RESOURCE & ECOSYSTEMS MANAGEMENT

A Technical Resource for Government and Private Industry

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Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Addressing Issues for

Water and Fish Resources Management

Declining water resources, endangered species, and competing needs have created a high-stakes controversy over the allocation of water resources. In the Northwest, power providers are locked in a debate with environmentalists over the economic and environmental benefits of breaching dams to protect endangered species. Throughout the nation, hydropower, fisheries, irrigation, commercial industry, and municipalities are struggling to meet operational demands with limited water supplies. The issues urgently call for scientifically based solutions that will protect salmon and other endangered species, yet meet the needs of people who rely on the river systems.

Addressing these key issues is a major research mission of the Pacific Northwest National Laboratory. For the past twenty years, our in-depth research and advanced technologies have supported critical decisions affecting hydroelectric dam and marine operations in the Pacific Northwest. Our work has included detailed, specific studies of juvenile fish behavior or toxicity studies for individual species. Our engineering projects have involved fish bypass structures and new turbine designs. Field studies have examined basin-scale watersheds to determine water resource volumes and stream flows on a regional basis.

We have scientific equipment and specialized facilities for research related to water resources and impacts to fish, wildlife, and the fragile aquatic ecology of river systems.

Our **aquatics laboratory** is equipped for in-vitro tests involving toxicity, fish physiology and behavior, and modeling of ecosytems. We control environmental factors, such as temperature and lighting, in the fish tanks to simulate seasonal and diurnal cycles. Rainbow trout, Chinook salmon and a variety of cold- and warmer-water species and invertebrate organisms are reared and cultured for research needs.

We have developed unique **fish tracking and habitat mapping** equipment to determine migration patterns of endangered fish species. Our innovative research tools include passive transponder tag systems, radio-tracking devices, mobile- and fixed-location hydro-acoustical sensor systems, underwater sonic and video cameras, acoustic- and laser-doppler flow quantification tools, and boat-based surveying and collection equipment with global positioning systems (GPS) and geographic information systems (GIS).

Our **water resource management tools** use advanced visualization and GIS algorithms to simulate flow and transport within watersheds, rivers and estuaries, lakes, and harbors. Our technologies encompass hydrologic forecasting, watershed analysis, ecological assessments, and water resource planning. For subsurface applications, we have developed a suite of modeling tools, including the CFEST and STOMP codes, which provide accurate plume maps for managing water resources within aquifer systems, as well as watershed-scale assessments of the effects of climate change, land use, landform modification, and water use on watershed performance.

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Project Summaries

Through numerous research projects, we have examined potential adverse impacts on fish, wildlife, and the fragile aquatic ecology of river systems. Our work has helped solve complex problems and has influenced important decisions on water management practices.

Modeling of Columbia and Snake River Systems -- In work for the U.S. Army Corps of Engineers, we developed and applied mathematical models of unsteady state flow and gas transport to the Columbia and Snake River Systems to predict flow volumes, velocities, temperatures, and dissolved gas concentrations. The research was used to determine impacts to fish and aquatic habitats and was factored into structural designs and operational alternatives for hydropower dams.

Salmon Recovery Studies -- A project for the U.S. Army Corps of Engineers, Walla Walla District, evaluated the effectiveness of surface bypass collectors for recovery of juvenile salmon in the Columbia and Snake River Basins. Our researchers applied fixed-location hydro-acoustic sampling devices and other field techniques to quantify fish passage, guidance efficiency, and hydraulic conditions. The study was used to support deployment of surface bypass collectors at hydropower dams to improve the survivability of migrating juvenile salmon.

Predicting Impacts to Salmon Survival -- To better understand the impact of hydroelectric dams on salmon survival, our scientists have coupled reservoir and aquatic ecosystem models to predict dissolved gas concentrations down-stream from spill operations at hydropower dams. The U.S. Army Corps of Engineers used these exposure predictions to determine impacts on juvenile salmon migrating within the Columbia and Snake River systems.

Impacts of Road Construction and Timber Harvest -- In work for a private client, we developed a GIS-based watershed model to evaluate the impacts of road construction and timber harvest on watershed hydrology. We used the spatially based vegetative model to predict new drainage basins and runoff patterns that ultimately could affect local surface water supplies.

Mapping of Chinook Salmon in Puget Sound – We conducted a study to help the Washington State Department of Transportation determine optimum routes for expanded ferry service without harming critical salmon habitats. The work involved use of side-scan sonar to map the eelgrass habitat of Chinook salmon in Puget Sound.

Monitoring, modeling and assessment services

- River and Estuarine Modeling
- Watershed Modeling
- Water Quality Modeling
- Water Resource Optimization
- Monitoring System Design
- Online Database Resources
- Integrated Environmental Monitoring
- Engineered Systems Assessments

In Hydrologic Sciences

"Taking Stock and Looking Ahead," **The National Research Council noted that our research in watershed hydrology** "represents the state-of-the-art in spatial modeling."