Environmental Restoration
and **Protection** CAPABILITIES

Pacific Northwest
NATIONAL LABORATORY

Restoration and Protection of our Nation's Vital Marine and Freshwater Ecosystems

For over 50 years, Pacific Northwest National Laboratory (PNNL) has been assisting federal and state agencies and stakeholders to understand how energy generation, storage, and use influence the function and health of many of our nation's most critical ecosystems. Our experts have defined the key processes and features controlling the health of our environments, including our most valued regional watersheds – Puget Sound and the Columbia River. Using this knowledge, PNNL has led the development and deployment of state-of-the-art technologies to mitigate impacts on our valued ecosystems, improve the quality of our environment, and enable a cleaner and sustainable energy future.

Core Competencies

Today, PNNL stewards the scientific and engineering underpinnings necessary to enable four core competencies and foundational, multidisciplinary scientific and technical expertise critical to resolving these challenges associated with environmental restoration and protection:

QUANTITATIVE SYSTEMS DYNAMICS

- 444 Peer-reviewed publications since 2010
- 31 + Technical experts

ECOSYSTEM RESTORATION

- 343 Peer-reviewed publications since 2010
- 27 + Technical experts
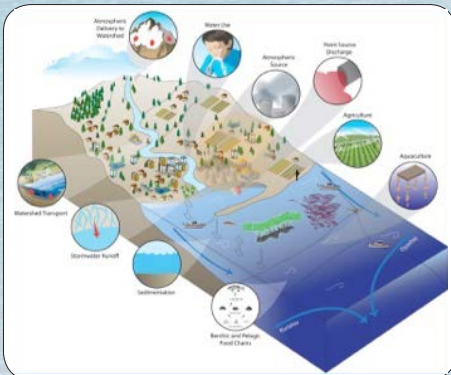
ECOSYSTEM PROTECTION

- 274 Peer-reviewed publications since 2010
- 17 + Technical experts

RISK AND DECISION ANALYSIS

- 169 Peer-reviewed publications since 2010
- 15 + Technical experts

Experimental Platforms and Key Capabilities

In addition to our technical experts, PNNL maintains state-of-the-art experimental and computational platforms central to providing the scientific and engineering knowledge necessary to:

- Conduct characterization and investigative assessments to determine the **quantitative system dynamics** of complex environmental issues that provide the technical basis or restoration and mitigation alternatives

- Apply scientific and analytical methods to develop and evaluate **ecosystem restoration** alternatives in freshwater, saltwater, and semiarid environments

- Ensure **ecosystem protection** through the development of environmental management and monitoring plans

- Conduct **risk and decision analysis** to evaluate risk and tradeoffs and facilitate effective communication between regulators and stakeholders

Energy Production and Climate Effects

Our experience in energy production and climate change effects on the environment enables our researchers to evaluate the cumulative impacts associated with energy development and climate change on complex environmental systems, which is essential to informing comprehensive, scientifically- based decision-making. Expertise includes:

- Local and regional impacts analyses, incorporating emissions and other climate change effects

- Integrated modeling under varying climate change and sea level rise scenarios

- Land-use/land-cover change analyses

Coastal Carbon, Ocean Acidification, and Coastal Analysis

PNNL researchers investigate nutrient loadings, cycles, and uptake in aquatic systems, including the global atmospheric carbon cycle and its role in ocean acidification, nitrogen loadings and hypoxia, and the effects of other airborne toxins on aquatic systems. Capabilities include:

- Coastal biogeochemistry

- Integrated coastal ocean modeling

- Coastal risk management
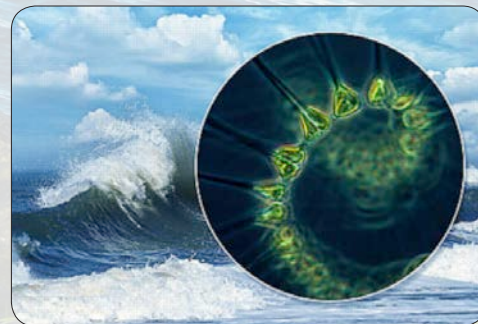
Human Health and Ecological Risk Assessment

A key to quantitatively evaluate near-term human health and operational environmental impacts and long-term performance and risks associated with natural resource management alternatives is understanding the proposed actions and options in the context of the physical, hydrologic and biological framework of the impacted environment. PNNL hydrologists have considerable experience and expertise integrating predictive tools with analysis capabilities of other multi-disciplinary teams to assess local- and regional-scale water quality, human health and ecosystem impacts. Expertise includes:

- Terrestrial and coastal ecosystem research
- Performance and risk assessment
- Environmental biomarkers

Remote Sensing for Landscape Assessment

Effective rangeland monitoring in the western US is challenging because land areas are vast, environmental conditions are subject to rapid and continuous change, there are multiple land uses and stakeholders interests, and financial resources to conduct monitoring are limited. PNNL researchers have developed tools to increase both the efficiency and effectiveness of rangeland monitoring, using a monitoring strategy that combines the broad area coverage and low unit costs available through remote sensing with data fusion methods that invoke both statistical and GIS-based analytical tools. Expertise includes:

- Remote sensing
- Landscape ecology
- Geospatial and geostatistical analysis
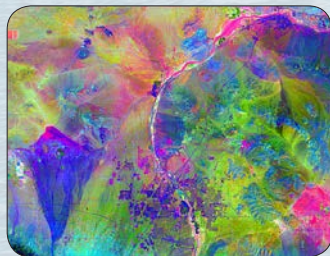
Regional-scale Restoration Planning

Restoration occurs at multiple sites and the collective effects are important to ecosystem function and species recovery. PNNL researchers develop and deploy science and technology to help governmental agencies and corporate land managers accomplish their primary missions while protecting and enhancing ecological resources. PNNL offers in-depth knowledge of ecosystem management that balances operational demands with effective stewardship of natural resources. Capabilities include:

- Terrestrial and coastal restoration
- Coastal ecosystem research
- Watershed modeling
- Climate adaptation modeling
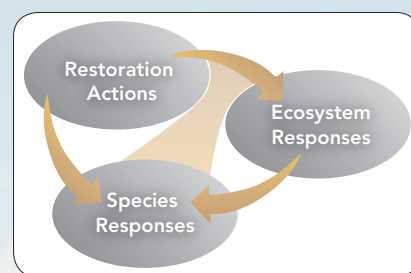
## Sustainable Offshore and Coastal Development

PNNL researchers are developing tools and conducting studies that will help the nation realize significant sustainable renewable energy from the nearshore and ocean environments. Our research programs are directed towards predicting and mitigating impacts of tidal, wave, ocean thermal, and offshore wind energy systems on coastal environments, optimizing siting of coastal energy installations, optimizing technologies to meet environmental and power production goals, and optimizing production of biofuels by marine algae. Expertise includes:

- Marine and hydrokinetic energy effects analysis
- Offshore, basin, and regional coastal modeling
- Scale test facility at PNNL's Marine Sciences Laboratory

River Systems

Our scientists and engineers possess both the depth and breadth of expertise in the scientific underpinnings and engineering applications associated with physical processes of riverine ecosystems. We employ state-of-the-art methods, electronics, sensors, computer hardware and software in our work on life history, behavioral, physiological, and physical habitat studies for many species, including pacific lamprey, white sturgeon, steelhead trout, and several species of Pacific salmon. The results of our studies lead to scientifically-based management plans, as well as mitigation, restoration, and enhancement strategies. Expertise includes:
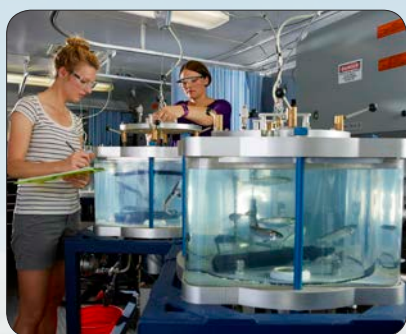
- Riverine processes and ecology
- Juvenile fish physiology and behavior
- Fish bypass and advanced turbine design
- Fish tracking and habitat mapping

Land Analyses

PNNL researchers have many years' experience in the characterization and monitoring of arid landscapes. They conduct surveys and collect data to monitor the status and condition of biological resources. Research is conducted at all scales, from the individual plant/animal to landscape-level processes. This information is used to identify sensitive habitats and species, and assure compliance with legal and regulatory requirements. Products from this research include:
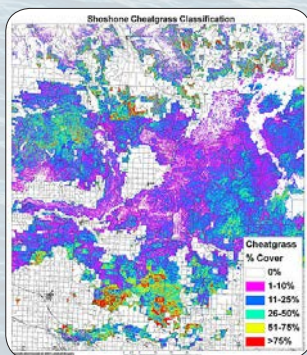
- Vegetation mapping
- Habitat suitability modeling for sensitive species
- Analysis of population trends for both plants and animals
- Characterizing ecological risk

Risk and Decision Analysis

Decisions related to environmental restoration and protection are extremely important to maintaining the delicate balance between human and natural systems. Risk and decision analysis are often used to support decision-making in uncertain and complex natural or engineered systems. These decision-support systems assist in evaluating the risk and tradeoffs of proposed mitigation and/or restoration alternatives and facilitate effective communication of information to key stakeholders in ways that are easy to understand, defensible, and consistent. Expertise includes:

- Stakeholder engagement and outreach
- Uncertainty characterization and modeling
- Integrated earth systems modeling
- Data visualization and decision support

Environmental Restoration and Protection Capabilities

Stewarding DOE's only marine science laboratory, PNNL researchers tackle the most challenging and complex environmental issues in marine and freshwater ecosystems through use of nationally recognized laboratories and facilities. With expertise in microbial communities and molecular sciences, hydrological and coastal sciences and engineering, marine aquatic sciences and engineering, and earth systems science, PNNL provides state-of-the-art equipment and resources for coastal carbon and ocean acidification analyses, coastal modeling research, ecological risk evaluations, molecular characterization, NEPA analyses, biotechnology development, climate adaptation analyses, and remote sensing analytics and applications, among many other research areas.

Microbial Communities and Molecular Ecology Sciences

- Molecular characterization
- Environmental sample processing
- Vertebrate/invertebrate physiological and molecular measurements
- Biotechnology development

Hydrological and Coastal Science and Engineering

- Hydrological processes
- Watershed modeling
- Water resource decision analysis
- Nearshore and wetland restoration planning and prioritization
- Integrated coastal ocean modeling
- Off-shore, basin, and regional coastal modeling
- Climate adaptation modeling

Marine and Aquatic Sciences and Engineering

- Seawater and freshwater mesocosms and aquatic testing
- Biotechnology development
- Ecosystem characterization
- Estuary and river restoration
- Coastal carbon and ocean acidification
- Ecological risk assessment
- Aquatic research testing with groundwater, surface water, and hypoheic systems

Earth Systems Science

- Terrestrial resources characterization
- Remote sensing analytics and applications
- Risk and decision analysis
- Human health and ecological risk assessment
- Water resource management
- Institutional computing

For more information, please contact:

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