

Category II: Aquatic Ecosystems

Distribution, Movement, & Outmigration of Juvenile Coho Salmon in the Shasta River: Relationships with Environmental Factors and Irrigation Water Management

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EXECUTIVE SUMMARY

Coho salmon (*Oncorhynchus kisutch*) within the Southern Oregon / Northern California Coasts Evolutionary Significant Unit (SONCC ESU), which includes the Shasta River watershed, were listed as threatened under the federal Endangered Species Act in 1997, and as threatened under the California Endangered Species Act in 2005. Agricultural water use, such as pasture irrigation, has been implicated in the decline of coho salmon in the Shasta River, yet there is little information regarding the response of coho salmon to environmental factors related to agricultural practices. This state of affairs severely hampers conservation and restoration efforts, while causing great uncertainty and concern for agricultural water uses in the watershed. In order to begin to rectify this situation, we will test the following hypotheses:

1. Juvenile coho salmon distribution, habitat use, & outmigration timing can be predicted by environmental factors such as flow, temperature, and dissolved oxygen.
2. Juvenile coho salmon over-summer in refugia areas with colder water than the majority of the Shasta River.
3. Coho salmon age of outmigration is related to spawning and rearing location.
4. Reach scale water temperature models may be inadequate to describe and predict juvenile coho distribution and habitat.

Our objectives are to

- (1) Collect data at a range of temporal and spatial scales to allow us to develop predictive relationships between coho salmon distribution, movement, and outmigration, and environmental factors such as flow, temperature, stream and riparian habitat, dissolved oxygen, water quality, and agricultural practices.

(2) Examine the role that sources of cold water refugia play in allowing coho salmon to persist in streams that are inherently warm.

(3) Determine rearing locations of juvenile coho salmon, and to relate these locations to spawning locations, cold-water refugia, and to eventual age-of-outmigration. Outmigrant juvenile coho salmon captured at the California Department of Fish and Game rotary screw trap at the mouth of the Shasta River are observed from two age classes, 0+ (young-of-the-year), and 1+. Typically, coho salmon are expected to outmigrate at age 1+. The outmigration of 0+ coho salmon has led to concerns that they are leaving early due to poor rearing conditions in the Shasta River, and that few, if any, of these early outmigrants will survive to reproduce.

Sampling for water quality, habitat, and juvenile coho salmon will be done along the mainstem Shasta River in 5 reaches between Dwinnell Dam and the confluence with the Klamath River. Flow data will be collected on a reach basis where logistically feasible, to supplement data collected on a continuous basis by the Department of Water Resources. Coho salmon will be captured in minnow traps and marked with a passive integrated transponder (PIT) tag. Two PIT antenna arrays will be operated at the downstream boundaries of reaches 1 and 4 (lower river and mid-river), to monitor the movement of PIT tagged coho salmon on a continuous basis. Marked fish may also be re-detected in subsequent trap surveys, or at the outmigrant rotary screw trap operated by the California Department of Fish and Game on the Shasta River at its confluence with the Klamath River.

Our results will be of immediate and direct use to managers and stakeholders involved in the management and recovery of coho salmon in the Shasta River, as well as to agricultural water users in the watershed. We will help to determine the current ecosystem baseline conditions affecting coho salmon. We will develop conceptual and numerical models relating the rearing and outmigration of coho salmon to environmental factors. Graphical analysis will be used to present temperature and fish catch data along the length of the river at a given time period, and over time in each reach. Data will be analyzed using linear mixed effects models (in S-Plus), in order to relate fish distribution, habitat use, and outmigration to environmental factors. Linear mixed effects analysis has distinct advantages for analyses of repeated measures field studies such as this one, and has been used successfully to analyze other California stream data sets. This study will help to guide the selection of future restoration actions, by pinpointing the locations and times at which these may be most effective. In addition it will provide a template for the field studies necessary to monitor ecosystem response to future management and recovery actions. Our results will aid in the design of irrigation best management practices targeted at minimizing impacts on coho salmon. The project will lead to increased landowner awareness and knowledge of fish habitat requirements, which in turn may lead to landowners having a greater understanding of coho salmon recovery actions.