# Coastal Restoration
## Marine Sciences Laboratory

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### Project Highlight: Assessing Cumulative Effects of Restoration Projects in the Columbia River

Traditionally, restoration projects are implemented and monitored at a single restoration site. However, often restoration goals for larger systems, like the Columbia River in the Pacific Northwest, aim to increase function over a broad extent. Monitoring the effectiveness and contribution of these individual projects for meeting basin-wide restoration goals can be difficult to track, and measures are lacking to evaluate the net improvement of multiple restoration projects.

We developed a new restoration framework for the Lower Columbia River based on a levels-of-evidence approach to evaluate the effectiveness of multiple restoration projects on the overall system goal of increasing rearing habitat for endangered juvenile salmonids. The approach uses a number of different criteria to assess the cumulative landscape effects of individual restoration actions, and includes collection of field data, remote sensing data, modeling and meta-analysis to determine the cumulative net ecosystem improvement (Diefenderfer et al. 2011). By using this framework, we are able to assist in assessment of the net effect of current projects, and thus to help managers with ongoing restoration program planning and decision making using adaptive management.

## Coastal Restoration Approach

PNNL scientists are nationally recognized for their research in both coastal restoration and coastal ecology. Our strategy for restoration employs an ecosystem-based approach with the fundamental goal of improving ecosystem functions and sustaining these functions over time. The systematic approach we use has five distinct but interactive stages: planning, implementation, monitoring, adaptive management and dissemination of results (Thom et al. 2011) and much of our research focuses on the first four stages. Our planning approaches link scientific research and technical innovation with restoration site selection (Diefenderfer et al. 2009, Yang et al. 2010). We have gained national recognition for our approach to adaptive management (Thom et al. 2000, Thom et al. 2005, and Thom et al. 2009) and have completed national reviews on restoration approaches and project outcomes (Shreffler et al. 1995, Borde et al. 2004).

Additional research programs focus on plant and fish ecology, coastal mapping, nutrient and contaminant assessment, and stressor evaluation. In addition, our facilities are used for evaluating sediment remediation methods and the effects of biophysical conditions on the establishment of plants. It is the sum integration of these elements that has proved to be instrumental in programs involving coastal ecosystem restoration and monitoring.

Salt marsh in Washington State

## Project Highlight: Coastal Restoration Planning in Alabama

Alabama coastal systems have experienced increasing pressure from a variety of human activities including urban and rural development and industrial activities and climate related effects. This has been paired with a decline in submerged vegetation (SAV) in recent decades. The National Estuary Partnership in Mobile Bay manages restoration in the Bay and is making decisions today about future restoration priorities, especially in the face of land use changes and climate change. One of the most difficult decisions can be to identify *where* the best locations for restoration would be.

Mobile Bay Restoration Priorities

To identify key areas, we forecasted potential future changes in submerged vegetation extent based on different land development scenarios. This involved the following four research elements:

1. Urban growth modeling, to assess how land use will change in the future;
2. Watershed modeling, to evaluate how changes in land use and climate will affect runoff and stream discharge;
3. Hydrodynamic modeling, to evaluate how changes in stream discharge will affect the salinity and temperature of Mobile Bay; and,
4. Evaluation of the potential impacts of these changes on SAV and other components of the aquatic ecosystem.

This provides spatially explicit outcomes of potential areas of SAV loss and gain under different scenarios that can help in restoration planning.

## References


Borde, AB., L O'Rourke, G Williams, R Thom, and H Diefenderfer. 2004. National Review of Innovative and Successful Coastal Habitat Restoration. Prepared for: NOAA, CSC. Battelle Marine Sciences Laboratory, Sequim, WA.

Diefenderfer HL, RM Thom, GE Johnson, JR Skalski, KA Vogt, BD Ebberts, GC Roegner, and EM Dawley. 2011. A Levels-of-Evidence Approach for Assessing Cumulative Ecosystem Response to Estuary and River Restoration Programs. *Ecological Restoration* 29:111-132.

Diefenderfer HL, KL Sobocinski, RM Thom, CW May, AB Borde, SL Southard, J Vavrinec, III, and NK Sather. 2009. Multiscale Analysis of Restoration Priorities for Marine Shoreline Planning. *Environmental Management* 44(4 ):712-731.

Shreffler, DK, RM Thom, MJ Scott, KF Wellman, MA Walters, and M Curran. 1995. National Review of Non-Corps Environmental Restoration Projects. Prepared for: U.S. Army Corps of Engineers, Institute for Water Resources. Pacific Northwest National Laboratory, Sequim, WA.

Thom RM. 2000. Adaptive management of coastal ecosystem restoration projects. *Ecological Engineering*, 15(3-4), 365-372.

Thom RM, GD Williams, AB Borde, JA Southard, SL Sargeant, DL Woodruff, JC Laufle, and S Glasoe. 2005. Adaptively Addressing Uncertainty in Estuarine and Near Coastal Restoration Projects. Journal of Coastal Research. JCR 40(sp. iss.): 94-108.

Thom RM**,** MG Anderson, D Tyre, and CA Fleming. 2009. *Adaptive Management for Decision Making at the Program and Project Levels of the Missouri River Recovery Program*. PNNL-18261, Pacific Northwest National Laboratory, Richland, Washington.

Thom RM, HL Diefenderfer, JE Adkins, C Judd, MG Anderson, KE Buenau, AB Borde, and GE Johnson. 2011. Guidelines, processes and tools for coastal ecosystem restoration, with examples from the United States. *Plankton & Benthos Research.* 5(Suppl.), 185-201.

Yang Z, KL Sobocinski, DW Heatwole, T Khangaonkar, RM Thom, and R Fuller. 2010. Hydrodynamic and Ecological Assessment of Nearshore Restoration: A Modeling Study. *Ecological Modeling* 221(7):1043-1053.


### About Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory, located in southeastern Washington State, is a U.S. Department of Energy Office of Science laboratory that solves complex problems in energy, national security and the environment, and advances scientific frontiers in the chemical, biological, materials, environmental and computational sciences. PNNL currently has approximately 4,900 staff members and a business volume of more than $1.1 billion. The Laboratory has been managed by Ohio-based Battelle since 1965.


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