UIdaho Law
Digital Commons @ UIdaho Law

In re Klamath River (Klamath Tribe)

Hedden-Nicely

12-4-2009

# Ex. 280-US-469

United States Forest Service

# Fivemile Creek Instream Flow

## Introduction

In 1990 the State of Oregon began the process of adjudicating water rights within the Klamath River Basin for water users with pre-1909 claims to water. The U.S. Forest Service (USFS) manages three forests within the Klamath Basin; the Fremont, Klamath, and Winema National Forests.

The Water Resources Team, situated on the Winema National Forest, was charged with quantifying the instream flow and consumptive water uses of the Forest Service Pacific Northwest and Pacific Southwest Regions within Oregon. Part of that charge involved development of fisheries claims based on the Multiple-Use Sustained-Yield Act of 1960. Flow, channel morphology, and fisheries data were collected, compiled, and analyzed in preparation of the fisheries water rights claims. The fisheries claims took the form of monthly minimum values as determined using two methods. An incremental flow model (PHABSIM) was used to determine recommended minimum monthly fisheries streamflows. Flows necessary to maintain fisheries habitat, i.e. channel maintenance flows, are superimposed upon the PHABSIM derived values. Quantities for these higher, less frequent, channel maintaining flows were determined through analysis of bedload sediment transport relationships.

The following report is a summarization of the steps taken to determine fisheries habitat flow recommendations for the adjudication process. It has been prepared to disseminate data to resource personnel for use in forest management decisions.

## Methods

Fivemile Creek is a 4th order stream that flows 28.1 miles to its confluence with the North Fork of the Sprague River. Ownership is a mixture of private (51%) and USFS (49%). At the lowermost Forest Service boundary at rivermile (RM) 10.9 (42°31'N, 121°07'W), the stream has a drainage area of 35.4 $mi^2$. Because the springs that feed most of the flow during baseflow originate at about RM 16, the upstream portion of the creek is dry through the baseflow months and only has flow during spring runoff or after precipitation events. Due to private property throughout the watershed and lack of flow at the upper end, only 3.1 miles of stream within National Forest land (RM 10.9-14.0) were surveyed in the 1992 Hankin and Reeves

USFS Stream Survey. This reach was characterized as a low gradient (<1%), non-sinuous stretch of river with sand and gravel substrate and lots of fish cover from large woody debris, undercut banks, and pocketwater pool formations. There are no known records of native fish in Fivemile Creek prior to the stocking of brook trout in 1940 and 1944 and rainbow trout from 1943 to 1957 by the Oregon Department of Fish and Wildlife. Presently, redband trout and brown trout occur in the stream.

The Physical Habitat Simulation System (PHABSIM) was used to model fish habitat in the stream and to make flow recommendations. The protocol for using PHABSIM is described in detail elsewhere (Milhous et al. 1989) and only a brief overview will be made here. The purpose of PHABSIM is to simulate a relationship between streamflow and physical habitat for various species and lifestages of fish. It consists of overlaying hydraulic simulations that represent the physical properties of the stream channel with Habitat Suitability Index (HSI) curves that represent the biological adequacy of these physical properties for a particular species and lifestage. Combining the physical properties with the suitability curves produces the habitat quantity and quality available for use.

In field measurements, each transect is divided into cells in which depth and velocity are measured over a number of discharges. Cell-by-cell depths and velocities are then simulated over a range of flows using standard hydraulic modeling techniques packaged into the PHABSIM computer software [proper PHABSIM modeling and calibration is technically the most difficult step in analyzing instream flows (Milhous et al. 1989), and is too complicated to discuss here]. Substrate is measured once and assumed to not change over the study period of one field season. It is assumed that the worth of a cell for fish habitat is determined by what the suitability of the depth, velocity, and substrate (represented by HSI curves ) would be at a particular discharge. HSI curve values vary from zero (unsuitable) to one (optimal) and were developed for each species and lifestage for the Upper Klamath River Basin by a regional panel of experts using published curves, existing data, and professional judgement. Each cell has an overall suitability derived from the product of the suitability for depth, velocity, and substrate. For example, a cell with a depth suitability of 1.0, velocity suitability of 0.5, and substrate suitability of 0.5 would have an overall suitability of 0.25 (i.e., 1.0 x 0.5 x 0.5 = 0.25). The PHABSIM model uses simulated depths and velocities, and recorded substrate, to determine the overall suitability for each individual cell at a given discharge.

The sum of the surface area of each cell that contains fish habitat, called Weighted Usable Area (WUA), is expressed as units of $ft^2$/1000 feet of stream length. We produced two quantities of habitat. "Total Weighted Usable Area" is all available habitat, regardless of the overall suitability of each individual cell. Therefore any cell with any suitability (i.e., overall suitability greater than zero) is included in the summation of usable surface area. Cells with overall suitability of 0.75 or greater is included in ">75% Weighted Usable Area". "Total WUA" is therefore defined as the total amount of habitat available for use, whether the quality is high or low, whereas ">75% WUA" is that amount of the total habitat that ranks as optimal habitat.

Continuous water temperature was collected with a datalogger at river elevation 4565' (RM 11.0) from 1992-97. The datalogger also recorded continuous water elevation in the creek, from which a hydrograph was developed for water years 1993-1995 (Figure 1) and 3-year monthly median discharge values were calculated. Using a regional predictive model developed by P. Bakke of the Winema National Forest's Water Resources Team (unpublished data), these 3-year monthly medians were used to predict long-term (30-year) monthly medians for Fivemile Creek, providing a starting point from which to recommend monthly values for fish habitat. Based on the amount of discharge present for a particular month, we analyzed how much total and optimal habitat would be available for all lifestages present during that month, and adjusted our flow recommendation to maximize fish habitat. We rarely recommended a minimum flow of more water than is available according to the long-term monthly prediction. Other anecdotal data (e.g., water temperature, upstream diversions) were also considered when selecting a monthly discharge value. Habitat requirements of threatened/endangered and sensitive fish species that currently exist in the stream were given priority over other species.

Sediment movement data were collected, analyzed, and used to determine a habitat maintenance (channel maintenance) discharge. Flows above the habitat maintenance discharge were determined to be those necessary to maintain a functioning stream channel and thereby maintain the fish habitat. For more information on channel maintenance results, see the corresponding channel maintenance folder for this stream. In instances where the PHABSIM-determined fish habitat discharge value exceeded the fish habitat maintenance discharge value, the habitat maintenance value was used as the monthly recommendation. For example, if 20.0 cfs was determined to provide adequate fish habitat for a given month, and flows of 30.0 cfs and greater were determined to be the flows needed for habitat maintenance, then 20.0 cfs would be the minimum fish flow recommendation. All natural flows between 0 and 20.0 cfs would be defined as necessary for fish habitat. When natural flows exceeded 30 cfs, all water would be defined as necessary for maintaining fish habitat. If the fish habitat maintenance value had been 15 cfs, then 15 cfs would be selected as the final flow recommendation value for that month.

## Results/Discussion

Water temperatures were moderated by the strong spring influence, and averaged around 16°C in the summer and 6°C in the winter during the period of 1992-1996 when we recorded temperature data (Table 1, Figures 2 through 8). Water temperature never dropped below 3°C during the winter (Figures 3 through 8). Temperatures did exceed 20°C each year that summer temperature was recorded (Table 1, Figures 4 through 7), which is well above the standard of 17.8°C set by the Oregon Department of Environmental Quality for trout (Boyd and Sturdevant 1996).

Seven cross sections, 3 riffles and 4 glides, were established in 1992 near the datalogger site to represent the fish habitat in the stream reach (Figure 9). Pool habitat comprised only 6% of the surveyed stretch of stream and therefore no pool cross sections were included in the PHABSIM analysis. Water surface elevations and cell velocities (Figures 10 through 16) were collected on four occasions at discharges of 19.5, 43.6, and 84.8 cfs, and were used for PHABSIM model calibration and simulations. The riffle cross sections were shallow (generally < 2 ft), and velocities approached 6 cfs at riffle 2 at the high calibration discharge but generally remained between 1 and 4 ft/s for most cells across the cross sections. Depths in the glide cross sections were much deeper (up to 4 ft) and velocities never exceeded 4 ft/s at glide 2 or 3 ft/s at the remaining glide cross sections at the highest calibration discharge. The HSI curves were similar between redband and brown trout, which generally ranked velocities less than 1 ft/s as optimal for all lifestages except spawning, which was ranked as optimal between 1 and 3 ft/s (Figures 17 and 18). Depths over 1 ft for adult and juveniles and between 0.5 and 2 ft for fry and spawning were ranked as optimal (Figures 17 and 18). All substrate was considered suitable except for spawning, which generally required small or large gravel for suitable habitat (Figures 17 and 18).

Redband trout, a USFS sensitive species and native to Fivemile Creek, took precedence over brown trout in our flow recommendations. Redband trout spawning period (including incubation) occurs from March to July, whereas brown trout spawn in the fall but egg incubation continues until the following spring (Table 2). The period of time that fry occur is similar between species, and juvenile and adult lifestages are present all year for both species (Table 2).

Total and optimal fish habitat was simulated for brown and redband trout from 18 to 120 cfs (Figure 19 and 20). The range of simulation was limited at the low end to the lowest discharge recorded during this study, and at the high end by overbank flow conditions at our cross sections, above which we generally did not simulate fish habitat. Discharge in Fivemile Creek generally ranges from a summer baseflow of around 18 cfs to a high of up to 240 cfs during peak spring runoff, though water year 1994 was a particularly dry year and discharge never exceeded 30 cfs (Figure 1). Long-term median monthly discharges ranged from a low of 18 cfs during the summer baseflow months to a high of 44 cfs during spring runoff in April (Table 3).

Based on PHABSIM modeling, redband total and optimal habitat is steadily reduced as flows recede from about 50 cfs to 18 cfs, our lowest simulation point. Brown trout total and optimal habitat remains steady over much of the range that habitat was simulated. At any given flow, there was more adult and juvenile redband trout habitat (total or optimal) than brown trout habitat. Month by month justification for final fish values appears in Table 3.

## References


Boyd, M., and D. Sturdevant. 1996. The scientific basis for Oregon's stream temperature standard: common questions and straight answers. Oregon Department of Environmental Quality Report.

Milhous, R. T., M. A. Updike, and D. M. Schneider. 1989. Physical habitat simulation system reference manual - version II. Instream Flow Information Paper 26. U.S. Fish & Wildlife Service, Biol. Rep. 89(16).