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REPORT
IN BRIEF

Fishes, Hydrology, and Ecology of the Klamath River Basin

The Klamath River basin in southern Oregon and northern California is the focus of a prominent conflict over competing uses for water in the American West. Management measures for the protection of threatened and endangered fish species in the basin that have left less water available for irrigation have increased tensions among farmers and other stakeholders and brought into question the scientific justification of these measures. Two National Research Council studies evaluate a series of federal scientific assessments and recommend scientifically justified approaches to the problem.

The Klamath River basin, spanning parts of southern Oregon and northern California, is a critical water resource for local residents and farms—as well as for two endangered and one threatened fish species. Regulatory actions resulting from a series of scientific assessments aimed at restoring these fish species have increased tensions among competing water users in the area since the late 1990s.

In 2001, the U.S. Bureau of Reclamation issued an analysis of a proposed operating regime for the Klamath Project, which diverts the basin's water for use in irrigation. The proposed regime could have resulted in reduced minimum water flows in the Klamath River and lower minimum water levels in Upper Klamath Lake. In response to this assessment, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service issued what are known as “biological opinions,” which called for measures to increase the water flows and lake levels to protect threatened and endangered fish species. These measures effectively reduced the amount of water available for irrigation; the problem for irrigators was exacerbated by a very dry year in 2001.

At the request of the U.S. Department of the Interior and the U.S. Department of Commerce, the National Research Council (NRC) convened a committee to assess the scientific support for increasing water flow and lake lev-



The Klamath River. SOURCE: W. L. Graf.

els as a way to restore the fish populations. The committee's first (interim) report, *Scientific Evaluation of Biological Opinions on Endangered and Threatened Fishes in the Klamath River Basin: Interim Report* (2002), concluded that the available data did not justify the flow and water-level increases in the river and lake for protecting the fish species in the basin. The committee's final report, *Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline and Strategies for Recovery* (2004), recommended a broad approach to restoring the fish populations, by incorporating measures to address a multitude of contributing factors in the species' decline.

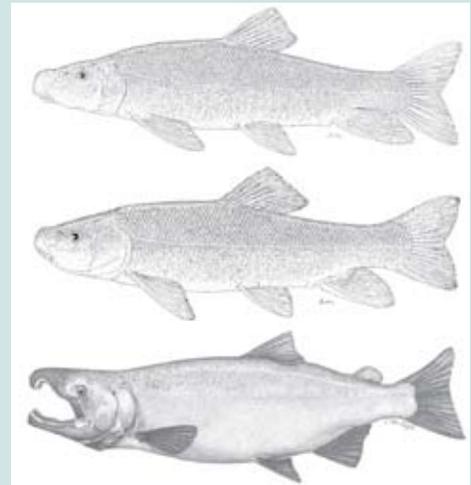
The NRC later convened a new committee at the request of the U.S. Department of the Interior to evaluate two new documents pertaining to the basin and its fishes. That

Threatened and Endangered Fishes in the Klamath River Basin

Three fish species lie at the heart of the Klamath River Basin conflict: the shortnose sucker (*Chasmistes brevirostris*), the Lost River sucker (*Deltistes luxatus*), and the coho salmon (*Oncorhynchus kisutch*). Once plentiful enough to support commercial fisheries, the shortnose sucker and Lost River sucker declined so much during the last half of the twentieth century that they were listed in 1988 as endangered under the federal Endangered Species Act. Although they spend most of their lives in lakes, fish of both species migrate or attempt to migrate into tributaries for spawning. Shortly after hatching, the young fish return to the lake, where they occupy shallow water at first and move to progressively greater depths as they mature.

The Klamath River's coho salmon population is part of the genetically distinct Southern Oregon/Northern California Coast population, which was listed as threatened in 1997. The coho salmon is an anadromous fish—it grows to adulthood in salt water but swims into freshwater streams to spawn. Juveniles spend the first 14-18 months of life in fresh water before migrating to the sea.

Some of the factors that may have contributed to the decline of these species include: deterioration in water quality and degradation of spawning habitat in some areas, overfishing, introduction of exotic species, blockage of migration routes, and entrainment of fish in water-management structures. The threatened coho salmon also may be affected by changes in the seasonal water flow patterns, substantial warming of the main stem and tributaries, and continuing introduction of large numbers of hatchery-reared coho.



Lost River sucker (Top), shortnose sucker (Middle), coho salmon (Bottom). SOURCE: Drawn by A. Marciochi (coho salmon drawn by C. M. van Dyck). Copyright University of California Press.

committee's report, *Hydrology, Ecology, and Fishes of the Klamath River Basin* (2007), evaluates the scientific assessments *Natural Flow of the Upper Klamath River* and *Instream Flow Phase II* (also known as *Hardy Phase II*). The committee's report also addresses the broader questions of the ecological needs of the basin's fishes and the importance of a comprehensive view of the basin's scientific needs.

History: Fish and Competing Water Uses in the Klamath River Basin

Federal Assessments

When species are listed as threatened or endangered under the Endangered Species Act, federal actions must be tailored to avoid causing harm to those species. The Act therefore requires that any action that could affect species listed as threatened or endangered have a scientific and technical justification to determine that it will not adversely affect those species. The burden for this justification falls mainly on the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, which have authority to issue biological opinions on proposed actions. If an action is judged to be harmful to the listed species, then the agency overseeing the action must deny the action or set conditions for its modification.

After the U.S. Bureau of Reclamation proposed an operating regime for the Klamath Project that could result in reduced minimum flows in the Klamath River and lower minimum water levels in Upper Klamath Lake, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service issued biological opinions on the proposal's potential implications for the basin's threatened and endangered fish species. The biological opinions concluded that lower flows and water levels would harm the listed species in the Klamath River basin and recommended that higher flows in the river and higher water levels in the lake be maintained for the benefit of the endangered and threatened fishes.

Federal agencies play several potentially conflicting roles in the management of the basin's water resources. While the U.S. Fish and Wildlife Service (of the Department of the Interior) and the National Marine Fisheries Service (of the Department of Commerce) are charged with protecting threatened and endangered species, the U.S. Bureau of Reclamation (of the Department of the Interior) is obligated to serve the needs of irrigators.

Competing Uses and Conflict

As with most water resources, the Klamath River basin supports a variety of water uses. Irrigation

water from the basin supports 220,000 acres of farmland; in addition to farmers, major stakeholders in the basin's water include commercial fishermen, Native Americans, conservationists, anglers, and hydropower producers.

In 2001, conflicts over the basin's water resources intensified when tighter restrictions on the use of water for irrigation coincided with a severe drought, severely impairing irrigated agriculture and causing substantial economic losses. The restrictions on water supply and the changes in water management were a source of great frustration to irrigators, causing many to bring into question the basis for the water management decisions.

Mass Mortality Events

Mass mortality events have affected several fish species in the basin. In 2002, about 30,000 migrating adult salmon were killed in the Klamath River by two common pathogens lethal to fish under stress. Most of the salmon killed were Chinook—which are not listed as endangered or threatened—but the event brought attention to the basin's ecological condition and intensified the controversy over the area's water operations.

Mass mortality events affecting suckers in Upper Klamath Lake have occurred for many decades. These are generally attributed to periodic algal blooms, which cause depletion of oxygen in the water. The authoring committee of the National Research Council report *Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline and Strategies for Recovery* (2004) found no relationship between water levels in Upper Klamath Lake and the frequency or severity of mass mortalities of suckers.

National Research Council Recommendations

The government asked the National Research Council to evaluate the federal assessments and biological opinions regarding water flows for Klamath River and lake levels for Upper Klamath Lake. The first report issued by the NRC, *Scientific Evaluation of Biological Opinions on Endangered and Threatened Fishes in the Klamath River Basin: Interim Report*, agreed with almost everything the opinions concluded, with two important exceptions. First, the NRC report found no clear scientific or technical support for the higher water-level or flow requirements. Second, the report also found no support for new operating practices that could have led to lower minimum water levels in Upper Klamath Lake or lower minimum flows of the Klamath River at Iron Gate Dam.

The second report issued by the NRC, *Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline and Strategies for Recovery*, concluded that, instead of focusing primarily on how water levels and flows affect the basin's threatened and endangered fish species, federal agencies should pay greater attention to other causes of harm to confront the root causes of the species' decline. The report identified several potentially effective initiatives to protect the fish, such as removing migration obstacles, improving habitat, and reducing summer water temperatures in the basin's tributaries. Both that report and a later report, *Hydrology, Ecology, and Fishes of the Klamath River Basin*, conclude that a more coherent, systematic, and comprehensive analysis of scientific and management needs for the basin should be conducted to identify the most important and urgent science needs to inform management decisions.

Recommendations Pertaining to the Natural Flow Study and Instream Flow Study

The most recent NRC report, *Hydrology, Ecology, and Fishes of the Klamath River Basin*, evaluates two recent studies that were designed to inform decision makers about the hydrology and fish ecology of the Klamath River basin. The first study, *Natural Flow of the Upper Klamath River* (here called the "Natural Flow Study") estimates the flows that would be observed if there were no agricultural development in the upper Klamath basin, in order to define the hydrologic conditions that supported the pre-development fish populations. The second study, *Instream Flow Phase II* (here called the "Instream Flow Study"), creates a model-based linkage between the hydrology and the resulting aquatic ecosystems that support the fish populations in the river.

The Natural Flow Study

Hydrology, Ecology, and Fishes of the Klamath River Basin concludes that the flows calculated in the Natural Flow Study are at best first approximations to useful estimates. Although the study does provide some basis for understanding natural flows in the basin, the NRC report identifies several fundamental shortcomings compromising the study's conclusions, including flaws in the construction and calibration of the model.

The Instream Flow Study

The estimates developed in the Natural Flow Study served as inputs to the Instream Flow Study, which investigates the relationship between water

flows and anadromous fish populations (including the threatened coho salmon). The most important outcome of the Instream Flow Study was that it indicated that increases in existing flows downstream from Iron Gate Dam probably would benefit fish populations. If these conclusions are borne out by future experimental studies, managers would be able to have greater confidence in the benefits of decisions to increase flows.

Hydrology, Ecology, and Fishes of the Klamath River Basin identifies some significant shortcomings of the Instream Flow Study, including the use of monthly data instead of daily, a lack of tributary analyses, and shortcomings in the study's experimental design. However, the report concludes that, despite these limitations, the flows recommended by the Instream Flow Study probably would have some beneficial effects on the suite of anadromous fishes in the Klamath River considered as a whole, although not necessarily for every species.

The Need for a Framework to Connect Science and Decision Making

Integrating science with effective decision making has been problematic in the Klamath River Basin as managers have struggled to deliver water

to users, sustain downstream fisheries, and protect populations of threatened and endangered species. *Hydrology, Ecology, and Fishes of the Klamath River Basin* concludes that assessments including the Natural Flow Study and the Instream Flow Phase II are not likely to contribute effectively to sound decision making until political and scientific arrangements that permit more cooperative and functional decision making can be developed.

That report also identifies a need for a "big picture" perspective based on a conceptual model encompassing the entire Klamath River basin and its many components. It recommends that agencies, researchers, decision makers, and stakeholders together define basin-wide science needs and priorities to address the basin's science and management needs. When the science needs for the basin are better characterized, the individual studies necessary to create a sound science-based body of knowledge for decision makers and managers will be more easily identified.

A hopeful vision is that increased knowledge, improved management, and cohesive community action will promote recovery of the threatened and endangered fishes in the Klamath River Basin. Such an outcome could also provide a model for the nation.

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Committee on Endangered and Threatened Fishes in the Klamath River Basin: William M. Lewis, Jr. (*Chair*), University of Colorado; Richard M. Adams, Oregon State University; Ellis B. Cowling, North Carolina State University; Eugene S. Helfman, University of Georgia; Charles D. D. Howard, Consulting Engineer; Robert J. Huggett, Michigan State University; Nancy E. Langston, University of Wisconsin; Jeffrey F. Mount, University of California, Davis; Peter B. Moyle, University of California, Davis; Tammy J. Newcomb, Michigan Department of Natural Resources; Michael L. Pace, Institute of Ecosystem Studies; J.B. Ruhl, Florida State University; Suzanne van Drunick (*Project Director*) and David J. Policansky (*Associate Director and Senior Program Director for Applied Ecology*), National Research Council.

This report brief was prepared by the National Research Council based on the committees' reports, *Hydrology, Ecology, and Fishes of the Klamath River Basin* (2007), *Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline and Strategies for Recovery* (2004), and *Scientific Evaluation of Biological Opinions on Endangered and Threatened Fishes in the Klamath River Basin: Interim Report* (2002). For more information or copies, contact the Board on Environmental Studies and Toxicology at (202) 334-3060 or visit <http://nationalacademies.org/best>. Copies of the reports are available from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; www.nap.edu.

