



**A Technical Resource  
for Government and  
Private Industry**



## Science and Technology for

# Land and Ecosystems Management

Managing land and water resources for fish and wildlife protection and enhancement is a critical requirement for many organizations and governmental agencies. Management and stewardship responsibilities involve integrating land and water use needs, preventing endangered species impacts, and protecting/enhancing fish and wildlife habitat, while still maintaining their primary missions. Reconciling these requirements with the other needs of these groups presents significant challenges.

For more than 25 years, the Pacific Northwest National Laboratory has been developing and deploying leading-edge science and technology to help governmental agencies and corporate land managers accomplish their primary missions while protecting and enhancing their ecological resources. At the Pacific Northwest National Laboratory, we continue to develop efficient approaches to ecosystem characterization, monitoring, and adaptive management.

We use these science-based approaches to evaluate ecosystem health, assess the effects of land and water use practices, and identify efficient ways to enhance and protect ecological resources. We use the best-available science to develop adaptive resource management tools and plans that focus on results. We provide our clients

with a framework for setting priorities and selecting optimal strategies that balance operational objectives with regulatory responsibilities.

Providing tools and techniques for assessing and managing habitats for wildlife is one of the major missions of the Pacific Northwest National Laboratory. We developed innovative methods for **quantifying habitat quality** using a combination of field- and satellite-based data and **geostatistics** tools that evaluate extensive areas quickly and at minimal cost. We developed a **remote sensing** platform using **data fusion** to quantify resource condition using a combination of high-resolution and low-resolution data to assist managers in screening operations/development alternatives. We have developed a **biological resource management system** for the US Department of Energy that incorporates adaptive management principles along with efficient monitoring to ensure that DOE's missions continue to operate favorably under high environmental scrutiny.

We have helped the Department of Defense and energy corporations assess **and manage the environmental consequences of their operations**, including contaminants effects. A fuzzy logic modeling system we developed uses any variety of information to **predict stream/watershed quality for fish habitat**. This is being incorporated into a life-history based modeling system for salmon and steelhead habitat management. We also developed a **watershed analysis model** that couples land cover types and physiography with overland, subsurface, and surface water transport to assess effects of land cover changes on the hydrologic system and resulting aquatic habitat quality at the watershed scale.

For more information, contact:  
Dr. Joseph L. Devary, Manager  
(509) 376-8345  
joe.devary@pnl.gov

or

Dr. Charles A. Brandt  
(509) 375-5345  
charles.brandt@pnl.gov

Resource & Ecosystems Management  
Environmental Technology Division  
PO Box 999  
Richland, WA 99352  
www.pnl.gov

**Pacific Northwest  
National Laboratory**  
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## Project Experience

• **Anadromous Fish Habitat Assessments.** We've conducted extensive research in the northwest, especially in the Columbia and Snake rivers, developing scientifically credible descriptions of spawning habitat for anadromous fish, using information on watershed, near-stream, and in-stream conditions. These assessments support hydropower operations management, environmental planning, and mitigation needs for a variety of clients in the region. We employ state-of-the-art field data gathering methods, including underwater video, hyporheic flow sensors, and remote sensing tools, along with basic research on life history, behavior, physiology, and reproduction for many species, including pacific lamprey, white sturgeon, steelhead trout, and several species of Pacific salmon. Our studies have been used to produce science-based management plans, as well as mitigation, restoration, and enhancement strategies.



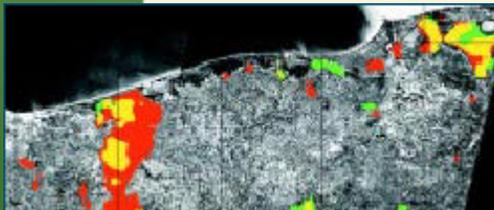
• **Tools for Monitoring Rangelands for the Bureau of Land Management.** We are pioneering an approach to habitat quality assessment over large tracts of rangeland that makes use of low-cost satellite imagery. The challenge is to develop and test methods that can be applied to large land areas, be less costly than on-the-ground measurement and have sufficient resolution identify changes in rangelands from both natural events and land management practice. This project uses geostatistical tools to increase the quality of low-resolution imagery through limited use of a few high-resolution images and already-available field survey data. This approach is being developed and tested on BLM rangelands in Wyoming and Idaho.



• **Ecosystems Management for the U.S. Department of Energy.** The Pacific Northwest National Laboratory has helped the U.S. Department of Energy manage fish and wildlife resources on the Hanford Site for over 20 years. We developed an adaptive management system based on three elements: resource monitoring, resource enhancement, and impact management. These elements are described and managed through a comprehensive Biological Resources Management Plan that was developed in consultation with U.S. Fish and Wildlife Service, National Marine Fisheries Service, the Native American tribes associated with the Hanford Site, and the local governmental agencies.



• **Ecosystem Quality Assessment on Yucatan Peninsula.** In work for the Mexican national oil company PEMEX on the Yucatan Peninsula, we assessed key ecosystem condition and health problems caused by land use changes, surface water changes, and chemical discharges resulting from 40 years of PEMEX operations in the area. Satellite imagery was a key component in assessing change in the terrestrial and surface water systems. Localized degradation of soils and surface water systems were found, root causes were identified, and remedies were defined that will mitigate the problems.



• **Habitat Management for the U.S. Army.** For over ten years, we have conducted extensive studies to guide habitat restoration and sensitive species management for the U.S. Army's Yakima Training Center. This work included developing and applying tools to combine satellite and aerial photography with on-the-ground data to predict habitat quality for sage grouse and to assess effects of training and wildfire on habitat quality.

### Advanced Techniques for Land Management

- GIS
- Geostatistics
- Remote Sensing