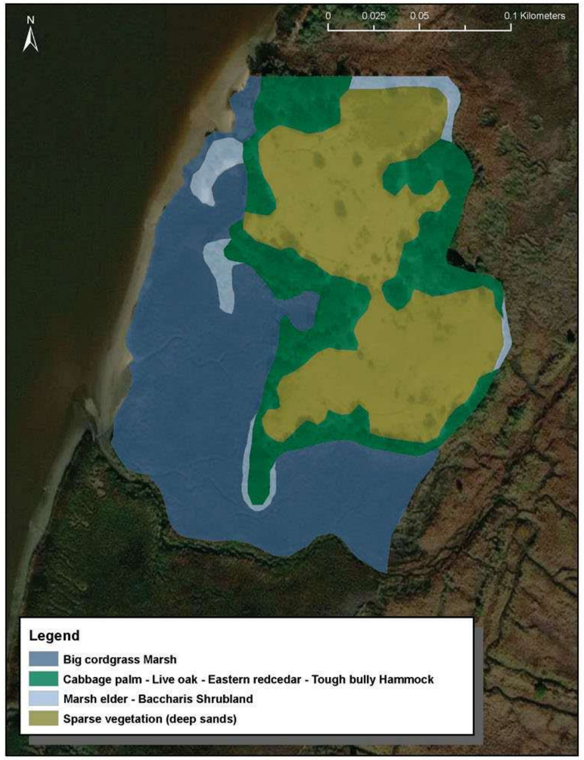
Case Study—Historical Dredged Material Projects



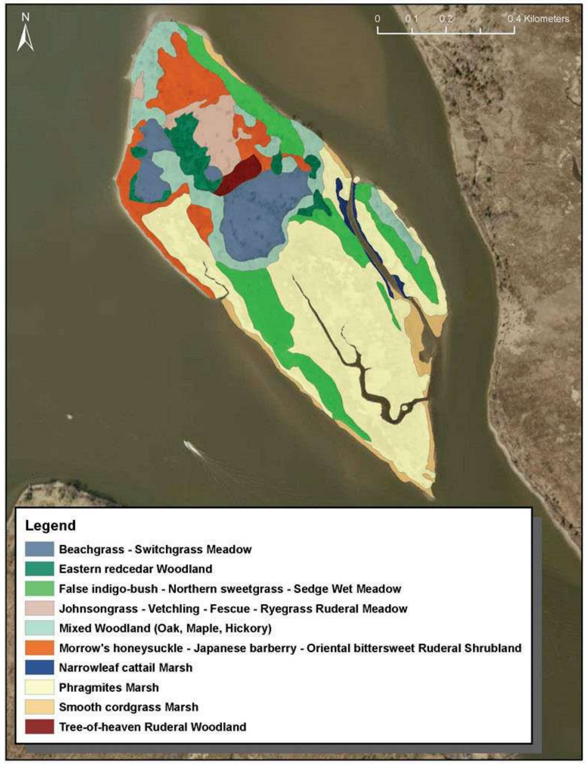
Cat Point reference site
Apalachicola, Florida



Point Mouillee CDF study site
Estral Beach, Michigan



Buttermilk Sound study site
Brunswick, Georgia



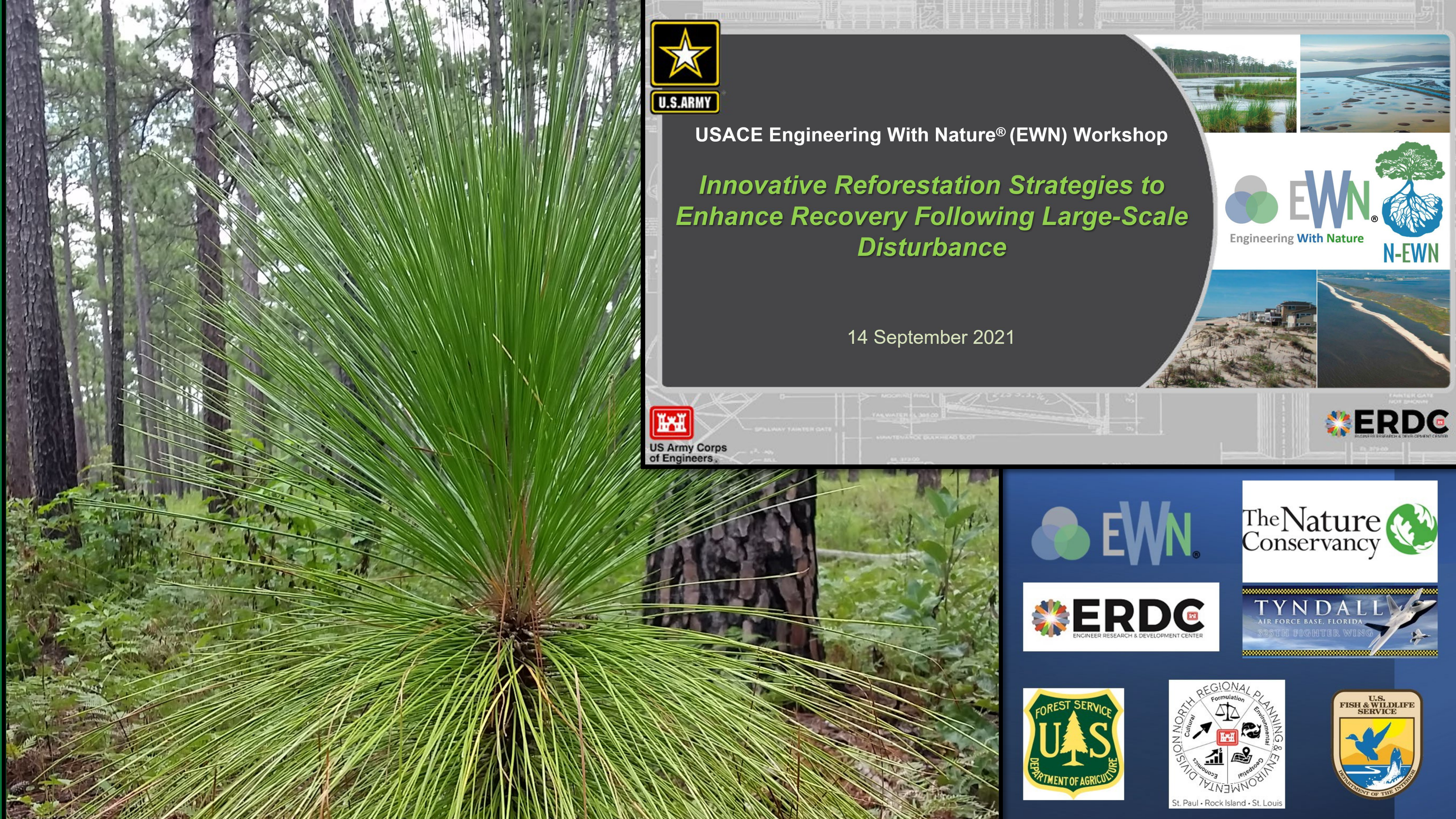
Nott Island study site
Old Lyme, Connecticut

Case Study—Historical Dredged Material Projects

- Evaluated long-term benefits of innovative dredged material management
  - Improved our understanding of ecological functional trajectories associated with long-term beneficial use project outcomes
  - Identified positive engineering outcomes derived from implementation of the dredged material beneficial use projects
  - These study sites have persisted with little to no intervention for more than 4 decades and provide an array of ecological functions and engineering benefits highlighting the EWN initiative—*an intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits through collaborative processes.*



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THANK YOU!

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Questions?

EngineeringWithNature.org

Download

- Executive Summary (70 pages)
- International Guidelines on NNBF for Flood Risk Management (1,000 pages)