that enter the system from upstream spawning areas. The U.S. Geological Survey developed a calibrated hydrodynamic and heat model for the Upper Klamath and Agency Lake system based on continuous measurements of velocity and temperature. This model was expanded to include the newly inundated portions of the Williamson River Delta. A series of numerical experiments were designed to determine the expected changes in travel time and the drift pathways of larval suckers entering the Delta from the Williamson River. Based on preliminary model runs, it is expected that restoration of the Delta will increase the travel time of sucker larvae from spawning sites in the Williamson River to Upper Klamath Lake and ultimately to the outlet of the lake at the Link River Dam for a given set of meteorological and hydrological conditions. Travel time is also strongly affected by the management of the lake in terms of lake elevation and outflow. To validate the results of numerical experiments we sampled larval sucker density in the Williamson River and Upper Klamath Lake prior to restoration and within and surrounding the Delta after restoration in 2008 and 2009. Samples were collected during the larval sucker migration period at strategically selected locations along modeled flow paths. Here we present the preliminary results of a comparison between sampled and modeled larval sucker densities.

Sprague River Basin Geomorphology Datasets

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The Sprague River basin encompasses about 1,610 square miles (4,170 square kilometers) of south central Oregon and is a principle tributary (via the Williamson River) of upper Klamath Lake. The lower reaches of the North Fork and South Fork Sprague River, the Sycan River, and the 86 miles (139 kilometers) of the mainstem Sprague River meander through broad alluvial valleys historically supporting agricultural crops and livestock grazing. National and regional interest in restoring Klamath Basin ecosystem conditions and processes has motivated several restoration strategies and projects in the Sprague River basin to improve aquatic, riparian, and upland habitat conditions, particularly for endangered fish species. This study, jointly conducted by the U.S. Geological Survey and University of Oregon and in cooperation with the U.S. Fish and Wildlife Service Klamath Basin Ecosystem Restoration Office and the Hatfield Restoration Program, documents historical and current channel and floodplain processes and conditions to assist management and regulatory agencies in evaluating restoration proposals and designing effective restoration and monitoring strategies for the Sprague River and its principle tributaries. The study involves multiple analyses, including assessments of historical channel change, riparian and floodplain vegetation, and surficial geology. To support these analyses, digital floodplain and channel maps were prepared to depict channel and floodplain conditions at different times. The geospatial database of current and historic channel and floodplain conditions will also enable evaluation of long-term trends pertaining to aquatic and riparian habitat conditions.

Klamath River Thermal Refugia as Critical Habitat for Threatened Juvenile Salmonids

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Late summer and early fall water temperatures on the Klamath River can reach levels that are physiologically stressful to endangered and threatened salmonids. At the limits of their thermal tolerance, salmonids may behaviorally thermoregulate by moving to localized patches of colder water, or thermal refugia. The presence of these refugia may be key to salmonid survival, especially during periods of elevated mainstem temperatures when refugia may be the only usable habitat available, yet their dynamics and importance are not thoroughly understood. While fish obtain thermal benefits by using refugia, trade-offs may include lower food availability and increased risk of disease, and the interplay between these factors influences how much time a fish chooses to spend in the mainstem river versus the refugia. My research focuses on defining the mechanisms driving salmonid thermal refugia use at both landscape and local scales, and the implications refugia use has for salmonid growth and survival. Previous studies have not explored the potential importance of diurnal temperature variations in determining juvenile salmonid survival. The energetic costs of surviving at daily maximum temperatures may make these temperatures critical for determining overall salmonid survival. Knowledge of individual salmonid behavior surrounding refugia is key to understanding how factors such as diurnal temperature variations and heterogeneous food availability impact salmonid growth and survival. To address these issues, I will conduct radio tracking studies to measure fine-scale spatiotemporal use of thermal refugia by individual juvenile salmonids. I will correlate these data with a high-resolution stream temperature model currently being developed by the National Marine Fisheries Service, which tracks Klamath mainstem diurnal temperature fluctuations. Finally, the results of my fieldwork will be integrated into a temperature and food driven bioenergetics model, which will allow me to gain a mechanistic understanding of the relative importance and long-term consequences of the factors affecting salmonid use of thermal refugia.

An Assessment of Using Wild-caught Larval and Juvenile Lost River and Shortnose Suckers for Supplementation Purposes

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Low adult survival and inadequate recruitment threaten Lost River suckers (*Deltistes luxatus*) and shortnose suckers (*Chasmistes brevirostris*) with extinction. In an effort to determine the feasibility of using wild-caught age 0 suckers for supplementation purposes, we collected larval and juvenile suckers from Upper Klamath Lake (UKL) and adjacent habitats in 2006 and 2007 and reared them.

Substantial numbers of larvae were collected using light traps and small dipnets in conjunction with bright underwater lights at night in Lake Euwauna near the outlet of the Link River in 2006. Additionally, numerous larvae were collected in the Williamson River approximately 1 mile upstream of UKL using dipnets during daylight collection and using dipnets and bright underwater lights during night collection in 2006 and 2007. Larval survival from collection to arrival at the rearing facility was above 95 percent. While pathogen and water quality problems were encountered raising sucker larvae and juveniles in the rearing facility, sucker larvae were successfully reared to sub-adult size in 2 years in small ponds with thermally-heated water, demonstrating that it is feasible to artificially rear wild-caught larvae provided that good water quality, nutritious foods, and adequate pathogen-control protocols are provided.

Juvenile suckers were collected in a screw trap in the Link River during late summer 2006, using fyke nets in the Caladonia Marsh when it was flooded during 2007, and using nets and electroshockers during fall 2007 canal salvage operations. Juvenile survival from collection to arrival at the rearing facility was 99 percent; however, juveniles generally were in poor condition due to high pathogen loads

Proceedings of the Klamath Basin Science Conference, Medford, Oregon, February 1–5, 2010

Edited by Lyman Thorsteinson, Scott VanderKooi, and Walter Duffy

Open-File Report 2011–1196

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2011

Suggested citation:
Thorsteinson, Lyman, VanderKooi, Scott, and Duffy, Walter, eds., 2011, Proceedings of the Klamath Basin Science Conference, Medford, Oregon, February 1–5, 2010: U.S. Geological Survey Open-File Report 2011-1196, 312 p.