12-4-2009

Ex. 277-US-400

Dudley W. Reiser

Ex. 277-US-400
BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF OREGON
for the
WATER RESOURCES DEPARTMENT

In the Matter of the Determination of the Relative Rights of the Waters of the Klamath River, a Tributary of the Pacific Ocean

~~The Nature Conservancy~~; ~~WaterWatch of Oregon, Inc.~~; John M. Mosby; Marilyn Mosby; Robert Cook, TPC, LLC; ~~Dayton O. Hyde; Gerda V. Hyde~~; ~~Wesley E. Sine; Kay M. Sine~~; Roger Nicholson; Richard Nicholson; AgriWater, LLC; Maxine Kizer; Ambrose McAuliffe; Susan McAuliffe; Company; Kenneth L. Tuttle and Karen L. Tuttle dba Double K Ranch; ~~Dave Wood~~; ~~Kenneth Zamzow;~~ Nicholson Investments, LLC; William S. Nicholson; John B. Owens; Kenneth Owens; William L. Brewer; ~~Mary Jane Danforth~~; ~~Jane M. Barnes; Franklin Lockwood Barnes, Jr.~~; Jacob D. Wood; Elmore E. Nicholson; Mary Ann Nicholson; Gerald H. Hawkins; Hawkins Cattle Co.; Owens & Hawkins; Harlowe Ranch; Terry M. Bengard; Tom Bengard; Dwight T. Mebane; Helen

AFFIDAVIT AND DIRECT TESTIMONY OF DUDLEY W. REISER, Ph.D.

Case No. 277

Claims: 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, and that Portion of Claim 612 pertaining to the Williamson River and its tributaries[1]

Contests: ~~1773, 1776, 1777, 1778, 1779, 1780, 1781, 1782, 1783~~[2], ~~2786~~[3], ~~2802, 2807~~[4], ~~3016, 3024, 3025, 3026, 3027, 3028, 3029, 3030, 3031, 3032, 3033, 3034, 3035, 3036, 3037, 3038, 3039~~[5], 3119, 3125, 3126, 3127[6], 3314[7], 3327, 3328, 3329, 3330, 3331, 3332,

[1] Claimant Klamath Tribes filed a notice withdrawing limited parts of its water rights claim. *See* KLAMATH TRIBES' NOTICE OF WITHDRAWAL OF STRUCTURAL HABITAT MAINTENANCE CLAIMS dated July 5, 2005.

[2] On July 17, 2003, Gerda V. Hyde, voluntarily withdrew Contests 1773, 1776, 1777, 1778, 1779, 1780, 1781, 1782, and 1783.

[3] Wesley E. and Kay M. Sine voluntarily withdrew Contest 2786 on March 31, 2006.

[4] The Nature Conservancy voluntarily withdrew Contests 2802 and 2807. *See* NOTICE OF WITHDRAWAL OF CONTESTS dated April 10, 2007.

[5] WaterWatch of Oregon, Inc.'s Contests 3016, 3024, 3025, 3026, 3027, 3028, 3029, 3030, 3031, 3032, 3033, 3034, 3035, 3036, 3037, 3038, and 3039 were dismissed. ORDER DISMISSING WATERWATCH OF OREGON, INC.'S CONTESTS, May 20, 2003.

[6] Change of Title Interest for Contests 3125-3127 from Boyd Braren, Boyd Braren Trust to Robert Cook, TPC, LLC (10/25/05).

[7] On October 31, 2003, William Bryant voluntarily withdrew from Contests 3314, 3328-3338, and 3340-3342. On October 26, 2004, Dave Wood voluntarily withdrew from Contest 3314. Change of Title Interest for Contest 3314 from Roger Nicholson Cattle Co. to AgriWater, LLC (2/4/05). Change of Title Interest for Contest 3314 from Dorothy Nicholson Trust and Lloyd Nicholson Trust to Roger and Richard Nicholson (2/4/05). Change of Title Interest for Contests 3314 and 3328-3338, and 3340-

Mebane; ~~Sevenmile Creek Ranch, LLC~~; James G. Wayne, Jr.; Clifford Rabe; Tom Griffith; William Gallagher; Thomas William Mallams; River Springs Ranch; Pierre A. Kern Trust; ~~William V. Hill~~; Lillian M. Hill; Carolyn Obenchain; Lon Brooks; Newman Enterprise; ~~William C. Knudtsen~~; Wayne Jacobs; Margaret Jacobs; Michael LaGrande; Rodney Z. James; Hilda Francis for Francis Loving Trust; David M. Cowan; James R. Goold for Tillie Goold Trust; Duane F. Martin; Modoc Point Irrigation District; Peter M. Bourdet; Vincent Briggs; J.T. Ranch Co.; Tom Bentley; Thomas Stephens; John Briggs; ~~William Bryant~~; Peggy Marenco; Jerry L. Neff & Linda R. Neff;

Contestants

vs.

United States, Bureau of Indian Affairs, as Trustee on behalf of the Klamath Tribes; The Klamath Tribes

Claimant/Contestants, and

The Klamath Tribes;

Claimant/Contestant.

3333, 3334, 3335, 3336, 3337, 3338, 3339, 3340, 3341, 3342, 3886, 3887, 3888, 3889, 3890, 3891, 3892, 3893, 3894, 3895, 3896, 3897, 3898, 3899, 3900, 3901, 4002, 4015, 4016, 4017, 4018, 4019, 4020, 4021, 4022, 4023, 4024, 4025, 4026, 4027, 4028, 4029, 4030

3342 from Kenneth Hufford, Leslie Hufford, and Hart Estate Investments to Jerry and Linda Neff (2/11/05). Change of Title Interest for Contests 3314, 3327, and 3328 from William and Ethel Rust to David Cowan (3/9/05). Change of Title Interest for Contests 3314, 3327, and 3328 from Walter Seput to Wayne James, Jr. (5/2/05). Change of Title Interest for Contest 3314 from Jim McAuliffe, McAuliffe Ranches, and Joe McAuliffe Co. to Dwight and Helen Mebane (7/8/05). Change of Title Interest for Contest 3314 from Anita Nicholson to Nicholson Investments, LLC (7/8/05). Change of portion of Title Interest for Contest 3314 from Dwight and Helen Mebane to Sevenmile Creek Ranch, LLC (8/15/05). Kenneth Zamzow voluntarily withdrew from Contest 3314 on September 2, 2005. William Knudtsen voluntarily withdrew from Contests 3314, 3327, and 3328 on September 13, 2005. Change of Ownership filed for Contest 3314 reflecting that William V. Hill is deceased and his ownership rights transferred to Lillian M. Hill (6/15/06). Sevenmile Creek Ranch voluntarily withdrew from Contest 3314 on March 1, 2007. Franklin Lockwood Barnes, Jr. and Jane M. Barnes voluntarily withdrew from Contest 3314 on April 6, 2007. Mary Jane Danforth voluntarily withdrew from Contest 3314 on June 19, 2008. Change of Title Interest for Contests 3314, 3327, and 3328 from Robert Bartell to Michael LaGrande (1/9/09).

CONTENTS

I. EXPERTISE AND BACKGROUND DR. DUDLEY W. REISER

1. Please state your name and occupation.

My name is Dudley W. Reiser. I am the President of and a senior fisheries scientist with the company R2 Resource Consultants, Inc. (R2) of Redmond, Washington. R2 specializes in environmental and engineering consulting with a special focus on fish and aquatic ecology including invertebrates (both in rivers and lakes), instream flow assessments, habitat assessments, fisheries engineering, and habitat restoration. The company also provides technical expertise to clients relative to issues involving the federal Endangered Species Act (ESA).

2. Have you provided a current resume or *curriculum vitae* (CV)?

Yes. Attached to and in support of my testimony here I have provided Ex. 277-US-401. Ex. 277-US-401 is a copy of my most recent CV that details my education, professional experience, and all publications and papers I have presented throughout my career as a fish biologist.

3. Please describe your educational background.

I received a Ph.D. degree in Forestry, Wildlife and Range Sciences (major in fishery resources) from the University of Idaho in 1981, a Masters of Science degree from the University of Wyoming in Water Resources in 1976, and a Bachelor of Arts degree in Zoology from Miami University in Oxford, Ohio in 1972. Briefly my coursework included classes in fishery management, ichthyology, fish culture and disease, aquatic ecology, limnology, water quality, hydrology, aquatic entomology, statistics, and a variety of other related courses.

My master's and doctoral research were focused on flow needs of various fish life history stage components, and both involved extensive field and laboratory studies. The title of my Ph.D. dissertation is "Effects of Streamflow Reduction, Flow Fluctuation, and Flow Cessation on Salmonid Embryo Incubation and Fry Quality." My master's thesis is titled "The Determination of Physical and Hydraulic Preferences of Brown and Brook Trout in the Selection of Spawning Locations." As part of both studies, I collected extensive physical and hydraulic measurements over areas used by salmonids for spawning.

4. Please describe generally your work experience since you received your Ph.D.

From 1980 to the present I have been involved in environmental consulting focusing on aquatic ecosystems, and in particular fish ecology and habitat requirements. Over my career, I have been employed by a number of large consulting and engineering firms including Camp Dresser and McKee (Denver) (1980-1982); Bechtel Corporation (California) (1982-1987); EA Engineering, Science and Technology (California/Washington) (1987-1992; Vice President); and R2 Resource Consultants, Inc. (Washington) (1992-present; President). In my capacity as a fish biologist, I have worked on a variety of streams, rivers and lakes throughout the Pacific coastal states (Washington, Oregon, California, Alaska) and Rocky Mountain states (Wyoming, Idaho, Montana, Colorado, Nevada, New Mexico). I have also worked on streams and rivers in a number of other states, including Massachusetts, Maine, Connecticut, New York, Vermont, Texas, Tennessee, and North Carolina.

5. Have you published in your field of expertise?

Yes. I have published articles in a number of scientific journals including Transactions of the American Fisheries Society, the North American Journal of Fisheries Management, Progressive Fish Culturist, Fisheries, Rivers – Studies in the Science, Environmental Policy and Law of Instream Flow, Regulated Rivers, Research and Management, Environmental Toxicology and Chemistry, and Hydroecologie Appliquee. I have also published chapters in eight books. A complete list of my publications is provided in my CV which is attached as Ex. 277-US-401.

6. In addition to your publications, have you written any other scientific papers or reports?

Yes. As outlined in my CV, Ex. 277-US-401, I have authored or co-authored over 100 technical reports or scientific papers related to fisheries, instream flows, and aquatic ecosystems. Of these, many were related to projects on which I was working. Some were made publicly available while others were for litigation and not publicly released. The publicly available reports are described in my CV, Ex. 277-US-401.

7. Have you made oral presentations at technical meetings and symposia?

Yes. As outlined in my CV, Ex. 277-US-401, I have made over 75 technical presentations at a variety of scientific conferences, technical meetings, and symposia.

8. Please describe your current position with R2 Resource Consultants.

I am the co-founder and president of R2 Resource Consultants (hereinafter "R2"). I am also a Senior Fisheries Scientist for R2. As president of R2, I am responsible for delegating responsibilities and assignments to a team of aquatic and fisheries scientists and water resource engineers, and overseeing their work. Since 1992, R2's staff of scientists and engineers have conducted, under my supervision, a variety of fisheries and aquatic studies and prepared designs related to management and restoration of aquatic ecosystems and support facilities that have included:

- Fish studies focused on evaluating species composition, population abundance, and population characteristics;
- Instream flow evaluations to support fish and aquatic life needs;
- Threatened and endangered species investigations and analysis;
- Aquatic invertebrate sampling and analysis;
- Ecological and fish population modeling;
- Flushing flow and sediment transport studies;
- Water quality monitoring and modeling;
- Water resources and hydrological investigations;
- Fish passage evaluations including barrier analysis;
- Fish passage concept development, cost estimating, and facilities design;
- Channel and habitat restoration, including culvert replacement for fish passage;
- Wetland and riparian ecological studies and habitat assessments; and
- Application of geographic information systems (GIS).

As a Senior Fisheries Scientist, I often lead and manage technical studies focused on fisheries and aquatic resources, especially as they may be affected by water resource and land-use impacts.

9. Please describe the types of technical studies you have worked on or are currently working on.

Since the completion of my doctoral research that involved defining spawning and egg incubation flow needs of anadromous salmonids, I have conducted numerous studies and published manuscripts related to determining instream flow needs and assessing effects of flow regulation on aquatic biota. I have been involved in instream flow projects in Washington, Oregon, Alaska, California, Colorado, Idaho, Maine, Montana, New York, Vermont, and Wyoming, and have applied a variety of different instream flow methods, including the U.S. Fish and Wildlife Service's (USFWS) Instream Flow Incremental Methodology, coupled with the Physical Habitat Simulation models (IFIM/PHABSIM), the Tennant method (also known as Montana method), the Tessman method, the Wetted Perimeter (WP) method, the Trout Cover Rating (TCR) method, the R-2 Cross Method, and the Oregon Method.

In addition to directing and managing studies for the Klamath Basin Adjudication, I am also directing instream flow studies on the Sultan River in Washington as part of hydroelectric relicensing studies for the Henry M. Jackson Hydroelectric Project, and serving as Technical Lead for instream flow studies on a large mining project in Alaska. The Upper Klamath Basin work on behalf of the United States has included defining instream flow needs for fish within major streams and tributaries of the Williamson River, Wood River, Sprague River, and Sycan River. I also recently served as project manager for completing a technical review and analysis of the North Coast Instream Flow Policy for the California State Water Resources Control Board and the Pit 1 Hydroelectric Project whitewater boating flow study in California which focused on evaluating impacts of pulse flow releases on fish and aquatic biota. I also recently managed two large-scale instream flow projects for the federal government. The first of these was for the

Bureau of Indian Affairs related to the Snake River Basin Adjudication, the second for the U.S. Forest Service involving a national technical support contract for which I participated in instream flow studies associated with hydroelectric projects in Alaska, California, and North Carolina. Other instream flow studies that I have directed include those on the Lostine River and Tualatin River in Oregon, the Clark Fork, Madison and the Missouri rivers in Montana; and Ward Creek and Whitman Creek in Alaska.

In addition, I have directed numerous studies focused on determining fish population abundance and dynamics in streams, rivers, and lakes. In doing so, I have applied a variety of fish sampling techniques including snorkeling, electrofishing, seining, trap/gill netting, pop-nets, cast nets, trammel nets, ichthyoplankton sampling, and others. These types of studies have most recently included fish studies conducted for the City of Kent, Washington (urban streams), General Electric (Housatonic River, Massachusetts), Seattle Public Utilities (Lake Chester Morse and Cedar River watershed, Washington), J.L. Storedahl Company (East Fork Lewis River and series of adjoining ponds, Washington), Ketchikan Public Utilities (Alaska), and the U.S. Fish and Wildlife Service (Coeur d'Alene basin and St. Regis River, Idaho).

10. Have you otherwise been recognized for your expertise?

Yes. In 1999, I was appointed by Governor Gary Locke to Washington's Independent Science Panel, which is focused on ESA and species recovery efforts statewide; I was re-appointed to this panel by Governor Gregoire in 2005. I have also been certified by the American Fisheries Society (AFS) as a Fisheries Scientist since 1981 (certification number 1447), and was re-certified in 2002 (certification number 2463), and have been an active AFS member for over 20 years.

11. Have you previously provided expert testimony?

Yes. I have provided testimony at trial and at hearings. I have also provided evidentiary declarations via deposition and affidavit. A list of cases in which I have provided testimony and or evidentiary declarations is as follows:

- Clark County, Washington, Public Land Use Hearings regarding Daybreak Mining and Habitat Enhancement, Case No. REZ98-011, CUP20004-00002 (provided testimony regarding potential mining impacts on anadromous salmonids in the East Fork Lewis River, Washington) on behalf of the J.L. Storedahl Company (2004));

- United States of America vs. ASARCO Inc. et al., Case No. 96-0122-N-EJL and Case No. 91-9342-N-EJL (District of Idaho) (provided testimony regarding losses of habitat and fish populations resulting from long term mining impacts on the South Fork Coeur d'Alene River, Idaho, on behalf of the U.S. Fish and Wildlife Service (1999 and 2001));

- State of Montana vs. Atlantic Richfield Company, No. CF-83-317-HLN-PGH (District of Montana) (provided testimony regarding losses of habitat and fish populations resulting from long term mining impacts on the Clark Fork River, Montana on behalf of Atlantic Richfield Company (1996 and 1997));

- Snake River Basin Adjudication, Case No. 39576 (Twin Falls District Court, Idaho) (provided declaration regarding instream flow needs for fish species found in the Snake River Basin, Idaho on behalf of the Bureau of Indian Affairs (1998, 1999));

- Klamath Basin Adjudication (before the Oregon Office of Administrative Hearings and the Oregon Water Resources Department) (provided declarations regarding 1) the basis of the lake level claims submitted by the Bureau of Indian Affairs, 2) the importance of habitats located beyond the original Klamath Indian Reservation boundaries in fulfilling the life cycle needs of fish species, and 3) the validity of the lake level-habitat-water quality process used for defining the lake level claims (1997 and 2006);

- Puget Sound Energy, Inc. – Federal Energy Regulatory Commission (White River Project No. 2494-002) (provided declaration regarding flow and habitat issues in support of Puget's request for a license order stay (1998)); and
- California State Water Resources Control Board (provided testimony regarding factors influencing current distributions and abundance of fish within the Sacramento and San Joaquin river deltas on behalf of the California Urban Water Agencies regarding proposed Salinity standards for San Francisco Bay–Delta (1995)).

12. Have you previously been qualified as an expert witness in other proceedings?

Yes, I have been qualified as an expert witness on Water and Fisheries Resources –Fish Biology and Fish Environment in the trials conducted in the U.S. District Courts including United States of America vs. ASARCO Inc. et al. (Case No. 96-0122-N-EJL and Case No. 91-9342-N-EJL) (District of Idaho, Boise, Idaho) and State of Montana vs. Atlantic Richfield Company (No. CF-83-317-HLN-PGH) (District of Montana, Great Falls, Montana).

13. When did you become involved in the Klamath Basin Adjudication and what has been your role?

I first became involved with the Klamath Basin Adjudication in 1990, when I was working for EA Engineering Science and Technology (EA). Then, the Bureau of Indian Affairs (BIA) had engaged EA to conduct technical studies to assist with quantifying instream flow needs of streams within the Upper Klamath Basin. I was the project director. In 1992, I left EA and co-founded R2, but continued to work with EA and remained as the principal investigator on the Upper Klamath Basin project.

As the principal investigator for this work, I have been responsible for organizing, implementing and managing the large-scale investigation focused on quantifying instream flows necessary to provide for a healthy and productive habitat for the Klamath Tribes' treaty fish species in the streams and rivers of the Upper Klamath Basin. These instream flow claims are divided into two components: the Physical Habitat Claims and the Riparian Habitat Claims (further described in Section II). Briefly, by "Physical Habitat" we refer to and mean the water environment in a stream that fish physically live in, whereas by "Riparian Habitat," we refer to and mean the streamside vegetative environment that surrounds a stream. Overall, the Physical Habitat Claim work has involved the collection and analysis of data from all major streams and tributaries within the Williamson River subbasin, the Wood River subbasin, the Sycan River subbasin, and the Sprague River subbasin. Representative types of data that have been collected on these systems have included data for instream flow assessments, habitat characterizations, fish utilization, invertebrate composition, and water quantity and quality.

14. What is the result of your investigations in the Klamath Basin?

As a result of my investigations in the Upper Klamath Basin, I have been able to form a sufficient basis to make recommendations for the flows necessary for the Williamson River subbasin (Claims 625 through 640) to provide a healthy and productive fish habitat. From 1990-1999, studies were conducted under my direction to quantify and prepare the Physical Habitat Claims, which were filed by the BIA as trustee on behalf of the Klamath Tribes in 1997 and amended in 1999. Since 1999, I, and others under my direction, have continued to analyze existing information and collect and analyze supplemental data that would further our understanding of the flows necessary to provide for healthy and productive habitats for the target fish species. During this time, I worked closely with Mr. Michael Ramey, a senior hydrologic engineer in our office, who was responsible for compiling and completing a technical review of all hydrologic information and data available for streams in the Williamson River subbasin. Ultimately, as a result of this collaborative work, I have been able to form a sufficient basis for updating the Physical Habitat Claims for the Williamson River subbasin (Claims 625 through 640). The 1999 Physical Habitat Claims form the upper limit for these updated claims. In addition, I have worked with Dr. David Chapin in preparing and updating the Riparian Habitat Claims.

15. What is the purpose of your testimony?

My testimony is directed toward describing the need and basis for the Physical Habitat Claims and the quantity of water claimed. My primary focus was on the habitat needs including stream flows of the Klamath Tribes' treaty fish species. The stream flow needs of treaty non-fish species, which also require sufficient stream flow in the Upper Klamath Basin, is presented in the testimony of other witnesses including Dr. David Chapin, Mr. Perry Chooktoot, and Mr. Jeff Mitchell.

The development of the Physical Habitat Claims reflects two decades of scientific work. This work involved a team of technical specialists working under my direction or supervision, including fisheries biologists, aquatic ecologists, riparian ecologists, aquatic entomologists, water quality specialists, hydrologists and hydraulic engineers (lead by Mr. Ramey; see Ex. 277-US-200, Affidavit and Direct Testimony of Mr. Michael Ramey (Mr. Ramey Direct Testimony)) and biometricians. Similarly, the Riparian Habitat Claim work, led by Dr. David Chapin, also involved a team of specialists. See Ex. 277-US-300, Affidavit and Direct Testimony of Dr. David Chapin (Dr. Chapin Direct Testimony).

The purpose of my testimony is threefold. First, my testimony provides an overview and chronology of the development of the Physical Habitat Claims. Second, my testimony describes the methods used, the rationale applied, and process followed to develop Physical Habitat Claims to provide healthy and productive habitats for the Klamath Tribes' treaty fish species, based on analysis of the habitat and flow needs of target fish species. Third, my testimony describes the updated Physical Habitat Claims for each claim reach (Claim 625 through Claim 640) by calendar month based on all information developed and collected over the last two decades. This information includes that additional information and analysis developed since 1999 when the amended claims were filed. Where appropriate, I refer to various reports, publications, data summaries, maps, photographs and other materials that I (or others under my direction) developed and/or relied upon in updating the Physical Habitat Claims. The rationale behind and methodology used to form the basis for the Physical Habitat Claims has generally remained consistent throughout the claims development process; however, many of the updated Physical Habitat Claim flows presented here are lower than the 1999 flows, but never higher. Any reduction is the result of our collection and analysis of data since 1999. Finally, my testimony also briefly addresses the Riparian Habitat Claims as an important component of a healthy and productive fish habitat.

16. Please summarize your basic conclusions.

My overall conclusion is that the instream flows reflected in the Physical Habitat Claims are sufficient to provide healthy and productive habitats in streams within the Williamson River subbasin at levels that meet, but do not exceed, the spatial needs of the target fish species. The flows also take into consideration the role that water temperature plays, the importance of invertebrates, and the overall significance of riparian habitat. I further conclude that such flows, when coupled with the Riparian Habitat Claims, described in Dr. Chapin Direct Testimony, will promote the restoration and/or maintenance of viable and self-renewing populations at levels from which tribal harvest can occur. Physical Habitat and Riparian Habitat flows represent necessary and essential components for achieving healthy and productive habitat; however, other factors may limit the abundance of target fish species. Further, although the focus of my work was on developing Physical Habitat Claims that would provide healthy and productive fish habitat, the methods employed and supplemental data collected were aimed to ensure that no more was claimed than that necessary. However, as I note in my testimony, such flows, while representing a necessary and essential component for achieving healthy and productive habitat, are not sufficient alone to provide a healthy and productive fish habitat. This can only occur when such flows occur in parallel with actions that address other factors that are continuing to limit the population abundance of the target fish species as described further in this testimony. Finally, the updated Physical Habitat Claims tend to be conservative, meaning they are generally on the lower side of the range of flows I would consider necessary to provide healthy and productive habitats.

17. Dr. Reiser, you have used several terms that need defining. First, please describe what you mean by "treaty species" and "target fish species."

In general, the term "treaty species" in this testimony refers to all species of plants and animals that are subject to the Klamath Tribes' treaty-protected harvest rights, and that were historically, or may be presently or in the future, hunted, fished, trapped, gathered, or otherwise harvested by the Tribes. For this testimony, I focus on the fish species that have been historically fished by the Klamath Tribes, or may be presently or in the future, which are referred to here as "treaty fish species."

The number of overall treaty fish species on the former Klamath Reservation is quite large; therefore, to focus our habitat analysis for target fish species, we selected certain of those fish species as "target fish species" for in-depth study. For purposes of this testimony, "target fish species," which form the basis for quantification of the Tribal instream flow Physical Habitat Claims, refers to the following fish species: redband trout, Bull Trout, Lost River sucker, Shortnose sucker, Klamath largescale sucker, and Chinook salmon.

18. Please describe what you mean by a "healthy and productive habitat."

To understand the phrase "healthy and productive habitat," it is instructive to look at each of the words separately. "Habitat" is an objective term used in biological analyses that refers to the environment in which a species exists throughout its life cycle, as well as those surrounding environments that provide material or support to the environment in which the species exists. For example, the fish habitat includes both the instream environment that provides living space, food, and protection from predation, as well as the bordering stream environment that contributes both food and nutrients and provides shade.

The terms "healthy" and "productive" are more subjective because these terms seek to describe the quality and quantity of habitat necessary for a species to exist in a sound state and to propagate. "Healthy" is best understood via the analogy used by the Administrative Law Judge to the provision of health care for a person wherein the primary question is "[w]hat are the basic health care needs of [a] person that will not only keep him alive but allow him to be healthy?" Amended Order on Motions for Ruling on Legal Issues, February 13, 2007, Case 277, p. 16. As such, a healthy habitat must have sufficient water to provide an environment wherein the needs of the target fish species are met in a way that allows the species to exist in a stable, sound state rather than a minimal state or just barely hanging on from year to year. Similarly, "productive" habitat must have sufficient water to support a species' ability to reproduce and provide a robust population that can withstand impacts from both environmental and man-made factors.

19. What is your definition of a "healthy and productive habitat?"

My definition of "healthy and productive habitat" for fish is: a stream environment that (i) allows the target fish species to exist in all life cycles in a stable and sound state; (ii) supports the target fish species' ability to reproduce on a long-term basis; and (iii) provides a robust fish population that can withstand harvest of the species and impacts to its habitat, such as from drought, land use practices, and other events.

20. Are there other terms in your testimony that require definition?

Yes. For convenience, I have included a Glossary that defines various scientific and technical terms, and acronyms, as an Appendix (see Appendix A) at the end of my testimony.

21. Do you reference and rely upon reference material in your testimony?

Yes. Throughout my written testimony, I make several references to government reports or published or copyrighted articles or books to support my testimony. A listing of all publications, reports, books, and other technical materials to which I reference in my testimony is attached as an Appendix (see Appendix B) at the end of my testimony.

22. How are exhibits presented in your testimony?

Throughout my written testimony, I make reference to material in support of my testimony designated as exhibits, which are generally designated in the form "277-US-4XX." Copies of these materials are being provided with my testimony. A complete list of the exhibits that are described and presented through my testimony is attached as an Appendix (see Appendix C) at the end of my testimony.

II. THE PHYSICAL HABITAT AND RIPARIAN HABITAT COMPONENTS OF THE INSTREAM FLOW CLAIMS

23. As an initial matter, please explain the basis of the Physical Habitat Claims and the Riparian Habitat Claims.

The Physical Habitat Claims are concerned with the living space provided by streamflow that is needed to support the life history function of fish and other aquatic organisms. The claims are specifically for flows necessary to provide healthy and productive habitats in streams within the Williamson River subbasin at levels that meet, but do not exceed, the spatial needs of the target fish species.

The Riparian Habitat Claims are concerned with the land-stream interface area bordering each side of the stream and the quantity of flow needed to maintain a healthy and functioning riparian zone. This interface area, referred to as the riparian zone, has special ecological significance relative to streams, rivers, and, most importantly, fish habitat. From a fish habitat perspective, the riparian zone provides a number of components necessary to the overall fish habitat: (i) shade that serves to keep water temperatures cool; (ii) a supply of wood to the stream that provides shelter to fish and habitat for fish supporting organisms; (iii) a source of nutrients to the stream in the form of leaf fall; and iv) a source of food organisms for fish resulting from insects dropping into the water from the vegetation. These flows also help in part to maintain the channel structure, flush and transport sediments, and create new habitat structures within the channel.

My testimony will primarily focus on the presentation of and support for the Physical Habitat Claims. Dr. Chapin Direct Testimony provides the presentation of and support for the Riparian Habitat Claims. However, to be clear, a healthy and productive riparian zone is necessary to a healthy and productive fish habitat in the streams of the Upper Klamath Basin.

24. How do the Physical Habitat Claims relate to the water rights claimed by the BIA as trustee on behalf of the Klamath Tribes (Tribal water rights)?

Basically, the Tribal water rights require the provision of flows necessary to provide healthy and productive habitats within the streams of the Upper Klamath Basin. This means, in simple terms, fish of a riverine system need flowing water in order to propagate and properly develop. More specifically, a sufficient quantity of flow to meet the requirements of each lifestage of a fish species is fundamental to a healthy and productive habitat. This is because fish living in flowing waters require adequate volumes of flow to meet all aspects of their life history or lifestages, from spawning, to egg incubation, fry, juvenile, and adulthood. Furthermore, maintaining a connection between different habitat types within the watershed is likewise important to the propagation of healthy, abundant populations of fish. For example, spawning habitat may be in different locations than the habitat where fish feed and grow. Flows must therefore be sufficient to allow fish to migrate between and within these areas.

Flowing water provides the basic habitat building block of living space for riverine fish. Fish distinguish the "livability" of flowing water based in part on water velocity and water depth. Water velocities above or below a certain velocity range are unattractive and even intolerable to fish. Likewise, water depths below a certain depth range, or that are too shallow, are also unattractive and are avoided by fish. Combinations of these velocity and depth parameters across a stream create a mosaic of habitat conditions used by different species and life stages.

In addition, a fish species' substrate (materials on the bottom of a stream such as gravel, sand, etc.) and cover (protective shelter) needs are impacted by flow and further refine the quality and usability of the living space. Substrates of varying sizes and shapes provide important spawning, rearing, and holding habitats. Protective structural cover in the form of undercut banks, overhanging vegetation, instream boulders/cobbles, and large woody debris add to the quality of the fish habitat. Further, good water quality conditions (e.g., suitable water temperatures, dissolved oxygen concentrations, turbidities, etc.) and an abundant food supply are conducive to the propagation of fish; both similarly depend on many of the same flow-related physical, hydraulic, and chemical conditions.

Flowing water also provides a mechanism for food delivery to drift-feeding fish such as trout. Terrestrial insects that fall into the stream and benthic macroinvertebrates (small organisms that live on or within the bottom of the stream) are swept downstream by the current and preyed upon by fish. Other species, such as suckers, are generally bottom feeders, relying on algae and insects attached to the substrate. Larval suckers observed within the Williamson River are believed to feed nearly exclusively on suspended organic material that is readily available during springtime high flow events.

Finally, flowing water is also critical to fish migrations. The temperature and chemical constituents of the flowing water serve as guides to migratory fish returning to natal waters. The volume of water must be sufficient to provide adequate depths for fish passage, particularly over shallow or obstructed areas.

25. You have thus far discussed fish species generally. Please discuss the fish species that were the focus of your work in the Upper Klamath Basin.

Because of the diversity of habitat conditions and widely ranging topography that create climatic variability and complex hydrology, the streams and rivers within the Upper Klamath Basin support a variety of fish species. Those fish species known to exist in the streams of the Upper Klamath Basin are included in OWRD Ex. 2, pp 4 through5. The Klamath Tribes historically utilized many of the different fish species found in the Upper Klamath Basin for subsistence and ceremonial purposes. See Ex. 277-US-412. Today, the abundance of most if not all of these species has been severely reduced in comparison to fish abundances reported in and throughout the 19th century and the early half of the 20th century (Nehlsen et al. 1991).

The Physical Habitat Claims were focused on six target fish species which are species of fish of particular importance to the Klamath Tribes and of particular interest to state (Oregon Department of Fish and Wildlife (ODFW)) and federal agencies (U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS)) for their sport fish value (e.g., redband trout), listing status under the Federal Endangered Species Act (ESA) (e.g., bull trout, Lost River sucker, shortnose sucker), and historical presence within the upper Klamath River Basin (e.g., Chinook salmon). These target fish species are but six of several other treaty fish species of the Klamath Tribes that are dependent on the stream flows of the Upper Klamath Basin.

I am generally familiar with the habits and needs of each of the target fish species as well as other fish species occurring in the Upper Klamath Basin. See OWRD Ex. 2, pp 4 through 5.

The six target fish species include the following three salmonid species (members of the trout family), and three sucker species (scientific names provided in parentheses):

Redband trout	(*Oncorhynchus mykiss newberrii*)
Bull trout	(*Salvelinus confluentus)*
Chinook salmon	(*Oncorhynchus tshawytscha) (Spring and Fall Chinook)*
Lost River sucker	(*Deltistes luxatus)*
Shortnose sucker	(*Chasmistes brevirostris)*
Klamath largescale sucker	(*Catostomus snyderi)*

The Physical Habitat Claims addressed in this testimony were directed toward providing no more than the flows necessary to provide a healthy and productive habitat for these target fish species (see OWRD Ex. 2, pp 5 and 6). I believe that these same flows will also generally provide healthy and productive habitats for other native fish species in the Upper Klamath Basin.

26. What is the major objective of the instream flow claims?

The Physical Habitat and Riparian Habitat Claims focus on establishing the amount of flow necessary in streams of the Upper Klamath Basin on a monthly basis to provide for productive, healthy habitats for target fish species subject to the Klamath Tribes' hunting, fishing, trapping, and gathering rights. As previously mentioned, the updated Physical Habitat Claims are centered on six target fish species that historically were or currently are important to the Klamath Tribes.

27. What, if any, is the relationship between the Physical Habitat and Riparian Habitat flows?

The Physical Habitat flows work with the Riparian Habitat flows to provide healthy and productive habitat for the target fish species. The Administrative Law Judge (ALJ) made an analogy in an earlier ruling in this case between the health of fish habitat and the health of a human patient (*see* Amended Order (February 12, 2007), Case 277, p. 16); the analogy is a good one to illustrate the important connection between the Physical Habitat component and the Riparian Habitat component of a stream ecosystem.

The analogy to a human patient centers on the fact that a patient is dependant on many systems working together. Each human system has independent and sometimes overlapping needs of blood, oxygen, and nutrients; however, meeting minimal blood, oxygen, and nutrients needs of just one system without consideration to other body systems would compromise the health of the patient. For example, without a healthy cardiovascular system, a patient will not thrive, survive, or be healthy despite otherwise intact respiratory, nervous, and skeletal systems. Another analogy would be with respect to the health of a human being as influenced by the health of his/her environment. Clearly, human populations subjected to conditions of insufficient air, water and food, in conjunction with an environment that provides limited physical space to inhabit, would not survive and propagate as well as populations living in areas with clean air and water, abundant food, and plenty of living space.

Likewise, healthy fish habitat in a stream consists of many components including the water environment that fish physically live in (Physical Habitat) and the surrounding streamside and vegetative environment (Riparian Habitat). The two habitats together provide the fundamental elements for fish survival. For example, a fish needs a specific range of flow conditions in order to complete essential life history functions including migration, spawning, feeding and growing, but a fish also needs the riparian environment to provide crucial stream components, such as stream energy (e.g., food, material, nutrients), structure (e.g., erosion control, large woody debris, riffle/run/pool habitat variety), and protection (e.g., protection from predators, substantial water temperature controlling stream shade). While the physical and riparian habitats have at times, different streamflow needs, both habitats depend on each other and on sufficient streamflow to create healthy fish habitat. Thus, the provision of flows to meet the needs of one type of habitat without providing for the other would affect the health of the aquatic ecosystem and limit the productivity of the fish populations. For these reasons, the Physical Habitat and Riparian Habitat flows are essential ingredients for providing and protecting important in-channel and out-of-channel processes, and for promoting healthy and productive fish habitats that lead to the propagation of target fish species for harvest by the Klamath Tribes.

28. What has been the extent of your work associated with the Tribal instream flow claims?

My work has involved consideration of all aspects of the Tribal instream flow claims in this case. However, as a fish biologist my work has primarily centered on developing the basis for and analysis of the Physical Habitat Claims. The Physical Habitat Claims were developed and updated over a period of 18 years extending from 1990 to present. Speaking on the broadest of scales, the work associated with the development of these claims involved research, field data collection, scientific analysis, review, critique, and professional judgment.

Between 1990 and 1999, I directed and/or participated in the conduct of research, fieldwork, and analysis to develop and support the Physical Habitat and Riparian Habitat Claims and amendments filed by the BIA. The majority of fieldwork and data analysis leading up to the 1999 claims was completed between 1990 and 1994 and the flow recommendations and ensuing claims were developed after that. Since 1999, we have continued to evaluate and update the Physical Habitat Claims and the Riparian Habitat Claims. This ongoing work has included the re-evaluation of existing data, the collection and analysis of additional field data and flow data, and the evaluation of other hydrologic data and basin hydrology, particularly that hydrology information and analysis developed by the Oregon Department of Water Resources (OWRD). The purpose of continuing this work has been to incorporate additional information into our analysis that would assist us in defining the flows necessary to provide a healthy and productive habitat.

29. What is the result of your work over the past two decades?

Based on the continued collection of data, analysis of existing and additional data, and evaluation of necessary flows, we have updated the Physical Habitat and Riparian Habitat Claims from the 1999 values. The updated Physical Habitat Claims presented in this testimony reflect additional information and analysis. It is my understanding that the 1999 claims must serve as an upper limit to the instream flow claims. Therefore, the updated Physical Habitat and Riparian Habitat Claims are either lower than the 1999 claims or equal to them.

30. What are the updated Physical Habitat Claims?

The updated Physical Habitat Claims are presented in Section IX. For each claim reach in this case (Claims 625 through 640), flows are specified for each of the twelve (12) months of the calendar year. The Physical Habitat Claims often have two components. The first component of the Physical Habitat Claims is for the target fish species presently occurring in the Upper Klamath Basin (otherwise referred to as "present target fish species"). These are the flows that should be put in place immediately to provide for the health and productivity of fish habitat for species occurring in the Upper Klamath Basin today. The second component of the Physical Habitat Claims is for all target fish species of the Upper Klamath Basin, including Chinook salmon (otherwise referred to as "all target fish species"). These flow claims are conditional and to be given effect only upon re-introduction of anadromous fish to the Upper Klamath Basin.

Finally, the support and updated flows for the companion Riparian Habitat Claims are presented through Dr. Chapin Direct Testimony that is filed simultaneously with my testimony. I have reviewed the updated Riparian Habitat Claims and am of the opinion that the claims are necessary to support the health and productivity of the physical habitat occupied by fish in the streams of the Williamson River subbasin. It is my opinion that the Physical Habitat and Riparian Habitat flows are those needed to provide healthy and productive habitats for the Klamath Tribes' target fish species.

III. THE UPPER KLAMATH BASIN AND THE WILLIAMSON RIVER

31. Are you familiar with the Upper Klamath Basin and the streams and rivers in the basin and its subbasins?

Yes. I am very familiar with the Upper Klamath Basin region, particularly the streams and rivers of the basin. My familiarity comes from many sources. As I have described, my work in the Upper Klamath Basin has spanned two decades. In support of my ability to form my expert opinion and recommendations, I have reviewed and studied topographic, biologic, hydrologic, and geologic data and reports, as well as public documents, maps, and references that characterized the physical setting of and the fish and streams in the basin. In addition, I have sought out and drawn upon the experience of both scientific and lay persons familiar with the basin. Further, I have firsthand familiarity with the basin and its streams from the many visits I have made and directed in the basin. Finally, I personally, and through the direction of those under my supervision, participated in the site selection and stream data collection activities on all of the instream flow study sites in the Upper Klamath Basin, including field data collection, stream fish surveys, and stream invertebrate sampling.

32. Please describe the physical boundaries of the Upper Klamath Basin which have been the focus of your work.

The Upper Klamath Basin is located in south-central Oregon, covering an area of approximately 3,810 square miles. For the purpose of this testimony, the Upper Klamath Basin includes all drainages extending from the eastern slope of the Cascade Range east to the Gearhart Mountains, which drain south and west, eventually discharging into Upper Klamath Lake (Figure III-1). Upper Klamath Lake is the largest lake in the basin, with a surface area of 100-140 square miles, depending on its stage (Gannett et al. 2007). The Link River flows out of the lower end of

Upper Klamath Lake and after 3.2 miles becomes the Klamath River below Klamath Falls. The Klamath River runs through southeastern Oregon and into northern California, ultimately emptying in to the Pacific Ocean in northern California.

Figure III-1. Map of the Upper Klamath Basin, Oregon depicting the Wood, Williamson, Sycan and Sprague River Subbasins.

33. What are the important physical features of the Upper Klamath Basin?

In terms of physical features, the western end of the Upper Klamath Basin, stretching along the eastern slope of the Cascade Mountains, typically consists of high, steeply sloped terrain underlain by highly permeable soils and basaltic formations. The basin has been dominated by volcanic activity and active faulting that has served to shape and control many of its broad valleys. This activity has created many springs that emanate through the volcanic rock and porous materials and contribute to flows in streams. A number of springs drain the eastern slope of Mount Mazama, a dormant volcano whose caldera created Crater Lake, contributing substantial flow in the Wood and Williamson rivers. The eastern portion of the basin is also mountainous, and includes the headwaters of the Sprague, Sycan, and Williamson rivers. Elevations within the Upper Klamath Basin in Oregon range from 9,182 feet at Mount Thiesen in the Cascade Range to as low as 4,139 feet at Upper Klamath Lake. The typical ridge elevations for the northern and eastern portions of the basin range from 5,500 to 7,000 feet, respectively. The lower portions of the basin consist of gentle slopes and poorly draining soils typified by marshlands when not under cultivation.

34. Please describe the principle drainage systems of the Upper Klamath Basin.

Principal streams in the Upper Klamath Basin which are the focus of my testimony include the Williamson River, the Wood River, the Sprague River, and the Sycan River. The Williamson River is a 1,420 square mile subbasin draining the northern and central parts of the basin. The Wood River originates at a series of large springs north of Upper Klamath Lake, and drains an area of 219 square miles. The Sprague River (a tributary to the Williamson River) is a 1,021 square mile subbasin draining part of the eastern side of the basin. The Sycan River (a tributary to the Sprague River) is a subbasin that drains an additional 559 square miles in the northeastern part of the basin. The combined Williamson River, Wood River, Sprague River, and Sycan River subbasins have a drainage area of approximately 3,000 square miles and constitute 79 percent of the total drainage area of the Upper Klamath Basin, and about one-half of the inflow to Upper Klamath Lake (Risley and Laenen 1999). In addition, the Upper Basin contains two remarkable and large marsh areas: the Klamath Marsh (approximately 232 square miles) in the Williamson River subbasin, and the Sycan Marsh (approximately 39 square miles) in the northernmost area of the Sycan River subbasin.

35. Please describe the land forms and landscapes of the Upper Klamath Basin.

Approximately 80 percent of the Upper Klamath Basin is forested (Gannett et al. 2007). Eastern upland forests are predominately ponderosa pine, with some areas of fir. Lower elevation upland forests are largely made up of lodge-pole pine stands. Forests in the Cascade Range are composed primarily of stands of mountain hemlock and red fir (Gannett et al. 2007). Stream valleys and the broad, sediment-filled structural basins generally have extensive marsh land, the most remarkable of which are Sycan Marsh and Klamath Marsh. At lower elevations in such areas as the Wood River and Sprague River valleys, the subbasins have been mostly converted to agricultural land.

36. Please describe the fish species in these systems.

As noted above, the main target fish species which have been the focus of our studies and analysis since 1990 included redband trout, bull trout, Lost River sucker, shortnose sucker, Klamath largescale sucker, and Chinook salmon. These are native fish species of the basins, meaning their occurrence was via natural processes rather than human introduction. Redband trout, bull trout, Lost River sucker, shortnose sucker, and Klamath largescale sucker are found in the Upper Klamath Basin today. Chinook salmon and steelhead trout (*O. mykiss*), an anadromous[1] relative of the redband trout, were both historically present in the Upper Klamath Basin (see Affidavit and Direct Testimony of Dr. Richard Hart at questions 19 through 47 and 49 through 55 (Ex. 277-US-100) (Dr. Hart Direct Testimony)), but were blocked by the construction of Copco Dam on the Klamath River.

I am also aware of and familiar with other reported fish species in the streams within the basin including a number of introduced species such as brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and brown bullhead (*Ictalurus nebulosus*).

37. Have you been involved in studies of these species?

Yes. In addition to having completed fish surveys in many of the streams and rivers within the Upper Klamath Basin and its subbasins, I have been involved in numerous technical meetings with many researchers and scientists in the region where the life habits and population characteristics of these species have been discussed. Most recently I served as an invited member of an Independent Scientific Review Panel convened by the USFWS that completed a 5

[1] Anadromous fish spawn in freshwater, with resulting progeny migrating downstream to the ocean where they spend several years before returning as adults to freshwater to complete the life cycle.

Year Review of the two endangered sucker species noted above. I have also kept up to date on much of the peer-reviewed literature pertaining to the species I have described.

38. What are the general life history characteristics of the target fish species?

I provided a description of the life history characteristics of each of the target fish species in a previous report (Reiser et al. 2001) a copy of which I provide as Ex. 277-US-402. Additional life history information can be found as part of ORWD Ex. 2, pages 5 through 15, and in Moyle (2002), Wydoski and Whitney (2003), and the National Research Council (2004 and 2008). As well, general life cycle diagrams of each target fish species are presented in Section IV of my direct testimony (see Figures IV-5 through IV-9). A specific life history table that depicts the timing of spawning, egg incubation, fry and juvenile rearing, and adult holding and migration of target fish species for the Williamson River subbasin is presented and discussed in Section VII of my direct testimony (see Figure VII-5).

39. You mentioned Chinook salmon and steelhead trout as being historically present in the Upper Klamath Basin. Were there other species that were also historically present?

Yes. Regarding Chinook and steelhead, substantial historical evidence shows that both Chinook salmon and steelhead trout historically used the streams of the Upper Klamath Basin for spawning and for juvenile rearing (Hamilton et al. 2005; Fortune et al. 1966). Dr. Hart Direct Testimony (at questions 19 through 55), along with the publications and materials relied upon by him, provides additional corroboration of the historical presence of anadromous species in the Upper Klamath Basin. In addition, Pacific lamprey, another anadromous species, reportedly used the streams of the Upper Klamath Basin (Hamilton et al. 2005). At the turn of the Twentieth Century, dams were built on the Klamath River. The consequence of the construction of these dams was to physically block the anadromous species from migrating upstream and into streams of the Upper Klamath Basin for spawning and rearing. Thus, anadromous species do not currently utilize the Upper Klamath Basin.

40. As to the selection of target fish species, does this mean that the other species are not important or were not considered in developing the Physical Habitat Claims?

No. Although the focus on the claims may have been on certain species, development of the claims considered all of the species known to be present or historically present and with a likelihood of return to the basin in the foreseeable future (e.g., Chinook salmon). As described above, OWRD Ex. 2, p. 4-5 is a complete list of fish species know to exist in the Upper Klamath Basin.

41. What are the fundamental needs of fish?

Fundamentally, fish need water to live. Fish possess gills for respiration which can only function when the fish is totally submerged in water. In general, the amount of water in a stream defines the physical boundaries within which animals that are completely dependent on water are located. It is only within these physical boundaries that these animals such as fish are able to complete all of their life history functions necessary to sustain their populations. In simple terms, the quantity of water flowing in a stream defines the outer limit of the possible habitat for a fish. Thus, if the amount of water falls below levels that allow for successful reproduction, protection of fry, rearing of juveniles, migration of adults, or other life history functions, the overall health of a fish population will be directly and adversely affected (e.g., the population will decline, population viability will be reduced, etc).

42. If there is sufficient water to keep a fish submerged, is that enough to allow it to survive?

No. Just as it is not sufficient for humans to survive by just being given enough air to breathe, it is not sufficient to simply keep a fish wetted or submerged with water to allow it to survive. Many flow-related factors influence the survival of an individual fish (e.g., food and waste product elimination), and many more flow related factors influence the survival of a fish population (e.g., those that relate to reproduction, growth and maturation). While flowing water is certainly necessary for survival of fish in a riverine system, flowing water must be provided in sufficient quantity and of a sufficient quality (e.g., velocity, depth, temperature, dissolved oxygen, etc.) to promote and sustain fish populations. In addition, the timing and frequency of flows is important since they impact lifestage functions such as the migration patterns of fish, spawning, and juvenile and adult rearing.

Similarly, and separately, flows of sufficient quantity, quality, and frequency are likewise needed to maintain important riparian habitats and promote channel and habitat diversity. As described earlier, these latter flows are the focus of the Riparian Habitat Claims described in Dr. Chapin Direct Testimony at question 25. The riparian habitats surrounding a stream are integral to fish habitat.

43. Did you consider the quantity, quality, timing, and frequency of flows as you developed the Physical Habitat Claims?

Yes. In the process of developing the Physical Habitat Claims, I considered these aspects of flows. I also considered other flow-related aspects such as riparian habitat (noted above), temperature, and aquatic invertebrates.

44. What is your opinion of what the Physical Habitat Claims will provide?

I believe the Physical Habitat Claims will provide healthy and productive habitats sufficient to allow the sustainability of the populations of the target fish species. In this case, the flows provided by the Physical Habitat Claims create the very basic "building" in which the fish species, and their lifestages, can reside. This physical space in a stream provided by flows is essential to a healthy and productive fish habitat. Other factors such as water quality, availability of food, availability of cover and shelter to avoid predation, and availability of suitable spawning habitat in terms of gravel quality and quantity, must also be present to provide a healthy and productive habitat in order to sustain viable fish populations. Thus, it is the physical space (provided by flows) in combination with other components that is needed to support an overall healthy and productive habitat.

45. You stated that flows are necessary to provide habitat. Is there a direct relationship between flow and the amount of habitat in a stream?

Yes. There have been hundreds of studies completed that have demonstrated habitat:flow relationships in streams. The application of the IFIM/PHABSIM methodology[2], as we used in the Upper Klamath Basin and as I will later describe in Section VII, specifically results in the development of species and lifestage specific habitat:flow relationships. It is important to keep

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2 "Physical HABitat SIMulation (PHABSIM) is part of a broad conceptual and analytical framework for addressing stream flow management issues called the Instream Flow Incremental Methodology (IFIM) (Stalnaker et al., 1995). IFIM provides a problem-solving outline for water resource issues in streams and rivers. IFIM and PHABSIM were developed as aids to instream flow decision making (http://www.fort.usgs.gov/products/Publications/15000/chapter1.html). The Physical Habitat Simulation System (PHABSIM) (Milhous et al. 1989) is an integrated collection of hydraulic and microhabitat simulation models designed to quantify the amount of microhabitat available for a target species over a wide range of discharges flows (Bovee et al. 1998; http://www.fort.usgs.gov/products/Publications/3910/chapter1.html). For purposes of this testimony, I have adopted the convention of citing the primary method used in developing the Physical Habitat Claims as IFIM/PHABSIM.

in mind that although direct relationships between stream habitat and flow exist, habitat:flow relationships can be complex depending on channel morphology and instream structure. In Section VII of my direct testimony, I provide an illustrative example of a habitat:flow relationship (see Figure VII-3). Also, in Section IX of my direct testimony, I provided the specific habitat:flow relationships for each of the claim reaches in the Williamson River subbasin (e.g., Ex. 277-US-420 associated with Claim Reach 625)).

46. You stated there is a direct relationship between flow and habitat in a stream. Is there also a direct relationship between flow and the number of fish in a stream?

Every stream has a theoretical, upper-limit carrying capacity above which no more fish can live in a stream. However, outside purely theoretical considerations, in most streams, the number of fish that live in a stream is set by a host of biotic (e.g., food availability, predation, disease) and abiotic (e.g., temperature, water quality, substrate, flow, climatic variability) factors. Under a given set of conditions, any one factor, alone or in combination with others, might mask or make unrecognizable a direct relationship between flow and population size. This is the reason that instream flow needs assessments are based on physical habitat (or indicators of such) relationships with flow, not population abundance. In my 32 years of experience in working on instream flow projects, I have yet to encounter a situation where the relationships between flow and fish abundance have been quantifiably established so they could be used in a flow prescriptive process.

47. Are there other factors in addition to flows that influence fish abundance in streams in the Upper Klamath Basin?

A number of factors in addition to flow influence fish abundance in the streams of the Upper Klamath Basin. These factors include water quality, land-use activities (e.g., grazing), disease, invasive (introduced) species, angling, and predation. Any one or combination of factors may mask the relationship between flow and fish abundance; however, if those other factors were not influencing the fish, then flows would have a direct controlling effect on fish abundance.

48. Does this mean that flows are not important to fish abundance in the Upper Klamath Basin?

No. Flow is one of the fundamental determinants for providing healthy, sustainable populations of fish. Relationships between flow and the numbers of fish exist; however, in basins such as the Upper Klamath Basin a determinable and predictive relationship regarding abundance generally cannot be established because of the many determinants involved. Therefore, it is generally not possible to define and then rely on flow:abundance relationships when prescribing an instream flow regime for a given stream system.

49. Is it possible to determine the amount of water necessary to provide a viable and self-renewing population of target fish species that would enable the exercise of the Tribal treaty rights?

Yes. By establishing stream flows for the Upper Klamath Basin streams, the health and productivity of fish habitat can be reasonably assured to the extent that the stream flow is assured. The Physical Habitat Claims provide for the creation and/or maintenance of the living space or structure within which healthy and productive fish habitat occurs and which is essential to the development and sustainability of viable populations of the target fish species. Without the flows that provide for such habitats, the population viability of the target fish species would be at best doubtful and correspondingly, the ability of the Tribes to exercise their rights to fish would be more uncertain.

IV. PROVIDING A HEALTHY AND PRODUCTIVE HABITAT FOR TARGET FISH SPECIES

50. Dr. Reiser, you stated that the Physical Habitat Claims will provide healthy and productive habitat for target fish species. How do you define "healthy and productive habitat"?

No single quantitative measure for or scientifically recognized definition of what constitutes "healthy and productive" habitat exists. What comprises a healthy and productive habitat and whether a healthy and productive habitat exists are questions that require consideration of a multitude of factors in combination with the exercise of scientific judgment, from a biological perspective.

In a general sense, healthy and productive habitat can be defined intuitively as habitat that possesses all of the essential ecological ingredients to allow aquatic biota to properly function (i.e., they are healthy) and to reproduce in numbers that are sufficient to sustain and allow harvest of a portion of the population under varying climatological conditions (i.e., they are productive). From a water perspective, this can be more narrowly defined as habitat that is afforded the right amounts of flow (perhaps the most important ecological ingredient) at the right times to allow fish species to fulfill all life history functions (i.e., they are healthy) and to reproduce at levels that allow harvest (i.e., they are productive). In the case of streams in the Upper Klamath Basin, this means the provision of flows that not only maintain the existing quality and quantity of habitat space that fish reside in, but also over the long term promote new habitats and habitat diversity within a stream.

51. Have other scientists considered what contributes to healthy fish habitat?

Yes. There have been a number of scientists who have attempted to render some definition of what constitutes a healthy riverine ecosystem. Karr et al. (1986), for example, suggested that a biological system is healthy when its inherent potential is realized, its condition stable, its capacity for self-repair when perturbed is maintained, and minimal external support for management is needed. However, Norris and Thoms (1999) suggest Karr's definition only focuses on the aquatic biota, while ignoring the non-biological and out-of-stream components (e.g., channel form, flow regime, riparian zone, and floodplain functions). Norris and Thoms (1999) question the notion that it is possible to have healthy assemblages of biota associated with an unhealthy channel.

An expansion of Norris and Thoms' question is whether it is possible to have healthy habitat without sufficient streamflow to provide for the living spaces of fish and other aquatic biota and to maintain the form and function of the stream channel. My answer to this question is no, it is not possible to have healthy habitat without sufficient streamflow. Moreover, healthy, self-sustaining populations of fish depend on combinations of physical, chemical, and biological factors that are provided by streamflow that occur in the right proportions and at the right times, i.e., under a healthy flow regime. Determining when and how much streamflow is needed to provide healthy and productive habitats in streams within the Williamson River subbasin was the focus of our field work and modeling analysis.

52. How is fish habitat related to stream productive capacity and streamflow?

To answer this question, I want to first frame the concept of healthy, productive habitat by employing a definition imparted by Levy and Slaney (1993), which coincidentally in part forms the basis behind Canada's Department of Fisheries and Oceans policy of "No Net Loss of Productive Capacity of Fish Habitat." The Levy and Slaney definition is for productive capacity which is the maximum natural ability or capacity of a habitat to support healthy fish or grow aquatic organisms upon which fish depend. Productive capacity is determined in part by flow, but also by other components such as water quality, food production capability, channel morphological characteristics including the amount of cover and shelter areas, geographic characteristics, and climate characteristics. Fish habitat represents a combination of stream productive capacity (again the natural ability of a habitat to support healthy fish or grow aquatic organisms upon which fish depend) as well as its useable area or space. In combination, these two elements define the carrying capacity of a stream, which in essence is the maximum number of fish supportable by the given set of habitat conditions. Importantly, while the amount of useable area or space will vary with the quantity of streamflow, the stream productive capacity does not necessarily vary with the quantity of streamflow; it may be controlled by one or more of the other items I mentioned above.

Shirvell (1986) demonstrated the importance of both elements (streamflow and stream productivity) to fish production and carrying capacity. Shirvell cited an example where the fish biomass in one stream changed over time even though there was no change in percent useable physical habitat as defined by streamflow. Thus, in that circumstance, factors related to productive capacity were more influential in determining fish production than the availability of space. The reverse of this is certainly true, especially in systems in which the factors that define productive capacity (e.g., water quality, food availability) are not limiting. In these instances, I would expect fish production to be more closely linked to the available livable space within a stream, and, by extension, to streamflow. Figures IV-1 and IV-2 serve to illustrate these concepts. Figure IV-1 demonstrates how the carrying capacity of a stream can vary with streamflow; more flow translates to more space that can be inhabited by fish, and hence, all things being equal, the ability to support a greater number of fish. Figure IV-2 depicts changes in carrying capacity that result from elements other than streamflow. In this case, although streamflows are the same under the three conditions portrayed (i.e., the amount of physical space is the same), a higher carrying capacity occurs as more instream cover is provided. Obviously, differing amounts of streamflow, coupled with different types and amounts of the factors that influence productive capacity will result in different carrying capacities of fish.

The Physical Habitat Claims presented today were focused primarily on providing for the spatial needs of the fish population as provided by streamflow and that are best represented in Figure IV-1; however, consideration was also given to some of the other productive capacity elements that are known to be influenced by streamflow, such as temperature, and in particular, as will be described in detail in Dr. Chapin Direct Testimony at questions 19 and 25, flows to support riparian habitat. In developing the claims, the goal was to achieve flows that would provide healthy and productive habitat sufficient to allow the Tribes to exercise their treaty fishing rights. Specific details of the overall process used for determining these flows are provided in Sections VII and VIII.

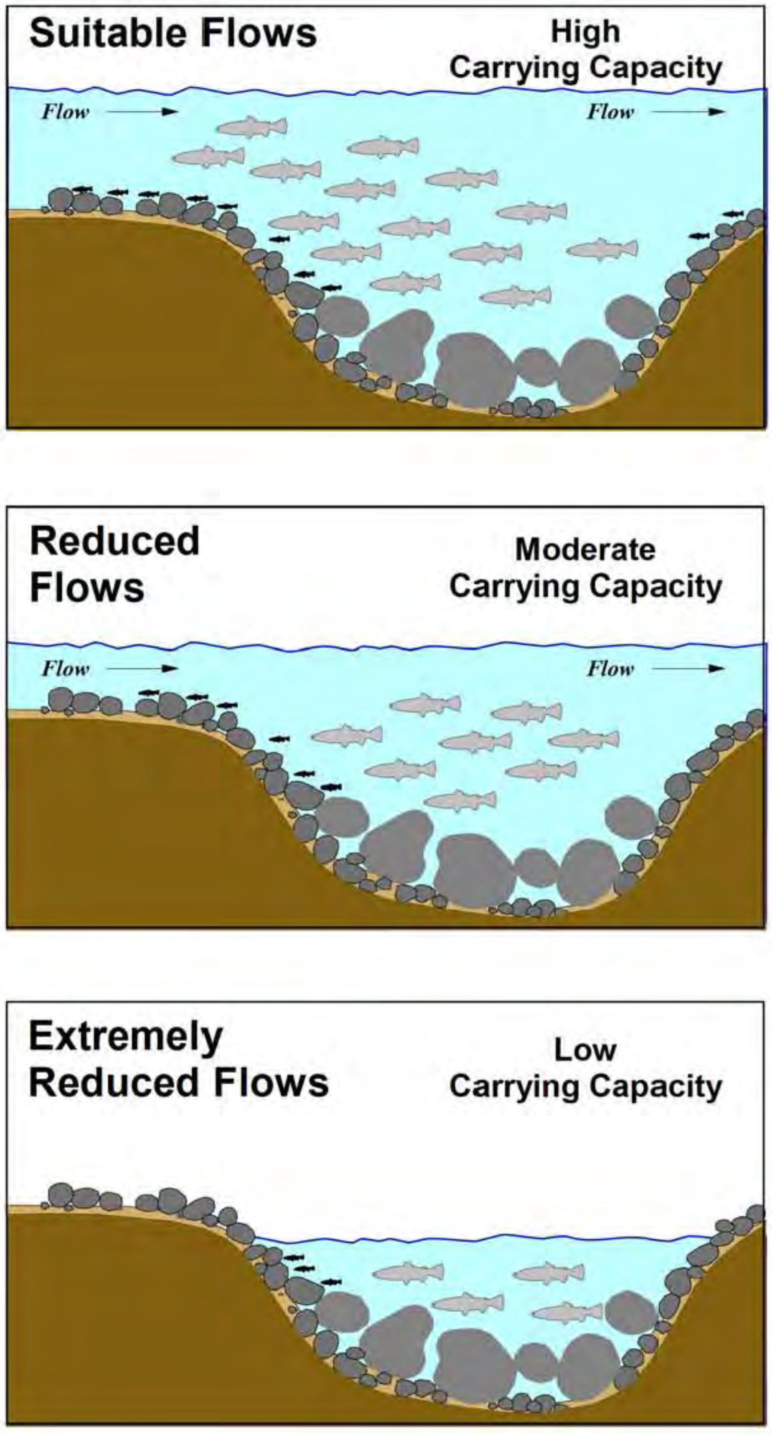


Figure IV-1. Influence of streamflow on fish carrying capacity. Under conditions of similar habitat, water quality, food availability, and instream cover, increases in flow will generally increase the carrying capacity of the stream up to some maximum level.

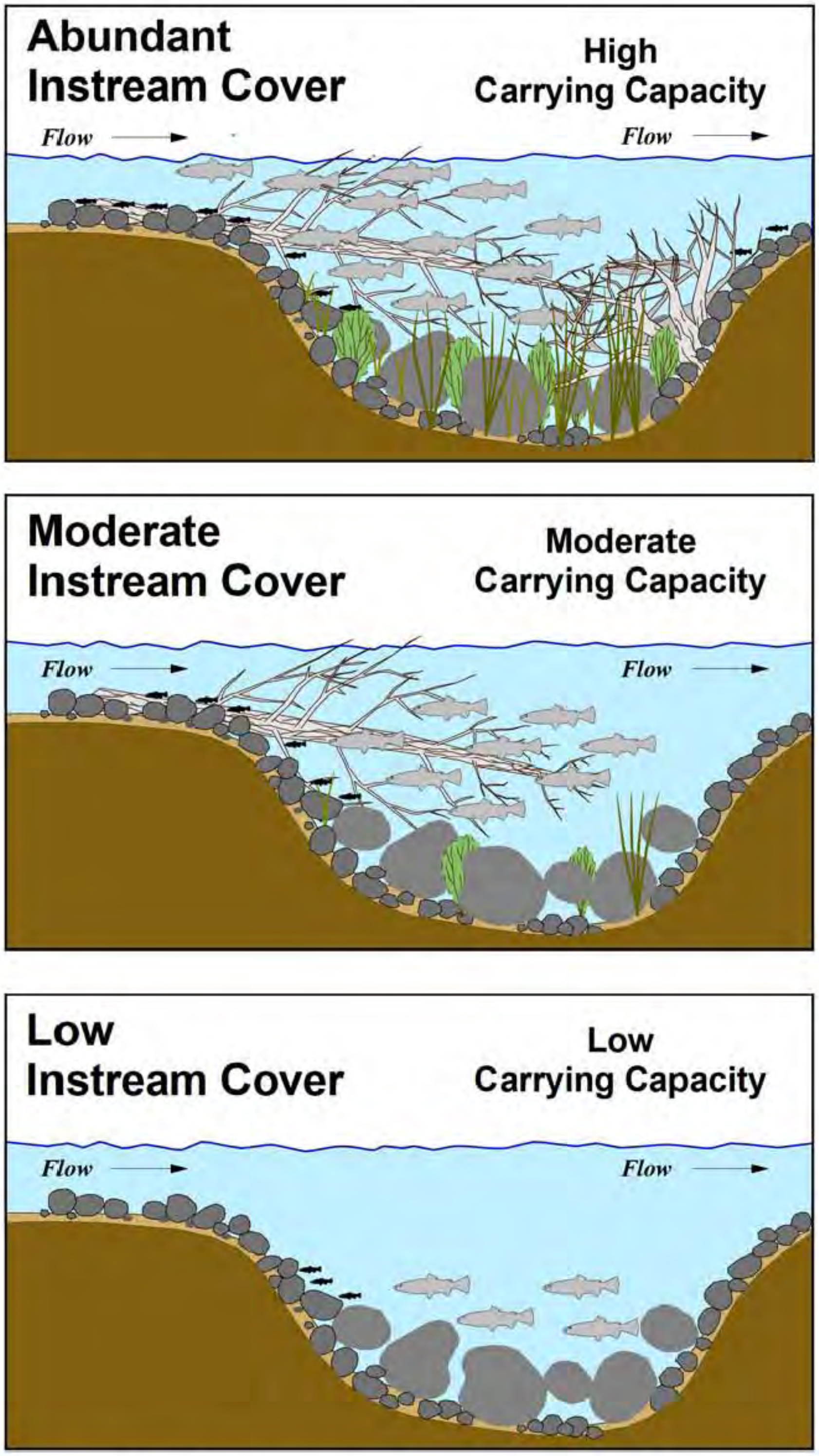


Figure IV-2. Influence of habitat components on carrying capacity. Under conditions of similar streamflow, changes in habitat structure, food availability, water quality, instream cover (this example) will generally result in changes in stream carrying capacity up to some maximum level.

53. What impacts, if any, can reduced flows have on carrying capacity?

Reductions in flow can concomitantly translate into reductions in carrying capacity, as has been demonstrated experimentally by White et al. (1981). Fewer fish can be supported due to the lower flows, and it is for this very reason that oftentimes it is the summer/fall low flow periods that actually set the carrying capacity of streams. The potential effects of flow diversions in the Upper Klamath Basin generally coincide with periods of summer/fall low flows. Since the stream is already at a relatively low flow condition in summer/fall, diversions can severely reduce the amount of space in pools, and concomitantly, the carrying capacity of the stream (e.g., Figure IV-1, lower panel). Because of the magnitude and timing of flow reductions in streams within the Williamson River subbasin, it is likely these types of limitations of carrying capacity are currently operating in these streams.

54. How do productive capacity and flow relate to streams in the Upper Klamath Basin, generally, and specifically to the Physical Habitat Claims?

Scientists have often described flows in streams in terms of natural, altered, regulated, and modified, with the last three essentially all describing conditions in which some aspect of the natural flow regime of a river has been changed by some act of manipulation by man (e.g., reduction in flows, changes in the seasonal patterns of flows, fluctuations in flows, etc.). With few exceptions, the flow regimes in most of the streams in the Upper Klamath River Basin have been altered to some degree, some quite substantially. If we start from the premise that natural flow regimes provide the maximum amount of healthy and productive habitat, the goal of establishing instream flow claims for the Upper Klamath Basin becomes one of determining at what point or threshold along a "flow alteration scale" the habitat ceases to be healthy and productive. The objective of the Physical Habitat Claims was to apply the best available science and information to identify the flow(s) just above that point, which would comprise the flows represented in the claims sought in this adjudication.

55. Can the condition of stream habitat be further classified in a way that factors in streamflow? If so, how?

Yes. Some finer definitions of the habitat:flow concept and how it relates to aquatic biota can be added by considering the following Ecological Management Classes of river regulation that have been applied elsewhere (Postel and Richter 2003):

- Class A (natural) – natural conditions (i.e., no flow regulation): negligible modification of instream and riparian habitats and biota.
- Class B (good) – largely natural with few modifications: ecosystem essentially in good state; biota largely intact.
- Class C (fair) – moderately modified: a few sensitive species may be lost; populations of some species likely to decline; tolerant or opportunistic species may become more abundant.
- Class D (poor) – largely modified (i.e., high degree of flow regulation): habitat diversity and availability have declined; mostly only tolerant species present and often diseased; population dynamics disrupted.

Conceptually under this system, the Physical Habitat Claims for the streams of the Williamson River subbasin were largely targeting Class B conditions that would provide healthy and productive habitats (and corresponding carrying capacities) at levels that would allow the Tribes to exercise their fishing rights.

56. Did you consider both flow-related principles and non-flow related principles when developing the Physical Habitat Claims?

Yes. When developing the Physical Habitat Claims, I gave significant consideration to the work of Naiman and Latterell (2005) who outlined eight relatively broad principles they considered necessary to maintain robust fish communities over the long term. Dr. Naiman is currently a professor at the University of Washington College of Ocean and Fishery Sciences and has published over 200 journal articles and written and edited ten books related to aquatic ecology and watershed management. His research interests have focused on the structure and dynamics of streams and rivers, riparian vegetation, and the role of large animals in influencing system dynamics. He has also been involved in researching interactions between marine-derived nutrients and riparian vegetation, and in evaluating the environmental consequences of changing water regimes. His full vitae can be found at http://www.fish.washington.edu/people/naiman/index.html. Dr. Latterell received his Ph.D. from the University of Washington where his research focused on understanding large wood dynamics in river ecology. He has published numerous articles related to large wood, riparian and river ecology, and streamflows, and is currently a senior ecologist working for King County, Washington as part of the Watershed and Ecological Assessment Unit.

I am familiar with many of Dr. Naiman's publications and felt that his 2005 work, with Latterell, in particular aptly describes many of the key precepts related to and ingredients of healthy and productive habitats that were used in developing the Physical Habitat Claims and the Riparian Habitat Claims (see Dr. Chapin Direct Testimony at question 19). Moreover, each principle is linked to others and most are related to streamflow by varying degrees. Thus, for these reasons, I considered the Naiman-Latterell principles in developing the Physical Habitat Claims.

The Naiman and Latterell principles are as follows:

1. Habitats can be created by "keystone" species and interactions among species;

2. Productivity of aquatic and riparian habitat is interlinked by reciprocal exchanges of material;

3. The riparian zone is fish habitat;

4. Fishless headwater streams are inseparable from fish-bearing rivers downstream;

5. Fish may utilize different habitats, in different locations, and at different times in their life-cycle;

6. Habitats change over hours to centuries;

7. Fish production is dynamic due to biocomplexity, in species and in habitats; and

8. Management and conservation strategies must evolve rapidly in response to present conditions, but especially the anticipated future.

57. Please describe Naiman and Latterell's first principle, which you stated is an underpinning for a healthy and productive fish habitat.

The first principle for healthy, productive habitat is that habitats can be created by "keystone" species and interactions among species. Naiman and Latterell (2005) recognized that certain animals exert a disproportionate influence on ecosystems and considered these "keystone" species. Keystone species animals carry nutrients, energy and/or genetic materials to and between otherwise separate habitats. They can influence the structure and dynamics of receiving habitats, even if they only utilize those habitats infrequently.

Examples of keystone species that presently exist in the Williamson River subbasin include the adfluvial redband trout, Lost River sucker, shortnose sucker, and Klamath largescale sucker. Although these species spend a large percentage of their lives within Upper Klamath Lake, they migrate into streams of the Williamson River subbasin to spawn. Resulting juvenile fish may also use the streams to feed and grow before moving back downstream to the lake. In these cases, the physical habitats of the streams are influenced by spawning activities that include disruption of the streambed and flushing of fine sediments from the gravels. Energy transfer occurs in the form of both waste products from both the adult and juvenile fish. In addition, although the above four species are iteroparous fish, meaning they can spawn more than one time, in general, a certain percentage of adult fish die following spawning. This percentage is reportedly even higher for redband trout in the reach of the Williamson River encompassed by Claim 628 (Roger Smith - ODFW, pers. com. D. Reiser), a result likely due to elevated water temperatures that render the fish more vulnerable to infection by a certain species of protozoan (Ceratomyxa shasta) (http://www.pacificorp.com/File/File19355.pdf). Nevertheless, the decomposition of adult carcasses provides an important source of nutrients to the stream that can be used by other aquatic organisms as well as trees and other vegetation that comprise the riparian zone.

Further, according to Hamilton et al. (2005), and as supported by Dr. Hart Direct Testimony at questions 19 through 55, two other "keystone species" that were historically present in the Williamson River subbasin are Chinook salmon and steelhead trout. Both of these species are anadromous, meaning they spend a substantial portion of their lives in saltwater where they grow and mature, and then migrate into freshwater for spawning and juvenile rearing.[1] Unlike steelhead, which is iteroparous, Chinook salmon have a life cycle of approximately five years and are semelparous, meaning that they spawn only once and afterwards die. The historical contribution of both species and in particular that of Chinook salmon to the nutrient cycle and energy transfer in streams within the Williamson River subbasin

1 Rearing is the term used by fish biologists for the period of time in which juvenile fish feed and grow. In the case of anadromous fish, the end of the juvenile rearing period culminates when the fish undergo smoltification, a process that results in physiological changes to the fish that readies them for transitioning to saltwater.

was almost certainly ecologically significant given their importance in other river systems (Naiman et al. 2002).

58. Was this principle of keystone species incorporated into developing the Physical Habitat Claims?

Yes. The work to develop the Physical Habitat Claims was specifically focused on providing for the spatial and temporal habitat needs of the target fish species, which can also be considered as keystone species based on Naiman and Latterell's definition. Stated another way, the work to develop Physical Habitat Claims was specifically focused on identifying those flows that would nurture the propagation and/or formation of healthy and productive habitats that are relied upon by the target (keystone) fish species.

59. Please describe Naiman and Latterell's second principle which you stated is an underpinning to a healthy and productive fish habitat.

The second principle for healthy, productive habitat is that the productivity of aquatic and riparian habitat is interlinked by reciprocal exchanges of material. Naiman and Latterell (2005) described this exchange linkage as a derivative of the "River Continuum" concept ("RCC") (Vannote et al. 1980), which is graphically displayed in Figure IV-3. The RCC simply states that the biological and physical conditions of any segment of a stream are influenced directly by conditions existing alongside and upstream of the segment. That is, the development of healthy and productive habitat at a given location for one or more of the target fish species is dependent on the delivery of flows of sufficient quantity and quality originating upstream, as well as energy and food inputs provided directly from the upstream and adjoining riparian zone. The RCC predicts that for natural, unperturbed stream ecosystems there is a gradient of physical conditions that determines community structure and ecological functions as the ecosystem progresses from headwaters to mouth. As the hydrologic processes, food resources, nutrient dynamics, and riparian vegetations change with the increasing stream size, the composition of fish communities and macroinvertebrate communities will change in response (Vannote et al. 1980; Cummins 1979). Studies have shown, for example, that a reduction in leaf litter and wood resulting from removal of riparian forests resulted in sharp reductions in the abundance and biomass of aquatic invertebrates, which represent one of the primary food sources of fish (Wallace et al. 1999).

60. Was Naiman and Latterell's second principle (reciprocal exchange of materials between aquatic habitats and riparian habitats) incorporated into developing the Physical Habitat Claims and the Riparian Habitat Claims?

Yes. The work to develop the Physical Habitat Claims focused on providing flows that maintain the linkages between the aquatic habitats that house the target/keystone species, and the riparian habitats that help to make them healthy and productive (via the Riparian Habitat Claims).

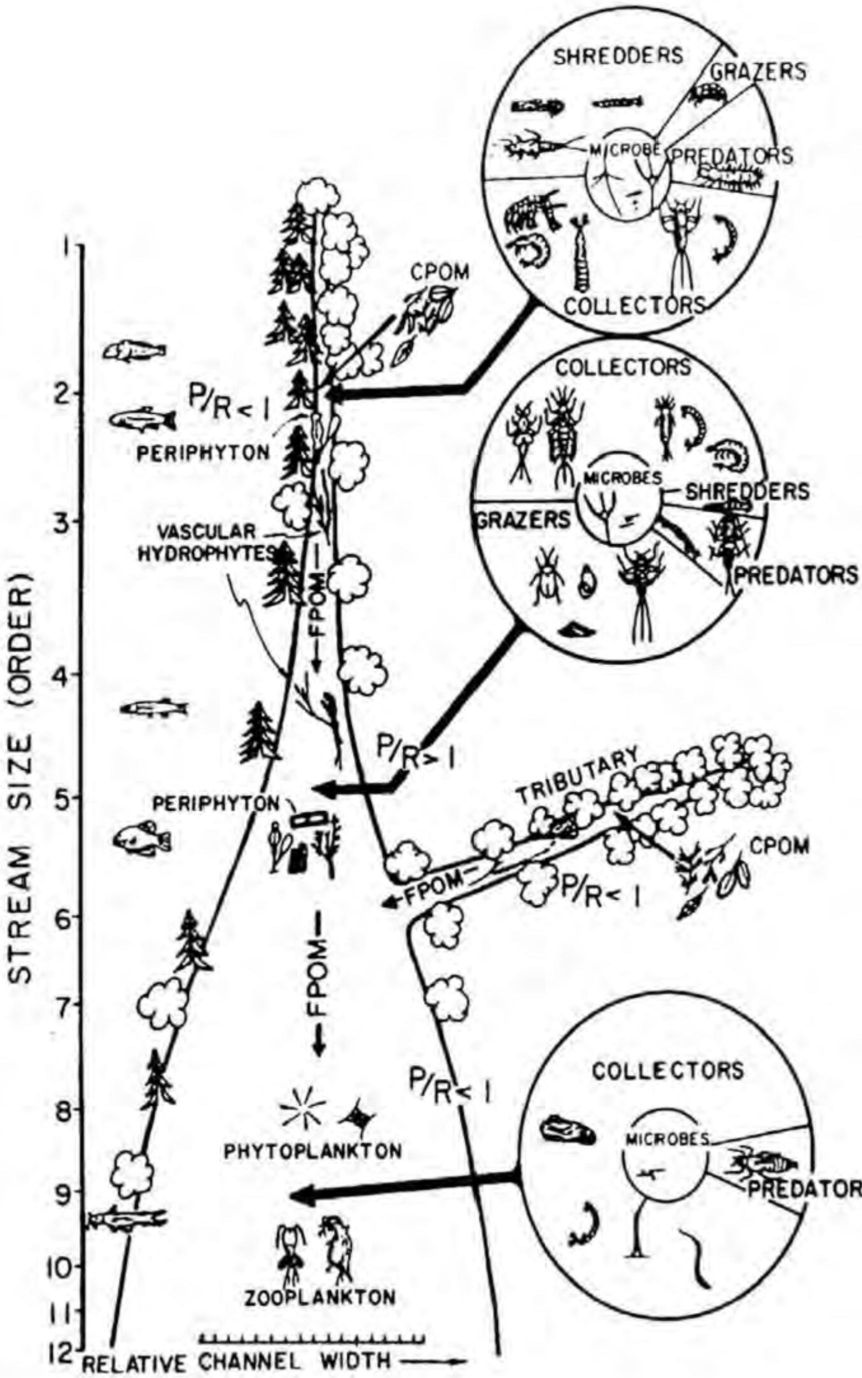


Figure IV-3. The River Continuum Concept, depicting the theoretical relationship between stream size (stream order – progresses from small streams (order 1) to larger streams (order > 1), energy inputs, and ecosystem functions (from Vannote et al. 1980).

61. Please describe Naiman and Latterell's third principle which you stated is an underpinning to a healthy and productive fish habitat.

The third principle for a healthy, productive habitat is that the riparian zone is fish habitat. This principle proffered by Naiman and Latterell (2005) is an extension of the linkage principle just noted, but serves to specifically highlight the ecological significance of the riparian zone to fish habitat. In their construct, Naiman and Latterell suggest that the consequences of large wood and food inputs on stream structure and productivity are so strong as to qualify the riparian zone as fish habitat. Naiman and Latterell (2005), Bilby and Bisson (1998), Fausch and Northcote (1992), and others have all noted the importance of large woody debris in fostering a healthy and productive aquatic ecosystem. Functionally, large woody debris has been shown to influence the shaping of channel structure and form, to facilitate the movement of particulate matter such as fine sediments, to provide habitat and a food base for macroinvertebrate communities, to create fish habitat complexity and form new habitats such as spawning areas, and to provide velocity shelters for fish during high flows, escape cover from predators, and protected feeding stations from which to forage on drifting insects. Studies have also shown that the overall densities of fish are higher in streams containing high concentrations of large woody debris (Fausch and Northcote 1992; Hicks et al. 1991), especially in the winter (Tschaplinski and Hartman 1983; Murphy et al. 1986).

The direct input of food from the riparian zone in the form of terrestrial insects (e.g., grasshoppers, crickets, beetles, flies, etc. that fall or are blown into a stream) is another reason that the riparian zone is fish habitat. As noted by Reiser and Bjornn (1979), terrestrial insects, which are important food items for salmonids may enter the stream by falling off riparian vegetation, by being blown off riparian vegetation, or by wave action that entrains some shoreline insects. Allan et al. (2003) reported that about half of the food items consumed by juvenile coho salmon in a southeast Alaska stream were comprised of insects of terrestrial origin. Wipfli (1997) measured terrestrial inputs of insects to six coastal Alaska streams and noted that food consumption by salmonids was equally split between terrestrial and aquatic insects. Wipfli (1997) concluded that terrestrially-derived insects comprised an important component of salmonid prey and that a riparian over-story with alder and denser shrub understory might increase the abundance of terrestrial invertebrates.

Importantly, the health of the riparian zone can be directly influenced by streamflow conditions. Further, such riparian zone health has a direct effect on the general health of fish populations. Figure IV-4 contains a conceptual diagram of a stream and its riparian zone under two sets of flow conditions. Under unregulated flow conditions in which normal high flow and low flow conditions occur at a natural frequency and magnitude (depicted in the upper panel of Figure IV-4), the riparian zone is healthy and diverse, and provides a variety of functions (shade, wood recruitment, cover, source of food) that serve to promote healthy and productive fish habitat and fish populations. Under regulated flow conditions, both high flow and low flow conditions can become reduced in frequency and magnitude leading to a reduction in the functionality of the riparian zone and correspondingly impact the health and productivity of fish habitat and fish populations.

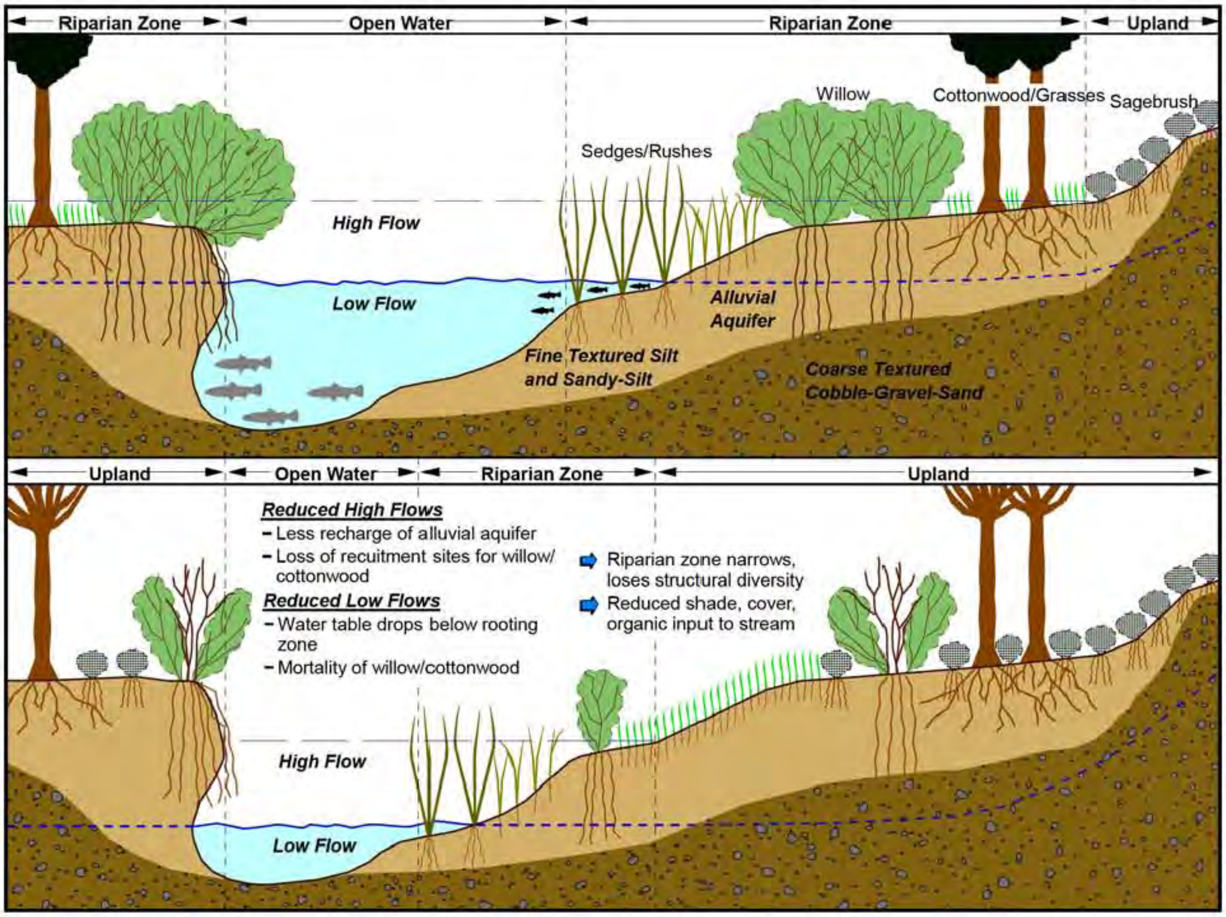


Figure IV-4. Diagram representing general effects of flow reduction on riparian habitats and its functionality. Riparian habitat is fish habitat as Naiman and Latterell's (2005) third principle notes.

62. Was the third principle (riparian zone is fish habitat) incorporated into developing the Physical Habitat Claims?

Yes. The work to develop the Physical Habitat Claims in combination with the Riparian Habitat Claims focused on maintaining the linkages between and functionality of both the needs of the aquatic system contained within the confines of the two stream banks and the adjoining riparian zone. Both of these are necessary ingredients in sustaining overall healthy and productive fish habitats. Without flows sufficient to maintain a healthy and productive riparian zone, the linkages between the physical habitat within and riparian habitats adjoining the stream would be de-coupled, creating a decrease in the health and productivity of habitats proximal to and for some distance downstream from the affected area.

63. Please describe Naiman and Latterell's fourth principle which you stated is an underpinning to healthy and productive fish habitat.

The fourth principle for a healthy, productive habitat is that fishless headwater streams are inseparable from fish-bearing rivers downstream. This principle relates directly to the second principle (linkage) noted above, in that conditions existing at any point within a stream reflect the physical, chemical, and biological inputs emanating from upstream sources. Indeed, there is often an identifiable location within a stream that marks the point upstream of where fish do not reside. While there may be physical barriers that block upstream movements of fish that prevent them from reaching and inhabiting upper segments of a stream, the waters emanating from these upper "fishless" streams represent important pathways for transporting nutrients, sediments, and food (invertebrates) to downstream reaches that harbor fish. Naiman and Latterell (2005) noted that the inputs received from upper stream segments contribute materials to downstream food webs and help shape the structural characteristics of fish habitats in lower reaches. Thus, even though sections of stream within these upper watersheds are fishless, it is important that they are protected and that sufficient flows be allowed to reach the downstream segments of stream that contain fish.

64. Was the fourth principle (fishless headwater streams are inseparable from downstream fish-bearing rivers) incorporated into developing your Physical Habitat Claims.

Yes. There are fishless headwater streams within the Williamson River subbasin that exist above the claim reaches. Although not explicitly claiming waters in these streams, the instream flow claims for the Williamson River subbasin implicitly afford some protection to these upstream systems and their physical, chemical, and biological inputs. This is because the headwater streams are contributory to the flows specified in a given downstream reach and therefore contribute to the formation of healthy and productive fish habitats. Indeed, the Physical Habitat and Riparian Habitat flow claims that are made downstream rely in part on flows from these smaller, fishless, tributaries. Thus, the provision of flow claims within the reaches of stream that contain fish, will by extension afford some protection to flows in the fishless systems.

65. Please describe Naiman and Latterell's fifth principle which you stated is an underpinning to healthy and productive fish habitat.

The fifth principle for a healthy, productive habitat is that fish may utilize different habitats, in different locations, and at different times in their life-cycle. Some fish species migrate from and to lake systems (adfluvial), from and to large river to small river systems (fluvial), from one section of the stream to another section within a relatively small distance (resident) and between ocean and freshwater habitats (anadromous). Such migration periods are typically genetically programmed to occur within a set time period that has been established by evolution to provide the greatest advantage for the success of that particular lifestage.

66. Was the fifth principle (fish may utilize different habitats, in different locations at different times) incorporated into developing the Physical Habitat Claims?

Yes. In developing the Physical Habitat Claims, consideration was expressly given to flows necessary to provide for specific life history needs including spawning, egg incubation, adult and juvenile rearing, and fry habitats. In addition, although a specific claim for a given month may have been directed toward a certain species and lifestage, the claim was reviewed in the context of its influence on other target/keystone species and lifestages that may co-exist at the same time. This was done as a check to make sure that the provision of flows intended to promote healthy and productive habitats for one species and lifestage would not severely impact the habitats of another.

67. Please describe the remaining sixth, seventh, and eighth Naiman and Latterell principles which you stated are underpinnings to healthy and productive fish habitat.

The remaining principles for a healthy, productive habitat are: habitats change over hours and over centuries (sixth principle); fish production is dynamic, due to bio-complexity in species in habitats and between the two (seventh principle); and management and conservation strategies must evolve rapidly in response to present conditions, but especially the anticipated future (eighth principle).

I group these last three components together since they all contain a "time" element. The sixth principle connotes the realization that habitats are not static but are continually changing in response to global, regional and local influences (sometimes called "forcing factors") such as those imposed by climate and weather-related events. The seventh principle links biology to these same forcing factors which can cause intra- and inter-annual changes in fish production. The final, eighth, principle stresses that management strategies should be adaptive and flexible in responding to future conditions.

68. Were the sixth, seventh, and eighth principles, (habitats are not static but continually changing biology; fish production is dynamic; and management strategies should be adaptive and flexible) incorporated into developing the Physical Habitat Claims?

Yes. The sixth, seventh, and eighth principles reflect a time component and the realization that habitats and associated aquatic biota that exist at any given time are not static and will change in response to a variety of forcing factors. The sixth and seventh of these time-related principles (continuously changing habitat and dynamic fish production) were considered in both the Physical Habitat and Riparian Habitat Claims developed for the streams of the Williamson River subbasin and relate to the hydrologic statistic applied to each. That is, as further described in Section VII, the Physical Habitat Claims are founded around the hydrologic statistic of the median, or 50 percent exceedance flow. The median flow is the flow amount equivalent to the value that would be equaled 50 percent of the time. In years of higher flow, the claimed flow may be exceeded, whereas in years of low precipitation and runoff the flows occurring may not attain the median level. In that sense, although specific flow values have been claimed for each month, there will be inter-annual variability in the amount of flows that actually occur. Likewise and as more completely described in Dr. Chapin Direct Testimony at question 36, the Riparian Habitat Claims are hydrologically limited and thus subject to inter-annual variability.

The final time-related principle, adaptive management, was considered; however, adaptive management is a form of resource management in which actions are implemented as experiments from which to learn and appropriately modify future actions. Such flexibility is not inherently possible under a water rights adjudication such as this, which specifically quantifies water rights with finality and does not operate within an ongoing adaptive management framework.

69. Dr. Reiser, please summarize how the Naiman and Latterell principles were brought together in your analysis.

These principles served as guide posts for developing the Physical Habitat Claims. They served to highlight the ecological linkages that must be met by the claims; linkages that are based on important life history requirements of the target fish species that are influenced by streamflow.

70. Please describe how streamflow specifically affects or meets a fish's life history requirements and biological needs.

As I described above with respect to the stream flows associated with the Physical Habitat Claims, I distinguish two different stream functions directly relevant to fish and fish physical habitat. First, streamflow provides physical space within which fish and other aquatic organisms can live. Second, streamflow provides the necessary hydraulic energy and forces to create and maintain physical structures and ecological function in and along the channel including pools, riffles, spawning areas (through the deposition of new gravels and flushing of fine sediments within existing gravels), off-channel habitats, and riparian communities. Both functions are necessary to promote healthy and productive habitat for fish.

Importantly however, as noted in Naiman and Latterell's fifth principle, habitat requirements can differ by fish species and their life history stage. For the target fish species present in the Williamson River subbasin, the key lifestages include spawning, incubation, fry, juvenile, and adult.

71. Are the fish lifestages connected to each other?

Yes. Collectively, lifestages represent the major steps that a fish progresses through as part of its life cycle. Just as the human life cycle can be characterized as a series of stages that include conception, birth, youth, adolescence, adulthood, etc., the life cycle of fish can be captured in a series of lifestages that represent important biological activities. For convenience, I have included Figures IV-5 to IV-9 that display the lifecycle diagrams and general periodicities for each of the target species that are currently or were historically found in the Williamson River subbasin, including redband trout, Chinook salmon (planned for reintroduction), Lost River sucker, shortnose sucker, and Klamath largescale sucker.

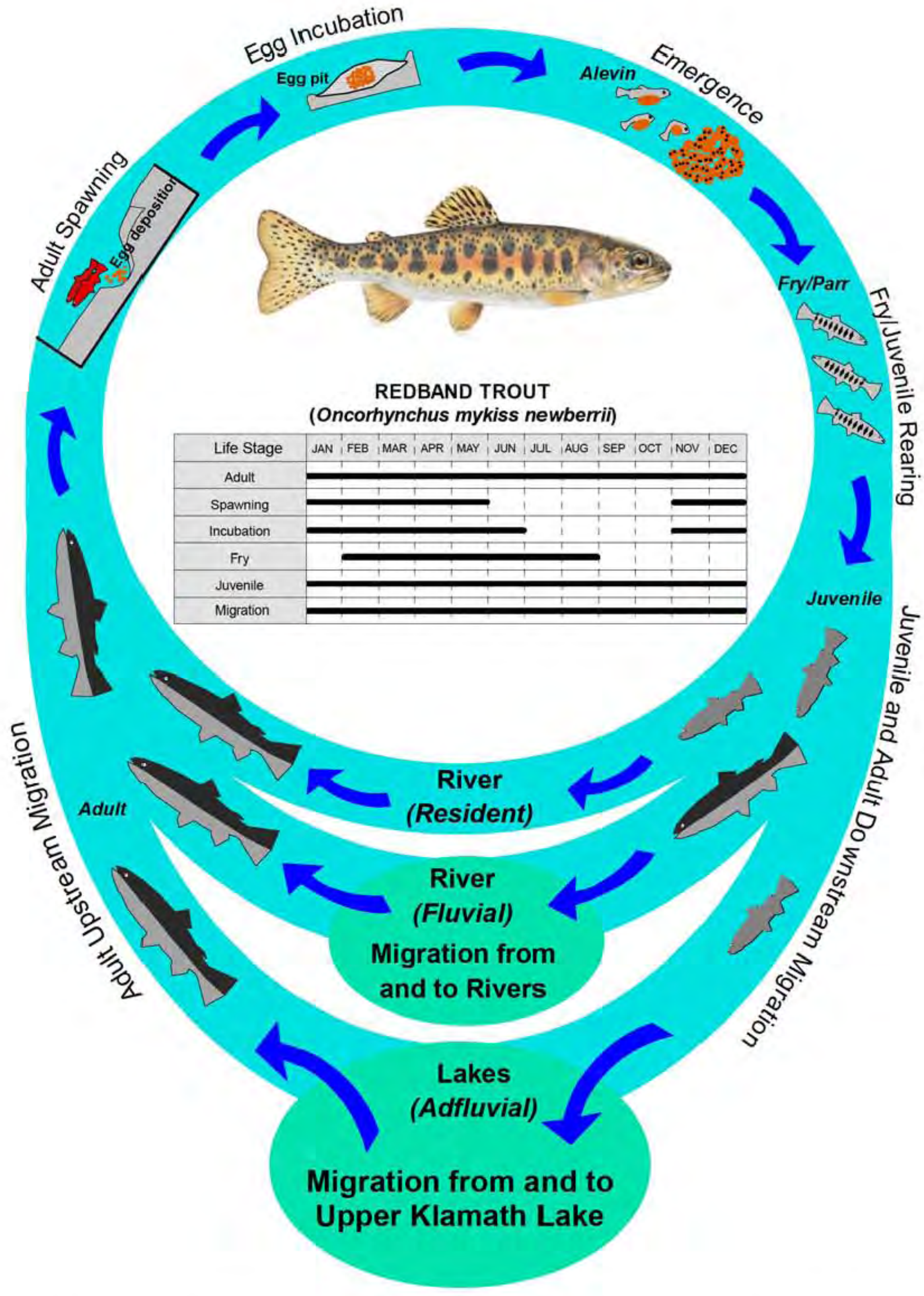


Figure IV-5. Life cycle diagram of redband trout depicting three life history strategies (adfluvial, fluvial, and resident) that occur in the Williamson River subbasin. A general periodicity chart is presented in the center of the diagram that shows the timing of lifestage functions throughout the year.

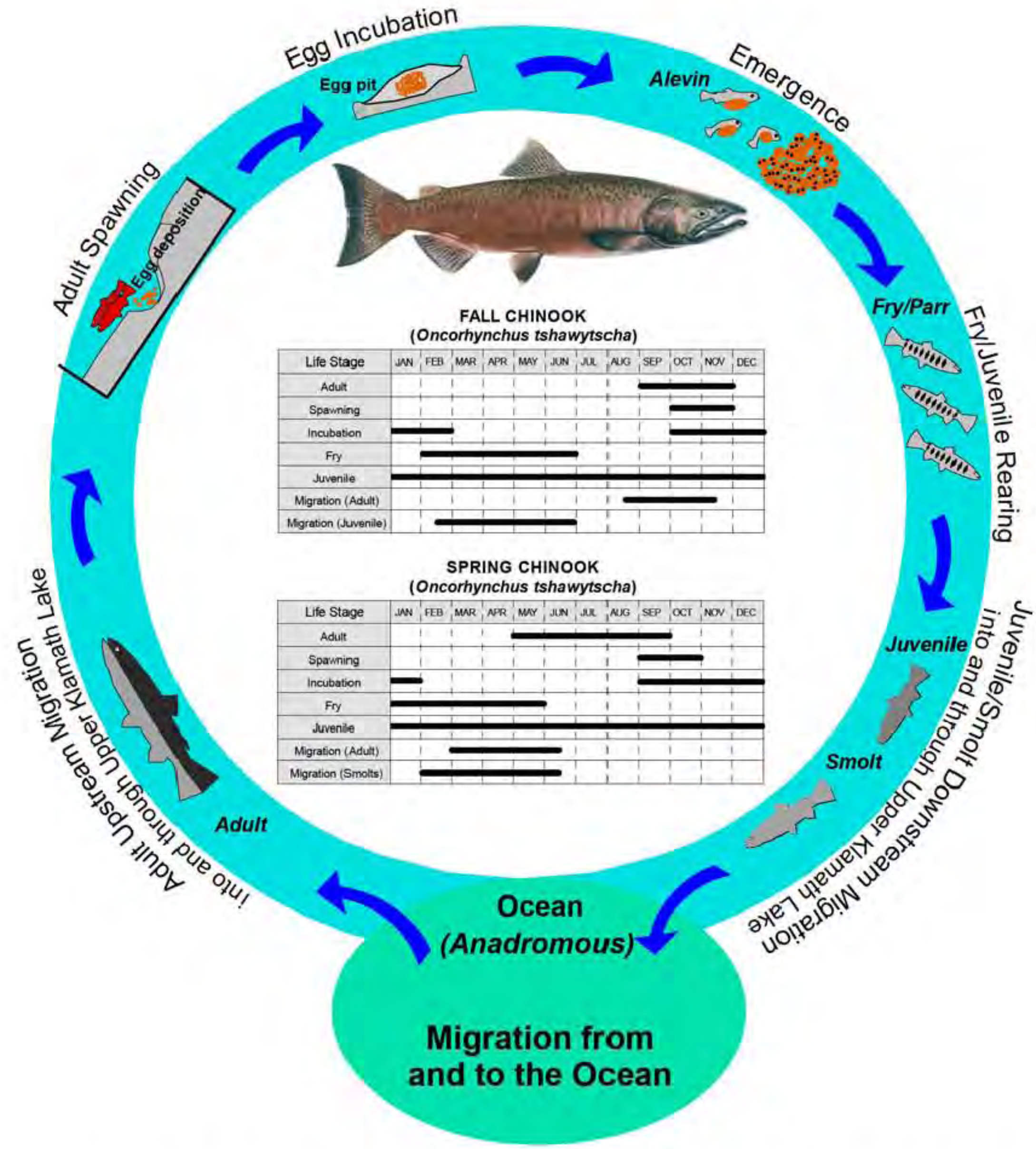


Figure IV-6. Life cycle diagram of Chinook salmon for part of the Williamson River subbasin. Chinook salmon were historically present and are proposed for reintroduction into the Upper Klamath Basin. Two races of Chinook salmon will likely be present, spring Chinook and fall Chinook. Adult spring Chinook enter freshwater in the spring and migrate upstream into the upper watershed where they hold until ready to spawn. Fall Chinook enter in the fall and migrate upstream to areas wherein they commence spawning shortly after arrival. As juveniles, spring Chinook typically remain and rear in freshwater from 1 to 2 years before migrating downstream to the ocean. As juveniles, fall Chinook spend a relatively short time in freshwater and generally commence moving downstream shortly after emerging from the gravels. All Chinook salmon adults die after spawning. Separate periodicity charts are presented in the center of the diagram that show the timing of lifestage functions throughout the year.

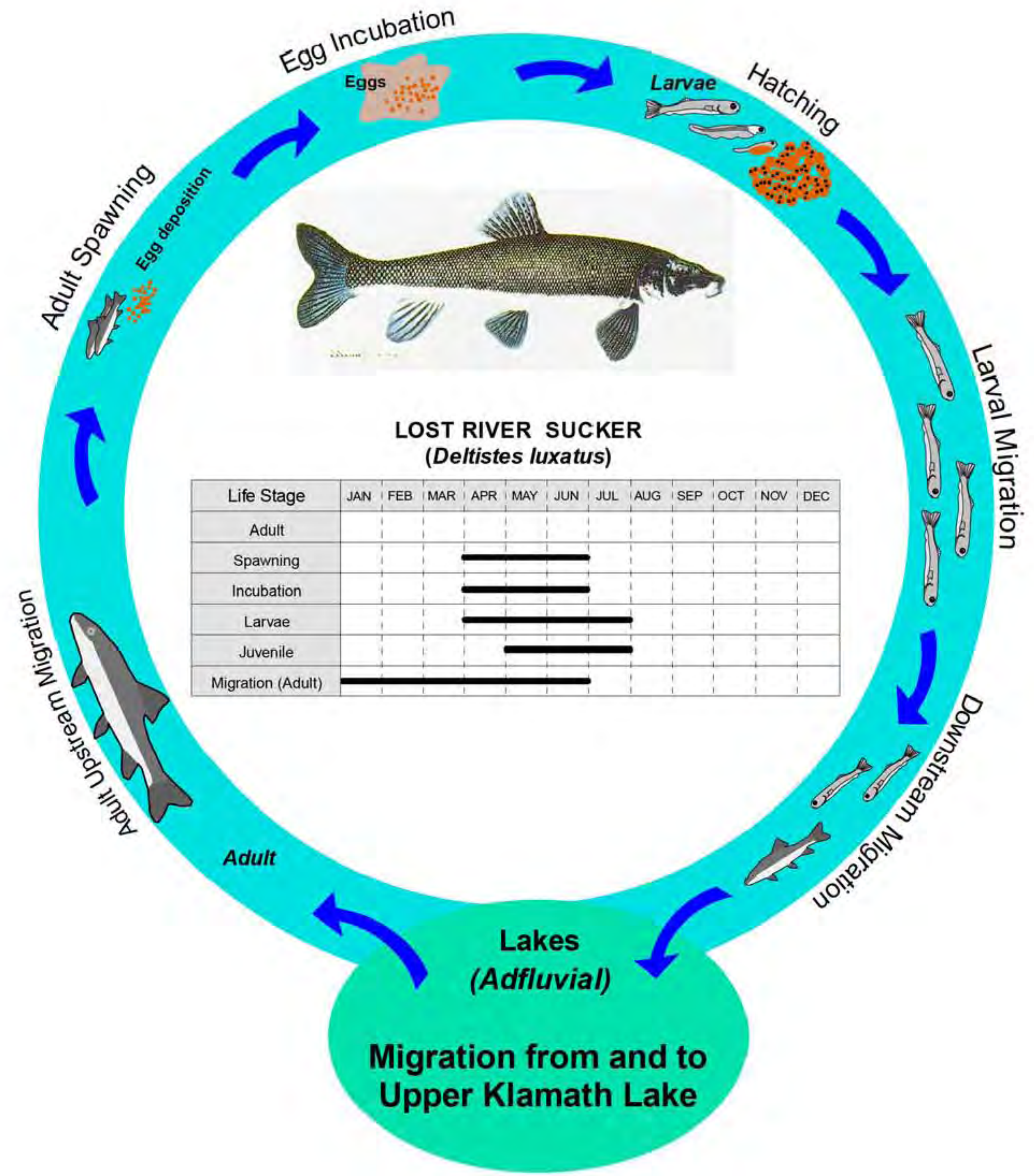


Figure IV-7. Life cycle diagram of Lost River sucker in the Williamson River subbasin. Lost River sucker exhibit an adfluvial life history strategy with adults residing in Upper Klamath Lake until they are ready to spawn, at which time they migrate upstream into the Williamson River to find spawning areas; afterwards, they return to the lake. A general periodicity chart is presented in the center of the diagram that shows the timing of lifestage functions throughout the year.

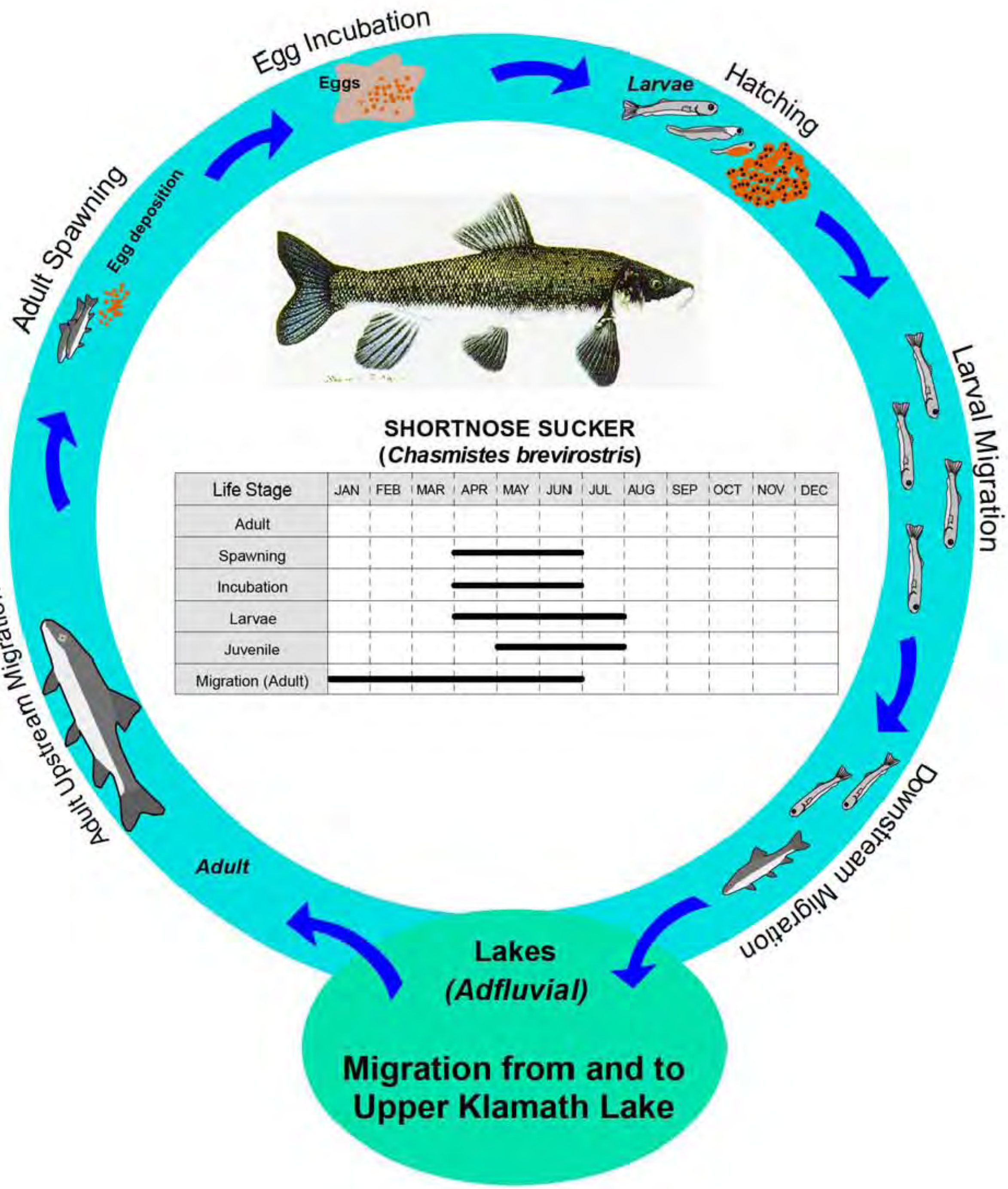


Figure IV-8. Life cycle diagram of shortnose sucker in the Williamson River subbasin. Shortnose sucker exhibit an adfluvial life history strategy with adults residing in Upper Klamath Lake until they are ready to spawn, at which time they migrate upstream into the Williamson River to find spawning areas. A general periodicity chart is presented in the center of the diagram that shows the timing of lifestage functions throughout the year.

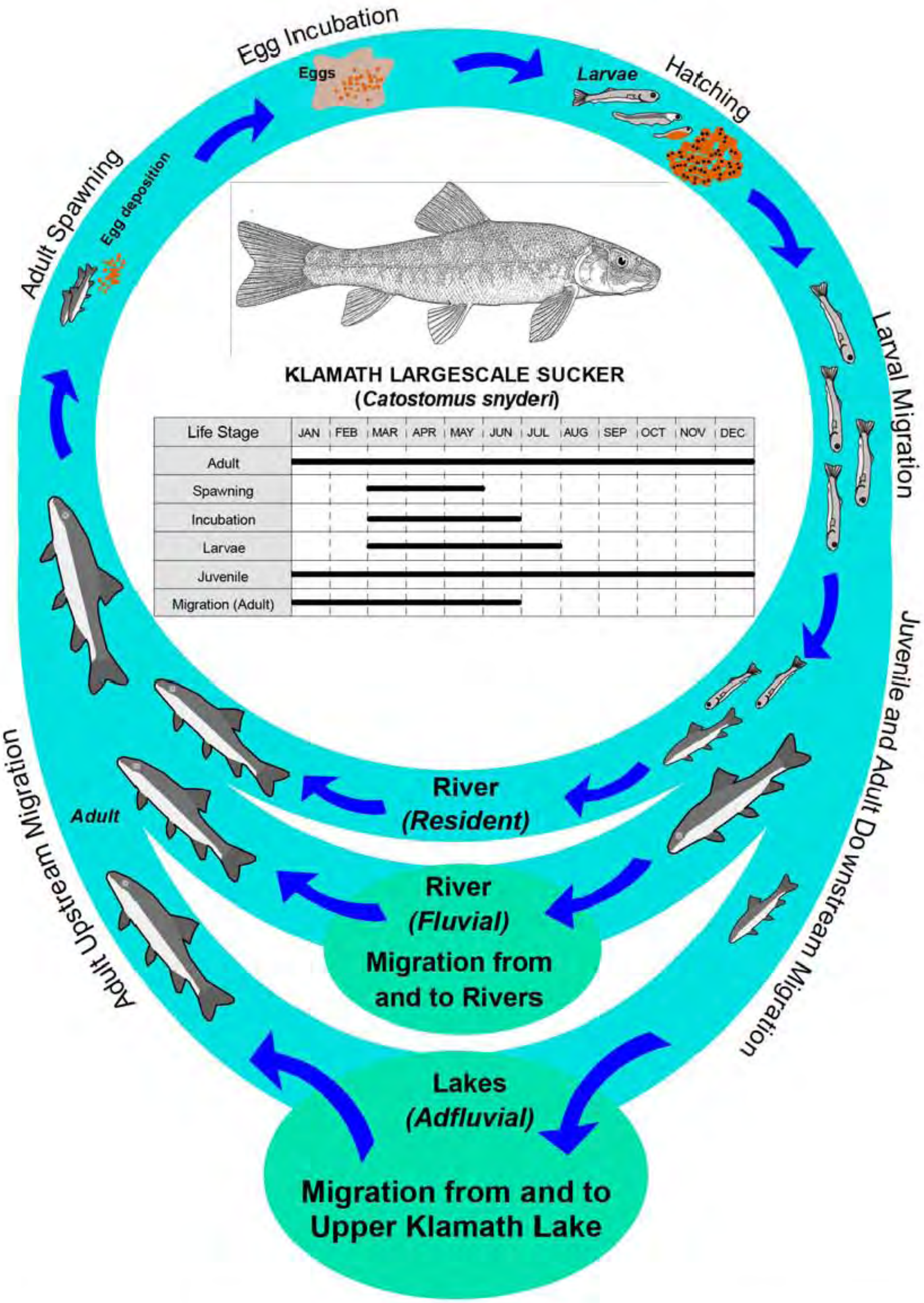


Figure IV-9. Life cycle diagram of Klamath largescale sucker in the Williamson River subbasin. Klamath largescale suckers exhibit three life history strategies (adfluvial, fluvial, and resident) in the Williamson River subbasin. A general periodicity chart is presented in the center of the diagram that shows the timing of lifestage functions throughout the year.

72. Do all of the target fish species have the same life cycle?

In a general sense, yes. All include some type of spawning stage, followed by egg incubation and hatching of fry or larvae; a juvenile stage marked by increased growth; and an adult stage in which the fish has reached sexual maturity. Afterwards, the lifecycle of the species repeats; however, differences do exist between the target fish species in the timing of these lifestages, as well as with the locations where they occur.

73. Please explain what you mean by differences in timing.

With respect to timing, differences occur among the target fish species in terms of whether and when adults migrate (upstream and downstream); when they spawn; whether and when post-spawning adults migrate downstream; when eggs hatch; when fry emerge; whether and when fry/larvae migrate (downstream); and whether and when juvenile fish migrate (downstream). Collectively, these timing differences are what biologists consider as elements of the periodicity of the lifestage; i.e., when a given lifestage occurs during the year.

74. Please explain what you mean by the differences in locations.

Differences in locations reflect where in a given stream certain lifestage functions occur, such as spawning and incubation, juvenile rearing, and adult holding and rearing. For example, certain locations within a stream may be used for spawning by some target species, and other locations used by different species. Likewise, differences exist as to where adult members of each target species typically reside: some spend most of their time in Upper Klamath Lake (adfluvial fish), some in the larger mainstem portion of a river (fluvial fish), others in tributaries (resident fish), and some species have life history strategies that utilize two and in some cases all three of these areas.

75. Are those the only differences between the target fish species?

The lifecycle differences I have described are some of the major differences between species; however, other significant differences exist between one of the target fish species, Chinook salmon, and the other species. First, Chinook salmon are anadromous and spend the majority of their time in the ocean where they feed and grow to maturity. They then enter the freshwater river system of their origin and migrate upstream *via* a homing instinct (olfaction that allows the fish to recognize specific odors and water quality characteristics) to locate a specific tributary or segment of stream to spawn. Chinook are strong swimmers and in some drainages migrate over 1000 miles to reach their natal spawning areas. Second, adult Chinook salmon die after they spawn, while adult members of the other target species do not necessarily die after spawning. The adults of other target species may spawn again for several more years.

76. Please describe the flow and habitat requirements associated with spawning, egg incubation, and fry emergence of young fish.

The habitat conditions that meet the reproductive or spawning requirements of the target fish species in the streams of the Williamson River subbasin are in my opinion the most important habitat conditions relative to sustaining a healthy and productive habitat. The conditions that exist during the period in which eggs are deposited in the gravel nests (called "redds"), embryos incubate and hatch, and young fish, (called "fry") subsequently emerge are primary determinants of the species year-class-strength (the ultimate numbers of fish that may be recruited into the fish population and return as adults) (Quinn 2005). Year-class-strength can vary widely inter-annually due to combinations of physical and hydraulic characteristics of the stream and the variation in climatic conditions.

The key components of spawning habitat include sufficient streamflow, proper substrate (gravels), temperature, and sufficient cover. The influence of streamflow on redds and egg incubation occurs in both a quantitative and qualitative manner. Quantitatively, streamflow regulates the amount of spawning habitat/area within a stream by determining the extent to which spawning gravels are submerged with the proper combinations of water depth and water velocity that have been shown to be used by adult fish (Bjornn and Reiser 1991). Fish are known to select specific areas in a stream that contain certain sizes of gravels, and certain combinations of water depth and velocity. The amount of flow in a stream largely determines the amount of suitable spawning habitat that is present. The topmost panel of Figure IV-10 illustrates conditions where water depths and velocities are suitable for spawning. In the case of salmonids such as redband trout, the female creates a depression in the streambed by repeated flexing movements of her body. Once the depression is of sufficient size, the female and male enter the depression where spawning occurs (i.e., simultaneous release of eggs and sperm). After spawning, the female moves just upstream and via additional flexions of her body, covers the fertilized eggs with gravel, which is what is illustrated in the figure. These fertilized eggs (embryos) remain in the gravels for a prolonged period of time that extends through hatching (at which time the newly hatched fish are called alevins; alevins receive all of their nutrients from an attached yolk sac), and up until absorption of the yolk sac at which time the fry emerge from the gravels. This entire period can extend from 3 to 6 months depending on water temperatures. Thus, sufficient streamflow is important throughout the incubation period (from egg deposition through fry emergence) to provide and maintain suitable conditions within the gravels (i.e., water temperature and oxygen). As illustrated in the lower panel of Figure IV-10, severe reductions in flow may result in the dewatering of redds and exposing the eggs/embryos to air, desiccation, and intolerable temperatures. The conditions exemplified in the lower two panels of Figure IV-10 do not portray healthy and productive habitat.

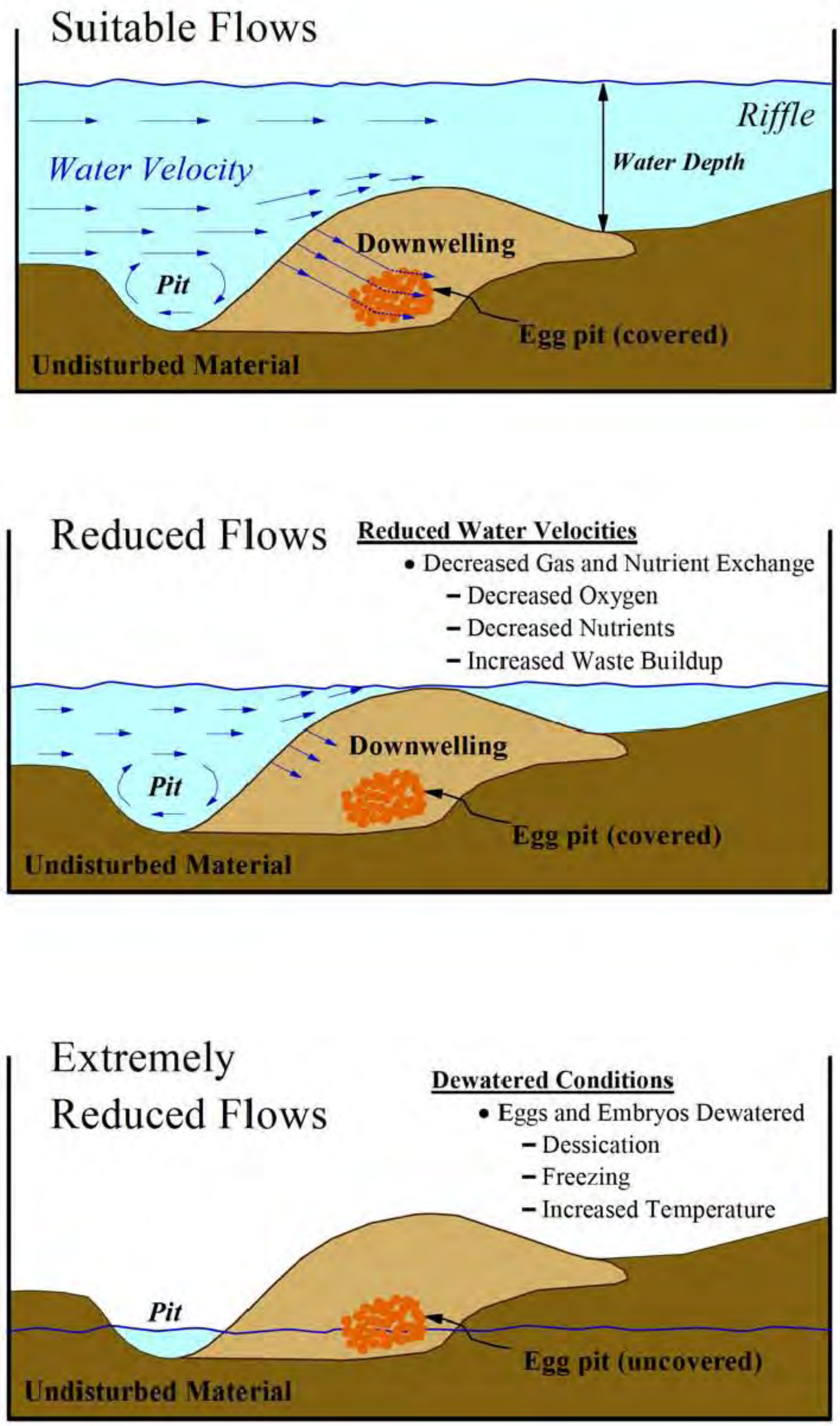


Figure IV-10. Conceptual diagram of salmonid redds illustrating generalized effects of streamflow reductions on the intragravel environment.

Qualitatively, streamflow plays an important role in providing and maintaining the quality of the spawning gravels. These flows typically serve, among other things to mobilize and transport fine sediments from spawning gravels which is important for increasing gravel permeability (rate of flow transport through the gravels) and facilitating the interchange of surface and intragravel flows as illustrated in the top and middle panels of Figure IV-10. This interchange is critical for the successful incubation of deposited eggs since the flows result in the transport of oxygen to and removal of metabolic wastes from the embryos (Reiser and White 1983; Wickett 1954; Chapman et al. 1982). In general, as the amount of surface flow decreases there will be less down-welling of currents into the redds, which can reduce the supply of oxygenated waters to the developing eggs, and may increase mortality. This is why it is important to maintain suitable stream flows throughout the incubation period. The flushing of fine sediments that occurs in conjunction with high runoff in the spring (as would occur in conjunction with the Riparian Habitat flows), also serves to increase the quality of the spawning gravels and enhances potential survival to emergence of fry. Further, such flows and the benefits related to sediment transport are not limited to spawning alone; cleansing of sediments from riffles is important for maintaining invertebrate production and providing for a continuous supply of food for fish (Reiser 1999; Waters 1995). Natural runoff processes that annually and seasonally provide high flows within a stream are extremely important for transporting sediments from riffles and pools, maintaining channel form, creating and maintaining physical habitat structure in the channel, and providing connectivity with the vegetation of the riparian zone. These types of seasonally high flows are part of the Riparian Habitat flow claims described in Dr. Chapin Direct Testimony at questions 19 and 25.

77. What role, if any, does cover have in spawning and incubation?

Cover (i.e., deep pools, surface turbulence, large wood, undercut banks and overhanging vegetation (Bjornn and Reiser 1991)) is regularly relied upon by adult fish both during their upstream migrations and during spawning. Such cover can protect the spawning fish from disturbance, predation, and high water velocities. Instream cover such as large wood can also protect the redds from high water velocities and scouring and removal of eggs from the gravel. All of these cover components are influenced by streamflow and all are likewise important ingredients of healthy and productive habitat.

78. Please describe the relationship of streamflow to stream temperature and spawning and egg incubation habitat.

The timing of spawning of salmonid and sucker species is closely linked to water temperatures (Bjornn and Reiser 1991). In the streams within the Williamson River subbasin, water temperatures are likely primary determinants of when fish spawn, how long the eggs incubate (development is directly related to water temperature (Leitritz and Lewis 1980), and when fry emerge and become free-swimming. Factors that may alter such temperatures and, therefore, affect spawning and incubation include flow depletions/diversions, and loss of riparian vegetation. Water temperature is thus an integral component of healthy and productive habitat.

79. Please describe the flow requirements associated with fry and juvenile habitat.

Subsequent to emergence from the gravels, the fry must find cover and begin to feed and grow. Because of their relatively small size (<30 mm), fry generally seek habitat that has abundant cover (to provide shelter from predators) and low velocities since they are not strong swimmers. These habitats are typically found along stream margins and in off-channel and backwater areas of streams. As fry grow and become juveniles, their swimming abilities increase and they can assume different locations in the stream to feed and continue growing. These habitats can be quite diverse and perhaps more complex than any other life history stage. As in spawning, streamflow is the primary determinant of a number of specific factors that contribute to defining suitable rearing habitat. These factors include but are not limited to water depth, water velocity, pool volume, water temperature, dissolved oxygen, substrate quality, and in many instances, physical structure and habitat such as large woody debris. Similar to those for spawning, these factors can be divided into those imparting a quantitative effect and those that are qualitative. The amount of flow in a river has a direct influence on the distribution and quantity of water depths and associated velocities that are most often utilized by fry and juvenile salmonids and sucker species. Chapman (1966) considered velocity to be perhaps the more important of the two factors, noting that without suitable velocities, no fish will be present. Relative to suckers, velocities are important in terms of transporting the larval suckers from spawning areas downstream to the lake where food and space are abundant. Studies have shown that fry of salmon and trout typically utilize velocities less than 0.3 feet/second (Chapman and Bjornn 1969; Everest and Chapman 1972; Griffith 1972). As fish grow, they become stronger and are often associated with higher water velocities (Smith and Li 1983). Shifts in velocity usage by fish have been observed seasonally, presumably in response to water temperature changes. The shifts are generally from higher velocities in the summer feeding periods to lower velocities during the winter holding periods (Chisholm et al. 1987; Tschaplinski and Hartman 1983).

Water depths used by salmonid fry and juveniles can be quite variable depending on associated factors, e.g., substrates, cover, food, velocity, predator density. Newly hatched fry often utilize the extreme edge habitats of a stream where velocities are low and there are few predators. As fish grow they are capable of using deeper waters with limits of use generally related to some other interrelated parameter such as water velocity. Bjornn and Reiser (1991) noted that some salmonids are found in higher densities in pools than other habitat types as a result of space availability. Again, there are probably other factors acting to regulate such densities; for example, the presence of large woody debris or overhanging vegetation can have a direct, positive benefit on increasing the carrying capacity of a given pool (see Figure IV-2).

Streamflow can and does regulate the carrying capacity of rearing habitats. This is illustrated conceptually in Figure IV-1, which portrays how the numbers of fish that are able to exist within a given pool changes in response to reductions in flow. Such reductions can occur naturally, (e.g., via the seasonal progression of flows from high spring runoff conditions to summer low flow conditions), and/or from human regulation, (e.g., the diversion of flows for irrigation). Figure IV-1 can be used to illustrate both. In this case, the upper panel might represent conditions occurring naturally under high flows, and the middle panel, natural conditions during summer/fall low flows. Under the relatively high flow conditions, the rearing areas encompassing pool:run:riffle habitats will afford living space for a certain density of fish as set by the other limits of food availability, space, cover, and water quality characteristics.

80. Please describe the relationship of cover to juvenile and fry habitat and streamflow.

Cover in the form of water depth, turbulence, boulders, large woody debris, undercut banks and overhanging vegetation is an absolutely essential component during the fry and juvenile lifestages. These features provide shelter from fast velocities, refuge to escape from predators, and areas from which to base feeding opportunities. Streams without cover or with limited cover will inherently have lower carrying capacities simply because there will be increased predation and therefore increased mortality of both fry and juvenile lifestages. This is illustrated conceptually in Figure IV-2 which depicts a given segment of stream under the same flow condition but having varying amounts of cover. In this figure, the upper panel contains the greatest amount of cover and has the highest carrying capacity. The two lower panels possess progressively lower amounts of cover and hence have reduced carrying capacities.

Importantly, the amount of flow in a stream can influence the usability of the cover features. That is, as flows increase or decrease, water depths and velocities that are associated with the cover feature will increase beyond or decrease below points where fish will use it. Severe reductions in flow may result in a narrowing and pulling away of the wetted channel from the stream banks, essentially decoupling the stream from cover features provided by vegetation of the riparian zone. In addition to influencing the usability of cover, streamflow of sufficient magnitude actually creates and maintains cover features in a stream, including connectivity to the riparian zone, which is the focus of the Riparian Habitat Claims.

81. Please describe the relationship of streamflow to stream temperature and juvenile and fry habitat.

Water temperature directly influences the survival and growth of fry and juvenile salmonids as well as other fish species. Salmonids and other species have evolved around and prefer certain ranges of temperatures that are conducive to their growth and promote general health. These temperature ranges are directly influenced by the natural flow regime that has developed within each stream system in response to regional and local topographic and orthographic features. Prolonged changes in temperature beyond the ranges conducive to the fish's normal growth have been shown to increase stress and render the fish more susceptible to disease outbreaks (Guillen 2003a). The water temperatures in streams within the Upper Klamath Basin are influenced by patterns of flow that occur in the run-off dominated streams as well as spring-dominated streams. As discussed more in Section V of my testimony, the Upper Klamath Basin experiences the benefit of numerous cool water springs. These spring-dominated streams can have a dramatic effect on temperatures in other streams that receive flows from these systems.

82. Please describe the flow relationships associated with adult fish habitat.

The juvenile lifestage continues until the fish matures and gonads become functional. At this time, the fish is considered an adult and can participate in the spawning process, which for some species (e.g., resident and adfluvial salmonids and suckers) can occur over many years.[2] For the adult lifestages, streamflow is an important determinant of a number of specific factors that contribute to defining suitable adult holding areas (areas adults remain in before spawning) in a riverine habitat. Factors affecting the adult lifestage that are benefited by streamflow include but are not limited to water depth, water velocity, pool volume, water temperature, and dissolved oxygen. In general, increases in flow tend to increase the quantity and quality of adult habitat by providing more space, improving water quality conditions, increasing the number of feeding stations, and enhancing the utility of instream cover such as large wood and boulders.

[2] Salmon and steelhead juveniles first migrate to the ocean as smolts, where they feed and grow until they mature to be adults and then return to fresh water to spawn.

83. Please describe the flow relationships associated with upstream migration of adults for spawning.

In the case of Chinook salmon and steelhead trout, as well as populations of fluvial and adfluvial redband trout in the Williamson River subbasin, strong homing and migrating instincts can result in adults seeking and finding the same streams and in many cases the same spawning areas within those streams in which they were produced. This homing capability has been shown to be linked to olfactory imprinting wherein juvenile fish essentially remember the specific bouquet of odors they encounter as they migrate downstream to the ocean. As noted by Bjornn and Reiser (1991), adult salmonids (as well as sucker species) returning to streams to spawn must do so at the proper time and with sufficient strength and energy to complete their life cycle. Although salmonid stocks have evolved such that successful migrations can usually occur under a variety of conditions (owing to differences in migration timing), man-induced and in some cases natural events can result in sufficient delays in migration to impair at least a portion of the spawning population and hence reduce egg and fry production.

Successful adult upstream migration is dependent on a variety of factors, all of which are related to streamflow. These factors include water depth, water velocity, water temperature, dissolved oxygen, turbidity, and no physical barriers (Bjornn and Reiser 1991).

84. You just stated that adult upstream migration is dependant on a variety of factors, including depth and velocity. Please explain the relationships of water depth and water velocity to adult fish migration activities.

Without sufficient streamflow in a stream or river, adult fish can not successfully migrate upstream to spawning areas. The quantity of such flows necessary for passage has been evaluated by a number of investigators who have assessed passage requirements on the basis of the percentage of the average annual flow (Baxter 1961) and on specific water depths and water velocities adult fish are capable of migrating through (Thompson 1972). For trout and salmon, adult migration is defined in terms of minimum water depths that range from 0.4 to 0.8 feet and maximum water velocities that range from 4.0 to 8.0 feet/second (Thompson 1972). These represent minimum depth and maximum velocity criteria and must be evaluated in the context of applying such to stream reaches that pose as potential migration barriers, such as wide, shallow riffles.

85. You stated that adult upstream migration is also dependant on water temperature. Please explain the relationship of water temperature to adult fish migration activities.

Because salmon and trout are cold blooded (poikilotherms), their metabolism and life history functions are closely linked to water temperatures. In the case of upstream migrations, water temperatures that are too warm or too cold have been reported to influence migration timing and may result in delays (Hallock et al. 1970; Bjornn and Reiser 1991).

Factors that can lead to altered thermal regimes in streams in the Williamson River subbasin include but are not limited to removal of riparian vegetation and forest canopy, irrigation withdrawals, and irrigation return flows. Such effects vary seasonally.

86. A third factor that you stated adult upstream migration is dependent upon is dissolved oxygen. Please explain the relationship of dissolved oxygen in water to adult fish migration activities.

Adult fish that are migrating are dependent on acceptable levels of dissolved oxygen (DO). In general, for salmonids, concentrations should be close to 8 mg/L, or at or near saturation levels in streams and rivers (Davis 1975; Bjornn and Reiser 1991). Suckers likewise require suitable DOs but generally can withstand lower concentrations than salmonids. The Washington Department of Ecology (WDOE 2002) reviewed various data and concluded that swimming fitness of salmonids is maximized when the daily minimum dissolved oxygen levels are above 8 - 9 mg/L. The amount of DO in streams is a product of atmospheric exchange with the water surface as well as the temperature of the water. Thus, concentrations of DO are influenced by surface agitation and resulting re-aeration that typically occurs in riffles and cascades. The amount of flow in a stream can affect the degree of re-aeration associated in these areas; increases in DO generally occur with higher flows that increase surface agitation, while decreases in DO occur with lower flows and surface agitation.

87. Finally, you stated that successful adult upstream passage requires there be no impassable, physical barriers. Please explain the relationship of physical barriers in water to adult fish migration activities and streamflow.

Physical barriers such as waterfalls, debris jams, and artificial structures (e.g., dams, irrigation flow deflectors) can delay or prevent upstream migration of adults. Salmon and trout have certain swimming and jumping capabilities that vary by species (Bell 1986; Powers and Orsborn 1985; Reiser and Peacock 1985). Darting speeds (maximum speeds attainable over a short period of seconds) reportedly range from about 6 feet/second for certain trout species to over 26 feet/second for steelhead trout (Bell 1986). Streamflow can directly influence the passage conditions at potential barriers. For example, under conditions of low flow, a particular set of falls or rapids may create conditions that exceed the combined jumping and swimming capabilities of salmon and trout, and hence, serves as a barrier to upstream migration. Under higher flow conditions, these same areas may become passable. An example of this condition occurs at Kirk Reef on the Williamson River. At this location over the summer and fall months, as flows decline, a large segment of the stream actually becomes dewatered preventing both upstream and downstream movement of fish. During higher spring-time flows, surface flow again occurs and fish passage throughout the reach would be possible. The important point here is that barriers that exist under one set of conditions may be passable under different flows.

In contrast, the boundaries of the original Klamath Reservation would not serve as barriers preventing further upstream migration of fish.

88. Why would the boundaries of the original Klamath Reservation not serve as barriers that would prevent further upstream migrations of fish?

Fish populations do not recognize human imposed geographic boundaries and will freely migrate from one area that is within the former Klamath Reservation boundary to another area outside the boundary, and vice versa. To the fish, there is no Klamath Reservation boundary, just as there is no Forest Service boundary, National Park boundary, or boundary between Oregon and California. Fish simply do not recognize human imposed boundaries on a map, unless they comprise a physical barrier. Absent such a physical obstruction or barrier, it is the biological needs of the fish that dictate when, and to what extent (i.e., where) certain fish will migrate in a stream.

In the Williamson River subbasin, the adult target species that spawn outside of Upper Klamath Lake (adfluvial redband trout, and three sucker species) generally need only to migrate upstream from Upper Klamath Lake relatively short distances (5-15 miles) to locate suitable spawning areas, and all of these areas are within the Reservation boundary. However, the upper portions of two streams tributary to the Williamson River (Sand Creek, Claim Reach 635 and Scott Creek, Claim Reach 636) extend beyond the former Reservation boundary. Both of these streams support populations of redband trout that experience their entire lifecycle within the relatively small areas of these streams; as I described previously, these populations are described as "resident" fish species.

89. Why were these small, upper portions of claims 635 and 636 included in the Tribal water right claims?

As I just noted, fish populations do not recognize geographic boundaries and may freely migrate from one area that is within the former Reservation boundary to another area outside the boundary, and *vice versa* to fulfill specific biological needs; e.g., spawning, foraging for food, or seeking shelter or better water quality conditions. While the distances migrated may be greater for populations that exhibit an adfluvial (movement from a lake to flowing water) or fluvial (movement from larger river to smaller stream) life history strategy, even resident fish populations will freely migrate within a stream to meet their biological needs. In the process of making these migrations, the fish may move from areas within the former Reservation boundary to spawning, feeding, or refuge areas located in stream segments outside of the former Reservation boundary or that span the former Reservation boundary. Because the Physical Habitat Claims focused on providing for all of the lifestage requirements needed to provide healthy and productive habitats for the target species, the geographic limits of the claims included the streams and stream segments noted above that extended beyond the Reservation boundary. These Physical Habitat Claims beyond the former Reservation boundary are just as biologically important as those within the Reservation boundary.

90. You stated that redband trout rely on the upper reaches of Sand and Scott creeks, tributaries to the Williamson River. Please explain that reliance?

Redband trout currently use both Sand and Scott creeks (Claim Reaches 635 and 636, respectively). The redband trout within these reaches are resident fish, meaning they complete their entire lifecycle (i.e., spawning, fry and juvenile rearing, and adult holding and rearing (see Figure IV-10)) within the reach rather than migrating from or to Upper Klamath Lake or other tributaries. This means that the movements and migratory patterns associated with these populations in meeting their lifecycle needs are restricted to within the claim reach, rather than extending downstream to Upper Klamath Lake or the Williamson River or upstream to smaller tributaries. Although the distances associated with their movement patterns may be less than those for adfluvial fish, the resident redbands' territorial range extends both above (Claim Reaches 635 and 636) and below the Reservation boundary. Thus, the daily and even hourly movement patterns of these fish may take them back and forth across the geographic location of the Reservation boundary.

91. Please describe any information you relied on regarding resident redband trout that supports the use of Claim Reaches 635 and 636.

The mere fact that the former Reservation boundary crosses a stream will not prevent resident fish from moving above and below that boundary to fulfill specific biological needs. Substantial information exists in the literature that supports the premise that resident salmonids move and migrate within the entirety of a stream segment to fulfill biological needs such as spawning, rearing, and foraging. Hilderbrand and Kershner (2000) for example found the range of movement of a resident population of cutthroat trout extending from about 1000 ft to 2 miles, with the longer distance associated with migrations to find spawning locations. Also, resident rainbow trout in the Yakima River were reported to migrate over 50 miles to locate suitable spawning areas (Hockersmith and Stuehrenberg (1995). Further, Meka et al. (2003) reported a range of movements ranging from about 1.5 miles to over 45 miles for adult rainbow trout related to feeding forays and to locate overwintering habitats.

For context, the entire Sand Creek claim reach (Claim Reach 635) is approximately 14 miles long, of which about 8.5 miles is located above the former Reservation boundary, while the

Scott Creek claim reach (Claim Reach 636) is approximately 7 miles long, of which about 2 miles is located above the former Reservation boundary. In 2004, R2 personnel, under my direction, walked an approximate ½ to ¾ mile length of both Sand and Scott creeks spanning the point at which the former Reservation boundary crosses those streams. No physical barriers were observed in the steams as a result of the former Reservation boundary (see Figure IV-11).

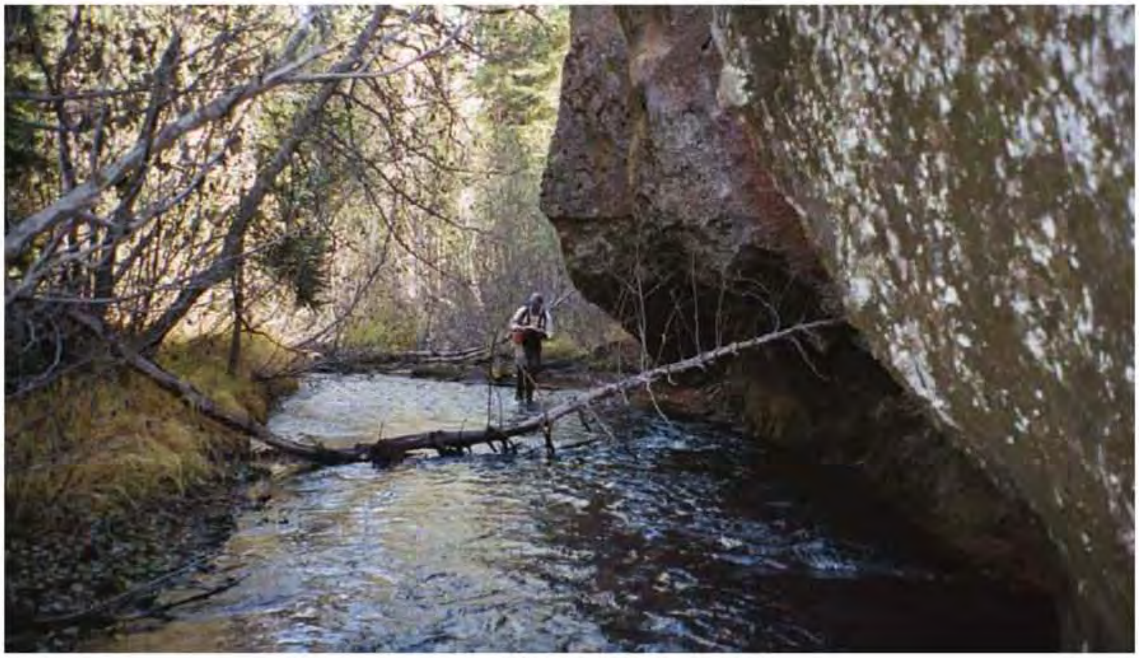


Figure IV-11a and 11b. Figure IV-11a (upper photo) depicts an image Sand Creek (Claim 635) beyond the former Reservation boundary (looking downstream). Figure IV-11b (lower photo) depicts an image of Scott Creek (Claim 636) beyond the former Reservation boundary (looking downstream). Both photos were taken in May 2004 and within ½ mile of the former Reservation boundary.

92. You mentioned temperature as being an especially important habitat component. Please explain how and why water temperature is important for fish habitat generally, and specifically its importance in streams within the Williamson River subbasin.

Water temperature is one of the most significant water quality parameters in streams; it affects rates of chemical and biological processes and is critical to the survival, metabolism, reproduction, growth and behavior of salmonid fishes and other aquatic biota (Welch et al. 1998). Water temperatures that are too warm or too cold have been reported to influence the migration timing of salmonids and may result in delays (Hallock et al. 1970; Bjornn and Reiser 1991). Further, in a broad study, Rieman and Chandler (1999) concluded from their analysis of temperature data from 581 sites containing bull trout that 95 percent of the observations of juvenile bull trout were made in waters with summer temperature maxima less than 18°C, and most were from waters with summer maxima temperatures less than 14°C.

Over the past 15 years of my studying the streams in the Klamath River Basin, I have noted on many occasions that life functions of fish including those related to their migration, spawning, feeding, and growth are influenced by water temperatures. In fact, many biological functions are triggered by stream temperature. For example, the migration and spawning of Lost River, shortnose, and Klamath largescale suckers all occur within a specific range of temperatures. Likewise, redband trout and bull trout spawning is linked to temperature conditions, and as well the duration of the egg incubation period is dependent on the prevailing temperatures; in general, the colder the temperatures, the longer the incubation period, provided the range of temperatures are within those tolerable for the developing eggs. Bull trout are of special significance in that its temperature requirements are generally the lowest of the fish species present in the Upper Klamath River Basin.

In addition, the adfluvial redband trout in the basin have likely evolved around and are attracted to coldwater areas for spawning and juvenile rearing. Spring Creek, for example (Claim 640), because of its stable flow and stable coldwater temperature regime supports an almost continuous influx of adult adfluvial redband trout into the stream. In Spring Creek, adfluvial redband spawn almost continuously (see Figure VII-6) even in the warmer summer months when no spawning occurs in any of the runoff-dominated systems. Correspondingly, fry emerge on an ongoing basis from this spawning area. Therefore, in Spring Creek the redband trout populations have adapted to unique ecological conditions to beneficially exploit the stable flow and temperature conditions and thereby increasing their productive potential. Further, it is reasonable to assume that both steelhead and Chinook salmon utilized the unique temperature and flow characteristics of this system for spawning prior to their extirpation from the basin, and will do so again upon their reintroduction.

Water temperature also directly influences the survival and growth of fry and juvenile salmonids as well as other fish species. Salmonids and other fish species have evolved around and prefer certain ranges of temperatures that are conducive to their growth and health. Sustained, elevated temperatures beyond these ranges increase stress on fish and render the fish more susceptible to disease outbreaks. For example, warm water temperatures were considered to be at least a contributing factor in the outbreaks of columnaris (bacterial disease of the gills) and *Ceratomyxa shasta* (digestive system parasite) in fishes in the lower Klamath River that resulted in large fish kills in 2002 (Guillen 2003a; Guillen 2003b; California Department of Fish and Game 2003). As I have described, temperature was an underlying consideration of the Physical Habitat flow claims for the spring-dominated streams and those runoff-dominated streams located downstream. Streams in the Upper Klamath Basin possess a certain temperature regime signature within which fish populations have evolved and become accustomed to. Protection of these thermal characteristics will be important for maintaining the streams' future health and productivity for fish.

93. Can the amount of flow in a stream influence its temperature?

Yes. There have been many studies that have shown this. There are a variety of means to assess water temperature changes in response to changes in flow and affects on fish, such as the deployment and monitoring of continuous recording water temperature gages, modeling of water temperature; flow relationships via computer models (e.g., Stream Network Temperature Model SNTEMP (Theurer et al. 1984); Stream Segment Temperature Model (SSTEMP) (Bartholow 1995 and others), and most recently the use of Forward Looking Infrared (FLIR) and Thermal Infrared Techniques (TIR) under a variety of flow conditions (Torgensen et al. 2001).

94. Did you use any such resources in the streams of the Upper Klamath Basin?

Yes. We relied on the results of ODEQ's Forward Looking Infrared (FLIR) imaging and TMDL assessment from which to assess temperature concerns and issues. Specifically, we reviewed the FLIR imaging of various stream segments to determine the extent to which the thermal influence of spring dominated streams extended within other streams. For illustrative purposes, I have incorporated several of the FLIR images provided by ODEQ into specific claim descriptions provided in Section IX of my testimony, including Claim 627, Claim 628, and Claim 640.

95. Dr. Reiser, can you explain why the information you just described concerning species life stage habitat needs and their relationship with flow was useful to you.

This information was not only useful, it was critical inasmuch as it formed the technical and biological underpinnings of the Physical Habitat Claims. Establishing flows necessary to provide healthy, productive habitats for target fish species required, first, careful consideration of all major flow-dependent factors that collectively comprise a healthy, productive fish habitat, i.e., careful attention to the eight principles of Naiman and Latterell. As well, establishing flows necessary to provide healthy, productive habitats required an understanding of how such factors change with flow, i.e., consideration of the flow-dependent life history requirements just noted. This information was coupled with habitat and flow data collected from multiple study sites, and then using those data with accepted methodologies and computer models, the Physical Habitat Claims were derived. These final elements are explained in detail in Sections VII and VIII.

V. DEVELOPING INSTREAM FLOW CLAIMS

96. Dr. Reiser, are you familiar with the methodologies and techniques used in your field to establish a relationship between the physical habitat available to fish and the amount of stream flow in a stream?

Yes. The methodologies and techniques used to establish a relationship between the physical habitat available to fish and the water flow in a stream have been the primary focus of my career as a fish biologist. I am very familiar with methodologies and techniques to establish a fish habitat:flow relationship. Further, I have had the first-hand opportunity to review, refine, and/or apply many of those methodologies and techniques. The methods and techniques that I have applied in the context of this adjudication have involved application of scientifically accepted and recognized techniques. Further, in the course of selecting and applying the methods and techniques used, I also considered a number of other available methods and techniques.

Since the 1970s, many different methodologies and models have been developed and used for quantifying fish habitat and formulating instream flow recommendations for aquatic biota. Wesche and Rechard (1980), Morhardt (1986), Stalnaker and Arnette (1976), the proceedings of the Symposium on Instream Flow Needs (Orsborn and Allman eds. 1976), and the Instream Flow Council (Annear et al. 2004; Locke et al. 2008) each reviews and provides an opinion on most of the instream flow methods commonly applied today. Throughout the process of formulating the Physical Habitat Claims here, I relied upon and considered those opinions and reviews in selecting, applying, analyzing, and reviewing the methods for application for streams in the Upper Klamath Basin.

97. Please describe the methods available to establish a relationship between fish habitat and streamflow.

Some of the more commonly applied methods that fish biologists often consider or apply in an instream flow analysis include the Oregon Method (Thompson 1974); the Tennant Method (otherwise known as the Montana Method) (Tennant 1975); Wetted Perimeter method (Nelson 1980); R-2 Cross Sag Tape Method (Espegren 1996); and the Instream Flow Incremental Methodology (IFIM), along with the companion computer software program called **P**hysical **Hab**itat **Sim**ulation (PHABSIM) (Bovee 1982; Milhous et al. 1984). The IFIM/PHABSIM method is the most prevalent and commonly applied of instream flow methods on which to base instream flow recommendations (Reiser et al. 1989; Annear et al. 2004).

98. Please describe the criteria that you considered in selecting the techniques and methodologies to be applied to your instream flow work in the Upper Klamath Basin.

In determining which methods would be most appropriate for the instream flow claims for the streams in the Upper Klamath Basin, I considered the following criteria:

1. the predictive capability of the method or model to extrapolate results over a range of anticipated flows;
2. the number of life stages considered in the method (e.g., spawning, fry, juvenile, passage);
3. the biological soundness of the methodology results (i.e., habitat-flow relationship curves and criteria that relate directly to the fish species present in the Upper Klamath Basin);
4. the applicability of the methodology to different fish species including resident and anadromous salmonids;

5. the sensitivity of method/model output to individual user (i.e., ability to control bias);

6. the reproducibility of results;

7. the ease of field data collection and analysis;

8. the validity of results (known linkages between habitat-flow-fish population relationships demonstrated);

9. the acceptability of the method/model for use in the State of Oregon;

10. the history of successful application of the method in Oregon and elsewhere; and

11. whether the method has been court tested.

Consideration of the above selection criteria and the size and complexity of this project resulted in the selection and use of the IFIM/PHABSIM method, in all areas where applicable, for collecting and analyzing habitat and flow information and formulating the instream flow claims. Application of the IFIM/PHABSIM method provided for the derivation of species and lifestage specific habitat:flow relationships that allowed for not only the determination of Physical Habitat Claims for a specific target species, but also a comparative assessment of how the claim flows might affect other target species and lifestages. The Tennant method was selected for use in a few areas (specifically Claim 633 in the Williamson River subbasin) where access restrictions prevented collection of field data, and for which sufficient hydrologic data existed or could be developed to derive annual flow statistics.

99. Please describe in general terms the IFIM/PHABSIM method.

The IFIM/PHABSIM methodology comprises both hydraulic and habitat models which, when interfaced, provide a means of estimating fish habitat as a function of stream flow

(Milhous et al. 1984; Bovee 1982). The methodology employs hydraulic simulation models so that habitat can be incrementally projected with streamflow. As already described, this predictive quality of the methodology was considered important relative to determining the amount of flow needed to provide for healthy and productive fish habitat. The IFIM/PHABSIM methodology allows a fish biologist to simultaneously consider multiple flows and multiple flow-dependent factors. Finally, the IFIM/PHABSIM represents a recognized method for use by the Oregon Water Resources Department (see OAR 690-028-0027(2)).

100. You stated that you primarily used IFIM/PHABSIM but in a few instances used the Tennant/Montana method. Please explain this.

In every instance possible for each Physical Habitat Claim, we applied the IFIM/PHABSIM methodology. In one instance in the Williamson River subbasin (Upper Williamson River, Claim 633), access restrictions to the property along the claim reach required the application of the Tennant/Montana method. The Tennant method was developed by Donald Tennant in 1976 (Tennant 1976) and is still a widely applied method for establishing instream flows for broad scale studies and regional planning efforts. The State of Alaska Department of Fish and Game (ADFG), for example uses the Tennant method extensively for developing instream flow recommendations for applying for instream flow water rights (Estes 1996). The Tennant method is based on the premise that the flow of a stream is a composite manifestation of characteristics such as drainage area, geomorphology, climate, vegetation cover, and land use. It can be used with limited or extensive hydrological and fishery data. In general, the method relies on eight flow classifications with each assigned a percentage or percentage range of the average annual flow (QAA) (Table V-1). The percentages are typically applied to specific times of year with the year divided into two six-month periods, April through September and October through

March. In the case of the Upper Klamath River Basin, we selected percentages based on lifestage priorities, with higher percentages (50% QAA) ascribed for periods during spawning, and lower percentages (30% QAA) during periods of adult and juveniles. This approach of aligning the percentages of QAA based on life stage use has likewise been applied by the ADFG (Estes 1996). Seven of the Tennant classifications characterize habitat quality for fish and the eighth provides for a flushing flow which focuses on cleaning (flushing) fine sediments from spawning gravels. The percentage of QAA for habitat quality range from less than 10 percent (Severe Degradation) to 60 percent - 100 percent (Optimal Range).

Table V-1. Instream flow regimes for fish habitat (Tennant 1976). The Physical Habitat Claims developed for streams in the Upper Klamath Basin employing the Tennant method were based on 50% of QAA during periods of spawning and 30% of QAA during periods of adult and juvenile rearing.

Narrative Descriptions of Flows	Base Flow Regimes (QAA)	
	Oct. – Mar.	Apr. – Sept.
Flushing Flow	200%	200%
Optimal Range	60-100%	60-100%
Outstanding	40%	60%
Excellent	30%	50%
Good	20%	40%
Fair	10%	30%
Poor or Minimum	10%	10%
Severe Degradation	10%	10%

101. Are you aware whether the Oregon Water Resources Department (OWRD) has recognized any habitat:flow technique and methodologies?

Yes. As I previously mentioned, OWRD has recognized the IFIM/PHABSIM methodology, and in fact has recognized several methods for determining instream flows. OAR 690-028-0027(2) states specifically that:

> A claimant shall provide supporting documentation of the methods used to estimate water quantities needed to satisfy the purpose or purposes of the reservation. Accepted methodologies for determining habitat needs include, but are not limited to:
>
> (a) Instream Flow Incremental Methodology habitat suitability curves published in a series of technical reports by the U.S. Fish and Wildlife Service;
>
> (b) The Oregon Method developed by the Oregon State Game Commission (Thompson, K.E., 1972, determining streamflows for fish life, pp. 31-50, in Proceedings of the Instream Flow Requirement Workshops, Pacific N.W. River Basins Commission, Portland, OR);
>
> (c) Forest Service Method developed by the Pacific Northwest Region USDA Forest Service, (Swank, G.W. and Phillips, R.W. 1976, Instream Flow Methodology for the Forest Service in the Pacific Northwest Region, pp. 334-343, in Proceedings of Symposium and Special Conference on Instream Flow Needs, Orsborn, J.F. and O.H. Allman, eds. Vol. II, American Fisheries Society, Bethesda, MD); and
>
> (d) Environmental Basin Investigation Reports conducted by the Oregon State Game Commission between the mid-1960's and the mid-1970s.

102. So, there are four specific methods that OWRD recognizes?

Yes. However, the OAR notes the four are not the only methods that can be applied. Thus, there is flexibility in the selection and application of a method based on project-specific conditions and study objectives.

103. The OAR mentions the Oregon Method. Please briefly describe that method and explain why you did not use it on this project?

The Oregon Method was developed by fish biologists from the Oregon State Game Commission (now ODFW) in the 1970s as a means to define instream flows that considered several important life history stages of fish, including spawning, juvenile rearing, and fish passage (Thompson 1972). For spawning, water depths and velocities are measured at different flows along transects placed across several spawning gravel bars. The percent of each transect meeting specified depth and velocity criteria is then determined for each flow. Results are averaged for all transects and plotted against the measured flows. The optimum spawning flow provides suitable depths and velocities over the maximum amount of spawning area within the stream. A minimum flow corresponds to the inflection point where flow increases provide less than a proportionate gain in habitat, and flow reductions result in a greater than proportionate decrease in habitat.

For rearing, a similar approach to defining spawning flow is used; this approach involves the measurement of velocities across selected riffle areas at different flows. Fish passage requirements are evaluated by comparing water depths and velocities provided by a given flow with fish body dimensions (in terms of depth) and swimming capabilities (in terms of velocity).

Although similar in principle to the IFIM/PHABSIM approach, in that a relationship of habitat area versus flow can be developed, the Oregon Method does not explicitly involve any hydraulic or habitat modeling that allows for the extrapolation of flows beyond those measured in the field. Thus, the habitat-flow relationships derived from the Oregon Method are limited to a relatively narrow range of flows that are empirically measured in the field. For that reason, we elected not to use the Oregon Method for this project.

104. The OAR also lists the Forest Service Method of Swank and Philips (1976). Can you describe that method and explain why you chose not to use it?

The Forest Service Method, which is also known as the USFS R-6 Method (Wesche and Rechard 1980) was developed by Swank and Phillips (1976) as a means to determine the optimum flow for fisheries purposes. In this case, Swank and Phillips (1976) defined the optimum flow as the one that provided the greatest amount of usable habitat in terms of spawning, rearing and food producing area. The method requires the establishment of cross-channel transects (depths and velocities) within representative habitats, that are measured at various intervals across the transect under at least three flow conditions. The useable width of each cross section is determined for each flow based on spawning, rearing, and food producing criteria, and graphical plots of the results are developed, from which the optimum flow is determined.

This method does not involve the development of hydraulic models to allow extrapolation of flow-habitat relationships and is therefore limited to the range of flows empirically measured in the field. In addition, the method does not consider individual differences in species relative to the lifestage criteria so that resulting flow recommendations are presumed to be suitable for all species. Because of these limitations and that we were concerned with different species and multiple life history stage, we did not use the Forest Service Method to derive any of the Physical Habitat flow claims.

105. The OAR also lists the Environmental Basin Investigation Reports that were completed by the Oregon State Game Commission during the mid-1960s and mid-1970s. Can you describe that method and explain why you chose not to use it?

The reference to the Environmental Basin Investigation Reports refers to a series of reports that were prepared by Oregon State Game Commission (OSGC) biologists for all of the major basins in Oregon. The Klamath River Basin was one of these, with the report published in 1970 (Thompson et al. 1970). The report provides an overview of the fish and wildlife resources in the Klamath Basin, describes the biological requirements of trout, discusses factors affecting the fish resources, presents the results of an instream flow study conducted on major streams within the basin, and provides a summary table of monthly instream flow recommendations. The actual development of the instream flow recommendations was based on the Oregon Method, which, as I explained above does not allow for extrapolation of flows beyond those measured in the field and for that reason was not used. However, the Basin Investigations for the Klamath Basin (Thompson et al. 1970), contain useful information related to many of the streams in the Williamson River subbasin and was used as a reference. Moreover, the instream flow recommendations developed by the OSGC for a given stream and listed in the report were subsequently compared with the Physical Habitat Claims in the Williamson River subbasin presented in this testimony for the same streams.

106. You also mentioned the Wetted Perimeter Method as a common method used by fish biologists to determine instream flows. Please briefly describe that method and why you did not use it.

This method was developed as a way to approximate fish habitat via the measurement of a few cross sectional parameters. Wetted perimeter is the length of the channel bottom that is wetted (i.e., in contact with water) as measured from one side of the channel to the other (Nelson 1980). Wetted perimeter changes with flow. Typically with this method, the analyst selects an area (typically a shallow riffle) as an index of habitat for the rest of the stream. When a riffle is used as the area, the assumption is that a minimum flow for that site would satisfy the needs for food production, fish passage, and spawning. The method generally results in a "minimum flow" recommendation that would be in effect year round, rather than a temporally variable set of flows as developed via PHABSIM. Because this method did not provide variability based on lifestages, we did not use this method for developing the Physical Habitat flow recommendations.

107. Finally, another method you mention as commonly applied is the R2 Cross Sag Tape method. Please describe that method and why you did not use it.

The R2 Cross Sag Tape method was originally developed in Region 2 (Rocky Mountain States) of the U.S. Forest Service (Rose and Johnson 1976 (277-US-403)). The method involves the placement of one or more transects across riffle habitats across which water depth and water velocity data are collected. These data are input into a computer model, which is called R2-Cross, which computes average depths and velocities across the channel at each of the measured flows. These values are compared with depth and velocity criteria designed to meet critical habitat needs such as food production, juvenile rearing, or passage. The flow that meets a certain amount or percentage of the criteria becomes the recommended flow. This method has been used extensively in the Rocky Mountain States for establishing minimum flows. However, the method is not species or lifestage specific and does not directly compute habitat:flow relationships that can be used in developing monthly flow recommendations. Like the wetted perimeter method noted about, the R2 Cross method generally results in a "minimum flow" recommendation that would be in effect year round, rather than a temporally variable set of flows as developed via PHABSIM. For these reasons, we did not use this method for developing the Physical Habitat Claims.

108. Turning to your applications of the IFIM/PHABSIM, please describe any physical features that affected such application.

As in most river basins, the quantity of flow in the streams of the Upper Klamath Basin typically changes over time. The rivers and streams in the Upper Klamath Basin also present unique hydrologic features. Possibly unlike any other major river basin, the streams of the Upper Klamath Basin involve a complicated mixture of both runoff water (waters that end up in a stream from snowmelt or recent rain events) and spring water (water that percolates to the surface from distant or unknown underground sources which are not directly tied to recent precipitation events).

A pattern to these flows exists and can be seen in the hydrograph of the system. Two general patterns of stream flow are evident: runoff-dominated streams and spring-dominated streams. Runoff-dominated and spring-dominated streams are explained in greater detail in Mr. Ramey Direct Testimony at questions 4 and 61.

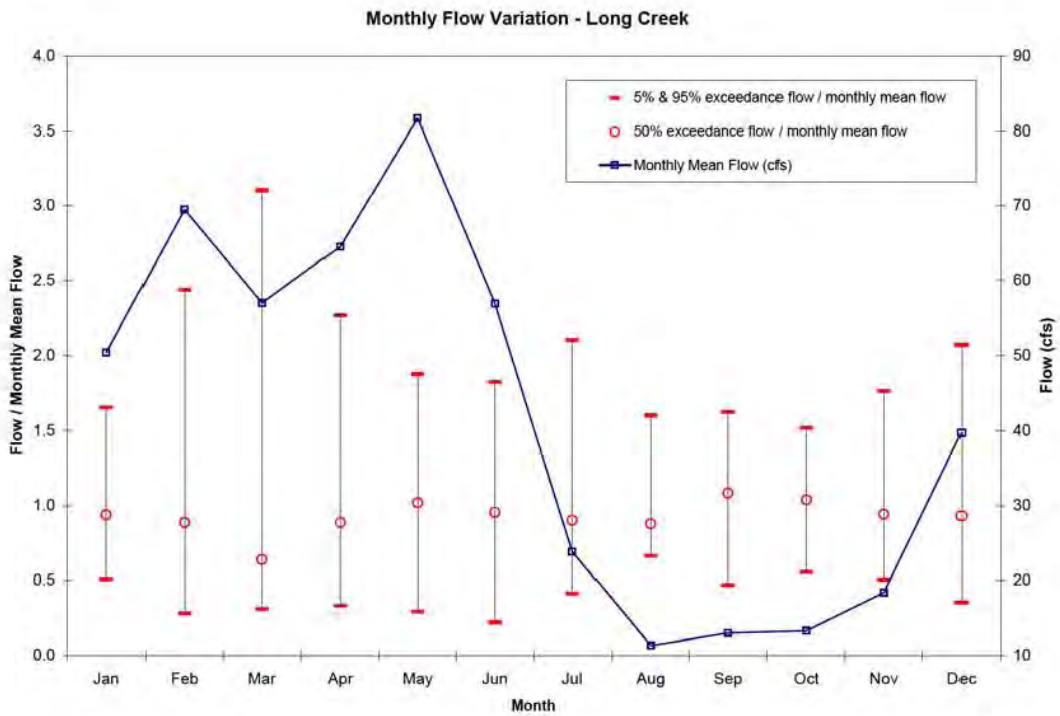
Three of the four major subbasins that drain the Upper Klamath Basin – the Williamson River, the Sprague River, and the Sycan River - contain reaches and tributaries that are dominated by runoff and dominated by springs. The fourth subbasin, the Wood River system consists primarily of spring-dominated streams. The runoff stream flow pattern is influenced primarily by the amount of snow that has fallen in the watershed over winter months and the resulting magnitude and timing of snowmelt runoff from the mountains. In runoff-dominated streams, the amount of flow in the stream typically increases substantially and reaches a peak during the spring months (generally sometime between February and June) in response to snowmelt runoff. As the amount of snow decreases, so too does the amount of flow in the stream. This results in a pattern of declining flows during the summer and fall months until reaching a base-flow condition. Base-flow conditions are generally marked by a condition of relatively low, stable flows that are the product of waters emanating from precipitation and groundwater infiltration to the stream. Base-flow conditions typically occur in the late fall (October/November) and winter months (generally, between October and February).

By contrast, the flow in the spring-fed stream is controlled primarily by the release of water emanating from underground springs and is largely independent of the amount of snow that has accumulated in the respective basins. These types of spring-dominated streams are characterized by having stable flows that remain relatively constant throughout the year.

109. Are there differences in the physical, chemical and biological characteristics between runoff- and spring-dominated streams, and if so, can you describe them?

Yes. The two different patterns of flow have created widely different and unique habitat characteristics in some of the streams in the Upper Klamath Basin that are relied upon by certain target fish species. Both runoff- and spring-dominated streams are important in providing healthy and productive habitats for the target fish species. The constant flow, cool water temperatures, and high water quality of spring-dominated streams make them uniquely important for salmonid (trout and salmon species) populations. Publications, field reports and observations conclusively establish that adfluvial populations of redband trout from Upper Klamath Lake utilize a number of spring-dominated streams for spawning and juvenile rearing including the Wood River (Claim 668), Crooked Creek (Claim 669), and Fort Creek (Claim 670) in the Wood River subbasin; and Larkin Creek (Claim 634) and Spring Creek (Claim 640) in the Williamson River subbasin.

Further, a comparison of annual flow and temperature patterns between representative runoff-dominated and spring-dominated streams illustrate major differences in annual flow and temperature cycles (Figures V-1 and V-2). The graphs illustrate the flow and temperature regimes of the runoff-dominated stream (Figure V-1 – Long Creek – Claim 665) are much more variable than the spring-dominated stream (Figure V-2 – Fort Creek – Claim 670). For a spring-dominated stream, the monthly flows and temperatures are quite similar throughout the year. This is evident in the constancy of the mean monthly flows and the similarity in the ratios of the 5 percent, 95 percent and 50 percent (median) exceedance flows normalized to mean monthly flow. On the other hand, the runoff-dominated stream (Figure V-1) displays substantial variation in both mean monthly flow and the normalized ratios.



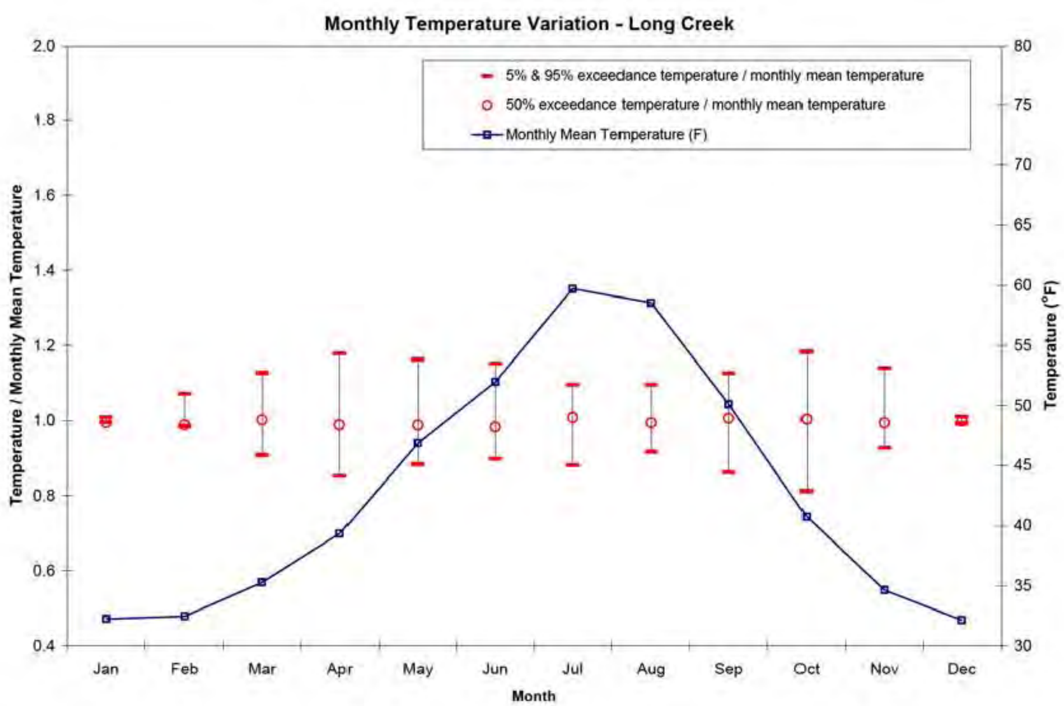
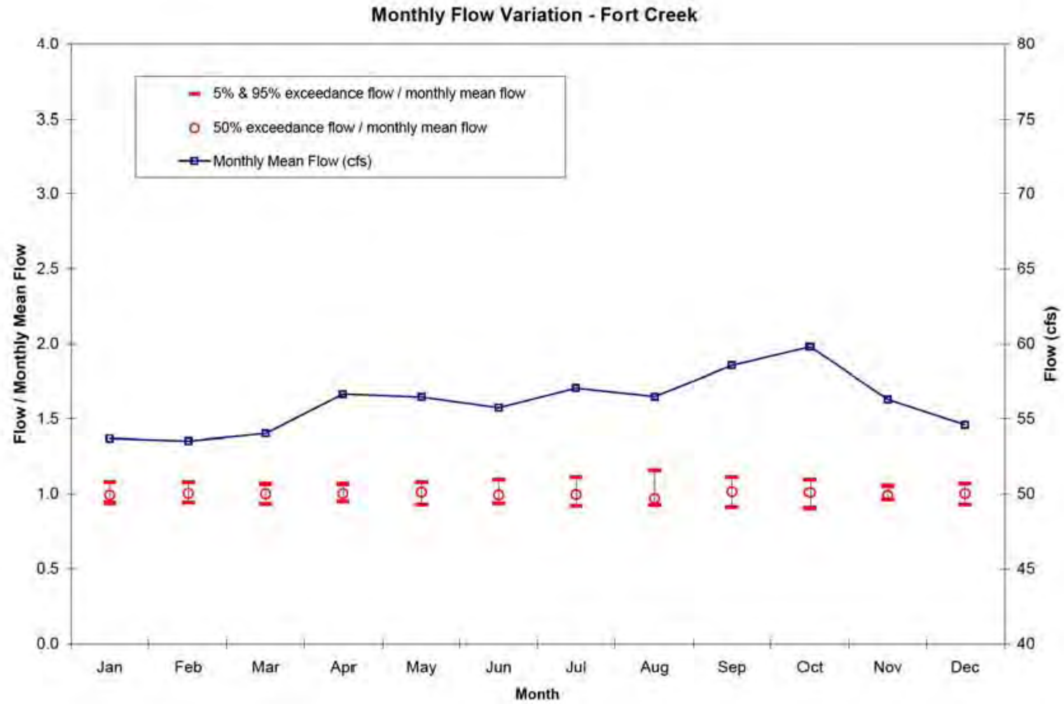


Figure V-1. Mean monthly flow and flow variation (Figure V-1a) and mean monthly temperature and temperature variation (Figure V-1b) for Long Creek (Claim 665), a run-off-dominated stream located in Upper Klamath Basin, Oregon.



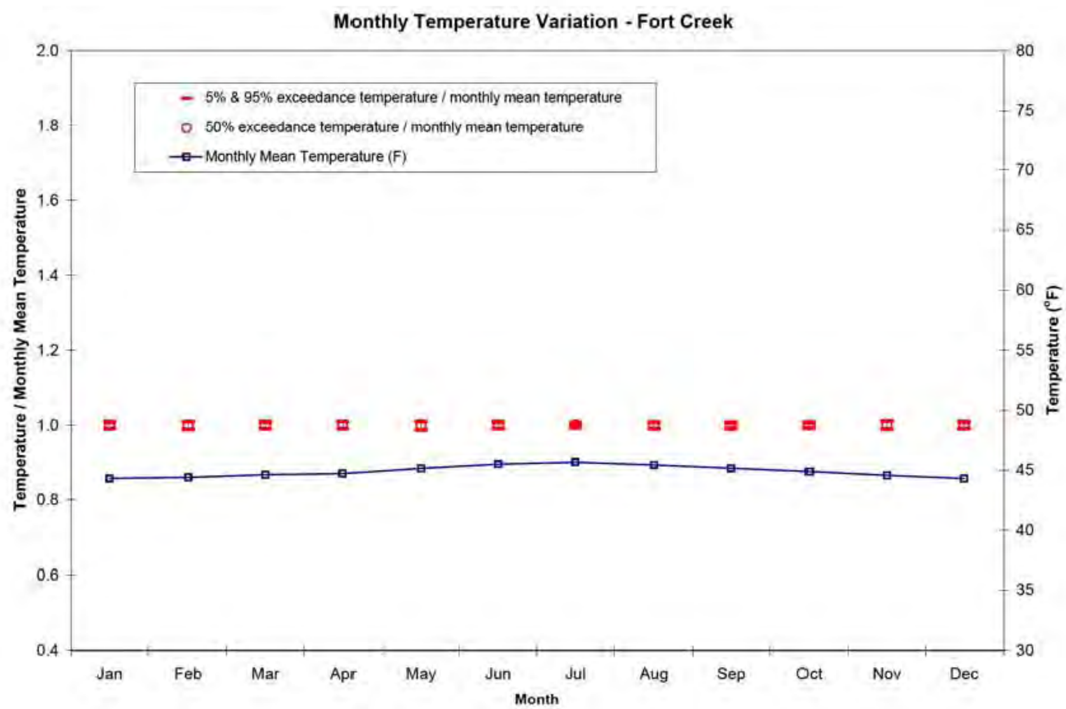


Figure V-2. Mean monthly flow and flow variation (Figure V-2a) and mean monthly temperature and temperature variation (Figure V-2b) for Fort Creek (Claim 670), a spring-dominated stream located in Upper Klamath Basin, Oregon.

Finally, two schematics illustrate some of the more notable physical differences between spring-dominated and runoff- dominated streams (Figures V-3 and V-4). In addition to flow and temperature constancy, spring-dominated streams also often contain abundant aquatic macrophytes (aquatic plants), uniquely arranged woody debris aligned perpendicular to the banks, rectangular, wide, and uniform channel shape, stable channel banks, abundant aquatic insects, and high water clarity. Each of these physical differences is an important component of a healthy and productive environment in the spring-dominated streams of the Upper Klamath Basin and those runoff-dominated streams downstream of the spring-dominated streams.

Of the streams for which claims were made in the Williamson River subbasin, four claims were designated as spring-dominated: Larkin Creek (Claim 634 – Figure V-5), Spring Creek (Claim 640 – Figure V-6), and two reaches of the upper mainstem Williamson River (Claim 632 – Figure V-7; and Claim 633). All other streams were designated as runoff-dominated.

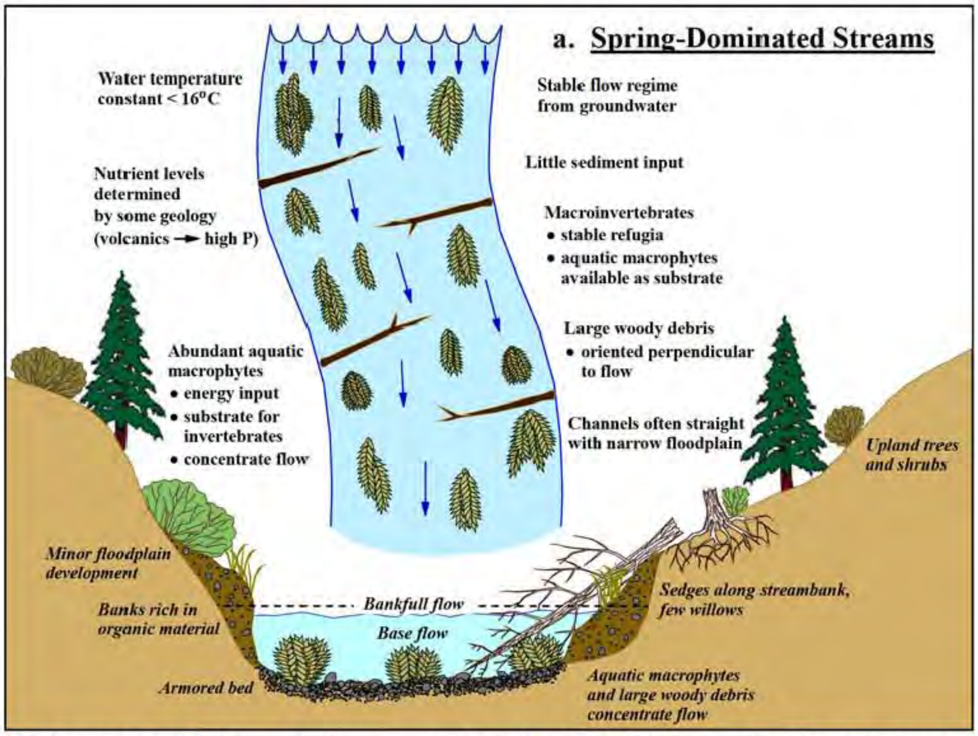


Figure V-3. Schematic planform and cross-section of a typical spring-dominated stream depicting representative channel and geomorphologic characteristics.

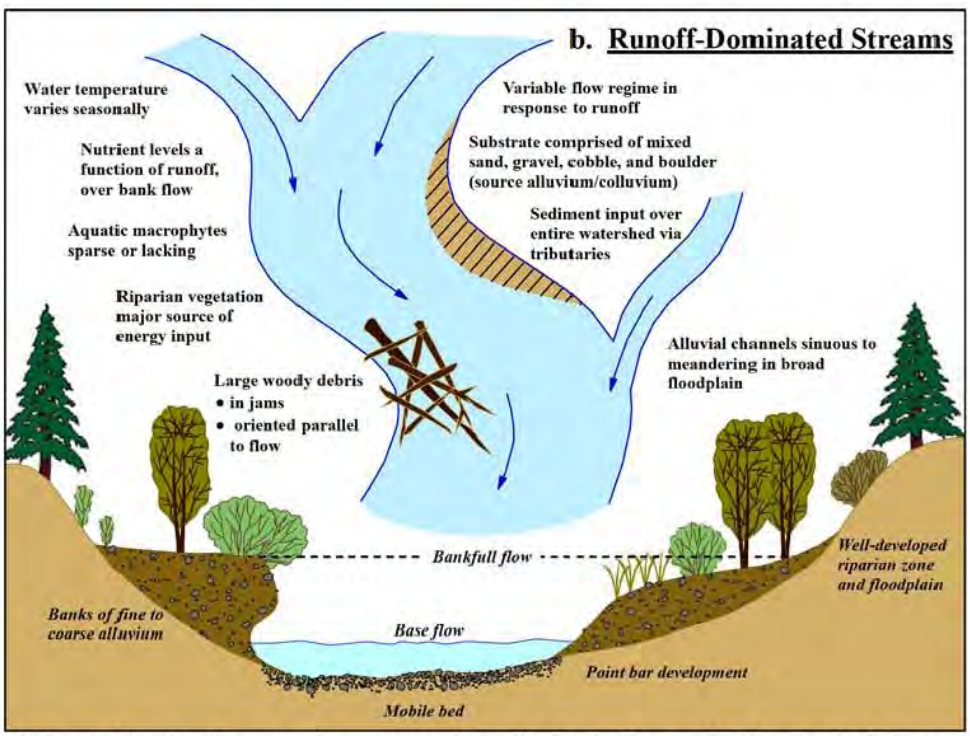


Figure V-4. Schematic planform and cross-section of a typical runoff -dominated stream depicting representative channel and geomorphologic characteristics.

Figure V-5a and 5b. Photograph of Larkin Creek (Claim 634) (Figure V-5a) approximately 500 feet above confluence with Williamson River. Larkin Creek is a spring-dominated stream that in addition to providing redband trout spawning habitat, also supports a population of pearl scale mussels (Figure V-5b). Photos taken September 2004.

Figures V-6a and 6b. Photographs of Spring Creek from Highway 97 Bridge. Upper photo (Figure V-6a) taken September 2, 2004 looking downstream from Highway 97 bridge; lower photo (Figure 6b) taken in the summer 2002 looking upstream from Highway 97 bridge.

Figures V-7a and 7b. Photographs of Campground Springs (Head of River Springs) that comprise headwaters of Williamson River Claim 633. Upper photo (Figure V-7a) is a view of the spring source; lower photo (Figure V-7b) is a view about 300 ft below spring source that shows formation of defined channel.

Further, spring-dominated streams also have a direct positive effect on the flow and temperature regime and associated biota of downstream systems. This was visually evident in the aerial thermal mapping images of a section of the Williamson River below where Spring Creek enters. The temperature influence of the colder Spring Creek water is evident for over five miles downstream (Figure V-8). In addition to providing distinct areas of thermal refuge for fish during the warm summer and fall months, upon mixing, the coldwater inflow decrease the overall water temperature of downstream reaches making them more conducive to salmonid production.

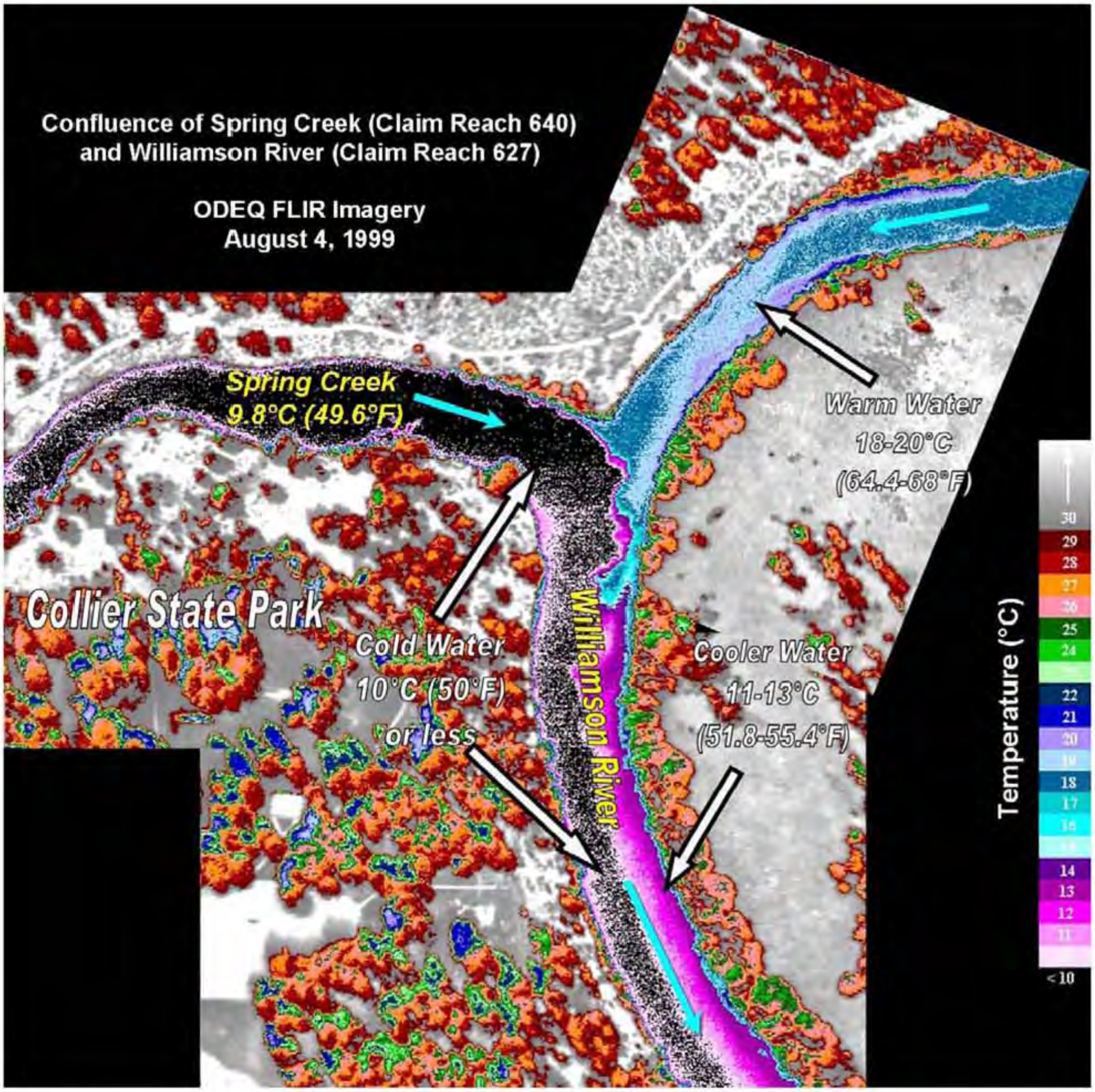


Figure V-8. FLIR image of Claim Reaches 627, 628, and 640 showing the junction of Spring Creek and the Williamson River. The colored bands apparent in the photograph represent different temperatures, with the coldest temperatures represented in black. Estimated flow in Spring Creek at time of image = 282 cfs; flow in Williamson River above Spring Creek = 22 cfs. Note that 10ºC = 50ºF; 20ºC = 68ºF.

110. Did the distinction between runoff-dominated streams and spring-dominated streams affect your application of instream flow methodologies?

Yes. As I explain further in Section VIII, in developing the hydraulic simulation models for runoff-dominated streams where flows differ throughout the year, three sets of flow measurements are typically collected representing a low flow, medium flow and high flow condition in the stream; this allows for a relatively wide flow extrapolation range (the range of flows which can be predicted lower than or higher than the flow that was measured in the field). With spring-dominated streams, flow conditions are generally stable so only one set of flow measurements is needed. Although the resulting range of extrapolation is narrower, with relatively constant flows, a broader range of extrapolation was simply unnecessary. Also, I necessarily gave additional consideration to the special qualities and unique characteristics imparted by the spring-dominated systems, including the provision of coldwater to downstream reaches.

111. In your opinion, is it appropriate to apply the IFIM/PHABSIM method both to runoff-dominated streams and spring-dominated streams?

Yes. IFIM/PHABSIM is completely applicable for developing habitat:flow relationships for both spring-dominated and runoff-dominated systems. In a recent peer reviewed publication (Reiser et al. 2006), I specifically described how the IFIM/PHABSIM method could be applied to both spring-dominated and runoff-dominated streams. I followed that approach here.

112. You mentioned spring-dominated streams as having unique flow characteristics that you considered when developing the Physical Habitat Claims. Were there any others?

Yes. Several biotic and abiotic flow related components unique to spring-dominated streams and streams with significant spring contribution exist that are important ingredients to a healthy, productive habitat. These include water temperature within tolerance ranges for target fish species, riparian vegetation of sufficient quality, and aquatic invertebrates in sufficient quantity. Each component is independently affected by streamflow and each component must exist to provide for a healthy and productive habitat.

113. Have you observed land-use practices in the UKRB that might result in increases in water temperature?

Yes. I have observed streams that have lost their riparian canopy as a result of land-use practices in the Upper Klamath Basin including the Williamson subbasin. Lost riparian canopy results in increased solar input (heat) to the stream and hence can result in the warming of the stream. Flow diversions from irrigation withdrawals can render them even more vulnerable to warming.

114. Can the amount of flow in a stream influence its temperature?

Yes. Lower stream flows can cause increased stream temperatures. As I have described in Section IV, we relied on the results of ODEQ's FLIR imaging (see Figure V-8) and TMDL assessment from which to assess temperature concerns and issues.

115. Were there any other factors you considered important when developing the Physical Habitat Claims?

Yes. I also considered riparian vegetation. Although this is discussed in much greater detail in Dr. Chapin Direct Testimony at question 19, I can provide a general description of the importance of the riparian environment to maintaining an overall healthy and productive fish habitat.

By riparian vegetation and riparian environment, I am referring to the vegetative communities that border streams and rivers. These communities provide important elements to a healthy and productive fish ecosystem that substantially contribute to sustained salmon and trout production. Obvious benefits from the riparian environment include stream shading/shielding from solar input (reducing water temperatures), fish cover (via overhanging vegetation), recruitment of both large woody debris and smaller debris (providing structure and cover), input of "leaf litter" (e.g., deciduous leaf fall, conifer needles) and other organic materials (providing nutrient input for invertebrate/food production), bank stability (via decreased erosion), and terrestrial insect (providing significant food supply) (Murphy and Meehan 1991; Platts 1991). There are many land-use activities that can destroy or reduce both the size of and effectiveness of riparian vegetation and the riparian environment. These most notably include livestock grazing, agricultural land development, and logging.

The diversion and reduction of streamflows reduce the vegetative communities (i.e., density, diversity, species composition) within the riparian zone and in some cases result in the complete collapse of the native riparian plant communities (Rood et al. 1995; Scott et al. 1997; Stromberg and Patten 1991). The long-term health of riparian plant communities depends on flood flows to recharge alluvial aquifers, provide sites for seedling establishment, transport and deposit seeds on the floodplain, and replenish nutrients in floodplain soils. Sufficient in-channel flows are often also important for maintaining the alluvial aquifer (an aquifer is a permeable formation that forms naturally and stores or conducts groundwater; an alluvial aquifer is formed by the deposition of weathered materials such as sand and silt particles; the water flow in these aquifers is slow) within or near the rooting zone of riparian plants through the growing season. Riparian species are typically hydrophytic plants (plants that occur in soils saturated or inundated for extended periods during the growing season), and require relatively high levels of soil moisture throughout the growing season, in contrast to adjacent upland plant communities. As a result of the various flow needs of the riparian zone, reduction in the frequency and magnitude of flood flows or reduced in-channel flows can cause the riparian zone to become smaller (both in width and in stature), less diverse, or even eliminated. Negative impacts on the riparian zone in turn have negative consequences for fish habitat. Without the support from the riparian zone described above, fish habitat would be without many necessary components; for example temperatures would be higher, cover would reduced, and trophic inputs would be negatively altered (see Figure V-9).

In sum, without a riparian zone and without the flows to support the riparian zone, only the spatial component of fish habitat as provided in the Physical Habitat Claims will be provided. While the quantity of flow identified in those claims was focused on creating healthy and productive habitats in streams that meet, but do not exceed the spatial needs of the target fish species, it was understood that the flows proffered by the Riparian Habitat Claims were likewise a critical ingredient of healthy and productive habitat and were thus included as a component of the overall tribal instream flow claims.

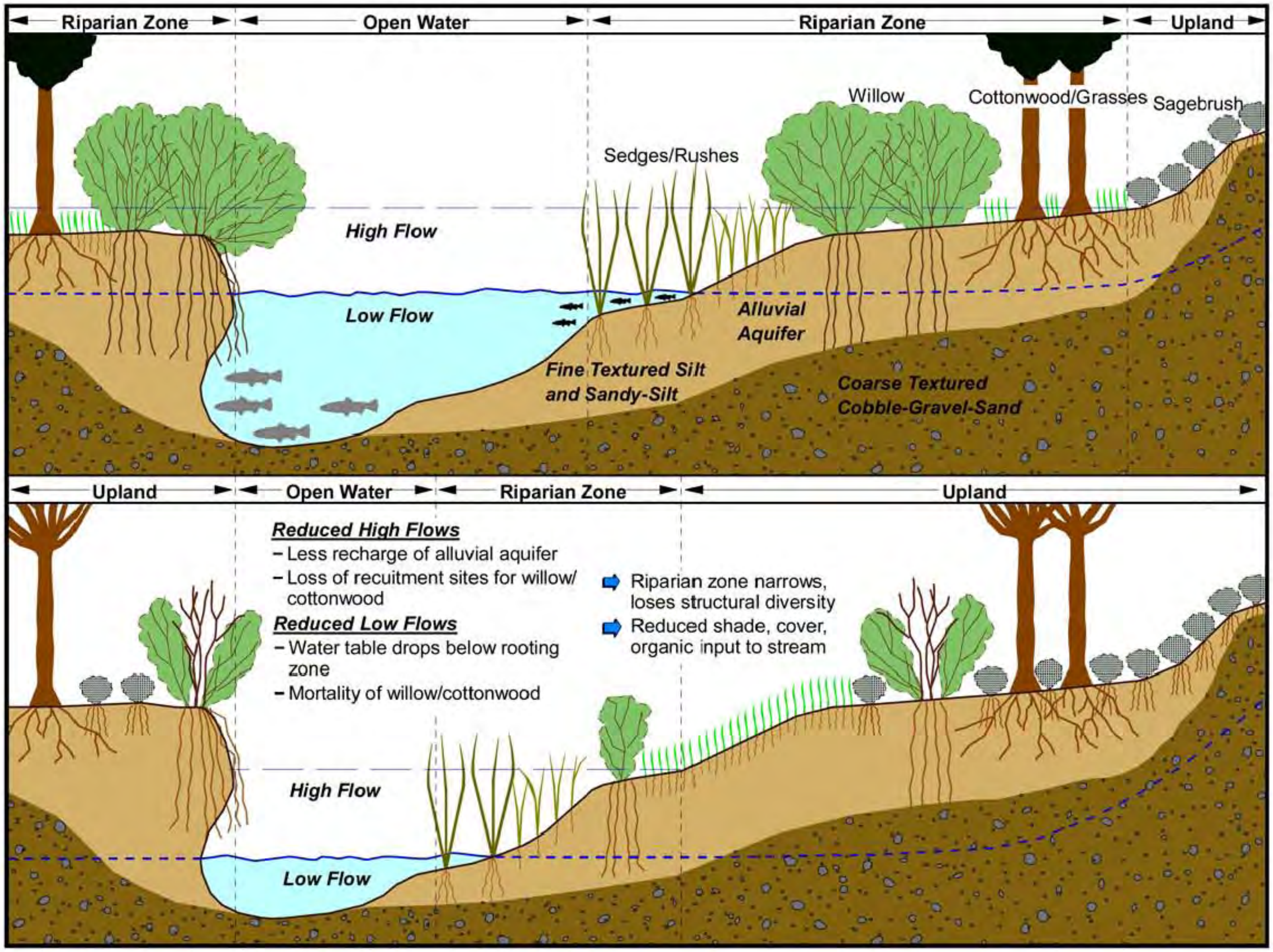


Figure V-9. Conceptual diagram illustrating general effects of streamflow reductions on riparian habitats.

116. Are there any other components of the ecosystem you considered of special importance when developing the Physical Habitat Claims?

Yes. Aquatic invertebrate communities within the streams are another necessary component of healthy and productive habitat for fish. I described above that fish need water to survive; fish also need food to survive. In most streams, and certainly those in the Upper Klamath Basin, the predominant source of food for fish is comprised of organisms that are referred to as aquatic benthic invertebrates. These organisms include flatworms, crustaceans (e.g., crayfish, snails, mollusks), and insects. Insects are most often the most abundant group of aquatic invertebrates residing in freshwater habitats (Hershey and Lamberti 2001; Ward 1992).

117. Are aquatic invertebrate communities affected by flow?

Yes. Flow has both direct and indirect effects on aquatic invertebrates. Many aquatic insects have developed in response to living in the currents (Ward 1992). Flow also has pervasive effects on the ecological processes involving aquatic invertebrates. The most notable effect is probably that of drift (the process by which aquatic invertebrates are transported downstream by flow). Drifting organisms are those most often sought after by fish that are actively feeding and represent those that anglers are continually trying to imitate as part of fly fishing. Streamflows also influence the quality of habitats that are used by aquatic invertebrates by flushing fine sediments downstream and creating new areas of habitation.

118. Did you collect aquatic invertebrate samples from streams in the Upper Klamath River Basin?

Yes. In September 2004, we collected and analyzed aquatic invertebrate samples from representative spring-dominated and runoff-dominated systems. Results of the sampling revealed distinct differences in the species and numbers of organisms found between the two types of systems. Overall, we found that aquatic invertebrate communities in spring-dominated systems had fewer kinds of invertebrates but showed an increased dominance of non-insects in community composition. One of the most dominant non-insect species present in the spring-dominated streams was the "spring snail" (hydrobiid pebblesnail). Because of their unique conditions and often disconnected distribution, spring communities have received increasing attention for representing unique systems harboring rare and endemic species and providing stable conditions for the persistence of these species. In spring-dominated streams, 11 species of pebblesnails (*Fluminicola*) have been found to be endemic to the basin (Frest and Johannes 1995 (277-US-404); 1996 (277-US-405); 1998 (277-US-406)). Three species from the Upper Klamath Basin (the Klamath pebblesnail, tall pebblesnail, and Klamath Rim pebblesnail) are especially important and have been designated as Record of Decision (1994) Survey and Manage freshwater mollusk taxa under the Northwest Forest Plan (Frest and Johannes 1999).

All hydrobiid snails have gills that make them dependent upon dissolved oxygen in the water in which they live. Hydrobiids are highly sensitive to water pollution, oxygen deficits, elevated water temperatures, and sedimentation. Both the tall and Klamath Rim pebblesnails are crenophiles (i.e., organisms living only in spring environments); whereas the Klamath pebblesnail prefers clear, cold, flowing waters found in spring-dominated streams. Current management recommendations for these taxa are to protect the required environmental conditions at known sites (USDA Forest Service and USDI Bureau of Land Management 1998). Among the activities listed that may impact these environmental conditions were dredging, grazing, nutrient enrichment, water pollution, and decreased water flow as a result of diversion for irrigation or other purposes (USDA Forest Service and USDI Bureau of Land Management 1998).

119. What did you conclude from the information gathered?

The information gathered suggests that the spring-dominated systems in the Upper Klamath Basin represent unique ecosystems that alone and in combination help to sustain native fish populations despite large scale losses of habitat, water withdrawals, and other human induced disturbances. Nightengale and Reiser (2005) (277-US-407) showed that the spring-dominated streams of the basin contain unique assemblages of organisms that likely exist due in large part to prevailing stable flow and temperature conditions. For example, the high abundance of organisms in Spring Creek (Claim 640) is likely a function of excellent water quality conditions and a stable environment that allows for year-round production of aquatic invertebrates. This high abundance of organisms in turn supports a food-web for fish capable of supporting year-round fish production. Therefore, the stream flows of these unique systems were considered to be important to providing a healthy, productive fish environment.

VI. CURRENT CONDITIONS OF STREAMS AND TARGET FISH SPECIES WITHIN THE UPPER KLAMATH BASIN

120. Dr. Reiser, can you describe the current conditions of streams and target fish species within the Upper Klamath Basin?

Yes. From a physical habitat or livable space perspective, some of the streams in the Upper Klamath Basin are in relatively good condition while at the same time many others are in relatively poor condition. I describe more specifically the current condition of each reach of the Williamson River subbasin streams in Section IX. As to the target fish species, the current opportunity for the Klamath Tribes to harvest target fish species is limited; four of the target species (shortnose suckers, Lost River suckers, Chinook salmon and bull Trout) have been either extirpated or listed as threatened or endangered under the Endangered Species Act and one of the target species, (redband trout), although present in the Basin, is closely managed by the ODFW as a highly regulated sport fishery. As such, none of the populations of the target species are in healthy enough condition to allow harvest activities that would support a commercial fishery, or more than an incidental infrequent subsistence fishery.

121. You just stated that many streams in the Upper Klamath Basis have poor conditions. What contributes to these relatively poor stream conditions?

Just as many components contribute to a healthy, productive fish habitat, a host of components can contribute to undermining fish habitat. Interestingly, although it requires many components in the right combination to ensure a healthy, productive habitat, it is possible for a single negative component to wholly undermine the health and productivity of fish habitat. Both streamflow related factors, such as diversions, and land use practices, such as grazing, can singularly and collectively contribute to poor conditions.

122. You stated that flow-related conditions can contribute to poor fish habitat conditions. Please explain.

Flow-related conditions can contribute to poor fish habitat conditions. Most notably in the Upper Klamath Basin, numerous diversions, primarily for irrigation, occur in streams resulting in significant reductions in stream flow particularly during the hotter summer growing-months when stream flows, especially those of runoff-dominated streams, are typically at their lowest flow levels.

123. How do such reduced flow conditions resulting from diversions impact the health and productivity of the fish habitat?

Diversions can severely reduce and even eliminate the flow of water in a stream. For streams in the Williamson River subbasin, this is most evident during the summer irrigation period when stream flows are naturally low. As Figures IV-1 and IV-3 depict in Section IV, reductions in flow can also undermine the survival of eggs in gravels, as well as reduce the amount of spawning and rearing habitats, and food production area in a stream. Reduced streamflows may likewise reduce the amount of escape-cover and refuge habitats resulting in an increase in fish predation by birds, mammals, and other fish species. Further, streamflow reductions have a downstream effect both in terms of reducing the amounts of habitat (due to low flows) and altering water quality, most notably water temperatures (decreasing the volume of water in a stream allows for increased warming as flows travel downstream). Thus, the effects of flow reductions can extend for a substantial distance downstream.

In the upper Williamson River subbasin, 412 points of diversion for water rights reportedly exist, with the majority (72%) comprised of diversions from surface waters (versus groundwater) (DEA 2005a). Some streams, including Jackson Creek (Claim 637), Irving Creek

(Claim 638), Sand Creek (Claim 635) and Scott Creek (Claim 636) have lost all surface connections to the Williamson River during the majority of the year, the latter two streams originally connecting through the Klamath Marsh (USFS 1998). The loss of surface flow connectivity to the mainstem river prevents the movement of fish to and from these tributary streams which contain important spawning and rearing habitats. These disconnects also result in the isolation and fragmentation of fish habitats and populations, and curtails the normal flow and exchange of genetic material, which overall reduces population viability. In some cases, Jackson Creek (Claim 637), for example, the isolation of habitats has prevented the movement of native redband trout from the Williamson River into the stream, which now appears to be occupied exclusively by non-native brook trout. Deep Creek (Claim 639), another stream in the upper Williamson River watershed has much of its flow diverted to the Aspen Creek drainage during the spring and summer months; however, it does maintain a surface connection to the Williamson River during high spring flows and periods of above average precipitation (USFS 1998).

One of the most obvious examples of flow reduction in the mainstem Williamson River can be found in the reach of Claim 629, a reach that extends from the lower end of Kirk Canyon upstream to the Town of Kirk. Figure VI-1 contains two images of the Williamson River near the upper end of the reach, the first taken in June 2006 when surface flows were occurring, and the second taken in September 1997 when no surface flow was present. DEA (2005a) reported, based on OWRD data that if all consumptive water rights were exercised during an average water year type, there would be no surface flow at Kirk Reef during the months of July through October. Further, for a dry water year type DEA (2005a) reported that the period of dewatering would extend from June through November. During these periods of dewatering, fish passage would be precluded between the upper and lowermost points of the reach. It is important to note that this reach of stream often goes dry in an average year type during the July through October periods even when all consumptive use rights are not fully exercised (DEA 2005a). Nevertheless, while the exact degree to which this reach is influenced by consumptive diversions is unknown, the above analysis presented in DEA (2005a) suggests that flow diversions associated with the consumptive rights likely influence the frequency and duration of low/no flow periods. Correspondingly, the curtailment or reduction of some of the consumptive rights would likely result in a reduction in the frequency and duration of the periods of low/no flow in this reach.

Another extreme example of the extent to which reduced flows can impact fish populations occurred in June 2001 on Scott Creek (Claim 635), when flow diversions dewatered a portion of the stream resulting in a fish kill. According to an ODFW memorandum (Messmer 2001 (Ex. 277-US-408)) 68 dead fish were observed in pools that had been isolated by the reduced flows. The lack or reduction of surface flows to these pools would have had the effect of cutting off or reducing the supply of dissolved oxygen (see Section IV for relationship of DO to streamflow) and increasing the temperature of the pool, and likely created anoxic conditions resulting in the fish kill. Obviously, as the last example dramatically illustrates, without sufficient flowing water there can be no fish or fish habitat.

Figure VI-1a and VI-1b. Photographs of segments of the Williamson River within Claim 629 during periods with (Figure VI-1a, upper photo, June 2007) and without (Figure VI-1b, lower photo, September 1997) surface flow. This reach of stream, which is below Klamath Marsh often becomes periodically dewatered during the summer months (July-October). During these times, neither upstream nor downstream fish passage is possible.

124. What would be the effect, if any, of the Physical Habitat Claims on current conditions?

At the most basic level, the Physical Habitat Claims would provide the necessary water to the claim reaches of the Williamson River under most circumstances. The streams would become dewatered or flows dramatically reduced only in severe natural events such as periods of extreme drought. For example, in the case of Claim 629 (noted above) in which sections of the stream are periodically dewatered, the effect of the Physical Habitat Claims would be to increase the frequency of occurrence, the duration, and the magnitude of surface flows within the otherwise dewatered stream segment. This is important not only because the increased flows would provide fish habitat within the channel and a corridor for fish to move through the channel, but also, consistent with the second and fourth principles of Naiman and Latterell (2005) (see Section IV), the flows would support and increase downstream ecological functions. As specifically noted by Naiman and Latterell (2005), inputs received from upper stream segments contribute materials to downstream food webs and help shape fish habitat in lower reaches. Thus, the Physical Habitat Claims would serve to reduce the length and severity of the period of dewatering within this reach and would directly benefit habitats both within Claim Reach 629 and downstream.

The Physical Habitat Claims would assure that, to the extent natural flows are available, water up to the amounts claimed would remain in the streams and provide important habitat for the target fish species and other species that are present. Maintaining the claimed flows over time will improve channel characteristics, increase fish habitat quality and quantity, create habitat diversity, maintain and/or restore hydrologic and habitat connectivity, and improve the degraded conditions that exist in some of the streams of the Williamson River subbasin.

125. You mentioned that some of the streams appeared to be in relatively good condition. Please explain what you mean by that.

There are a few streams in the Williamson River subbasin for which Physical Habitat Claims have been made that appear to be in relatively good physical condition. The most obvious one is Spring Creek (Claim 640) which is located in the lower Williamson River subbasin. In contrast, the lower portion of Jackson Creek (Claim Reach 637) has been heavily influenced by agricultural practices and substantially disconnected from the Williamson River (see above discussion).

By good physical condition, I mean there is little visual evidence of any direct man-made influences affecting either the quality or quantity of physical habitats in the respective streams. The physical characteristics and structure of both the instream habitats and adjoining riparian areas appeared to be largely intact. The reason Spring Creek is in relatively good condition is because it is located within lands protected by the State of Oregon (Spring Creek lies within Collier State Park). This particular area is not subject to significant depletions or significant landuse activities that are detrimental to fish habitat.

126. What is the importance, if any, of the streams you characterized as being in "relatively good physical condition?"

For streams in the Upper Klamath Basin, we have uniformly applied a recognized instream flow methodology to provide a healthy and productive fish habitat in all streams singularly and collectively. The Physical Habitat Claims were developed to provide no more water than necessary to provide healthy and productive fish habitat. Providing flows that will continue to promote healthy and productive fish habitats in streams that appear to be in relatively good physical condition is every bit as important as providing flows that will help improve or rebuild the health and productivity of degraded habitats.

Under the Physical Habitat Claims, systems currently functioning properly within an ecosystem context should be protected, while those that are not functioning properly should be improved, or rebuilt/recovered. The utility of the Physical Habitat Claims and the Riparian Habitat Claims clearly fits within this dual, protection-recovery strategy.

127. You have generally described the current conditions of the habitat in the Williamson River subbasin, can you now describe the condition of the fish populations. Specifically, are the fish populations of the target fish species that exist within the Williamson River subbasin currently healthy, viable, and self-renewing at levels sufficient to support a harvestable fishery?

The answer to that question varies depending on which target species is considered as well as which stream is considered. More importantly, the determination of whether a particular fish population is healthy and capable of supporting harvest is not a simple process and requires a substantial amount of information.

Both Lost River sucker and shortnose sucker are listed under the federal Endangered Species Act. This listing indicates that the populations of those target species that exist within streams of the Williamson River subbasin are not currently healthy, viable and self-renewing at levels sufficient to support any harvest. The recent decisions of the USFWS based on a 5-year review of the suckers to keep both the shortnose sucker (status: endangered) (USFWS 2007b) and Lost River sucker (status: threatened) listed and protected under the ESA affirms the tenuous conditions of the populations (USFWS 2007a). Similarly, Chinook salmon were extirpated from the Upper Klamath Basin. Upon reintroduction of anadromous fish, successful establishment of returning salmon populations will require substantial effort and time. Until such establishment, the Klamath Tribes cannot look to salmon for harvest.

The Klamath largescale sucker is not listed under the ESA indicating that populations of this species are in better condition than the other two sucker species. However, Moyle (2002) noted that the Klamath largescale sucker is one of the least understood fish in the Klamath River watershed. Moreover, since there have been no quantitative assessments made of the population size of this species, it is not possible to state with any certainty the overall condition of the population, nor whether and to what extent it is capable of supporting any kind of harvest. With waters of the Upper Klamath Basin closed to all fishing for suckers and mullet (see question 144, below), harvest of Klamath largescale suckers is not currently possible.

Finally, as previously described, redband trout exist throughout the Williamson River subbasin following either an adfluvial (lake to small stream), fluvial (large stream to small stream), or resident (small stream) life cycle (see Figure IV-5). However, the redband trout populations in the Williamson River subbasin are currently managed as a highly regulated sport fishery, with specific regulations/restrictions varying depending on location in the watershed.

128. Please briefly explain what you mean by "harvest."

In essence, harvest represents the biomass of fish that can be removed from a population without having negative impacts on the population's continuance. For a population to be sustainable, a certain number of adult fish are needed to produce sufficient progeny that will survive and grow to maintain or replace the same number of adults; however, if just enough progeny are produced to do this, while the population would be sustainable, it would neither grow nor would there be any surplus fish that could be harvested. On the other hand, if the population of adults is able to produce more progeny than are necessary to maintain the existing adult population, then either the population will increase or the surplus fish can be harvested. Harvest can occur for subsistence, for sport, and for commercial purposes.

129. Please explain what is meant by sport fish harvest.

Sport fish harvest refers to the capture and taking of fish that is done for sport. One important aspect of sport fish harvest is that such harvest is not sold or otherwise traded for profit or money; i.e., the harvest is for sport and not as part of a commercial fishery. Sport fishing is best exemplified by the angling/fishing that is done by the general public for recreational purposes. For some, the attraction to fishing is simply the act of catching a fish and returning the fish to the water unharmed (known as "catch and release" fishing). For others, part of the fun of fishing is being able to eat some of what is caught, which is why ODFW carefully considers creel limits or fish possession limits as part of their regulations.

130. Please describe what is meant by a commercial fishery.

A commercial fishery is one in which fish are harvested for purposes of being sold, bartered, or traded. Commercial fisheries generally operate where fish populations are abundant, traditionally in the open ocean, on certain large rivers, and on some of the Great Lakes. Certain fish species, such as Pacific salmon, are designated as a commercial species since they can be, when their population levels are sufficient, commercially harvested in the ocean.

131. Please explain what is meant by subsistence fish harvest.

Subsistence fish harvest pertains to the capture and consumption of certain fish species for personal, family, and community consumption and subsistence and for traditional/ceremonial purposes. In Oregon, subsistence fishing is generally limited to members of Indian tribes who possess certain treaty rights to fish, hunt and gather. In the case of the Klamath Tribes, the Tribes has a right to hunt, gather, and fish within the former Klamath Reservation. The Klamath Tribes have a long history of using and depending on the native fish species of the Upper Klamath River Basin. See 277-US-412 and http://www.klamathtribes.org/information/background/cwaam.html.

132. In general, how can you tell whether a particular fish population can allow harvest?

Determining whether a particular fish population is harvestable requires an assessment of whether the population is healthy, viable, and self-renewing. The best way to make this determination is to collect data of the population of fish under consideration over a period of time that allows for an assessment of population metrics that are indicators of the health and viability of the population. This requires the completion of field surveys specifically designed to provide quantitative estimates of the biomass and numbers of fish within the given segment(s) of stream, the results of which can be extrapolated to other stream segments of similar size and morphology. Such metrics typically include, but are not limited to, population estimates (i.e., total numbers and weight of fish within a given stream), information on age class structure (which describes how many members of a given age are present in the population), and length and weight information to describe the growth rates and the general size of members of the population. Collected over time, these types of information can be used to track population trends (in terms of both numbers and biomass) and to identify population vital statistics such as mortality and survival rates. Collectively, this information would allow for an estimate of current population levels relative to potential numbers (if vital rates were changed) and whether and the extent to which harvest could occur.

133. Are there other types of data that can be collected that would not require as detailed of a study?

Yes. Some information on population health can also be gathered with less rigorous surveys designed to evaluate the relative abundance of the fish population based on metrics that typically involve a per unit of area or time basis. Fish sampling (such as electrofishing, seining, trapping, and snorkeling) is conducted within a stream and numbers of fish captured are expressed as fish per area sampled, or fish per unit of effort (e.g., number of fish collected within a certain amount of time, number per seine haul or net set, etc.). These all represent indices of abundance that can be used in combination with other data available, noted above, to evaluate the health and viability of the population.

134. What if you cannot directly sample the fish?

If fish sampling is not available, other metrics and methods exist that could be used to provide some understanding of population health; however, with less data available, an estimate becomes more general and approximate. For example, one method that is often used to indirectly monitor fish abundance over time is to count the number of redds (egg nests) of trout or salmon within a stream. Repetitive counts made over the entire period of spawning will provide an estimate of total numbers of redds for a given year. Assuming that each redd is representative of *at least* two fish (one female and one male, although in many cases more than one male spawns with a female), redd counts can be expanded into approximate estimates of numbers of mature adult fish in the population. Conducted over a period of years, redd counts provide one index of the relative size of the population and its stability; i.e., is the population constant, increasing, or decreasing.

Another method of indirectly monitoring the health of the fishery is *via* a creel census or angler survey. These essentially entail a series of interviews (conducted at specified times and over set periods) with anglers to find out the numbers and sizes of fish captured within a given stream or waterbody. Provided the surveys are conducted in a uniform manner and that anglers are accurate in their responses, annual creel censuses can provide information that is useful for evaluating general trends in population abundance. For example, changes in annual capture statistics (i.e., decreased or increased capture) might suggest changes in population abundance, assuming the same fishing regulations have been in effect over the period of comparison.

135. Are there any abundance or population data of the types you just mentioned available for the target fish species in the Upper Klamath Basin?

Some fish population data are available. A number of entities, including most notably the Oregon Department of Fish and Wildlife, The Nature Conservancy, the Klamath Tribes, and the USFS have completed fish surveys focused on evaluating fish populations and their habitats within selected streams in the Upper Klamath Basin.

136. What kinds of studies has the Oregon Department of Fish and Wildlife (ODFW) conducted regarding fish populations in the Upper Klamath Basin?

As the primary manager of the fish resources in the Upper Klamath Basin, the ODFW has a long history of completing studies and surveys in the basin designed to monitor the status and health of the fish populations. Based on my review of relatively recent ODFW monthly reports extending from 1990 to 2008, as well as technical documents, the types of studies have ranged from several long term monitoring programs such as redd counts in Spring Creek to stream specific studies focused on determining fish density estimates. ODFW has also been involved in radiotagging studies of redband trout designed to track fish movements and behaviors in the Upper Klamath Basin (including the Williamson River subbasin) and has been actively involved in efforts to monitor and recover federal ESA listed species in the Upper Klamath Basin.

Finally, in 2005 ODFW completed a statewide assessment of the status of native fish populations (ODFW 2005a) in accordance with the Native Fish Conservation Policy (NFCP) (OAR 635-007-0507).

137. Were streams within the Williamson River subbasin included in the 2005 ODFW status assessment?

Yes. Two of the ten redband trout populations identified in the Upper Klamath Basin were found in the Williamson River subbasin, one above, and one below the set of barrier falls within Kirk Canyon. The population below the falls is comprised of both adfluvial and fluvial/resident forms of redband trout. The population above Kirk Canyon and largely above the Klamath Marsh is comprised exclusively of resident forms. Claim Reaches 625 through 628, 634, and 640 are located below the barrier falls. Claim Reaches 629 through 633, and 635 through 639 are located above the barrier falls.

138. What was the result of the 2005 ODFW status assessment for the redband populations in the Williamson River subbasin?

The results of the ODFW studies indicated that the population of redband trout in the lower Williamson River is in relatively good condition compared to the population of the upper Williamson River. Notably, redd counts in Spring Creek (Claim 640) and the lower Williamson River below Spring Creek (Claim 627) appeared relatively stable. In addition, the lower

Williamson River population supports more than 50 spawning adult fish. In contrast, the upper Williamson River population had a low biomass rating (compared with a set of benchmark density estimates from other streams), and in terms of productivity, has problems associated with isolation, channelization, habitat degradation, and irrigation withdrawals (ODFW 2005a).

139. Do you know how ODFW has used its redband status assessment information?

I can reasonably conclude that ODFW used the assessment as one of several pieces of information to set its fishing regulations post-2005.

140. What generally are ODFW's fishing regulations?

Every year ODFW issues a set of sport fishing regulations as a means to regulate the number and size of fish that can be taken (harvested) by an individual (non-commercial) angler within a given stream or water body. Sometimes the regulations are broad and pertain to an entire watershed, while in some instances there may be very specific regulations for a certain species and for a given stream or stream reach. In the broadest sense, the intent of these regulations is to protect fish populations and keep their numbers at levels that will maintain population viability and sustainability. Thus, regulations will tend to be more restrictive for streams and waterbodies in which the numbers of fish in a population either already are at or could be at levels which could affect the sustainability of the population. Such restrictions might come in the form of restricting the timing and duration of fishing, reducing the numbers of fish that can be captured by an individual angler (called the "creel or bag limit"), changing the minimum size of fish that can be harvested, specifying the use of certain types of fishing gear, and, in some cases imposing "catch and release" restrictions that requires all fish of a given species to be safely released without any harvest.

Each type of restriction can benefit a species in different ways. By restricting the timing and duration of a fishing period, the regulations restrict harvest to periods that minimize impacts on critical lifestages (i.e., spawning). By restricting the number of fish that can be taken, the regulations prevent the fish population from being overfished and overharvested by angling activities. By restricting the size of the fish that can be taken, the regulations serve to protect certain age classes of fish from overharvest, such as large, adult fish that provide substantial reproductive capacity to the population. And finally, by restricting the manner in which fish are caught, the regulations make it more difficult for an angler to catch a fish and, likewise, prevent serious injury to fish that are caught (e.g., fishing restricted to use of artificial lures with barbless hooks). At the extreme end when fish populations are low or have been listed as threatened or endangered, the regulations may simply impose the closure of a stream or waterbody to any fishing for a given species.

141. Do you know how Oregon's fishing regulations are set?

Generally, yes. The annual regulations are set by the Oregon Department of Fish and Wildlife Commission, and that changes to fishing regulations are based primarily on two considerations: conservation of the species and societal values (William Tinniswood, pers. comm). Conservation generally pertains to the general health of a given species and considerations relative to ODFW's species protection. The information provided in ODFW's 2005 status review, as well as biological data collected from annual surveys, represent the types of data that would be used in assessing the conservation of the species. Also included in this assessment are aspects related to ESA listed species (e.g., bull trout, Lost River sucker and shortnose sucker); for ESA listed species, conservation takes precedence over all other considerations. With respect to societal values, ODFW considers input and recommendations from local residents, as well as tribes, and local fishing groups regarding fishing regulations. For the Upper Klamath Basin, there has been a general trend over time of the societal recommendations becoming more conservative relative to the regulations; i.e., supporting more restrictive regulations. This is likely due in part to a greater public awareness that in order to preserve and protect fish populations, regulations need to be more stringent.

142. Are you familiar with some of the earlier regulations that were in effect for streams on the Upper Klamath Basin?

Yes. I compiled and reviewed various sets of fishing regulations for the Upper Klamath Basin as a means to determine over time whether and the extent to which the regulations may have changed. My purpose in doing this was to determine whether the regulations had become more restrictive or more lenient, which would be one indicator of the general health of the population, as perceived by ODFW, for that year.

143. How many years of regulations did you compile and review?

My review focused on six years that encompassed a 30-year period that extended from 1979 to 2009; the six years included 1979, 1981, 1992, 1999, 2000, and 2009. These years included periods both before and after ESA listing of the two sucker species (in 1988) and bull trout (in 1999). The comparison focused on the regulations pertaining to five of the target fish species: bull trout, redband trout, and the three sucker species. I focused on the regulations for the Upper Klamath Basin and, to the extent possible, assigned them to individual claim reaches.

144. In general, what did the results of your review of ODFW regulations show?

My review of the regulations showed that over time, the fishing regulations for the majority of streams in the Upper Klamath Basin, including the Williamson River subbasin, have become more restrictive. This was evident, for example, for Spring Creek (Claim 640) where in 1980 the regulations for redband trout allowed for the harvest of 10 trout larger than 6 in. per day, with not more than 5 of the 10 larger than 12 in. and not more than 2 of the 5 larger than 20 in. The total possession limit (i.e., the numbers of fish a person could have at home (from previous fishing trips)) was limited to 20 fish larger than 20 in., or in 7 consecutive days not more than 4 fish larger than 20 in. The 1980 regulations specified that all angling was closed from April 21 through May 25 in a 300 ft segment extending from the mouth upstream. That segment of Spring Creek contains important spawning habitat and the regulation, therefore, focused on protecting the high concentration of fish that use the area during the spawning period.

In contrast, the 2009 regulations regarding redband are much more restrictive. Regulations today at Spring Creek limit the number harvested to 5 trout larger than 8 in. with 2 daily limits (i.e., 10 fish) in possession; with 1 trout larger than 20 in. For the mainstem segments of the Williamson River below the barrier falls, the regulations have likewise become more restrictive both in the numbers and minimum size limits of catch. The restriction was also added (noted first in 1999) of having a "catch and release" restriction for all trout from August through October. This latter restriction was likely imposed to protect the post-spawning population of fish that are in a weakened condition and hence more susceptible to angling. The restriction would therefore serve to protect those fish that could potentially spawn the next year.

With respect to the sucker species, the 1979 and 1980 regulations were generally silent on specific limits for suckers, and, therefore, the same general bag limits specified for trout applied to suckers. However, the regulations since 1992 all clearly state that all waters containing these sucker and mullet species were closed to angling for these species. This drastic regulation change was made in response to the 1988 decision to list the Lost River sucker and shortnose sucker as protected under the federal Endangered Species Act. This also means that no angling can occur for Klamath largescale sucker that reside in those same waters; a necessary restriction to avoid possible hooking injury or mortality to the listed species.

Likewise, even though they have not been present in the Williamson River subbasin, the regulations for bull trout have become more restrictive, and from 1992 to present all waters of the Upper Klamath Basin have been closed to any angling for bull trout. Bull trout were listed as threatened under the federal Endangered Species Act in 1999.

145. What, if anything, does this trend in ODFW fishing regulations tell you regarding the health and viability of the target fish species in the Williamson River subbasin?

The trend of increased restrictiveness in ODFW's fishing regulations indicates, in part, the increasing risks to many of the target fish populations. Because of the ESA listing of the shortnose sucker and the Lost River sucker, all angling for sucker species has been eliminated. The restrictions imposed for the sucker species, which do not allow for any harvest, indicates that those populations are not healthy and viable, and are certainly not at levels capable of supporting any harvest.

For redband trout, the trend of increased restrictiveness of the regulations likely reflects a combination of ODFW's conservation directive based on biological data, and an increased societal awareness of the need to protect important fish populations. The regulations on the redband trout populations allow a limited sport fish harvest during certain periods of time, and no harvest (i.e., catch and release only) during the post-spawning period. These restrictions are designed to control the amount of harvest on the populations and protect them from overfishing, which can lead to population declines.

146. Are any of the populations of the target fish species at levels that would allow for a commercial fishery to operate?

No. All of the populations of the target fish species are well below levels that would support commercial harvest.

147. Are any of the populations of the target fish species at levels that would allow for a subsistence fishery to operate?

For the three listed species (i.e. Lost River sucker, shortnose sucker and bull trout), no, the populations are below levels that could even support a subsistence fishery. However, certain populations of redband trout and possibly Klamath largescale sucker might be able to support some incidental, infrequent subsistence harvest, although the numbers of fish taken should be monitored.

148. What is the implication of ODFW's trend in fishing regulations, if any, relative to flow conditions and the Physical Habitat claims?

In a broad sense, because ODFW fishing regulations currently allow some amount of sport harvest of redband trout in many streams within the Williamson River subbasin, it can be surmised that flows within this subbasin have generally supported some fish production. However, the ODFW observed in the 2005 native fish status report (ODFW 2005) that Oregon Basin redband trout populations tend to fluctuate annually with drought cycles and instream flow conditions. Further, Smith and Tinniswood (2004) (Ex. 277-US-409) cited some of the fish monitoring results of C. Bienz of The Nature Conservancy (TNC) noting that fish population numbers tended to follow high and low flow water years. For example, results of fish surveys indicated that redband trout abundance in portions of the upper Williamson River was relatively high during the "good" water years of 1997 and 1998, while for one of the sites, no redband trout was captured during the low water years of 1999 and 2000. Although the relationship of flow to habitat to fish populations is generally not direct, if the amount of water remaining in the stream to support fish populations is not protected and tends to decrease with time, as may occur in streams within the Williamson River subbasin, then depending on the severity of the flow decreases, I would expect fish populations to decline.

149. How does this relate to the Physical Habitat Claims for the Williamson River subbasin?

Fundamentally, the Physical Habitat Claims would reduce the severity of current and potential future flow reductions in streams that would otherwise occur, thereby protecting populations of target fish species. The Physical Habitat Claims would provide flows specifically designed to provide for or maintain healthy and productive habitats in streams currently supporting, or that will support in the future (i.e., Chinook salmon), populations of the target fish species. Coupled with the Riparian Habitat flows that, in part, mimic portions of the high flow hydrograph, the flows will provide a healthy and productive fish habitat in streams that appear to be in relatively good physical condition, and improve or rebuild the health and productivity of currently-degraded habitats.

VII. APPROACH, METHODOLOGIES, AND PROCESS APPLIED TO DEVELOP AND SUPPORT PHYSICAL HABITAT CLAIMS

150. Please summarize the IFIM/PHABSIM method.

Section VII describes a variety of methodologies that exist and are available for developing instream flow recommendations. IFIM/PHABSIM's primary function is to describe a relationship between streamflow and physical habitat by combining information and data pertaining to the physical and hydraulic characteristics of a stream with information that describes the habitat preferences of different fish species and lifestages. In general, IFIM/PHABSIM is exercised in three major steps: (i) simulate water surface elevations under different flows; (ii) simulate flow velocities and depths; and (iii) simulate the physical habitat versus streamflow relationships. The first step results in development of what is termed a stage – discharge relationship, which simply means that for a specific location, a given water surface elevation (i.e., stage) corresponds to a specific amount of flow. Hydraulic simulations are used to describe the areas of a stream having various combinations of depth, velocity, and substrate as a function of flow. This hydraulic information is combined with another computer program that incorporates habitat suitability criteria and together this collective information is used to calculate Weighted Usable Area ("WUA"). WUA is a habitat metric that represents an index of the amount of fish habitat present under a given range of flows. The final flows derived are based on the appropriate WUA versus flow relationship for a specific target fish species and lifestage.

As described in Section IV, we selected IFIM/PHABSIM because 1) it is the most widely recognized method in North America, 2) it is recommended by the State of Oregon for use in instream flow studies, and 3) it is the most appropriate method for evaluating incremental changes in habitat with changes in flow. I have used IFIM/PHABSIM repeatedly over my career as a fish biologist whenever there are competing interests for flow and there is a need to assess how different flows change fish habitat.

151. You mention "weighted usable area (WUA)." Please describe this further.

WUA represents an index of the amount of habitat present in a given stream location under a given range of flows for a certain species and lifestage of fish. The stream parameters that are considered in the computation of WUA are water depth, water velocity, and stream-bed substrate. The first two of these are directly related to stream flow (water depth and water velocity), while the latter (substrate), although fixed, does change by stream location.

In the IFIM/PHABSIM process to determine the WUA, the cross-sectional stream profile is divided into numerous individual cells and analyzed for depth and velocity suitability. Respective depths and velocities assigned to a given cell are computed as averages of measured depths and velocities from adjacent vertical measurement points. One way to think about WUA is to view a river or stream as being comprised of small, 3-dimensional cells with each cell representing some combination of depth and velocity. Figure VII-1 illustrates a cross-sectional view of a river that contains many 3-dimensional cells that collectively would be analyzed to determine WUA.

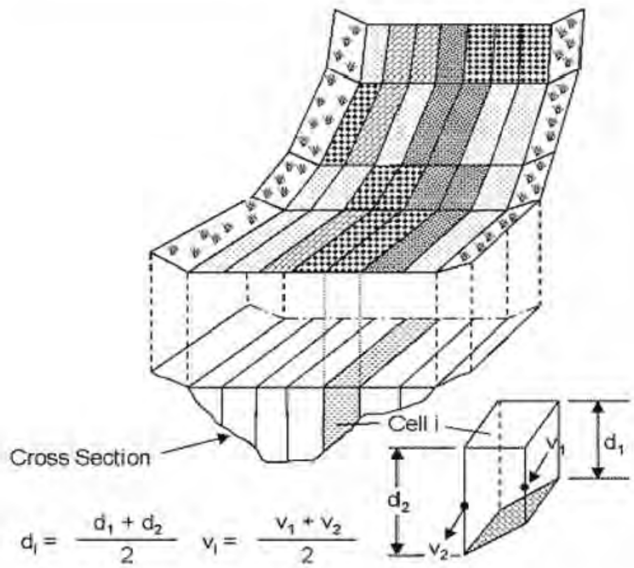


Figure VII-1. The cross-sectional stream profile is divided into numerous individual cells and analyzed for depth, velocity, and substrate suitability.

As streamflow increases or decreases, the values of depth and velocity within each parcel also change. Since each of the depth and velocity combinations in a parcel represents a certain amount of habitat, then by extension, as flows change, the amount of fish habitat changes. The "weighting" of the habitat comes into play by factoring in the relative value of each depth, velocity, and substrate combination as defined by the preference for that combination by different fish species and their lifestages. This "weighting" is illustrated in Figure VII-2, which depicts the computational process of WUA that occurs via linking of the measured depths, velocities, and substrates defined for a given parcel with respective Habitat Suitability Curve (HSC) criteria for different species and lifestages. If lifestage and species preferences for various depth and velocity combinations can be determined over the entire range of parcels that occur in a stream, then the actual amounts of habitat that are contained within each parcel will be weighted and combined accordingly. Thus, the summation of the weighted habitat areas represents the weighted useable area (WUA) for a given flow of that species and lifestage.

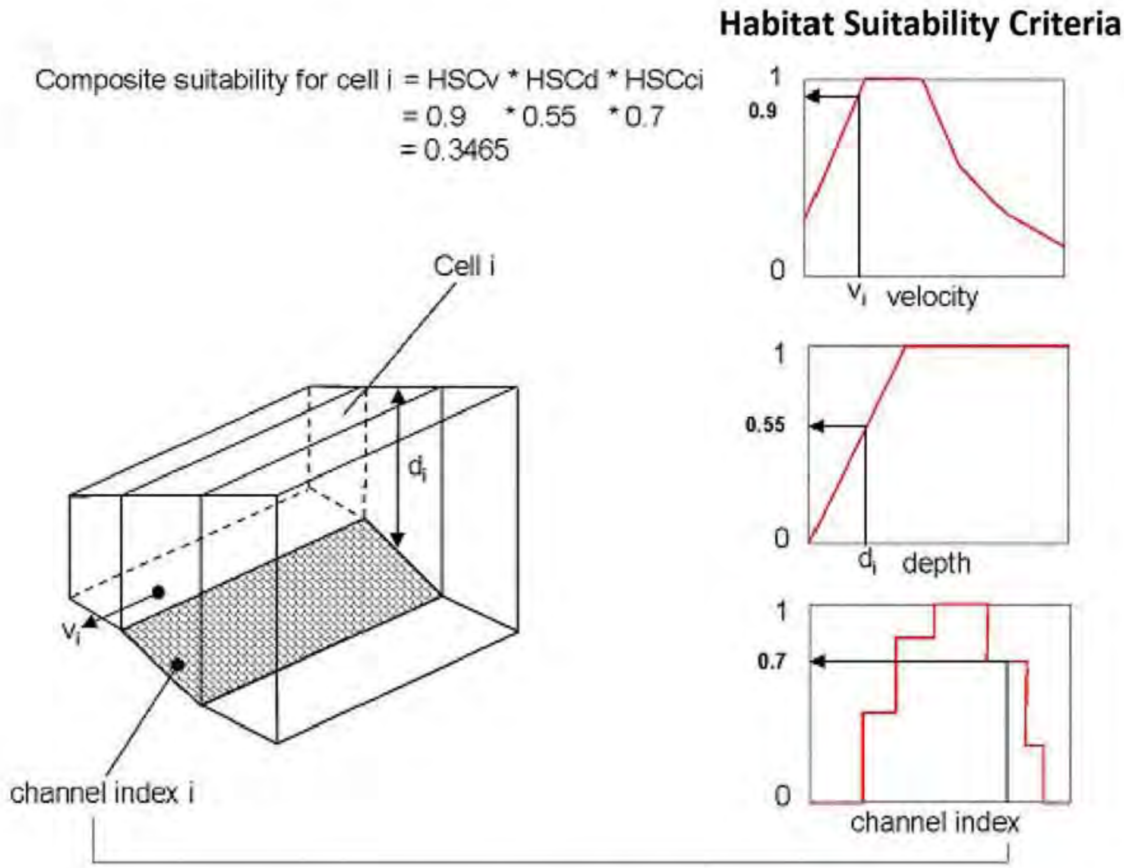


Figure VII-2. Illustration of a representative water cell within a stream. The cross-sectional stream profile is divided into numerous individual cells (see Figure VII-1) and analyzed for depth and velocity suitability, and the suitability of the stream substrate (designated here as channel index). The figures on the right depict representative Habitat Suitability Curve (HSC) criteria which are used in the computation of WUA for a given cell, represented here for Cell i.

It is important to recognize that the WUA of a stream reach changes with flow; however, maximum flows do not simply result in greater amounts of WUA or fish habitat. This is because as flows increase, water velocities will likewise increase and will ultimately exceed those preferred by a given species or lifestage. At that point, increases in flow will actually begin to decrease the amount of WUA. An illustration of four overlaid redband trout WUA curves is provided below in Figure VII-3.

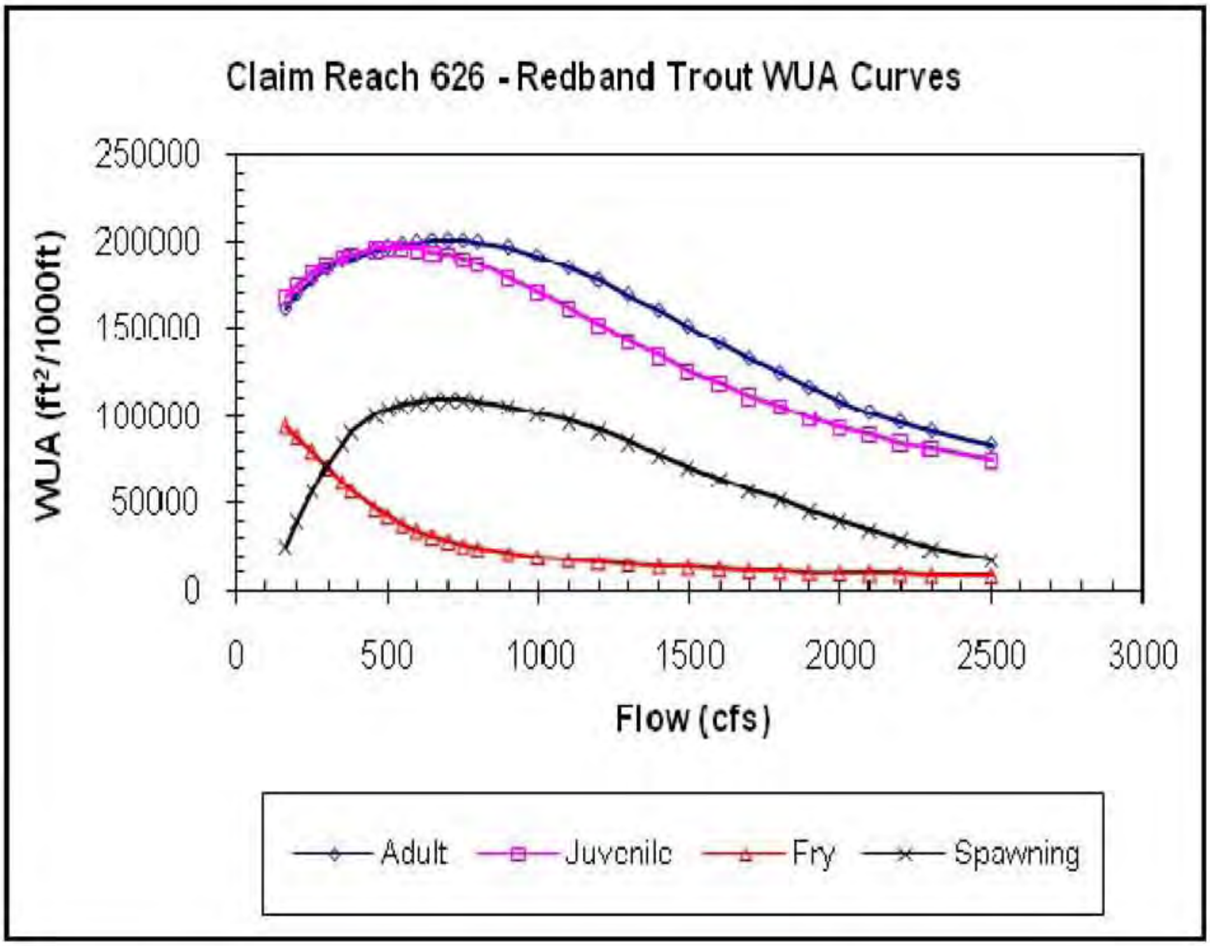


Figure VII-3. Example WUA:flow curves for the four lifestages of redband trout for Claim 626. Different habitat:flow relationships exist for each of the four lifestages.

152. Was WUA the only habitat metric computed for deriving the Physical Habitat Claims?

WUA was the only metric computed for deriving the Physical Habitat Claims developed from IFIM/PHABSIM. However, access restrictions to one site (Claim 633) in the Williamson River subbasin prevented us from collecting field data needed for an IFIM/PHABSIM analysis. For that claim, we applied the Tennant Method (Tennant 1976) for computing the habitat metric.

153. Please summarize the Tennant Method.

The Tennant Method is founded on the observation that aquatic habitat conditions are similar in streams carrying the same proportion of the mean annual flow. As a result, Tennant (1976) defined several categories (Optimal, Outstanding, Excellent, Good, Fair, Minimum) of protectiveness based on percentages of average annual flow (see Section V for further discussion); however, the percentages assigned by Tennant to the various categories were based on rivers within the Midwest. As a result, similar to how Estes (1984) adjusted Tennant percentages for Alaska streams based on different lifestages of fish, we adjusted the percentages for application to streams in the Upper Klamath Basin.

The adjustments made by Estes (1984) resulted in the separation of flow recommendations based on two lifestage groupings, 1) spawning/passage, and 2) incubation/rearing. The corresponding instream flow values recommended by Estes (1984) usually ranged from 60 percent to 100 percent of average annual flow (representing the Optimum category) for spawning/passage, and from 10 percent to 40 percent (representing from Minimum to Outstanding) for incubation/rearing. We similarly separated the flow values into two groupings, one based on spawning, and the other adult/juveniles (i.e., rearing). For periods of spawning, we considered flows needed to provide for healthy and productive habitat as those representing 50 percent of the average annual flow, and those for rearing, 30 percent.

Estimates of average annual flow were developed using median monthly flow estimates provided by Oregon Water Resources Department. See Mr. Ramey Direct Testimony at questions 53 through 57. By applying the Tennant Method to those areas where access was restricted, I was able to identify a Physical Habitat Claim that, in my opinion, would provide and maintain a healthy and productive habitat.

154. Have you ever used the Tennant method on other projects?

Yes. I have applied the Tennant Method on a number of other instream flow projects, including most recently an instream flow study conducted in conjunction with the relicensing of a hydroelectric project (owned by Portland General Electric) on the Oak Grove Fork in Oregon.

155. Was the Tennant method the only other instream flow method besides IFIM/PHABSIM that was used to derive the Physical Habitat Claims?

Yes. In addition, it is important to remember here that we also developed the flows necessary to maintain riparian habitat ("Riparian Habitat Claims"). The Riparian Habitat Claims were developed by Dr. Chapin and are described in Dr. Chapin Direct Testimony at questions 19 and 64. As I noted in Section IV, riparian habitat is inextricably ecologically linked to the aquatic ecosystem of a stream and its protection is critical to maintaining healthy and productive fish habitats. Two of Naiman and Latterell's (2005) principles considered necessary for maintaining robust, healthy fish communities centered around the importance of riparian habitat (see Section IV). Thus, the instream flow claims are comprised of two interrelated components: Physical Habitat Claims which are described and defined in this testimony, and Riparian Habitat Claims that are described and defined in Dr. Chapin Direct Testimony.

156. Please describe the approach that you used to develop the Physical Habitat Claims.

The basic approach used was to apply a nine-step decision framework that ultimately provided the necessary information from which to derive the Physical Habitat Claims. This nine-step framework gathered the data and information collected throughout the two decades of work in the Upper Klamath Basin including data analysis and IFIM/PHABSIM modeling results (or in one instance, results applying the Tennant methodology). Each of the nine steps contributed pieces of information or data that was ultimately considered and or used in the final derivation of the Physical Habitat Claims (described in Section VIII of my Direct Testimony).

157. Have you ever employed this decision framework on any other projects?

I have been involved in more than 50 other instream flow investigations which employed many of the same methods and techniques we applied in this basin.

158. In gathering the data and information necessary to derive the Physical Habitat Claims, how was this work organized?

The gathering of data and information necessary to support the Physical Habitat Claims required an extensive, coordinated effort over many years. Nine steps were taken that led to the development of the Physical Habitat Claims. Each step contributed pieces of information or data that were ultimately used in the final derivation of the Physical Habitat Claims.

159. Please describe the nine steps that led to the development of the updated Physical Habitat Claims that you present in your testimony today.

The nine steps that led to the development of the updated Physical Habitat Claims are:

Step 1 – Identification and Selection of Claim Reaches and Study Sites;
Step 2 – Selection of Target Fish Species;
Step 3 – Determine Species Distribution and Lifestage Periodicity;
Step 4 – Lifestage and Species Prioritization;
Step 5 – Development of Species Habitat Suitability Criteria (HSC) Curves;
Step 6 – Field Data Collection;
Step 7 – Instream Flow Hydraulic and Habitat Modeling;
Step 8 – Hydrologic Limitations – Median Flow Threshold; and
Step 9 – Other Flow Considerations – Limitation of 1999 Amended Flow Claim.

Section VIII describes the final review of the information gathered in a logical, systematic manner to make final updates to the Physical Habitat Claims.

160. Does the order in which the nine steps are presented reflect how they were completed?

The steps do not necessarily reflect a strict temporal sequence in which they occurred. The steps are listed in logical sequence, but the completion of each may have varied temporally.

161. Please describe the first step of the nine-step process – Identification and Selection of Claim Reaches and Study Sample Sites.

Because the drainage area represented by the Williamson River subbasin includes several mainstem channel reaches of the Williamson River and tributary streams, the first step focused on the identification and selection of specific study reaches within a claim reach and still smaller study sites from which physical and hydraulic data would be collected and which would form the basis for the Physical Habitat Claims. A "claim reach" is that section of the stream to which a tribal Physical Habitat water claim applies. A "study reach" is that portion of the "claim reach" that was surveyed and habitat mapped to determine the composition of habitat types. And finally, a "study site" is the portion of the "study reach" that was randomly selected for detailed study. The "study site" contains the transects that were surveyed and from which field data were collected.

162. How did you complete Step 1?

Initially, we compiled and reviewed USGS topographic maps of the drainages to become familiar with watershed boundaries, topographic features, and the overall network of streams within the Upper Klamath Basin. In consultation with the Klamath Tribes, we identified specific streams and stream reaches that are important to the Tribes' fishing, hunting, trapping, and gathering. A site reconnaissance was completed to assess the physical setting of the subbasins and to view a representative number of streams. Based on this review, a list of candidate streams for study was developed.

163. How was the candidate list of streams used?

We used the candidate list as a means to focus our field-work efforts. First, we located the streams on USGS maps and divided the streams into claim reaches, based on a number of considerations: the size and length of the respective streams; the change in topography or landscape around the stream; tributary junctions with the main stem river; an initial review of the diversity of habitat types present in each system; areas of importance for fish species; and property ownership and access limitations. Once claim reaches were identified, we selected study reaches based on channel characteristics (e.g., channel slope, confinement) we considered representative of those occurring within the claim reach. The study reaches were marked on the USGS maps and subsequently used in the field to guide selection of study sites. Unless field inspection revealed unforeseen circumstances such as access problems, the study sites were randomly selected within the study reaches.

164. What was the final number of study sites that were established in the Williamson River subbasin?

Based on the process described above, a total of 15 instream flow study sites were established in the Williamson River subbasin. The study sites were located on the mainstem Williamson River (above and below Klamath Marsh) and the river's major tributaries. A list of claim reaches is provided in Table VII-1 and displayed in Figure VII-4.

Table VII-1. Williamson River Subbasin Claim Reach Numbers and Upper and Lower Boundaries.

Claim Reach No.	River/Stream	Upper Boundary	Lower Boundary
625	Williamson River	Highway 97	Upper Klamath Lake
626	Williamson River	Sprague River confluence	Highway 97
627	Williamson River	Spring Creek	Sprague River confluence
628	Williamson River	Lower End of Kirk Canyon	Spring Creek
629	Williamson River	Town of Kirk	Lower End of Kirk Canyon
631	Williamson River	Deep Creek	Klamath Marsh
632	Williamson River	Wickiup Spring	Deep Creek
633	Williamson River	Campground Springs	Wickiup Spring
634	Larkin Creek	Larkin Creek source	Williamson River
635	Sand Creek	Sand Creek source	Klamath Marsh
636	Scott Creek	Scott Creek source	Klamath Marsh
637	Jackson Creek	Jackson Creek source	Williamson River
638	Irving Creek	Irving Creek source	Jackson Creek
639	Deep Creek	Deep Creek source	Williamson River
640	Spring Creek	Spring	Williamson River

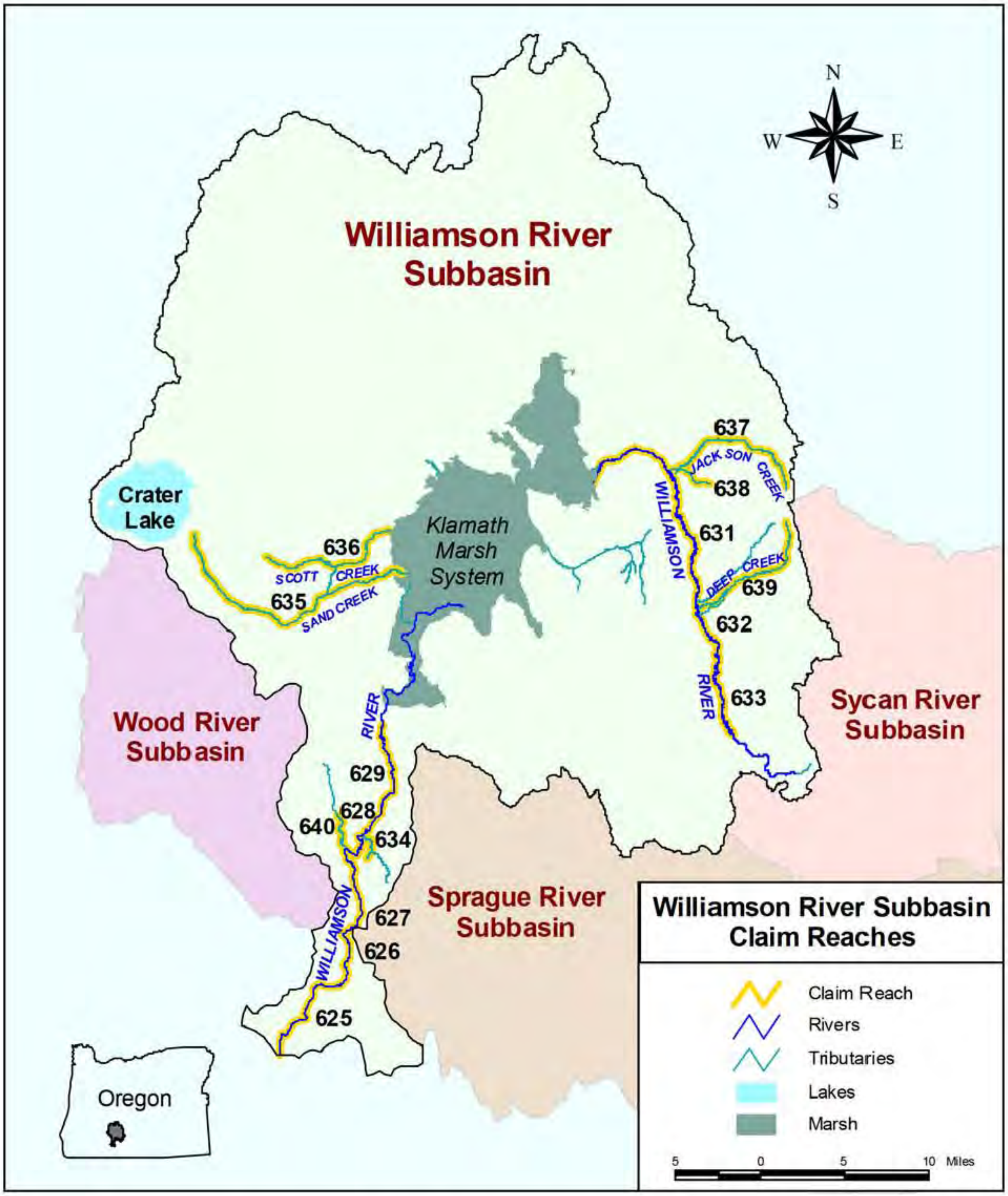


Figure VII-4. Location of Physical Habitat Claims in the Williamson river subbasin.

165. Please describe Step 2 of the nine-step process - Selection of Target Fish Species.

Step 2 was conducted in parallel with the selection of claim reaches and study sites. Early on in the project, as discussed in Section II above, we identified fish species of importance termed "target fish species" and listed in Table VII-2. The six species include three salmonid species (Chinook salmon, redband trout, and bull trout) and three catastomid species (shortnose sucker, Lost River sucker, and Klamath largescale sucker); all are native to the Upper Klamath Basin. These native fish species are treaty species which represent species that currently are or historically were harvested by the Klamath Tribes. In addition, these target fish species are those that state (ODFW) and federal (USFWS, NMFS) agencies have found are important. The species selection and prioritization process we used is commonly applied on projects involving decisions related to flow quantification, regulation, and management. For example, I was recently involved on two projects associated with hydroelectric relicensing in which a similar procedure was applied, the first as part of the instream flow studies on the Clackamas River in Oregon, and most recently, an instream flow study for the Sultan River in Washington.

Table VII-2. Common and scientific names of the six target fish species considered for the Upper Klamath Basin and indication of their presence in the Williamson River subbasin.

Common Name	Scientific Name	Current and Historical Presence in the Williamson River subbasin
Chinook salmon	*Oncorhynchus tshawytscha*	*Currently absent/Historically present*
Bull trout	*Salvelinus confluentus*	*Currently absent/Historical presence uncertain*
Redband trout	*Oncorhynchus mykiss newberrii*	*Currently present*
Lost River sucker	*Deltistes luxatus*	*Currently present*
Shortnose sucker	*Chasmistes brevirostris*	*Currently present*
Klamath largescale sucker	*Catostomus snyderi*	*Currently present*

166. Are there other species of fish in the Williamson River subbasin besides the six target fish species noted above?

Yes. A number of native and non-native fish species exist in the Williamson River subbasin. OWRD Ex. 2 pp. 4 through 5 contains a more detailed listing of fish and aquatic species, both native and non-native, found in the Upper Klamath Basin generally. Although steelhead are not currently present, historical records indicate steelhead were present in the Williamson River subbasin (Hamilton et al. 2005). Steelhead were not identified as a target species, but we have concluded that steelhead flow requirements would be satisfied based on those of the redband trout because redband trout and steelhead trout are taxonomically similar (both are *Oncorhynchus mykiss*, and the size and physical characteristics of adfluvial redband closely resemble the size and physical characteristics of steelhead).

167. You stated that the three salmonid target fish species (Chinook salmon, bull trout, and redband trout) are species of importance. Generally what is the importance of these three species?

Chinook salmon is a fish species that was historically present in the Williamson River subbasin (below Klamath Marsh), however, it is not currently present in the subbasin or anywhere in the larger Upper Klamath Basin. As described in detail in Dr. Hart Direct Testimony at questions 19 through 47, and as frequently identified in publications, anadromous fish, including Chinook salmon, were historically present in the subbasin before the construction of impassable dams on the Klamath River at the turn of the 20th Century (Hamilton et al. 2005; Fortune et al. 1966; Logan and Markle 1993).

Recent studies suggest that with the provision of suitable passage facilities at downstream dams or dam removal, Chinook salmon could be re-introduced and restored to waters in the Upper Klamath Basin (Huntington and Dunsmoor 2006; Hooton and Smith 2008). Also, the

Federal Energy Regulatory Commission (FERC) recently decided that if a license to operate the dams is reissued it will be conditioned on providing adequate salmon passage around those dams (FERC 2006 and Hooton and Smith 2008). The action taken by FERC in conjunction with recognition of the re-introduction feasibility supports the likelihood of salmon returning to the Upper Klamath Basin in the foreseeable future. Therefore, Chinook salmon is included as a target fish species with the understanding that the Physical Habitat Claims developed for them is conditional upon reintroduction into the Upper Klamath Basin.

Bull trout, another target fish species is presently limited to relatively few streams in the Upper Klamath Basin, not in the Williamson River subbasin, and is not likely to return to the subbasin in the foreseeable future. Thus, bull trout is not discussed further as it is not part of claim development in the Williamson River subbasin.

The other salmonid target fish species is redband trout. This species is perhaps the most ubiquitous salmonid species present in the basin (Smith et al. 2003 (Ex. 277-US-410) and Messmer et al. (2000) (Ex. 277-US-411)). However, it is still unique in that two different life history strategies (adfluvial and resident) are seen in redband trout populations within the Williamson River subbasin. The adfluvial form of redband trout is a large-body fish that live in Upper Klamath Lake and migrate into the Williamson River subbasin below Kirk Canyon to spawn. Behnke (1992) suggested that ancestors of these fish may have been anadromous steelhead. The resident form of redband is much smaller and spends its entire life within streams above and below Kirk Canyon.

168. You stated that the three sucker species (shortnose, Lost River, and Klamath largescale) are species of importance. Generally, what is the importance of these three species?

All three of the sucker target species are endemic to and found only in the Upper Klamath Basin. All three species are long-lived species, with the Klamath largescale reportedly living as long as 31 years or more (Moyle 2002), the shortnose for as long as 33 years or more, and the Lost River for 43 years or more (Scoppettone 1988). The shortnose and Lost River sucker species were listed as endangered under the federal Endangered Species Act in 1988. Sucker species are also of special cultural significance to the Klamath Tribes and were historically a primary food source (see 277-US-412). Indeed, each spring the Tribes hold a ceremony marking the return of these fish (http://www.klamathtribes.org/information/background/cwaam.html). With the Lost River sucker and shortnose sucker species threatened with extinction in the Upper Klamath Basin, the Tribes do not currently harvest any sucker species.

169. Are the six target fish species of importance to the Klamath Tribes?

Yes. The standing policy management statement of the Klamath Tribes describes the general importance of the target fish species to the Tribes. See Ex. 277-US-412.

170. Was there anything else noteworthy related to Step 2?

Yes. The current absence but likely future presence of anadromous fish species, and specifically Chinook salmon, within the Williamson River subbasin caused a refinement in the process we used in developing the Physical Habitat Claims. Specifically, the updated Physical Habitat Claims are divided into two components: 1) Physical Habitat Claims based on *present* target fish species; and 2) Physical Habitat Claims based on *all* target fish species, which includes Chinook salmon. The former claims are referred to as *present* claims, and the latter are referred to as *conditional* claims, and should only go into effect when anadromous fish are reintroduced into the Upper Klamath Basin.

171. Please describe Step 3 of the nine-step process - Species Distributions and Lifestage Periodicities.

The biological basis and justification for the Physical Habitat Claims centered on determining the flow quantities necessary to provide no more than that flow necessary to provide a healthy and productive habitat for target fish species. Thus, I wanted to make sure that a flow claim for a particular reach was based on the target fish species that actually occurred or would likely occur within the reach. Once the six target fish species were identified, our efforts focused on determining their distribution within the Williamson River subbasin. Our efforts also focused on determining the periodicity and distribution for each fish species.

172. Please explain what "periodicity" and "distribution" means.

As mentioned in Section IV, the periodicity of a fish species describes the specific biological functions that are occurring at a given time. In other words, a fish's life can be partitioned into phases or periods, which fish biologists call "lifestages." These include the spawning lifestage (i.e., reproduction/conception), the incubation/hatching lifestage (i.e., birth), the fry lifestage (baby), and the juvenile (inclusive of youth to juvenile) and adult lifestages. Thus, for example, the periodicity of redband trout involves five lifestages (spawning, egg incubation, fry, juvenile, and adult) each occurring at a specific time of the year.

Since Physical Habitat Claims were made for many different segments and tributaries of the Williamson River, we needed to know the species distribution (i.e., the target fish species found within each claim reach), and the periodicity of each species, (i.e., the specific lifestages occurring in specific geographic areas in each month of the year). In the case of Chinook, we needed to know its potential distribution and periodicity within the basin.

173. Please explain how you determined the distribution of the target fish species within the Williamson River subbasin.

Distribution of the species was determined with information gathered through a number of sources: the compilation and review of available published and unpublished information; personal contacts with local fish biologists from the U.S. Forest Service (Dick Ford), U.S. Bureau of Reclamation (Mark Buettner), U.S. Geological Survey (Rip Shiveley), Oregon Department of Fish and Wildlife (Roger Smith and William Tinniswood), and the Klamath Tribes (Craig Bienz and Larry Dunsmoor); and direct observations and technical studies we performed in the subbasin.

174. What do you mean by published and unpublished information?

Published information is information that typically has gone through a peer review process and then is formally published or presented through a number of avenues: scientific journals, books, graduate thesis and dissertations, and peer reviewed proceedings of scientific symposia. Published information relied upon to determine the distribution of target species within the Williamson River subbasin included, but was not limited to, Moyle (2002), Wydoski and Whitney (2003), and Nehlsen et al. (1991). Types of unpublished information include technical reports, technical memorandum, data summaries, technical presentation materials, and other information. Unpublished information related to the distribution of target fish species within the Williamson River subbasin included, but were not limited to, the reports of Buettner and Scoppettone (1990), Bienz and Ziller (1987) (Ex. 277-US-413), and David Evans and Associates (2005a).

175. You stated that you conducted technical studies in the basin for defining the distribution of fish species in the basin. Please describe those studies.

We completed several field sampling efforts to document species occurrence and composition within different sites. These included a 1993 effort that involved electro-fishing 11 sites in the Williamson River subbasin (4 sites on the mainstem river and 7 sites on river tributaries). Additional field surveys were completed in 1998, 2003, 2006, and 2007 within a variety of the claim reaches in the Upper Klamath Basin. These were part of the field efforts focused on collecting site specific habitat utilization which I describe further below. However, they also served to document species presence within the areas surveyed. A listing of fish species we observed in the Williamson River subbasin as part of these field efforts as well as species documented from other information sources is found in Table VII-3.

Table VII-3. Fish species found in the Williamson River subbasin (* signifies historical presence).

Fish Species	Common Name	References
SALMONIDAE	TROUTS	
Oncorhynchus mykiss newberrii	rainbow trout / redband trout	USFS 1998; DEA 2000, 2005.
Oncorhynchus tshawytscha	Chinook salmon*	Hamilton et al. 2005
Salmo trutta	brown trout	USFS 1998; DEA 2005a.
Salvelinus confluentus	bull trout*	Buchanan et al. 1997; USFWS 2005
Salvelinus fontinalis	brook trout	USFS 1998; DEA 2005a.
CYPRINIDAE	CARPS AND MINNOWS	
Gila bicolor	tui chub	DEA 2000, 2005a.
Gila coerulea	blue chub	DEA 2000, 2005a.
Pimephales promelas	fathead minnow	DEA 2005a.
Rhinichthys osculus	speckled dace	DEA 2000, 2005a.
PETROMYZONTIDAE	LAMPREYS	
Lampetra lethophaga	Pit-Klamath brook lamprey	DEA 2000; Lorion et al. 2000; Kostow 2002.
Lampetra minima	Miller Lake lamprey	Lorion et al. 2000; Kostow 2002; DEA 2005a, ODFW 2005b.
Lampetra similis	Klamath River lamprey	DEA 2000; Lorion et al. 2000
COTTIDAE	SCULPINS	
Cottus klamathensis	marbled sculpin	DEA 2000
Cottus princeps	Klamath Lake sculpin	DEA 2000
Cottus tenuis	slender sculpin	DEA 2000, 2005b.
ICTALURIDAE	BULLHEAD CATFISHES	
Ameiurus nebulosus	brown bullhead	DEA 2005a.
CATOSTOMIDAE	SUCKERS	
Castostomus snyderi	Klamath largescale sucker	DEA 2000, 2005a, 2005b.
Chasmistes brevirostris	shortnose sucker	USFWS 1994; White et al. 1995; DEA 2000, 2005b; NRC 2004; USFWS 2007b.
Deltistes luxatus	Lost River sucker	USFWS 1994; White et al. 1995; DEA 2000, 2005b; NRC 2004; USFWS 2007a.

176. Were you able to establish a distribution of target fish species throughout the Williamson River subbasin?

With the information I just described, we went through each of the streams in the Upper Klamath Basin and systematically assigned a presence or absence of each of the target fish species. In the end, we were able to integrate these data into a GIS format and create fish species distribution maps for each of the streams in the Williamson River subbasin. These maps and accompanying data were used in assigning the appropriate target fish species to a given claim reach. Figures VII-5a through 5e are the fish distribution maps developed for the Williamson River subbasin.

177. Since Chinook salmon are not currently present in the Williamson River subbasin, how did you assign its distribution in the basin?

For Chinook, we reviewed the published and unpublished information that described its historical distribution in the Upper Klamath Basin. The reports of Hamilton et al. (2005), Fortune et al. (1966), and Nehlsen et al. (1991), and Dr. Hart Direct Testimony (see questions 19 through 47 and 49 through 54) were especially useful. With historical information, we could reasonably evaluate each of the streams of the subbasin to determine whether a specific claim reach would provide Chinook salmon habitat. Figures VII-5e is the Chinook distribution map for the Williamson River subbasin.

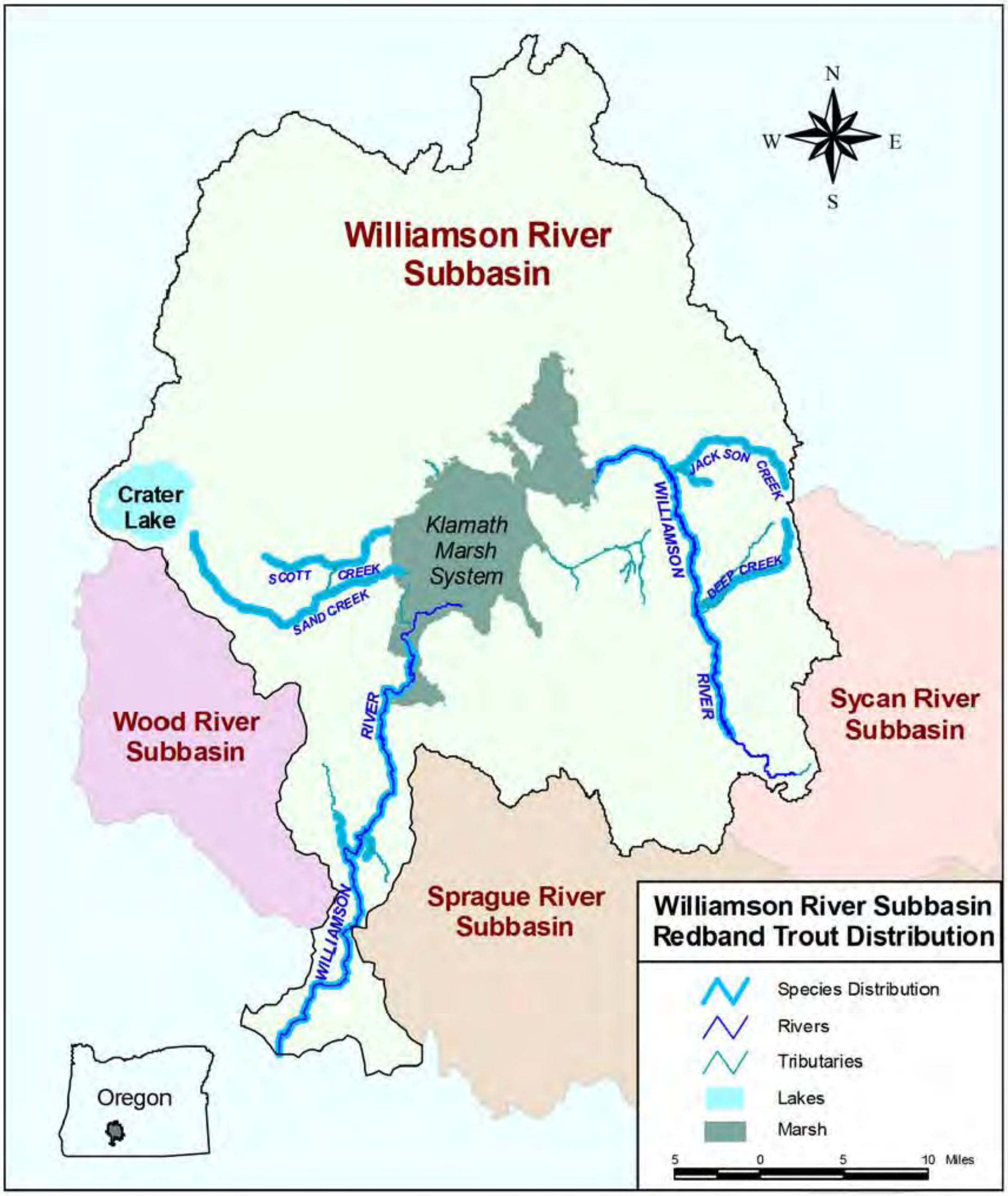


Figure VII-5a. Redband trout distribution in the Williamson River subbasin.

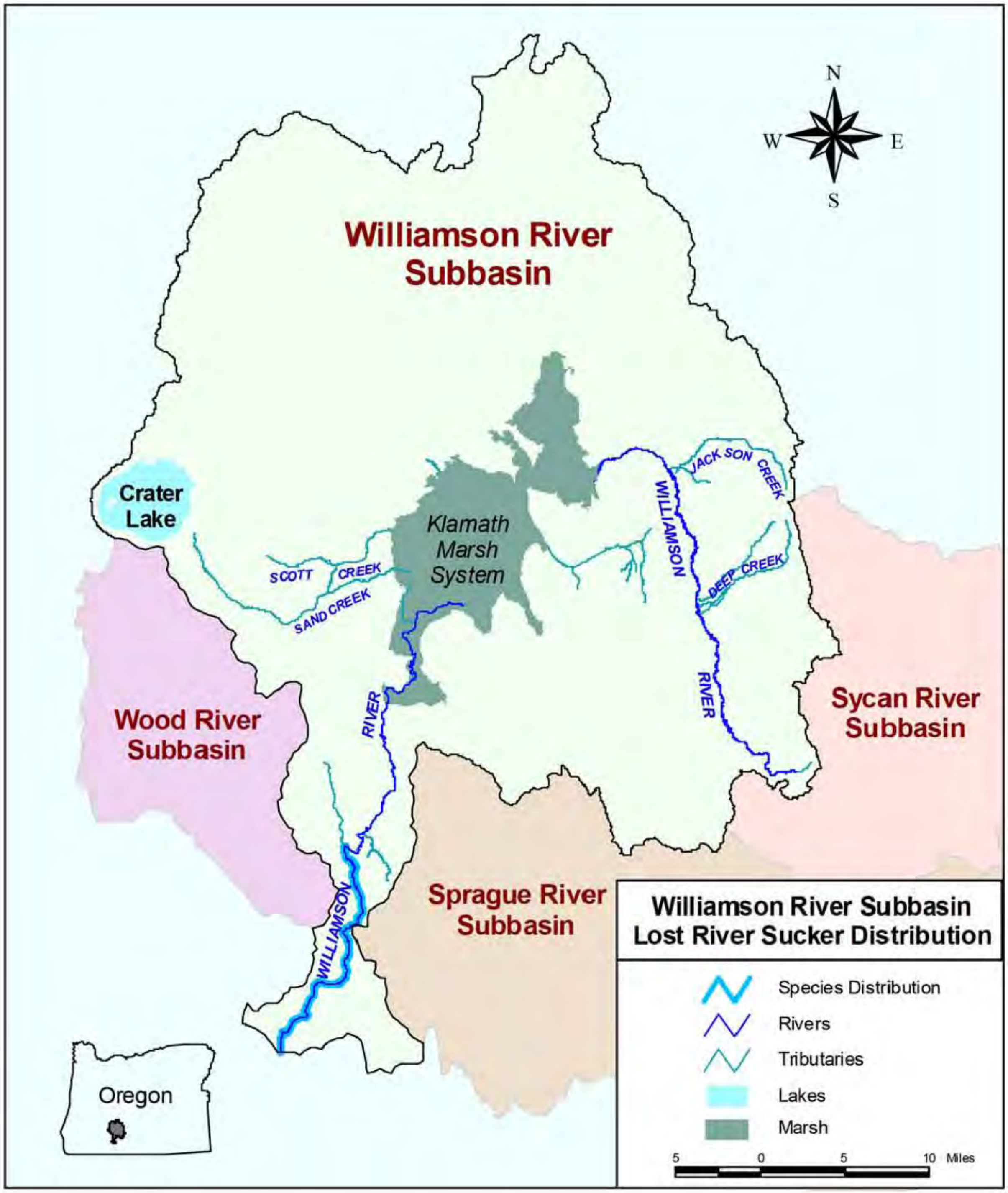


Figure VII-5b. Lost River sucker distribution in the Williamson River subbasin.

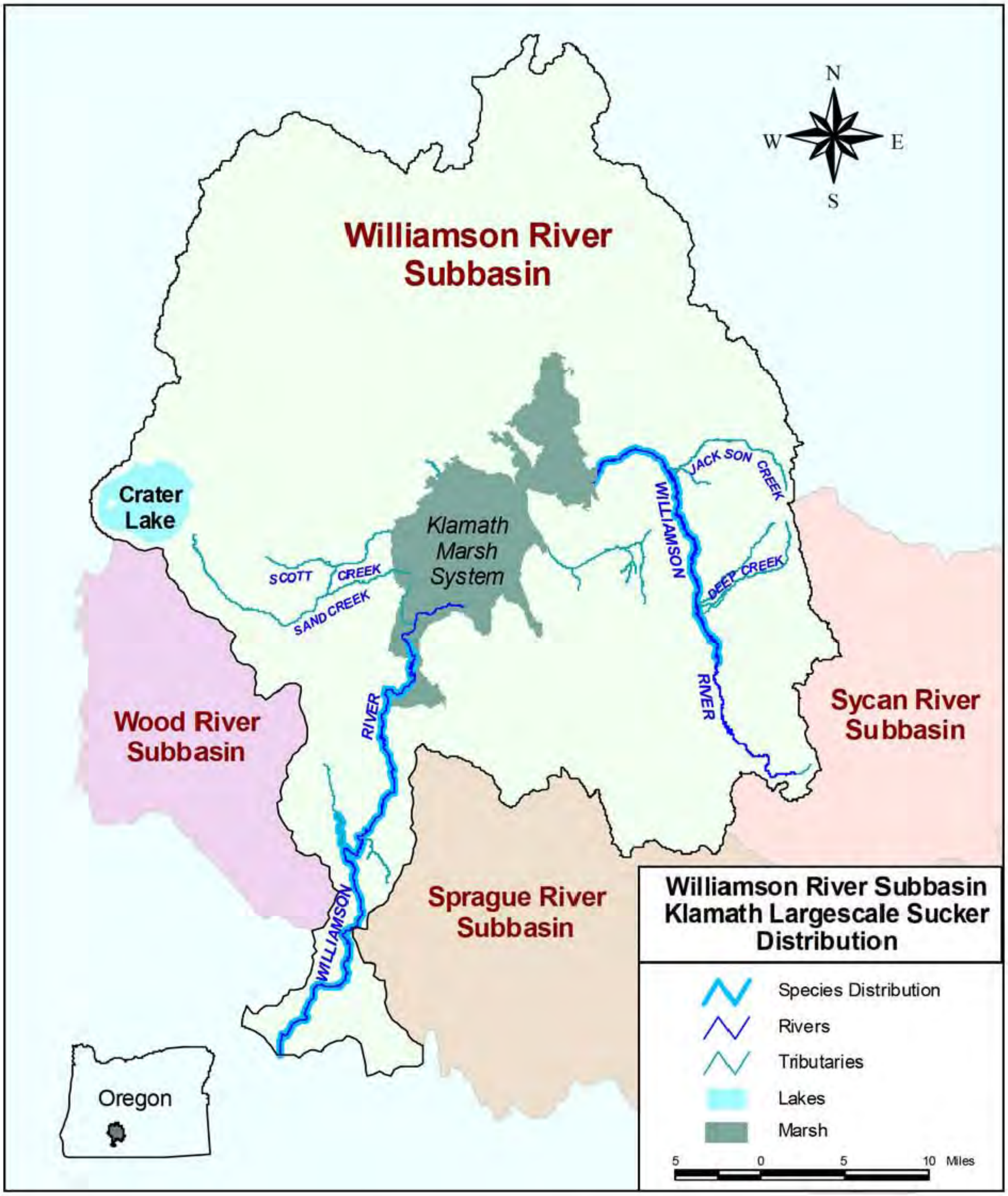


Figure VII-5c. Klamath largescale sucker distribution in the Williamson River subbasin.

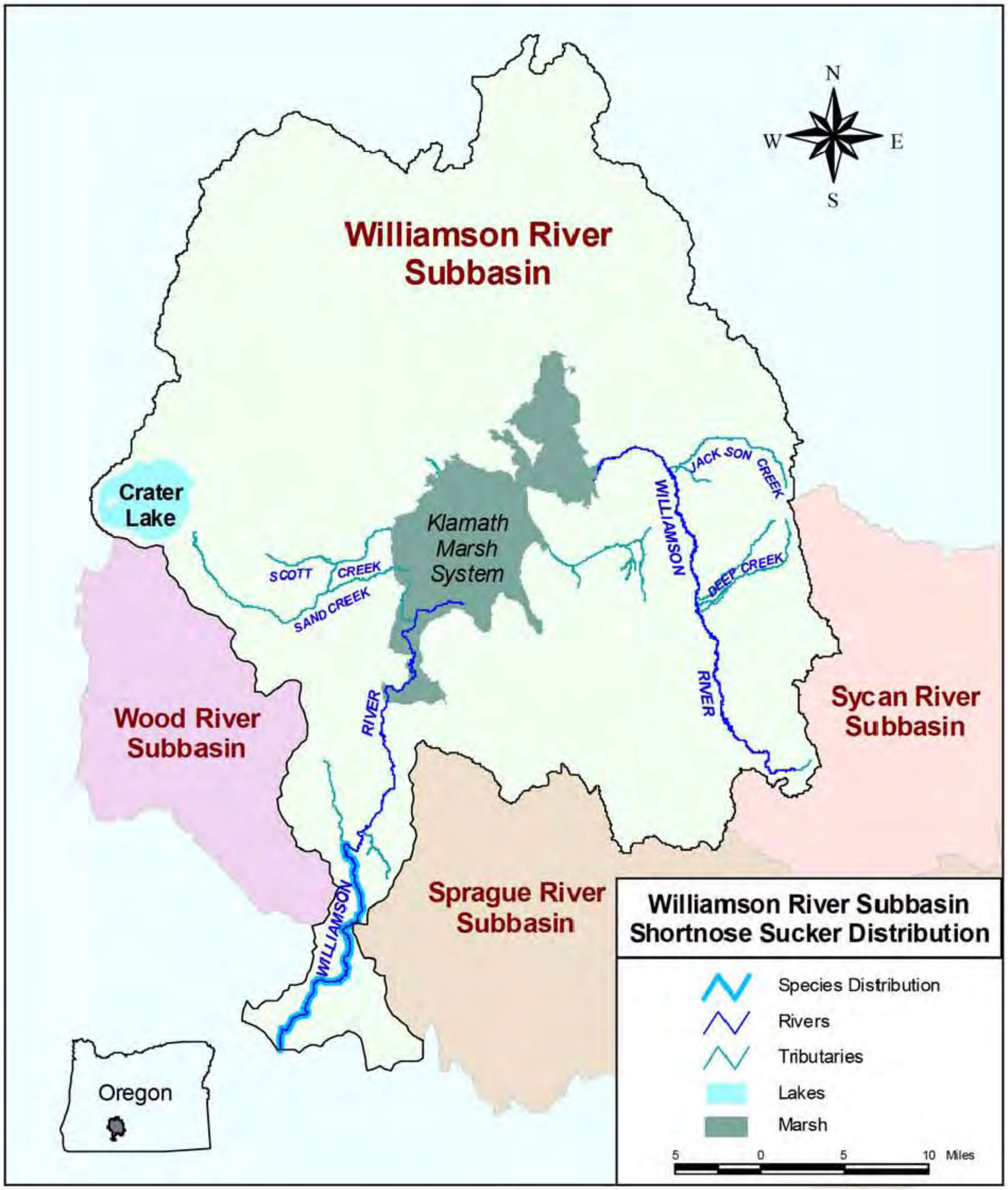


Figure VII-5d. Shortnose sucker distribution in the Williamson River subbasin.

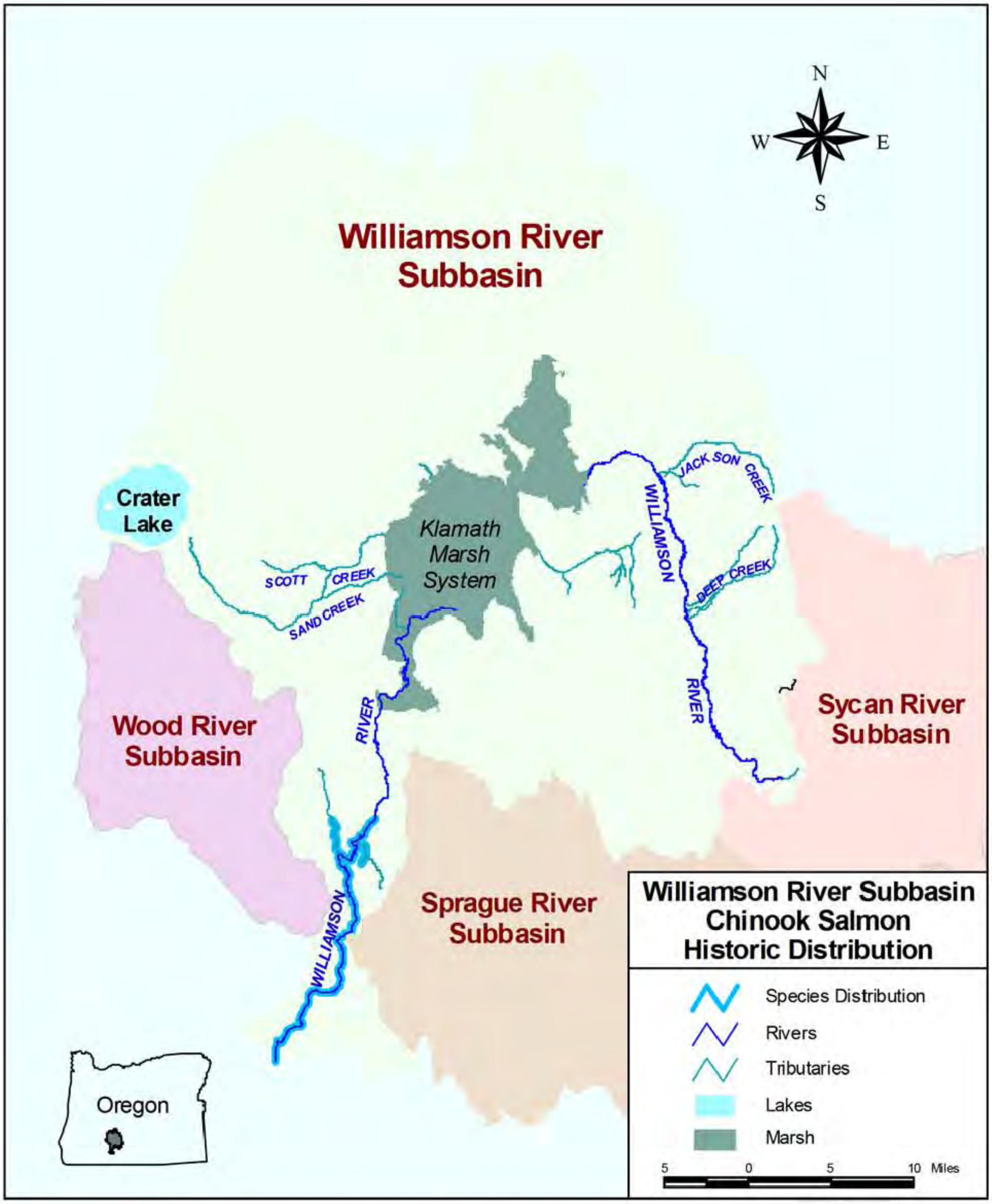


Figure VII-5e. Historic and anticipated Chinook salmon distribution in the Williamson River subbasin.

178. Does only one of these lifestages occur in a species at any given time?

No. Often, for a given location in a stream in a given month, some or all lifestages are occurring simultaneously for the same species. For example, oftentimes you will find both the juvenile and adult lifestages of a species within the same segment of stream. Across species, different lifestages can likewise occur in a given location in a stream in a given month.

179. Why was it important to determine the lifestage periodicities of the different species?

The monthly lifestage periodicities of the target fish species factor into the derivation of the monthly Physical Habitat Claims. The flow recommended for a given month relates to a specific species and a specific lifestage occurrence during that time. That is, different lifestages for different species have different flow needs. Therefore, it was important to determine the lifestage(s) of each species for each month.

180. How did you identify the monthly lifestage periodicities for each of the target fish species within the Williamson River subbasin?

Like determining the species distributions, the lifestage periodicities for the Williamson River subbasin were determined based on a review of available published and unpublished information, and information gathered through contacts made with local fish biologists from the U.S. Forest Service, USBOR, USFWS, ODFW, and the Klamath Tribes. We relied heavily on periodicity information provided by ODFW, in particular, a series of periodicity tables prepared by Smith et al. 2003 (ODFW) (Ex. 277-US-410) and Messmer et al. (2000) (ODFW) (Ex. 277-US-411) that depicted species lifestage utilization for all of the major streams in the Upper

Klamath Basin, including the Williamson River subbasin. Using the combined information, we were able to construct lifestage periodicity charts that display the target fish species and the lifestage functions that occur during any month. This was first done for the entire Upper Klamath Basin and then refinements made to account for river subbasin specific differences. The lifestage periodicity chart for the entire Williamson River subbasin is depicted in Figure VII-6.

181. Does the lifestage periodicity chart reflect the lifestage periodicities for the target fish species for each stream in the Williamson River subbasin?

Yes. The chart is organized by species and includes separate periodicities for each species. For redband trout, three separate periodicities are depicted that reflect certain stream-specific variations in the timing of different lifestage functions. Importantly, throughout our study of the Upper Klamath Basin, species distribution and periodicities were re-evaluated on an ongoing basis so that the most current information available was used as the basis for the Physical Habitat Claims. This resulted in some changes to the species periodicities that formed the basis for the 1997 and 1999 Physical Habitat Claims that are reflected in the Updated Physical Habitat Claims presented here through my testimony.

182. Can you give an example of this stream-specific variation experienced?

Yes. A good example of such stream-specific variation is Spring Creek (Claim 640) which supports populations of adfluvial redband trout. These populations have taken advantage of the constant flow and stable temperature regime afforded by this spring-dominated system and extended its spawning period to all months except September.

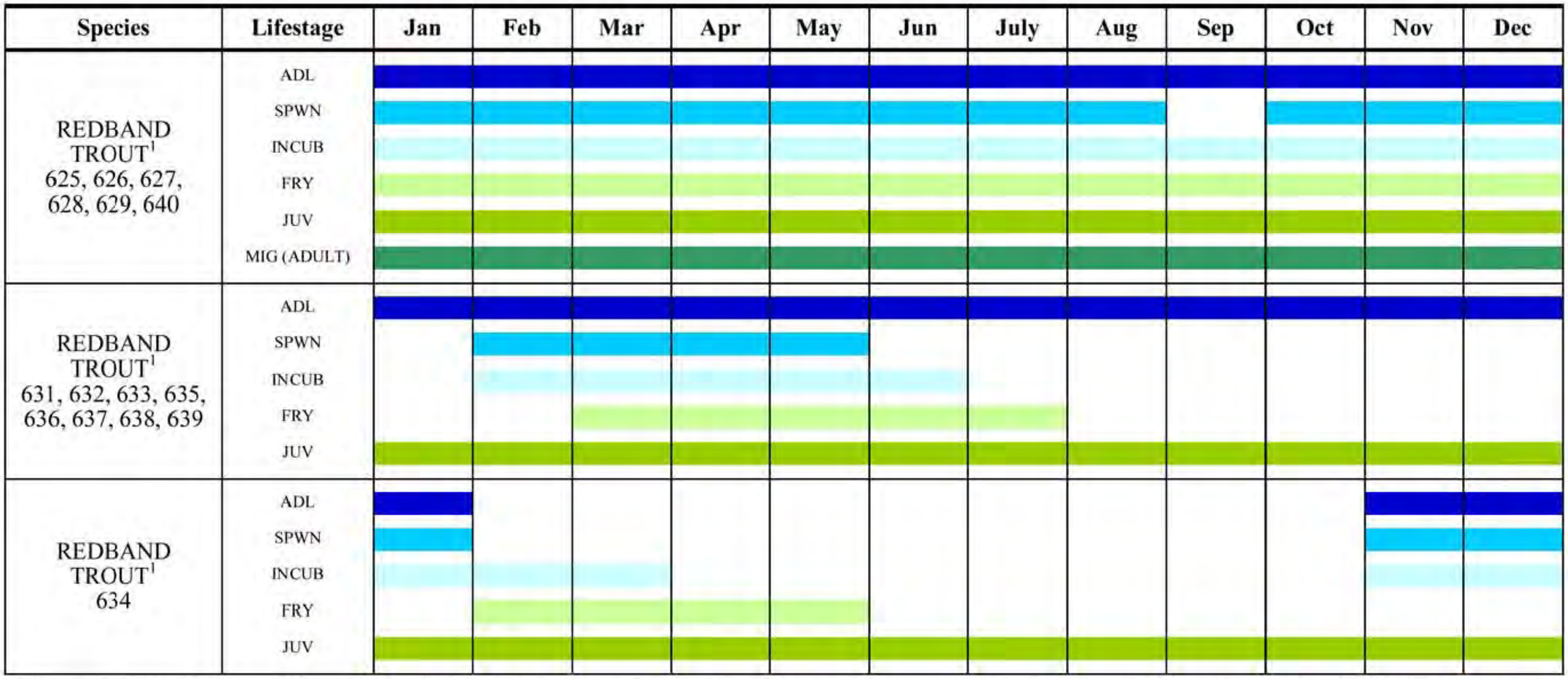


Figure VII-6. General life stage periodicity for target fish species, Upper Klamath Basin, Oregon–Williamson River subbasin (sources of information and references are listed at the end of the figure).

[1]Includes both resident and adfluvial populations

*Historically present

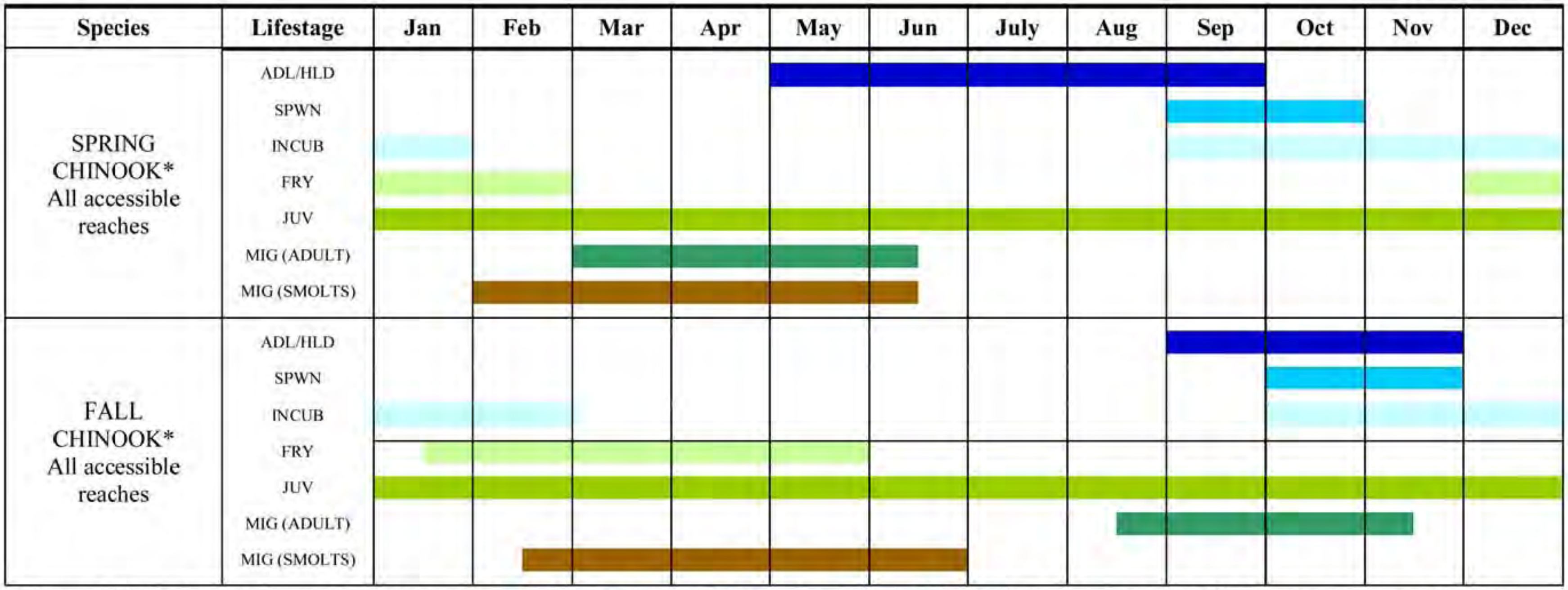


Figure VII-6. (cont) General life stage periodicity for target fish species, Upper Klamath Basin, Oregon–Williamson River subbasin (sources of information and references are listed at the end of the figure).

[1]Includes both resident and adfluvial populations

*Historically present

Figure VII-6. (cont) General life stage periodicity for target fish species, Upper Klamath Basin, Oregon–Williamson River subbasin (sources of information and references are listed at the end of the figure).

[1]Includes both resident and adfluvial populations

*Historically present

Sources of information and references used to construct species periodicities:

Ellsworth et al. 2007 (Ex. 277-US-414); Ellsworth et al. 2009; FishPro 2000; Hamilton et al. 2005; Hooton and Smith 2008; Huntington et al. 2006; Messmer et al. 2000 (Ex. 277-US-411); NRC 2004; Smith et al. 2003 (Ex. 277-US-410); and Tyler et al. 2007 (Ex. 277-US-415).

183. Please describe Step 4 of the nine-step process – Determining the Lifestage and Species Prioritization.

Once the target fish species, distributions, and lifestage periodicities were established, we needed to determine how this information would be used in developing the Physical Habitat Claims. For any given reach of stream, there could potentially be up to five (under current conditions), or six (with future reintroduction of Chinook salmon) target fish species present. For any given month, multiple lifestages might exist for each species within the same reach. Step 4, therefore, focused on developing a prioritization framework from which to identify the appropriate lifestage and species that would be primarily considered for deriving each of the Physical Habitat Claims for any given month. This step required an understanding of the life history requirements and the biological needs of the target fish species.

184. Do flow needs change for a fish species by lifestage?

Studies have shown that the flow needs of fish vary by lifestage. Fry, for example, cannot withstand as high a velocity of water as can juvenile or adult fish and seek slower waters. Therefore, the amount of flow needed to provide fry habitat in a stream is typically less than that needed for juvenile and adult habitat. For spawning habitat, the amount of flow needed depends in large part on the location and amount of spawning gravel, and the amount of flow required to provide suitable water depths and velocities over such gravels. This may require different flows than those for either juvenile or the adult lifestages.

185. Why was lifestage important to consider?

Species prioritization alone does not lead to derivation of a specific monthly flow that provides for healthy and productive fish habitats. If we only based the claim on the highest priority species, which for some basins would be redband trout, need would still exist to determine which lifestage should form the basis for the claim since multiple lifestages of various sub-species of redband occur during most months (see Figure VII-3). In addition, because the claim was to provide for the flow needs of all of the target fish species, consideration had to be given to the lifestages of other target fish species. This required a prioritization of the lifestages based on their biological importance in maintaining the population viability of the target fish species. Therefore, by considering the lifestages most important to maintaining a healthy and productive fish population, we prioritized the lifestages of fish. In turn, flow conditions tied to specific lifestages were established.

We reviewed habitat mechanisms likely influencing the populations of the target fish species. This resulted in the ranking of the lifestages from highest (most important) to lowest as follows: Spawning (first priority); Adult (second priority); Juvenile (third priority); and Fry (fourth priority). The process of prioritizing lifestages is commonly done as part of instream flow studies, and was the case for the two studies noted above, Clackamas River in Oregon (FERC 2006), and Sultan River in Washington (Reiser et al. 2009). Indeed, those two studies generally resulted in the same lifestage hierarchy as noted above. Afterwards, we identified and ranked those flow conditions that impacted lifestages and that could be quantified and analyzed as part of the IFIM/PHABSIM method.

186. Please explain the rationale for the ranking of lifestages.

The rationale for the hierarchy just noted pertains to the biological importance of the four lifestages with respect to flow needs. **Spawning** represents the reproductive component of a fish population and pertains to the future propagation of the various target fish species. Thus, we determined that the spawning lifestage should be given highest priority. As noted above, the amount of flow needed for this lifestage depends in large part on the flow required to provide suitable water depths and velocities over spawning gravels.

The **Adult** lifestage, ranked second, represents the factories or engines that produce the offspring needed to sustain a given population. Although the fish during this lifestage are not spawning, after they spawn they must continue to feed and grow in the meantime. Therefore, flows sufficient to create suitable adult habitat are needed to provide for healthy and productive fish habitats.

The **Juvenile** lifestage, ranked third, occurs between the fry and adult lifestages and encompasses the time when the fish is actively developing to when it reaches sexual maturity. The provision of flows that create habitats of sufficient quantity and quality must be maintained to promote growth and survival of juvenile fish.

The **Fry** lifestage, ranked fourth, occurs between egg emergence and the point at which they become juveniles. Because fry seek shelter in areas with low velocity and that contain abundant cover from which to avoid predators, fry habitat needs are generally met with flows much lower than those for the other lifestages. Fry habitat is generally not limiting in fish populations and, therefore, this lifestage was assigned the lowest priority. I observed no months in which the fry lifestage was the only lifestage present. Thus, the fry lifestage did not become a priority lifestage and no flow claims were based on the fry lifestage.

187. Were there any other lifestages considered as part of this prioritization?

Yes. We also considered the period of **Egg Incubation**. This period occurs immediately after spawning and extends through emergence of fry from the gravels. Egg incubation was considered to ensure that the flow conditions after spawning would remain suitable throughout the period of egg incubation.

188. As to the Physical Habitat Claims for target fish species currently present in the Upper Klamath Basin, were any species of primary importance?

All six of the target fish species are important for the Physical Habitat Claims, but in order to develop the updated Physical Habitat Claims, a species hierarchy was employed based on the cultural, ceremonial, and management values of the Klamath Tribes, as well as state and federal recovery and management goals. Assuming the species was present in a given claim reach, this hierarchy prioritized the species as follows: redband trout (first priority); Lost River sucker (second priority); shortnose sucker (third priority); Klamath largescale sucker (fourth priority), and bull trout (fifth priority). Chinook salmon, the sixth target species was given special consideration in that upon its reintroduction it would be given first priority. Because Chinook salmon is not currently present in the Williamson River subbasin, the Physical Habitat Claims focused primarily on the next two priority species, redband trout and Lost River suckers. As mentioned above and as will be further described in Sections VIII and IX, because Chinook salmon was historically present in the Williamson River subbasin and is likely to be re-introduced, conditional Physical Habitat Claims were also developed for those claim reaches that Chinook salmon historically utilized or it is reasonable to believe that they will utilize upon reintroduction into the Upper Klamath Basin.

189. As to the selection of target fish species, does this mean that the other species are not important or were not considered in developing the Physical Habitat Claims?

No. Although the focus on the claims may have been on certain species, development of the claims considered the species known to be present or historically present and with a likelihood of return to the basin in the foreseeable future (e.g., Chinook salmon). It would be impractical and unnecessary to perform an analysis of every fish species present in the Upper Klamath Basin. It has been my experience that instream flow studies routinely focus on the needs of several fish species considered as target species, rather than on every fish species present in a given river system. As described above, OWRD Ex. 2, pp. 4 through 5 is a complete list of fish species known to exist or have existed in the Upper Klamath Basin.

190. Please describe how the species and lifestage priorities were used in developing a decision framework to derive the Physical Habitat Claims.

The decision framework involved consideration of both lifestage prioritization and species prioritization. The decision process for each month proceeded as follows: first, the months were identified in which spawning (highest priority lifestage) occurs for all of the target fish species present within the reach. The flow claims for those months were thus based on the spawning lifestages of the respective target fish species. Spawning overlap between two or more target fish species resulted in a Physical Habitat Claim based on the higher priority species. Thus, species prioritization was a secondary consideration implicated only if there was overlap for a given priority lifestage by more than one species.

Second, for months in which spawning does not occur, the months were identified in which adults were present. The flow claims for those months were based on the adult lifestage of the respective target fish species. Again, for any overlap for a given month between species, the flow claim was based on the higher priority species.

Third, for any months in which neither spawning nor adult lifestages occur, the months were identified in which the juvenile lifestage occurred. The flow claims for those months were based on the juvenile lifestage of the respective target fish species, with any overlap being dictated by the highest priority species.

191. Did the fry lifestage factor into the decision process?

As I described, the fry lifestage was a fourth priority lifestage. I observed no months in which the fry lifestage was the only lifestage present. Thus, the fry lifestage did not become a priority lifestage and no flow claims were based on the fry lifestage.

192. What level of protection did you assign to the incubation flows?

Incubation flows were developed for each stream in which spawning occurred and correspond to 2/3 of the previous month's spawning flow (Thompson 1972). The 2/3 fraction of flow provides flow conditions conducive to egg incubation such as maintaining sufficient water depth, oxygen content, and velocity (Thompson 1972).

193. How did the incubation lifestage factor into this decision framework?

As I described above, sufficient stream flow associated with protecting eggs and providing for their development during incubation must be provided to ensure a healthy and productive habitat. Therefore, egg incubation operated as a "shadow" lifestage to the spawning lifestages, and was considered in months immediately following a spawning month. Egg incubation became flow-determinative when the flow for the priority lifestage in that post-spawning month was less than that for the incubation flow.

Take for example, the hypothetical instance in which the flow for a given month might be based on Lost River sucker spawning. In the next post-spawning month, the priority lifestage and species might be the adult redband trout. If the necessary physical habitat flow for the redband trout adult in that second month were less than what would be required for Lost River sucker egg incubation (2/3 of Lost River sucker spawning flow), then for that second month, the flow claim would need to be based on the incubation needs of Lost River sucker eggs. Similarly, if the adult redband flow exceeded the Lost River sucker egg incubation flow, no change would be needed and the claim would be based on the flow needs of the adult redband trout.

194. Have you applied this lifestage and species prioritization on any other projects?

Yes. As noted above, this procedure has been used on several other recent instream flow projects (e.g., Clackamas River, Oregon; Sultan River, Washington) that were related to the relicensing of hydroelectric facilities. The prioritization process was used to establish the Physical Habitat Claims filed in 1997 and 1999, and ultimately the updated claims presented here through my testimony.

195. Did you check on whether the flow claims you derived from this process were impacting other lifestages and species?

Yes. As part of the Physical Habitat Claim development process, we incorporated an evaluation procedure to ensure that a Physical Habitat Claim would not act to the significant detriment of another species' lifestage. For example, if the Physical Habitat Claim for one month was based on redband trout spawning, and other lifestages of target fish species were also present in that system at the same time, we reviewed the claim with respect to the habitat:flow relationships for the other lifestages and species to ensure that the flow would still provide suitable amounts of habitat for them. The specific details of this procedure are presented in Section VIII.

196. Please describe Step 5 of the process-Development of Species Habitat Suitability Criteria (HSC) Curves.

In Step 5, we developed species-specific habitat suitability criteria curves (HSC curves). HSC curves are a necessary component of the IFIM/PHABSIM modeling process that must be identified and/or developed to ultimately generate the necessary habitat:flow relationships. In fact, this step and the next two (Steps 6 and 7) all relate directly to data, information and modeling that all contribute to the computer modeling associated with PHABSIM.

197. What are Habitat Suitability Criteria (HSC) Curves and why are they important?

This is best answered by first discussing briefly one of the end products of the IFIM/PHABSIM analysis. The end product of the IFIM/PHABSIM analysis is a habitat:flow relationship curve that plots the amount of habitat in a stream (Y-Axis expresses as weighted useable area ("WUA")) against possible stream flows (X-Axis expressed in cubic feet per second). Figure VII-3 (presented earlier in this section) provides an example of four typical habitat:flow relationship curves overlaid onto each other. WUA is the amount of square feet of habitat across a cross section of a stream per 1,000 linear feet of stream.

Based on field data, we calculated and used these relationships to guide the selection of the Physical Habitat Claims. The important point here is that different relationships exist for each target fish species and each lifestage. Figure VII-3 depicts specific habitat:flow relationships for each redband trout lifestage – adult, juvenile, fry, and spawning in claim Reach 626. The HSC curves were used in the computer modeling process to generate habitat:flow relationship curves.

198. Why are there different relationships for each species and lifestage?

Each species and lifestage combination has unique requirements or tolerances for velocity, depth, and substrate combinations in a stream. For example, as noted above, fry prefer slow velocities, while juveniles and adults may select higher velocities in combination with certain depths. The spawning lifestage depends on ranges of velocities in conjunction with suitable water depths and substrates. These different requirements or tolerances for velocity, depth, and substrate combinations, when integrated into the IFIM/PHABSIM process result in different habitat:flow relationships.

199. How are these different requirements represented and integrated into the IFIM/PHABSIM analysis?

That is where the HSC curves come in. In essence, the HSC curves are probability functions that depict the velocity, depth, and substrate preferences of fish for each species-lifestage combination. In other words, HSC curves represent how suitable a particular water velocity, water depth, and substrate type in a stream is to a target fish species during a specific lifestage. The HSC curves contain numerical values that reflect these probabilities. These probabilities are then linked with the PHABSIM computer models resulting in the derivation of the habitat:flow relationships found in the WUA graphs that show the amounts of habitat at various flows for each target fish species and lifestage.

200. What do HSC curves look like?

Figure VII-7 is an example of two HSC curves used for target fish species (velocity and depth curves overlaid on top of each other and displayed in a single figure). The curves represent the suitability of water velocities and water depths for redband trout spawning. As shown, the HSC values range from 0 (unsuitable) to 1.0 (optimal or preferred) with probability on the Y-axis and units of measurement (depth or velocity) on the X-axis. HSC curves of similar form were developed and used for each lifestage of each target fish species. Once developed, HSC curves could be used for a species or lifestage in any stream/river in the Upper Klamath Basin.

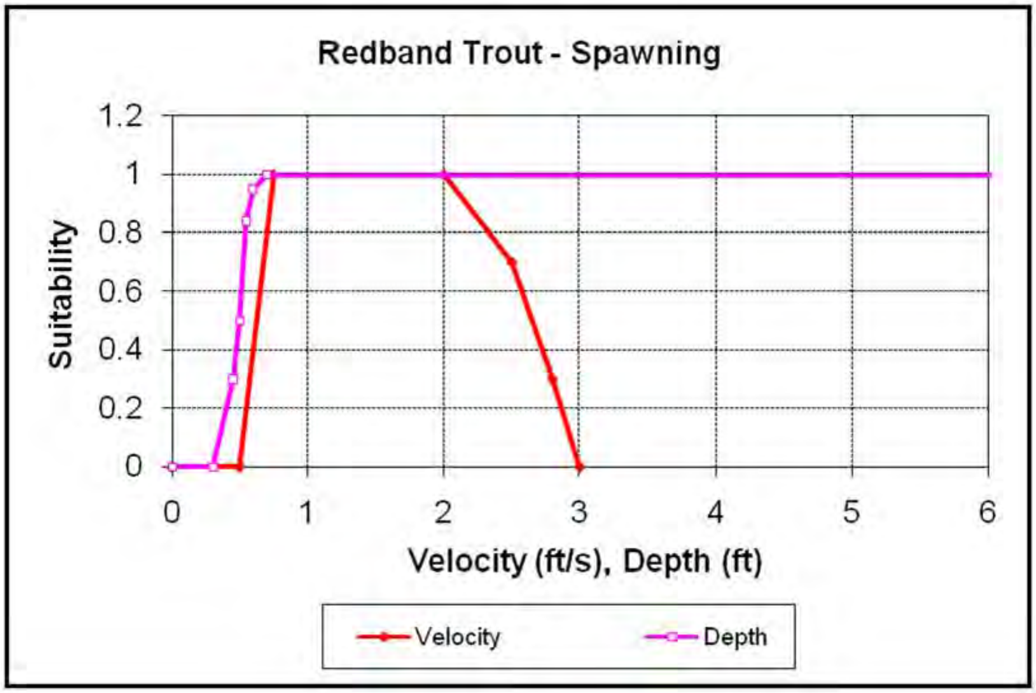


Figure VII-7. Habitat suitability criteria (HSC) curves for redband trout spawning. Here, the depth HSC curve is presented together with the velocity HSC curve.

201. Is there a standard approach or methodology for developing HSC curves that is generally followed by IFIM/PHABSIM practitioners?

Yes. HSC curves are developed based on factors that are project-specific including the availability of existing data, the feasibility of collecting new data, and the time available.

Several avenues can be followed for deriving HSC curves. The U.S. Geological Survey (USGS)[1] classifies HSC curves into three categories (Categories 1, 2, and 3) based on the types of data used (Bovee 1986). Category 1 curves are derived from personal experience and professional opinion, from literature based curve sets, or from negotiated definitions. Category 2 curves are based on frequency distributions of site-specific data that reflect microhabitat attributes measured at locations used by the target fish species. Category 3 curves also rely on site-specific data and are designed to factor in the availability of certain habitat attributes into the curves thereby reducing bias. A more detailed description of these curve types and procedures for HSC criteria development is available from the USGS website: (http://www.fort.usgs.gov/products/Publications/15000/chapter3.html#categories).

202. Did you use any of the three USGS categories to develop the HSC curves for the Upper Klamath Basin?

Yes. In fact, we used a combination of approaches including the compilation and review of literature-based HSC curves applied in other studies, round table discussions with regional and local experts, and the collection of site-specific data.

203. Please explain briefly what was done in your HSC curve process.

For the Upper Klamath Basin, we compiled and reviewed more than 100 HSC curve sets that had been developed and used on other investigations. These curves were organized by species and lifestage and distributed to fish experts knowledgeable in the lifestage requirements of the target fish species. Each expert was subsequently invited to a round table meeting at

[1] The U.S. Geological Survey (USGS) is the agency within which the original developers of the Instream Flow Incremental Methodology (IFIM) and PHABSIM reside. The USGS is responsible for the dissemination and production of all technical information related to the IFIM/PHABSIM methods.

which a consensus was reached on a set of draft HSC curves for the target fish species except bull trout. For that species, a separate meeting of bull trout experts was convened, representative HSC curves reviewed, and a consensus reached on the bull trout HSC curves for use in the Upper Klamath Basin.

Since that time, we have updated the HSC curves based on site-specific microhabitat data we collected for a number of target fish species and lifestages. This primarily involved field studies that were completed during the summer and fall of 1998 and 2003 in the Upper Klamath Basin. During these studies, snorkel observations were made to observe where fish were residing and the velocity, depth, and substrate measurements were taken at these locations.

204. What do you mean by snorkel observations?

One of the ways in which fish biologists locate and observe fish is to submerge themselves in a stream with mask, snorkel, and protective outer-wear. The general process is for the snorkeler to move slowly in an upstream direction to locate a fish, mark the position of the fish, and then have a second person take depth and velocity measurements at that particular site.

205. Are there standard approaches for collecting snorkel-observation data?

Yes. We generally followed the methods and procedures as outlined by Bovee (1986).

206. Did you collect any other types of data?

Yes. We took fish depth measurements, stream velocity measurements, and when active spawning areas containing egg nests (redds) were visually located, we also took depth, velocity, and substrate measurements.

207. How many measurements of each type of observation did you make?

A tabulation of the number of observations made during 1998 and 2003 surveys is presented in Table VII-4 by species and lifestage.

Table VII-4. Summary of the number of microhabitat use observations (fry, juvenile, adult) and measurements (egg nests/redds) made during site specific surveys to confirm and/or modify literature based HSC curves for the Upper Klamath Basin, Oregon.

Species	Lifestage	Number of Observations/Measurements
Redband Trout	Fry	301
	Juvenile	145
	Adult	196
	Spawning (redds)	149
Bull trout	Juvenile	6
	Adult	18
Lost River Sucker	Adult	31

208. How were those observation data used?

These site-specific data were analyzed and used to revise and update the previously applied HSC curves to better reflect the habitat characteristics that are actually being utilized by the target fish species in the Upper Klamath Basin. In some cases, the changes to the HSC curves were small, in others, the changes were greater.

For example, Figure VII-8 below illustrates the changes made to the original HSC curves for redband spawning based on the collection of site-specific data. In general, as a result of the collection and analysis of site-specific data, there was a shift toward a lower range of velocities considered as optimum, but essentially no change in the depth suitability curve.

Figure VII-8 first shows that redband trout prefer water depths at or greater than .75 ft at which suitability reaches optimum (suitability level 1). Figure VII-8 also illustrates how with more site specific Upper Klamath Basin data, the optimum water velocity *decreased* in range from between 1.75 ft/s and 3 ft/s to .75 ft/s and 2 ft/s (comparing original and revised velocity lines).

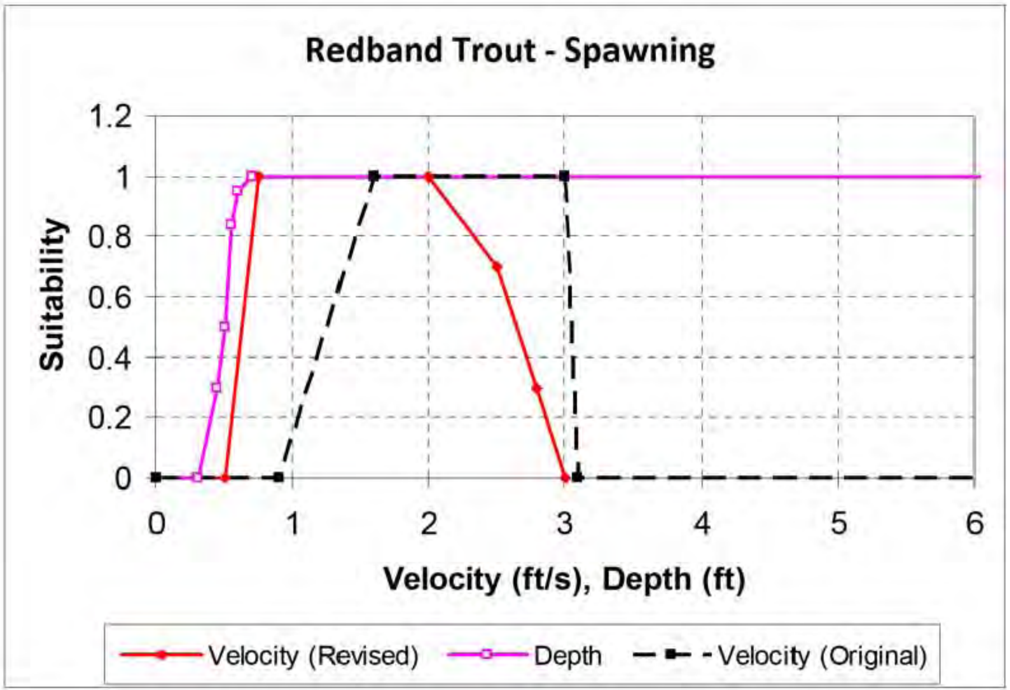


Figure VII-8. Habitat suitability criteria (HSC) curves for redband trout spawning, comparing coordinates from the HSC curve used for the 1997 and 1999 claims, with the revised HSC curve developed subsequently and used for the updated Physical Habitat Claims.

Ex. 277-US-416 contains copies of all of the final HSC curves used in deriving the Physical Habitat Claims for the Williamson River subbasin.

209. Please describe Step 6 of the process – Field Data Collection.

With all of the information described in the first five steps either assembled, in the process of being assembled, or identified as necessary to be determined, we initiated Step 6, which is the Field Data Collection component needed for the IFIM/PHABSIM process. This step was completed at different intervals over the course of the Upper Klamath Basin study. The largest IFIM/PHABSIM field data collection efforts occurred from the fall of 1990 to the summer-fall of 1991 and in the summer-fall of 1993. A number of the original sites were re-sampled in 2004, and, since then, a number of field data collection sites were added to capture unique areas (e.g., spawning riffles), to provide additional sampling within relatively long claim reaches, and most recently in 2009, to collect field data from one site (Whisky Creek Claim Reach 649, Sprague River subbasin, case #280 Klamath Basin Adjudication) for which prior access restrictions prevented field data collection.

210. Who collected the field data?

Field data were collected by EA or R2 field crews under my direction, consisting of 2-3 individuals for smaller wadeable streams, and 3-4 individuals for larger streams requiring a raft for data collection. Field crew leaders all had extensive training and experience in stream surveys and collecting IFIM/PHABSIM data and all crew members were given instructions on sampling and survey protocols.

211. What methods did you use to collect the IFIM/PHABSIM data?

We used standard methods recognized in the field for collecting IFIM/PHABSIM data. The data collection sequence implemented in the field is listed below, followed by a more detailed description. These steps generally followed the standard procedures outlined by Bovee and Milhous (1978), Trihey and Wegner (1981), Bovee (1982), and Bovee et al. (1998).

Under step 6, the general sequence for collecting IFIM-PHABSIM data involved the following steps:

Step 6.A – Locate the candidate site from the site descriptions and maps;

Step 6.B – Randomly select the starting point of the study site;

Step 6.C – Map habitat in an upstream direction (25 average channel widths);

Step 6.D – Select habitat types to be measured;

Step 6.E – Select 3 transect locations within selected habitat types;

Step 6.F – Establish and survey transects, headpins, working pins, and bench mark;

Step 6.G – Survey level loop and water surface elevations;

Step 6.H – Collect bed profile and depth and velocity measurements; and

Step 6.I – Data reduction for modeling and Quality Assurance and Quality Control

212. Please describe more specifically the IFIM-PHABSIM field data collection sequence.

Step 6.A and 6.B regarding site and starting point selections are straightforward. As described earlier, a candidate study site was selected and marked for habitat mapping on a 1:24,000 topographic map (i.e., map scale equivalent of 1 inch = 24,000 inches or 1 inch = 2000 ft). The general site location was established in the field with the actual starting point of the study site determined randomly. Each of the study sites had its own field book; the crew leader began a new field book at each site and filled-in basic information such as basin number, stream name, site location and directions, field crew members, and equipment used.

Step 6.C established sample sites (selected in Step 6.A and B) approximately 25 mean channel widths long. This was done to conservatively capture the variability of habitat types that typically become repetitive within 5 to 7 channel widths (Leopold et al. 1995). The crews began habitat mapping from the upstream end of a study reach for a length of approximately 25 bankfull-channel-widths. The necessary distance to map was determined while mapping, by periodically measuring 10 channel widths using a tape or stadia rod (survey rod that has increments of length etched on the side) in most cases.

Stream habitats can be characterized as follows: Pool, Run/Glide, Riffle, Cascade or Island (see Table VII-5). The linear stream distance of each habitat unit was measured to determine the total percentage that the habitat made up of the study reach. Where the channel was not wadeable (for example because of high spring runoff), the channel width was estimated using a measured reference point (e.g., highway bridge, trail bridge, etc).

Table VII-5. Classification of habitat types used in the Williamson River subbasin (based on Bisson et al. 1982; USFS 2001; Pleus et al. 1994).

Habitat Type	Description
Pool	Water velocity relatively low, non-turbulent. Relatively deep, with distinct longitudinal depression in streambed. Water surface gradient very low; water level determined by a distinct hydraulic control.
Run/Glide	Relatively fast but non-turbulent flow; relatively deep, but fairly uniform in depth; steeper gradient than pool, less steep than a riffle, slightly influenced by a hydraulic control.
Riffle	Water velocity relatively high. Relatively shallow; water surface gradient high, but water level not determined by distinct hydraulic controls. Considerable surface turbulence; zero depth at zero discharge.
Cascade	Water velocity high with shooting flows and considerable turbulence. Hydraulic controls closely spaced. Frequent obstructions by large substrate. Gradient steeper than for a riffle. May contain pocket water.
Island	Single or more vegetated islands creating multiple (one or more) channels with complex, variable habitats within each channel.

In Step 6.D, a single habitat unit of each type of habitat accounting for greater than 10 percent of the study reach was randomly selected for sampling. The 10 percent criterion was created based on the reasonable belief that habitat types accounting for less would have a negligible effect on the overall flow recommendation. The exception to this 10 percent criterion was made for what we considered "critical" habitats, such as small falls or cascades or limited spawning areas, for which flow changes could influence their use. These areas were sampled even though they may have represented less than 10 percent of the total study reach.

In Step 6.E (select three transects), by applying a random selection process to avoid bias, crews determined the habitat unit(s) to be measured and studied. Once identified, three transects were located within each selected habitat unit for sampling. For pool habitats, the crew also located and placed a fourth transect across the hydraulic control of the pool point in a stream that, based on channel form, likely controls the water surface elevation of the pool for some distance upstream to the next control point for hydraulic modeling purposes.

213. For the field data collection Step 6.A-C you have thus far described, please provide an illustrative example of how the field data collection steps were followed?

I will describe the field data collection steps associated with Claim Reach 626 on the Williamson River. The study site was first identified from maps and through consultation before anyone was sent to the field (Field Data Collection Step 6.A and B). Once in the field, the stream widths at the study site were measured and found to be an average of 67.5 feet wide. Thus, the study reach was determined to be 1,687.5 feet long (67.5 ft x 25 channel widths) (Field Data Collection Step 6.C). Walking upstream, two cascades, three riffles, and one glide (i.e., six habitat units) were identified within the site. The total length of the two cascade units comprised 37.9 percent of the site length, the three riffles comprised 37.8 percent and the one run/glide unit comprised the remaining 24.2 percent of the sample site length. One riffle and one cascade habitat unit was then each randomly selected for collecting depth, velocity, and substrate data across transects (Field Data Collection Step 6.D). The single run/glide unit was automatically selected for sampling. Three transects were then randomly placed across the river in each sample unit, for a total of 9 transects at that site (Field Data Collection Step 6.E).

214. Please describe Steps 6.F (Establish and Survey Transects, Headpins, Working Pins, and Bench Mark), and 6.G (Survey Level Loop and Water Surface Elevations).

Step 6.F involved the surveying of transects. Once the transect locations were identified, a benchmark (BM) pin was established for each habitat unit. Next, rebar (metal rods) headpins were installed in solid, stable bank material to mark transect locations above the high water mark. Wooden stakes were driven into the ground next to the rebar headpins on each bank (or fence post if boat and cable were used), and were used as working pins for the transect location. Further, these working pins were placed so that the transect would be perpendicular to the flow direction and where water surface elevations (WSEs) were reasonably similar on both sides of the channel. With working pins in place, survey tape was extended between and attached via clamps to the working pins to allow measurements to be made at the same locations across each transect. Figure VII-9 illustrates a cross-sectional view of a transect location for Claim 626. Figure VII-10 illustrates general transect placements used in this study over different habitat types, including those for pool habitats.

With the transects set, we moved to Step 6.G, and completed a survey level loop and water surface elevation (WSE) measurements. The survey level loop ensured accuracy of surface elevation measurements and was performed before data collection began. The survey level loop simply involved taking elevation measurements of the bench mark, headpin elevations, and fixed locations. This process checks for any changes in headpin elevations that may occur during and between survey periods. Finally, after the survey level loop was successfully completed, WSEs were surveyed following standard surveying practices.

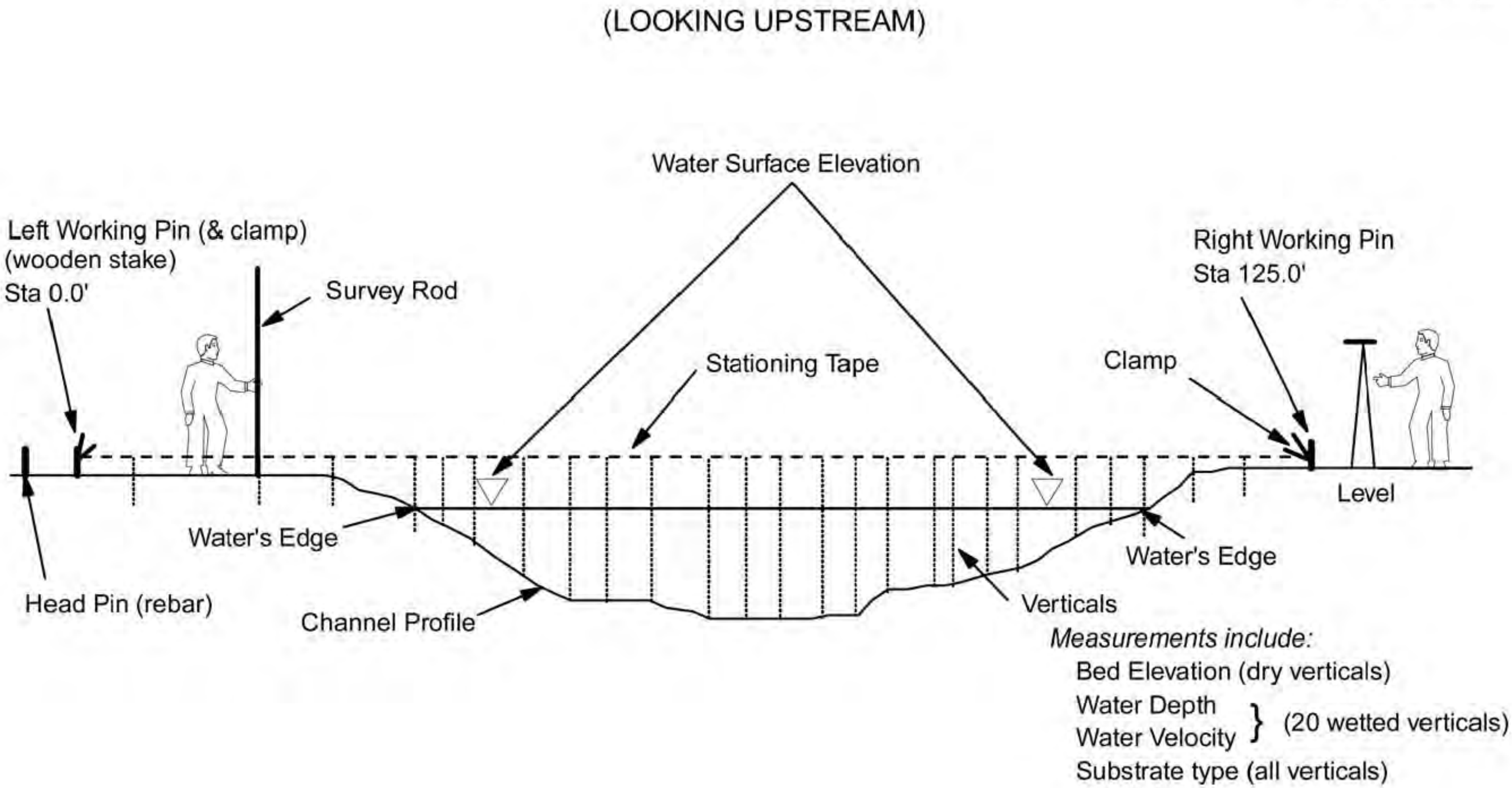


Figure VII-9. Cross-sectional illustration of IFIM/PHABSIM transect organization and measurement points during the development of the Physical Habitat Claims.

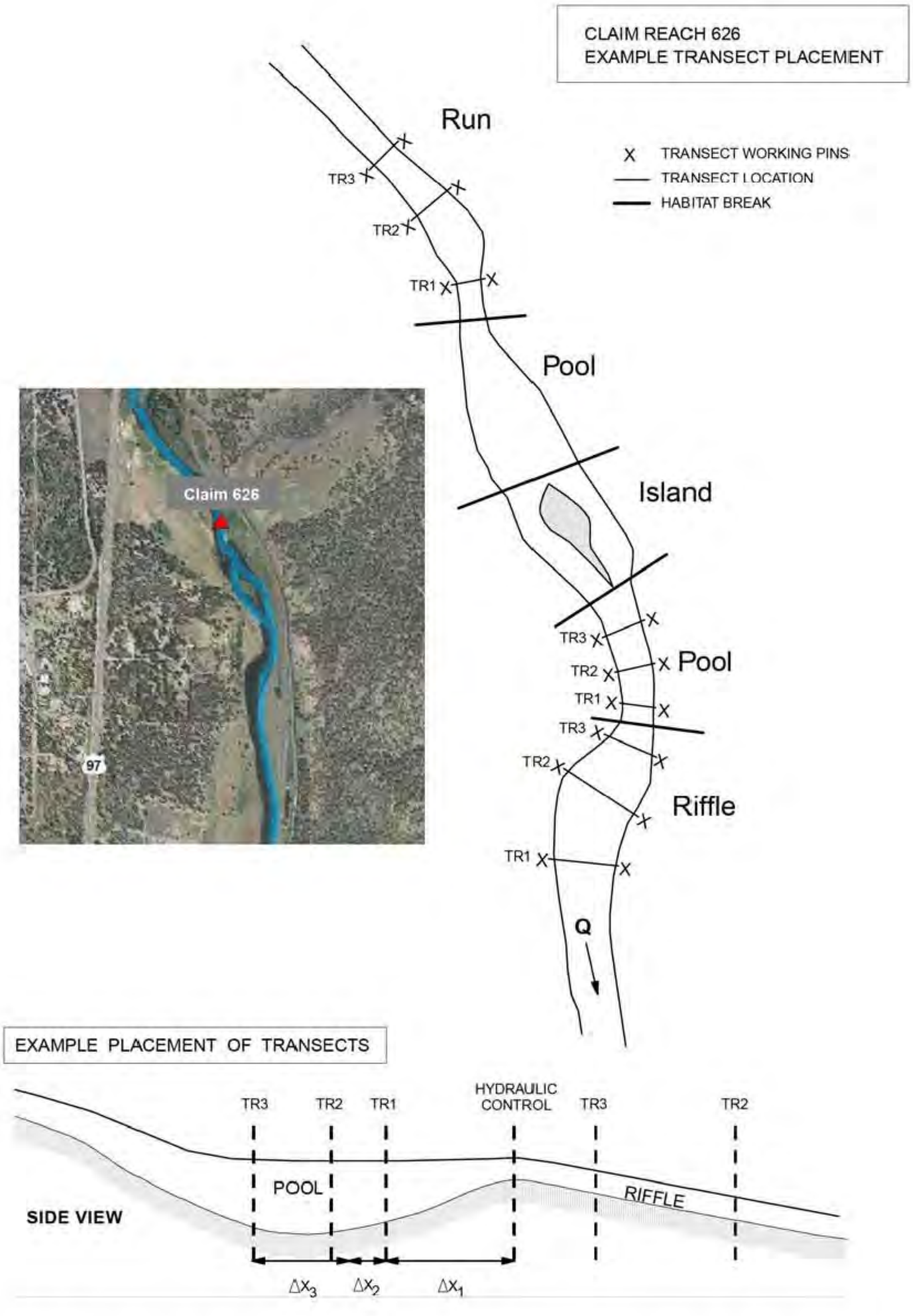


Figure VII-10. Illustration of transect placements in representative habitat units within Claim 626 study site.

215. Please describe Step 6.H (Collect Bed Profile and Depth and Velocity Measurements).

Step 6.H involved collecting bed profile data and depth and velocity measurements. Here, the transect's bed profile was surveyed and recorded once with a stadia rod that is placed on the streambed at short regular intervals. Also, flow velocity and water depth were measured at regular intervals across the transect (each interval referred to as "verticals" or "cells") using a Swoffer Model 2100 current meter and topset wading rod. (see Figure VII-9). For larger streams, at least twenty wetted verticals were measured. For smaller streams less than 20 feet wide, depth and velocity measurements were spaced either every foot or at ten verticals, whichever was greater. Small stream measurement locations were chosen to capture the cross-channel variation in velocity and bed elevation, rather than using regular spacing which can miss important habitat features. In the process of gathering stream measurements, representative photographs were taken of each study site during each field effort.

Most study reaches were visited three times to collect IFIM/PHABSIM data at three different flow stages. Data collection intensity was highest during the first field visit and included habitat mapping, transect selection and setup, level-loop surveys, and bed profile, depth and velocity measurements. Depth and velocity measurements were generally completed on all transects at two out of three visits, with only stage and discharge data measured on the remaining visit. When only stage and discharge data were collected, at least one cross-section was measured for depths and velocities to obtain the discharge measurement. This cross-section was located where possible in run-like habitat, which typically provides the most uniform flow conditions for discharge measurement.

As already described in Section IV, because of the relatively consistent flows, spring-dominated streams need only one IFIM/PHABSIM collection effort; however, all spring-dominated streams need only one IFIM/PHABSIM collection effort; however, all spring-dominated streams of the Williamson River subbasin (Claims 634 and 640) were visited no less than and had stream data collected on three occasions. Spring-dominated streams associated with the streams of the Williamson River subbasin include those stream reaches associated with.

216. Please describe Step 6.I (Data Reduction for Modeling and Quality Assurance and Quality Control).

All aspects of the study including data collection, data reduction and analysis, and modeling were subjected to a quality assurance and quality control process that was included in the final step noted above, Step 6.I. The data collection steps described above were instituted and followed to ensure that data were accurately collected during each survey.

217. Returning to the nine-step process, please describe Step 7 – Instream Flow Hydraulic and Habitat Modeling.

With the necessary stream measurements collected from the sample sites within each claim reach of the Williamson River subbasin (Claims 625 through 640), Step 7 involved applying the necessary IFIM/PHABSIM computer models to determine the relationships between the quantity of water flowing in the stream and the quantity of habitat for each of the target fish species and lifestages. As previously described, habitat quantity within a stream was expressed as weighted usable area (WUA).

218. Please describe any linkage between the collection of field data and the application of the computer models.

The IFIM/PHABSIM process involves the collection of field data that describe the hydraulic and physical characteristics of the stream at several different flows. These data serve as input to a series of computer programs that allow for the predictions of hydraulic and physical characteristics at various flows. This flow-extrapolation is a central feature of IFIM/PHABSIM that allows the derivation of habitat and flow relationships. The development of the computer models used to make these flow extrapolations was completed by the USGS. The models are available on the Internet with the USGS and we utilized one of the USGS-approved versions (DOS-based version V 2.1 JULY, 1989) for our modeling.

219. Are there standard procedures to follow when using these models?

Yes. The USGS has provided an extensive collection of documents that serve to guide users of the IFIM/PHABSIM system including those of Bovee et al. (1998), Bovee (1982; 1986), and Milhous et al. (1984).

220. Were those procedures and methods followed in completing the IFIM/PHABSIM modeling for the streams in the Upper Klamath Basin?

Yes. I have been trained in the application of the IFIM/PHABSIM models and have worked directly with them. In this case, the application of the IFIM/PHABSIM models, hydraulic model calibrations, and the production of the habitat:flow relationships were completed under my direction, and the direction of Mr. Michael Ramey, P.E. because of his extensive experience in hydraulic modeling. Mr. Ramey provided technical oversight and supervision of two other senior hydraulic engineers who were responsible for development and calibration of all hydraulic models used in the IFIM/PHABSIM analysis. Specific methods and procedures applied as part of the model development and calibration process are described in Mr. Ramey Direct Testimony at questions 21 and 23. Once the models were calibrated, I worked directly with the modelers in selecting the appropriate HSC curves to use in developing the species and lifestage specific WUA versus flow relationships used in deriving the Physical Habitat Claims.

221. What was the final result of the IFIM/PHABSIM modeling?

The IFIM/PHABSIM analysis combined the field data and the HSC criteria. As I have previously described, the end product of the IFIM/PHABSIM hydraulic and habitat modeling was a series of habitat:flow curves (expressed in an x-y graph with WUA along the y-axis and flow expressed along the x-axis). These curves graphically depict the habitat:flow relationships for each transect, for each lifestatge of each target fish species. The habitat-flow relationships (by species and lifestage) that were developed for each of the three transects of a specific habitat type/unit were subsequently averaged (1/3 each). A composite habitat-flow relationship (for each species and lifestage) was then developed for the study site by applying a weighting factor based on the percentage composition of each habitat type derived from the reach habitat mapping (see question 213). An example of one of these habitat:flow relationships was presented in Figure VII-3. This figure describes the four habitat:flow relationships for the four lifestages of redband trout in Claim Reach 626. Similar figures were generated for each of the Williamson River claim reaches for each species.

222. Please describe Step 8 of the nine-step process – Hydrologic Limitations.

Step 8 involved identifying and applying a connection between the hydrology of the Upper Klamath Basin and the habitat:flow relationships derived from the IFIM/PHABSIM modeling. Every stream has a hydrologic regime that essentially describes the general timing and magnitude of flows that occur within the system. This hydrologic regime can be represented in a graph that shows how the flows are distributed over time (or hydrograph). Figure VII-11 is an example of one of the Williamson River hydrographs (for Claim 626) developed and used during the claim development process. The figure depicts flows on the y-axis and months on the x-axis.

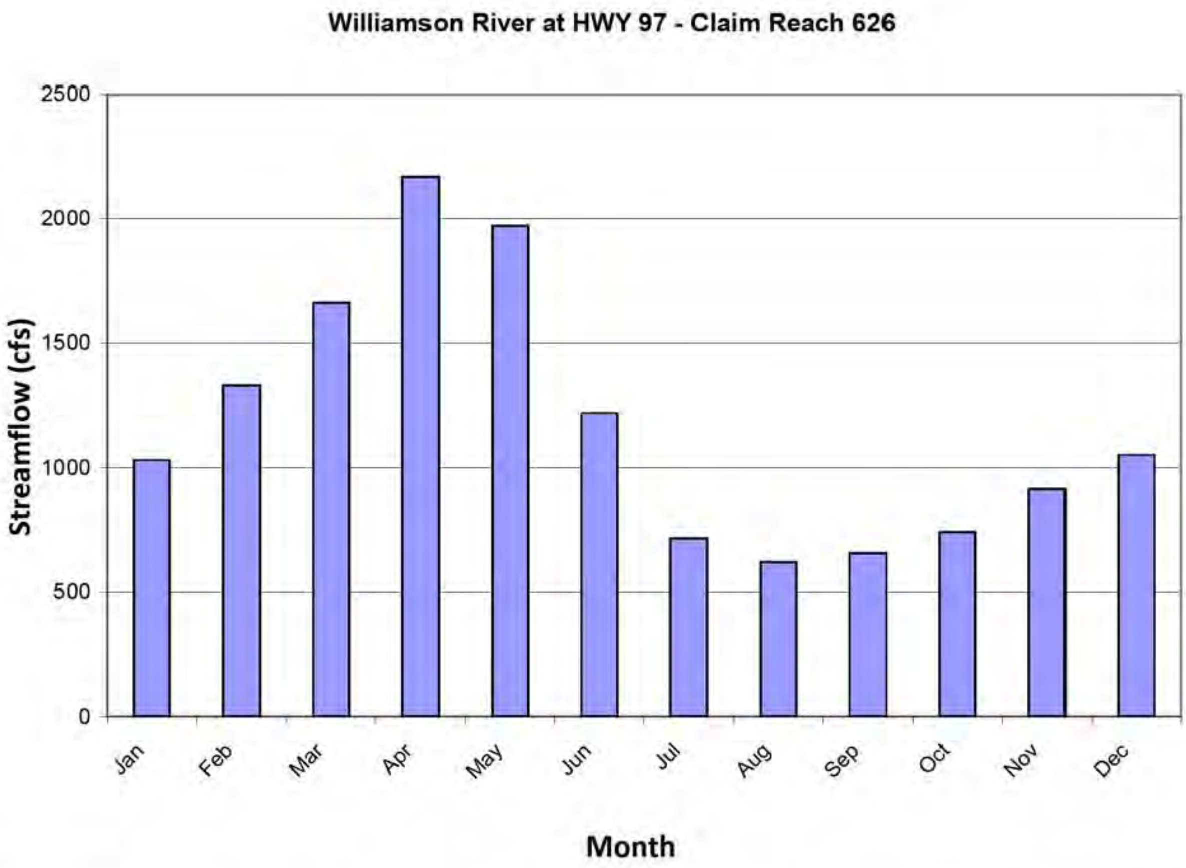


Figure VII-11. Williamson River monthly hydrograph (median flow values) at the confluence with the Sprague River (Claim Reach 626) (Source: Cooper 2004).

223. Why was this information relevant for developing Physical Habitat Claims and how was this incorporated?

A criticism of the IFIM/PHABSIM methodology is that habitat:flow relationships may or may not fit within the hydrological regime of a system. The critical argument goes that an IFIM/PHABSIM analysis projects habitat:flow relationships over a range of flows, some of which might not realistically ever occur within the stream system. Consideration and use of Upper Klamath Basin specific hydrologic information ensured that the derived habitat:flow relationships would fit within the hydrologic regime of the Williamson River system as we did not want to recommend a flow that never occurred, or that occurred so infrequently that it would not be biologically meaningful.

224. How did you factor the hydrologic regime of the Williamson River subbasin into the development of the flow recommendations?

I consulted with Michael Ramey, principal hydraulic engineer in our office, regarding the hydrologic statistics for each claim reach. Mr. Ramey reviewed the hydrology that had been developed by OWRD for streams of the Upper Klamath Basin. He identified and provided to me the reliable hydrologic statistics available for the Upper Klamath Basin. Working with Mr. Ramey, I concluded that the natural monthly median exceedance flow estimates developed by OWRD were a reasonable upper limit on the Physical Habitat Claims. This upper limit represented a conservative upper limit on the Physical Habitat Claims that would nonetheless provide the amount of water necessary, and no more, for a healthy and productive habitat for the target fish species. This upper limit also ensured that the developed PHABSIM habitat:flow relationships were hydrologically connected to the streams of the Williamson River subbasin.

225. How was this hydrologic statistic applied in developing the instream flow recommendations?

The IFIM/PHABSIM derived habitat:flow relationships are based in large part on physical and hydraulic characteristics of the channel. These characteristics provide a means for incrementally evaluating how the relative quantity of habitat in a specific channel might change relative to changes in flow. In theory, one could review the modeled relationships (expressed graphically as WUA versus flow curves) and select the value on the WUA curve that simply provides the most living space for a given species and lifestage for a particular month. However, absent hydrology information, this could lead to the erroneous selection of a specific monthly flow that may never occur or only rarely occurs in the system. Using the WUA:flow relationship for Claim 626 as an example (Figure VII-3), if the IFIM/PHABSIM derived maximum habitat flow is 500 cfs, but the stream hydrology reveals that 500 cfs occurs every 20 years, then there would be little biological justification for that flow.

For these reasons, the Physical Habitat Claims have been conditioned on both the physical habitat that the stream channel provides as well as the stream flow (hydrology) that the system generally provides. The Physical Habitat Claims presented as part of my testimony today are limited in every instance to the *lesser* between the PHABSIM-derived flow and the monthly median flow. In other words, at no time does any Physical Habitat flow recommendation exceed the monthly median flow as calculated by OWRD.

226. Could the IFIM/PHABSIM habitat:flow relationships alone be used to develop physical habitat:flow claims?

In theory, yes. IFIM/PHABSIM habitat:flow relationships could alone form the basis for physical habitat:flow claims. As I mentioned, one could review the curves and select the value on the WUA curve that simply provides the most living space for a given species and lifestage for the particular month. This approach, often called "peak of the curve" approach, is based on the premise that the stream channel characteristics alone serve as the physical template behind the resulting habitat:flow relationships. Strict reliance on the peak of the curve would be followed under the assumption that the potential maximum fish production of a system can only be achieved when the amount of habitat is maximized. Thus, the "peak of the curve" becomes the recommended flow. We did not strictly rely on the peak of the curve, but rather we conditioned the habitat flows based on both the physical habitat that the stream channel provides as well as the streamflow (hydrology) that the system generally provides.

227. From where did you gather your hydrology information for the updated Physical Habitat Claims?

For the streams in the Upper Klamath River Basin, we relied on the hydrology for each of the basins as developed by OWRD (Cooper 2004). This information was not available when the BIA submitted its amended Physical Habitat and Riparian Habitat Claims in 1999. Once this information became available in 2004, we completed a detailed review and evaluation of the OWRD hydrology in developing the updated Physical Habitat Claim. The review and evaluation was led by Mr. Ramey and is described in Mr. Ramey Direct Testimony at questions 45 through 48.

228. Please describe Step 9 of the nine-step Physical Habitat Claim process – Other Flow Considerations – 1999 Amended Flow Claims Limitations.

In addition to the consideration given to the median flow (median flow values), the 1999 amended Physical Habitat Claims represent an absolute limit to the Physical Habitat Claims even when the latest results of our analysis suggests greater flow than the amount claimed in 1999. In the claims where this limit is reached, I reviewed the extent to which the 1999 claimed flow value would be less than the flow indicated by our updated analysis, and then evaluated whether the 1999 flow limit would still provide for healthy and productive habitat; I concluded that, in those few instances, they would.

229. With the nine-steps completed, what was your next course of action to develop the Physical Habitat Claims?

With the above nine steps completed, we were able to assemble and apply the information generated in a measured way to update the specific monthly Physical Habitat Claims for each of the 15 claim reaches identified in this case. Therefore, my final actions were to identify the specific flow levels for each claim reach using the large body of information and data assembled. This was done in a final decision-logic sequence described in Section VIII.

230. Was the work you have been describing regarding the Physical Habitat Claims reviewed by a third party?

Yes. Much earlier in this adjudication process, at OWRD's request, information was provided to OWRD regarding the BIA's work that encompassed studies commencing in 1990 and extending through June 1999. OWRD transmitted the BIA's information and data related to the BIA Physical Habitat Claims to Dr. Tim Hardin of Hardin-Davis, Inc. OWRD directed Dr. Hardin to complete a "technical review of the adequacy of the data and interpretations related to the BIA instream flow claims" (OWRD Ex. 1, p. 673).

The BIA amended its Physical Habitat Claims in October 1999. In October 1999, Dr. Hardin presented a report of his findings: Analysis of Hydraulic and Habitat Models Supporting BIA Instream Flow Claims in the Klamath River Basin (OWRD Ex. 1, pp. 669-700, plus

Appendices OWRD Ex. 1, pp. 701-810) ("Hardin report"). It is unclear from Dr. Hardin's report whether he was able to review the BIA's amended 1999 Physical Habitat Claims and I assume that he did not. Nonetheless, the focus of Dr. Hardin's report was on the information and data provided by the BIA through June 1999 which formed the basis of the amended 1999 Physical Habitat Claims.

231. Are you familiar with Dr. Hardin and whether he is qualified to complete a review as requested by OWRD?

I consider Dr. Hardin qualified to complete a technical review of PHABSIM-type data. I understand that he has been involved in conducting instream flow studies for many years, primarily as a private consultant working for Hardin-Davis, Inc.

232. What was the nature of the Hardin report?

I understand that Dr. Hardin was retained by OWRD to review the BIA instream flow data to help OWRD better understand the basis for the BIA's instream flow claims. Dr. Hardin was asked for his opinion as to the adequacy of the underlying data, the data collection methods, and the data analyses. The review focused on four key questions (OWRD Ex. 1, pp. 674-675):

a. Was the Physical Habitat Simulation model (PHABSIM) the appropriate model for the study? (OWRD Ex. 1, p. 674)

b. Were elements of the study designed well? (OWRD Ex. 1, p. 674)

c. Were hydraulic data collection and processing carried out correctly? (OWRD Ex. 1, p. 674) and

d. Was the HABITAT model applied correctly? (OWRD Ex. 1, p. 675)

233. What were the findings of the Hardin report?

In general, the findings served to identify both strengths and potential weaknesses in BIA's approach, the level of data collection, and the analyses that had been completed by the time of Dr. Hardin's 1999 review.

234. Please explain generally the conclusions of the Hardin report related to each of the four questions noted above, starting with the first question - was PHABSIM the appropriate model for the study?

Dr. Hardin acknowledged that other methods are available and specifically cited some of those I have described in Section IV of my testimony, including the Tennant Method and Oregon Method. Dr. Hardin concluded that "PHABSIM was an acceptable method to use in quantifying fish habitat potential as a function of flow" (OWRD Ex. 1, p. 676).

235. Did you use take any steps or measures as a result of the report's conclusion related to the PHABSIM model?

Generally, yes. We continued to apply IFIM/PHABSIM in developing the Physical Habitat Claims on as many streams as possible, and only resorted to another method, the Tennant Method, when access restrictions precluded collection of field data. As part of this, we added a number of new study sites beyond those reviewed by Dr. Hardin, from which IFIM/PHABSIM data were collected and analyzed. These additional sites were added, in part, to address some of the other technical concerns noted by Dr. Hardin, presented below, and to refine the Physical Habitat Claims presented in my testimony today.

236. What did the Hardin report conclude regarding the second question – were elements of the study well designed?

Dr. Hardin proffered five separate conclusions corresponding to six separate elements (streamflow records, channel equilibrium, water quality, priority species and lifestages, selection of sites and transects, and habitat suitability curves) that he considered in addressing the question.

237. What was the report's conclusion regarding the first element of the second question – streamflow records?

Dr. Hardin concluded that "[t]he BIA claims need more hydrological context. Monthly claims should, at a minimum be compared to the natural 50% exceedence flows" (OWRD Ex. 1, p. 677).

238. Please describe generally any steps or measures taken to address the report's conclusion related to the first element - streamflow records.

For element 1- streamflow records, we completed a number of steps subsequent to the Hardin report that focused on hydrology. This included a more thorough review of available hydrology data for streams in the Upper Klamath Basin including, in particular, the OWRD hydrology as described in Cooper (2004), which was not available in 1999. In addition, we also collected additional years of streamflow data that were used in evaluating the Cooper (2004) hydrology. The overall process we used for applying the hydrology data to the Physical Habitat Claim derivation process is described more thoroughly in Mr. Ramey Direct Testimony. Of note, we are now specifically using the 50% exceedence flow statistic mentioned by Dr. Hardin (termed "median flow" throughout my testimony), as the hydrologic limit of the Physical Habitat Claims.

239. What was the report's conclusion regarding the second element of the second question - channel equilibrium; and the third element - water quality?

Dr. Hardin combined both the second element - channel equilibrium - and the third element - water quality - into a single conclusion. Dr. Hardin concluded:

> Some of the study streams are seriously degraded by overgrazing. This decreases bank stability, shade and cover to a great extent. Flow restoration alone will have limited fishery benefits unless grazing and other land use issues are also addressed. This does not mean that the BIA focus on flows is invalid; it means that flows are only part of the equation.
> (OWRD Ex. 1, p. 677).

240. What steps or measures were taken or additional studies completed to address the report's conclusions related to the second and third elements?

I generally agree with Dr. Hardin's conclusion that flow is not the only component of a healthy and productive fish habitat. Grazing and other land use practices have a significant impact on fish habitat. I described this and, generally, the current conditions of the subbasin in Section VI of my testimony (questions 120 through 126). Related to water quality, we considered dissolved oxygen as a factor affecting fish habitat (see generally Section IV, question 86). In addition, to the extent that information and data were available, we completed and considered water temperature information as provided in the FLIR imaging when establishing Physical Habitat flow values in each claim reach (see generally Section IV, questions 92 through 94). However, as recognized by Dr. Hardin, sufficient streamflow is a critical ingredient in the development and sustainability of a fishery. In addition, quantifying streamflow is the only focus of the Adjudication. Thus, we focused on determining the amount of flow necessary in the claims work.

241. What was the report's conclusion regarding the fourth element of the second question – priority species and life stages?

Dr. Hardin's overall conclusion was that "[t]he BIA claims are almost entirely based on WUA results for rainbow trout. This simplifies the analyses but may be hard to justify ecologically" (OWRD Ex. 1, p 678).

242. What steps or measures were taken or additional studies completed to address the report's conclusions related to element 4 – priority species and life stages?

None explicitly; however, at the time of his review, Dr. Hardin was not aware of two components of the basis and rationale for developing the claims. First, Dr. Hardin was not aware of the lifestage prioritization we used in developing the claims that resulted in lifestage rankings: spawning (first priority), adult (second priority), juvenile (third priority), and fry (fourth priority). Second, Dr. Hardin was not aware of the species prioritization we used in developing the claims that resulted in species rankings: redband trout (first priority species); Lost River sucker (second priority species); shortnose sucker (third priority species); Klamath largescale sucker (fourth priority species); and bull trout (fifth priority species). These components were described earlier (see generally Section II question 25 and Section VII questions 165 through 170).

With this information, Dr. Hardin's critique is addressed as to the technical and ecological basis for the claims, and why certain species and lifestage combinations formed the basis for specific monthly claims more frequently than others. In addition, although, as alluded to in the report, there are other approaches to data analysis that could have been used, including "the simultaneous evaluation of a bewildering mix of species and lifestages," (OWRD Ex. 1 p. 678), the results of that type of an analysis are typically difficult to interpret and do not lend themselves to the situation where the prioritization of lifestages and species have been clearly defined.

243. What was the report's conclusion regarding the fifth element of the second question – selection of sites and transects?

With respect to this element, Dr. Hardin concluded in 1999:

> In my opinion, the number of transects used in this study is minimal, and probably insufficient. The use of low numbers of transects has serious implications for the precision of the PHABSIM model. Low numbers of transects mean that the final results may be more of a general indication of the WUA vs. flow relationship, rather than an accurate quantification. Because no rainbow trout spawning transects were placed and the amount of potential spawning habitat is low in many reaches, the WUA figures for rainbow trout spawning are unlikely to be reliable for setting flow claims. Rainbow trout spawning should probably be removed as a priority life stage in at least a third of the sites.
>
> (OWRD Ex. 1, p. 679).

244. What steps or measures were taken or additional studies completed to address the report's conclusions related to element 5 – selection of sites and transects?

With respect to the critique related to the number and types of sites and transects selected, we engaged in a comprehensive review of the transects we relied upon. Since the Hardin report, we have collected supplemental data from re-established transects at a number of existing sites; established and collected data from several additional sites and transects including three (3) sites on the lower Sprague River, one (1) site on the lower Williamson River, one (1) site on the South Fork Sprague River, and one (1) site on Whisky Creek; and completely re-analyzed the existing data used in the 1999 amended claims development process.

The above efforts have substantially increased the overall numbers of transects from which PHABSIM data have been collected, analyzed, and applied in developing the Physical Habitat Claims presented in my testimony today. In addition, for those areas in which we did not establish new or gather additional transect data, our further analysis confirmed that given the uniformity of stream habitat conditions (substrate, flow, depth, channel shape, etc.), additional transect data were not necessary.

Further, several of the new transects were purposely located across known sucker and redband trout spawning areas. In addition, we developed an additional step (see Section VIII, question 260, Final Step Four) as part of the flow derivation process that specifically considered the amount of spawning habitat available under different flows for a given site. Under that step, if the amount of spawning habitat available at a specific site was determined to be below a threshold amount, then consideration was given to shifting the basis for the claim to the next priority life stage/species.

245. What was the report's conclusion regarding the sixth element of the second question – habitat suitability curves?

Overall, Dr. Hardin concluded:

> [t]he depth and velocity curves are probably acceptable for most of the priority life stages. New data should be reviewed if possible, for bull trout, and winter rainbow trout, these curves may need to be adjusted. Binary aspects of the rainbow trout spawning curves should be changed, if this life stage is to remain a priority. The models appear to be overly general for rainbow trout. The decision not to include cover reduces the resolution of the study.

(OWRD Ex. 1, p. 680).

246. What steps or measures were taken or additional studies completed to address the report's conclusions related to element 6 – habitat suitability curves?

As described earlier in this section, since 1999 and in part to address Dr. Hardin's observations, we have collected more than 700 redband trout microhabitat use measurements for fry, juvenile, adult and spawning lifestages; 24 bull trout habitat measurements; and 31 Lost

River sucker habitat measurements (See Table VII-4). These measurements were used in developing site specific HSC criteria for redband trout spawning and adult life stages, and for updating the previously applied HSC curves to better reflect habitat characteristics actually being used by the target fish species in the Upper Klamath Basin. Our decision not to incorporate cover into the HSC criteria was based on the fact that cover is highly site specific and, therefore, would not be representative of conditions in claim reaches that often encompassed long stretches of stream.

247. Moving next to Dr. Hardin's third question, what did the Hardin Review conclude regarding the third question – were hydraulic data collection and processing carried out correctly?

Dr. Hardin's review and conclusions relative to the collection and analysis of hydraulic data centered on the quality of the data and resulting model output used in deriving the 1999 amended claims.

248. What steps or measures were taken or additional studies completed to address the report's conclusions related to hydraulic data collection and processing?

As to each of the hydraulic data issues identified in the Hardin report, each was given additional, careful consideration, and each was addressed as part of the comprehensive evaluation I just described of all data and model calibration details used in the development of the amended 1999 Physical Habitat Claims. As a result of our comprehensive review, model recalibrations were made on a number of the sites, supplemental field measurements were collected from existing sites and used in model calibrations, and several new sites were established from which new data sets were collected and used in model development. These efforts served to refine and supplement the data that had been collected to support the amended

1999 claims. Overall, these efforts increased the reliability of the data and model results that were used in deriving the Physical Habitat Claims presented in this testimony.

249. What did the Hardin report conclude regarding the fourth and final question – was the HABTAT model applied correctly?

Dr. Hardin provided comments relative to four categories under the final question: (1) site-by-site WUA; (2) level of confidence in the final WUA curves; (3) interpretation of WUA to obtain flow claims; and (4) other issues in WUA interpretation.

250. What steps or measures were taken or additional studies completed to address the report's conclusions related to WUA?

The first category - site-by-site WUA - was simply a check of the data output of the WUA models which Dr. Hardin confirmed were correct. The second category - level of confidence in the final WUA curves - pertained to the data issues described above. As I described, these issues were resolved by the subsequent review of data, recalibration of data sets, re-sampling of certain sites, and establishment and measurement of new sites and additional transects.

For the third category - interpretation of WUA to obtain flow claims - Dr. Hardin concluded:

> [t]he BIA calculations of WUA per site are consistent with the input data. Flow recommendations did take into account values other than peak WUA. However, considerable uncertainty remains in the final WUA figures due to low numbers of transects, field data problems, and over-extrapolation of the hydraulic models.
>
> (OWRD Ex. 1, p 685).

The uncertainty in the final WUA figures noted by Dr. Harding was, again, related to data collection and analysis concerns which have been addressed as described above.

The fourth category - other issues in WUA interpretation - was directed toward consideration of flow-versus-habitat and flow-versus-fish population relationships. I discuss the conceptual differences between these relationships in Sections III and IV. There, I point out that it is generally difficult to demonstrate a direct relationship between flow and numbers of fish because of the many factors that serve to influence population abundance. Further, no recognized methodology exists, as a predictive tool, to establish a flow-versus-fish population direct relationship throughout a river basin environment. For these reasons, we applied an accepted method (the IFIM/PHABSIM method) that focused on habitat–versus-flow relationships

251. Were there any other comments proffered by Dr. Hardin that you considered?

Yes. Dr. Hardin also discussed the extent to which a change in habitat (WUA) could have a notable effect on the fishery. He noted the variability of possible effects on the fishery, "[a] 5% change in WUA could be significant in some instances, while a 25% change could have no effect in others" (OWRD Ex. 1, p.686). He further concluded that "it is useful to look at the whole range of WUA values, as opposed to just the peak value. In particular, the flows providing 90% or more of peak WUA should be taken into consideration in formulating flow recommendations" (OWRD Ex. 1, p.686).

I generally agree with the points raised by Dr. Hardin here. Further, our evaluation of the WUA curves considered the full range of values, and specifically those providing 90% or more of the peak WUA (see Section VIII, question 260, Final Step Three).

252. Please summarize your overall response to the Hardin report's conclusions.

In general, I found Dr. Hardin's review to be objectively based on the information that had been provided OWRD in June 1999. Dr. Hardin's review was useful in helping to identify specific elements of the overall approach used to derive the 1999 amended Physical Habitat claims that warranted additional consideration. Indeed, subsequent to receipt of the Hardin report, we completed a thorough review of all of the IFIM/PHABSIM data collected. As a result, we completed additional analyses, gathered additional data, and conducted a number of supplemental studies which addressed Dr. Hardin's concerns or conclusions and our own assessments.

VIII. INFORMATION ASSEMBLED AND SPECIFIC ACTIONS TAKEN TO ARRIVE AT THE FINAL UPDATED PHYSICAL HABITAT CLAIMS

253. Dr. Reiser, please briefly describe your actions to finalize the updating of the Physical Habitat Claims.

The updated Physical Habitat Claims presented in my testimony are the result of the following substantial actions: an extensive review of the pre-1999 data; recalibration of hydraulic models; establishment of and data collection from several new (post-1999) IFIM/PHABSIM study sites; adjustment of HSC curves; additional (post-1999) development of habitat:flow relationships; additional (post-1999) hydrologic information provided by OWRD; review of recent data on species lifestage utilization of Williamson River subbasin streams; and the completion of ongoing technical analyses that have both confirmed and refined (downward) the Physical Habitat Claims. The objective consistently throughout this lengthy process was to gather and use the best available scientific information from which to base the Physical Habitat Claims.

I have already described the general methodology applied and steps or procedures followed which formed the basis for the Physical Habitat Claims. Therefore, I will now describe the detailed processes used for updating the specific Physical Habitat flow values necessary for each claim reach and each claim month.

254. Please describe whether consideration of anadromous fish species, and specifically Chinook salmon impacted the specific steps you took to arrive at the final Physical Habitat Claims.

As discussed earlier, the current absence of but the likely future presence of anadromous fish species, and particularly Chinook salmon, has caused a refinement to the 1999 Physical

Habitat Claims. The Physical Habitat Claims are now divided into sub-parts: Physical Habitat Claims based on *present* target fish species, and *conditional* Physical Habitat Claims based on *all* target fish species, including the anadromous Chinook salmon.

255. Please describe what you mean by *present* target fish species and what you mean by *all* target fish species.

As I have already described in Section VII of my testimony, the target fish species which were the focus of our work and the Physical Habitat Claims included Chinook salmon, bull trout, redband trout, Lost River sucker, shortnose sucker, and Klamath largescale sucker. These six species constitute *all* target fish species.

Present target fish species include those five target fish species that currently reside in the streams of the Upper Klamath Basin, i.e., bull trout, redband trout, Lost River sucker, shortnose sucker; and Klamath largescale sucker. Return of Chinook salmon and other anadromous species to the area of the Upper Klamath River Basin is reasonably possible under a number of scenarios (FERC 2006; Hooton and Smith 2008). When the anadromous fish return, they are likely to return to those habitats that they once occupied so long as the fish habitat is of sufficient quality (i.e., healthy) to support its relevant lifestages. They will also likely discover and utilize new habitats to support their lifestages.

As I have described, the habitat:flow relationships analyzed and calculated to ultimately determine the flows necessary to ensure no more than a healthy and productive habitat turn, in part, on the fish species considered. Though the process and steps to determine an appropriate habitat:flow relationship remain the same, with the needs of an additional fish species taken into consideration the opportunity arises for different flow recommendations to result.

256. Please describe what you mean by *conditional* Physical Habitat Claims.

To the same extent that I have gathered data and applied an established methodology to form the basis to make Physical Habitat Claims for target fish species that currently reside in the streams of the Upper Klamath River Basin, I have gathered sufficient data and applied the same methodology to form the basis to make Physical Habitat Claims for *all* target fish species, including Chinook salmon. The notion of *conditional* Physical Habitat Claims takes into account the probable return of anadromous species, including the Chinook salmon, to the Upper Klamath River Basin. These *conditional* Physical Habitat Claims should be followed when anadromous fish are reintroduced to the Upper Klamath Basin.

257. Please describe the Physical Habitat Claims which are based on *present* target fish species and how they are distinct from *conditional* Physical Habitat Claims.

In the simplest of terms, those Physical Habitat Claims that I have determined to be necessary for *present* target fish species are those flows necessary *today,* to provide for the physical habitat of fish. These flows establish that amount of flow necessary to provide a healthy and productive habitat for the target fish species currently living in the upper Klamath River Basin generally and the Williamson River subbasin specifically. The present Physical Habitat flow claims do not take into consideration the needs of Chinook salmon or any other anadromous species.

The Physical Habitat Claims that I describe as *conditional* are those flows that I have determined will be needed in the future when anadromous fish are permitted to return to the Upper Klamath Basin. These flows establish that amount of flow necessary to provide a healthy and productive habitat for *all* target fish species, including Chinook salmon. These *conditional* Physical Habitat Claims were established by considering all six target fish species.

258. Are the updated Physical Habitat Claims that you describe today, whether *conditional* or not, greater than those values claimed through the 1999 Physical Habitat Claims?

No. In every instance, whether for present target species or for all target species, the Physical Habitat Claims are *at or below and certainly no more than* the Physical Habitat flows claimed in 1999. Further, the Physical Habitat Claims today are refined into two components: a component based on *present* target species in the Upper Klamath Basin and a conditional component based on the *future likely return* of the important anadromous target fish species, Chinook salmon. By refining the Physical Habitat Claim into current and conditional claims, we are assured that no more than the water necessary to provide healthy and productive habitat for fish is claimed.

259. Please describe the specific information that you assembled to form the final basis for the Physical Habitat Claims in the Williamson River subbasin for each calendar month.

With all field data gathered and reduced and all computer analysis and modeling performed, a logical sequence of decisions was developed to account for all relevant information and to base my final recommendation for a specific claim reach and a specific month. Also, as the Physical Habitat Claims for present species and all species (i.e., present and *conditional* Physical Habitat Claims) involved the same final decision-making process, the materials and information assembled for both were virtually identical.

Immediately below, I briefly describe the information specifically assembled to arrive at the Physical Habitat Claims, and the source that was generally relied upon for the information.

- **Target fish species presence, lifestage use, and periodicity (including historic distribution):**

Though possibly present in the greater Williamson River subbasin, not all target fish species were or should be considered present in each claim reach. Therefore, species, lifestage and periodicity for each reach needed to be specifically identified. This information was obtained from a variety of sources that included the Klamath Tribes, ODFW, USFWS, USGS, and USFS. Further details regarding the identification of target fish species, and lifestage periodicities are provided in Sections II and VII.

- **Prioritization of lifestage and target fish species (primary, secondary, tertiary):**

For the lifestages, species, and periodicity identified, the information was assembled based on developed priorities. Further details regarding the establishment of lifestage and species priorities are provided in Section VII.

- **Identification of claim reaches that support federally protected species and/or with special habitat characteristics and conditions (e.g., spring dominated, critical spawning habitat, upstream passage corridor):**

Here, reach-specific information related to the presence of ESA-listed species and any special conditions (e.g., water quality, critical spawning, adult passage conditions, etc.) was obtained primarily from the USFWS or the ODFW. In addition, identification of special characteristics and conditions within a given reach was based on information obtained during our review of literature, results of extensive field surveys conducted over the previous two decades, and discussions with the resource agency and the Klamath Tribes. For example, there are a number of spring-dominated streams in the Upper Klamath Basin that are characterized by stable flow and stable temperature conditions. The influence of these conditions extends well below a given reach. Likewise, certain claim reaches serve as the main passage corridors through which adult adfluvial target fish species (e.g., redband trout, Lost River sucker, shortnose sucker, Klamath largescale sucker and Chinook salmon (when reintroduced)) must migrate through in order to reach spawning and rearing habitats. As fish habitats and fish use have developed around these unique characteristics and conditions, this information needed to be considered in the development of the Physical Habitat Claims.

- **Habitat:flow relationship curves:**

The habitat:flow relationship (WUA-Q) values and curves generated for various lifestages and target fish species were the primary outputs from the IFIM/PHABSIM modeling. These values and curves were the primary basis on which many Physical Habitat Claims were made.

- **Monthly median flow:**

The monthly median flow represents flow that for a given stream and month that would be exceeded half of the time based on hydrological records. The specific median flow estimates used in my analysis were those established by OWRD as described in Mr. Ramey Direct Testimony at question 50. As described in Section VII and based on a conservative determination of the threshold needs provide a healthy and productive habitat, this flow statistic represented a hydrologic limit of the Physical Habitat Claims for all reaches and all months and ensures connection between the hydrology of the Upper Klamath Basin and the IFIM/PHABSIM based flow values. No Physical Habitat flows for any claim reach or any calendar month exceeded OWRD's median flow estimates.

- **1999 Physical Habitat flow claims:**

As described in Section VII, the 1999 Physical Habitat Claims formed the final consideration of the claims analysis and a second upper boundary of the updated Physical Habitat Claims for both *present* and conditional claims. Similar to the median flow limit, no updated Physical Habitat Claim for any claim reach or any calendar month, exceeded the 1999 Physical Habitat Claim values.

260. Please describe the final process by which you determined the final updated Physical Habitat Claims in the Williamson River subbasin.

I assembled the above information in updating the Physical Habitat Claims for each month and for each claim (Claims 625 through 640). I then reviewed the assembled information to ensure accuracy and completeness. With the assembled information, I applied the information in a decision process to develop specific monthly flow recommendations for each claim reach. It was in this review process that I considered those principles and factors described by Naiman and Latterell (Naiman and Latterell 2005) and the Instream Flow Council (Annear et al. 2004; Locke et al. 2008) (see Section IV).

Below, I describe the eight specific steps of the final decision process followed to ultimately arrive at the final updated Physical Habitat Claims for each claim reach and each calendar month.

- **Final Step One – Derivation and Review of habitat:flow relationship (WUA-Q) values:**

Broadly speaking, the WUA provides the best indication of the "livable area" that a stream provides a given species lifestage at a given instream flow. After establishing the habitat:flow relationships over a range of flows, the flow levels that provided optimal WUA or the greatest livable area for each month's priority were identified. The resulting flow was recorded based on priority species, lifestage, claim reach use, and/or sensitivity of or value to listed species. Flows providing 90 percent and 80 percent of the optimum habitats were likewise computed.

- **Final Step Two – Application of habitat:flow relationship (WUA-Q) values for claim reaches containing unique characteristics or critical habitat features:**

We then determined whether the claim reach should be considered "unique." First, we questioned whether the claim reach served a critical role (e.g., temperature, water quality, critical spawning, adult passage, etc.) in supporting target fish species habitat characteristics within the reach, and whether the conditions critically influenced downstream claim reaches. If the answer was yes, we then focused on selecting the flows that would allow for the full range of habitats to occur (i.e., provide the greatest amount of livable space for the priority lifestage and species).

In the Williamson River subbasin, there were seven claims (Claim 625, 626, 627, 628, 629, 634, and 640) that because of the ecological significance to other reaches and the overall importance in supporting target fish species, I considered unique. For those claims, the Physical Habitat Claims focused on providing flows that would allow for the full range of habitats of the priority lifestage and species to occur, as governed by the conditions imposed by final steps three through eight described below. The rationale for the designation of each of these claims as unique is found in Section IX under the specific claim number.

- **Final Step Three – Application of habitat:flow relationship (WUA-Q) values for claim reaches that do not contain unique characteristics or critical habitat features:**

For claim reaches not containing unique characteristics or critical habitats, the habitat:flow relationship curves for the priority lifestage and target fish species were carefully reviewed in terms of their shapes and the flows providing habitat amounts at different levels (100%, 90%, and 80%) on the curves. A broad review of all curves for all claim reaches suggested that the gains in habitat that would occur as a result of the selection of the flow that would have provided the full range of habitat values (i.e., 100%) would not have, in my opinion, substantively increased the amount of productive habitat. In contrast, I believed that decreasing the flow level to that providing 80 percent of the full range of habitat would not have allowed for the long term sustainability of healthy and productive habitats. Therefore, I selected the 90 percent WUA value as the primary basis for selecting a flow value (subject to the hydrologic and 1999 claim limitations noted below). I believe this value would provide for no more than a healthy and productive habitat.

- **Final Step Four – available spawning habitat:**

Sufficient spawning area is necessary for creation of spawning redds for resident, adfluvial, and anadromous salmonids. For spawning priority months, if the recommended flow resulted in <1,000 square feet per thousand feet of spawning habitat for adfluvial or anadromous species or <500 square feet per thousand feet for resident trout species, the claim reach was flagged for further individual review. Using the average stream width, the total available square feet of spawning habitat in 1,000 feet of the stream was calculated. If the updated claim resulted in spawning area comprising less than 10 percent of the total area, then we considered increasing the flow to provide additional spawning area. If additional flow would not increase the amount of spawning habitat, consideration was given to shift the basis of the claim to the next priority lifestage.

- **Final Step Five – egg incubation flow:**

For each month following a spawning priority month that was within the incubation period, the incubation flow was two-thirds the recommended spawning flow level. Two-thirds of the spawning flow is considered necessary to protect eggs from dewatering, freezing, and inadequate water quality (Thompson 1972). The incubation flow operated as a "shadow" to the spawning lifestage and thus was only invoked in those post-spawning, incubation months if the necessary flow for the priority lifestage was less than the incubation flow. For those months, the updated flow claim was based on the incubation flow.

- **Final Step Six – consideration of whether the flow compromised other species or lifestages:**

To ensure that the derived flow would not benefit habitat conditions for one species or lifestage at the expense of another, we reviewed the habitat:flow relationships of other species and lifestages. This review focused on evaluating the amounts of habitat that would be provided for the other species and lifestages by the flow amount for the priority lifestage and species.

- **Final Step Seven – Median flow limit:**

We then compared the habitat:flow based flow derived from Steps 3 through 6 above with the median flow values, and the flow value became the lower of the two. The median flow limit provides an upper limit to the Physical Habitat Claims that is well below any notion of a "wilderness servitude" and is within the realistic boundaries of what the hydrologic conditions of the subbasin provides. Further, it is reasonably assumed that the median flow will meet the necessary basic flow requirements of target fish species and provide no more than sufficient flow to provide and maintain healthy and productive fish habitat.

- **Final Step Eight – 1999 Physical Habitat Claim limit:**

As a final step, we compared the flow derived from Steps 3 through 7, above, with the 1999 Physical Habitat Claim value. The updated Physical Habitat Claim became the lower of the two. Therefore, in those instances where the 1999 Physical Habitat Claim was less than the PHABSIM-based flow and the median flow, the 1999 Physical Habitat flow claims became the basis for the monthly Physical Habitat Claim.

261. Was the final eight-step claim update process applied to Physical Habitat Claims for present target fish species and for conditional Physical Habitat Claims for all target fish species?

Yes. For the purposes of the final claim update process described above, the only distinction between the Physical Habitat Claims based on present species and all species is the number of species considered, five species and six species, respectively. For the purpose of establishing the conditional Physical Habitat Claims, the final eight steps were followed a second time with Chinook salmon included as a possible priority species. Any change in Physical Habitat Claims in the second application of the decision steps resulted in a conditional Physical Habitat flow, only to be given effect in the event Chinook salmon are reintroduced in the Upper Klamath Basin. If the second application of the decision steps resulted in no change to the Physical Habitat Claim, no conditional claim was made.

262. By applying these final steps that you have described above what were you able to achieve?

The uniform final process described above and applied to each claim reach in the Williamson River subbasin (for each calendar month) provides several benefits. First, these processes allowed me to assemble, sort, and apply a vast amount of data and information to prepare and support the basis for my conclusions. Second, by establishing and engaging in these processes in advance, the information necessary to update the Physical Habitat Claims was consistently and uniformly considered in my analysis. Finally, each applicable factor was given appropriate consideration.

IX. THE WILLIAMSON RIVER PHYSICAL HABITAT CLAIMS

263. How many Physical Habitat Claims are there for the Williamson River subbasin?

There is a total of 15 separate claims for the Williamson River subbasin, consisting of 8 claims (Claims 625, 626, 627, 628, 629, 631, 632, 633) for separate reaches of the mainstem Williamson River, and 7 claims (Claims 634, 635, 636, 637, 638, 639, 640) for individual tributaries to the river.

264. In what order will you present and discuss the individual Physical Habitat Claims?

I will discuss the individual Physical Habitat Claims in numerical order, beginning with Claim 625 and ending with Claim 640. Generally, these claims move from the mouth of the mainstem Williamson River upstream toward the headwaters, and then move to each of the tributaries claimed.

For each of the Physical Habitat Claims, I will first describe the reach of the stream encompassed by each claim (e.g., general characteristics such as, length and location of the reach, and stream hydrology). To aid in this, I have included a map depicting the location of each claim, and a hydrograph showing the monthly median flows for the reach, as determined by Cooper (2004). I will then describe other salient information about the claim reach including my familiarity with the reach; the stream environment (such as the channel composition, substrate, and vegetation); the target fish species that are or were historically present in the claim reach; and the field data collected and used to develop habitat:flow relationships for the claim reach. This is followed by a description of the flow quantities and the rationale for each individual updated Physical Habitat Claim, including the updated current and conditional monthly claim flow values. As discussed in Section VII, the "current" Physical Habitat Claims reflect the flows necessary for the target fish species that currently exist in the Upper Klamath Basin, and the "conditional" claims reflect the flows that are necessary for, and which would be applied subsequent to the reintroduction of anadromous fish to the claim reach.

265. Prior to discussing each individual claim, please describe generally the basis and technical rationale that you applied to develop each updated Physical Habitat Claim.

The basis and technical rationale for each updated Physical Habitat Claim and its monthly flow values included the following primary determinants: the lifestage/species priority for each month; incubation flows in months following spawning; the median monthly flow, which represents the hydrologic limit to the Physical Habitat Claim; and the 1999 monthly flow value, which represents the overall upper limit to the Physical Habitat Claim. Consideration of each of these determinants provided the specified flow value for each month of the claim. The general basis and technical rationale for the Physical Habitat Claims' monthly flow values are further described in Sections VII and VIII.

As to the conditional Physical Habitat monthly flow values, the same determinants as noted above provided the rational for the conditional flow values, with the only difference being that in certain months a different species prioritization applied; that is, for streams or stream reaches in which Chinook salmon was historically present (based on historical information and data), and for which there would be a biological likelihood of presence if reintroduced, Chinook salmon serve as the priority species. For each reach in which a conditional claim applies, I have provided a separate discussion that describes the rationale involved in selecting each of the conditional flow values.

CLAIM 625 – WILLIAMSON RIVER: UPPER KLAMATH LAKE TO HIGHWAY 97

266. Please describe the stream reach associated with Claim 625.

Claim 625 encompasses the lowest reach of the Williamson River extending from the river's mouth where it enters Upper Klamath Lake, upstream approximately 7.0 miles to the Highway 97 Bridge (hereinafter called "Claim Reach 625"). See OWRD Ex. 3 at page 30 describing the upper and lower boundaries of the Claim Reach 625; also see Figure IX-625-1 and Figure IX-625-2.

Physically, the Williamson River within Claim Reach 625 is low gradient (<0.03%) and possesses a wandering, unconfined channel averaging approximately 180 feet wide (Ex. 277-US-417; OWRD Ex. 2, pages 1858-1886). The river valley in this claim reach can be characterized as a wide floodplain with gently rolling slopes. As shown in Figure IX-625-3, peak median flow (2,180 cfs) in the claim reach typically occurs in April and the low median flow (620 cfs) occurs in late summer. The confluence of the river with Upper Klamath Lake includes the Williamson River delta; this area has been highly modified by agricultural activities. Extensive restoration efforts are currently underway in an attempt to reconnect the Williamson River with its historic delta (DEA 2000).

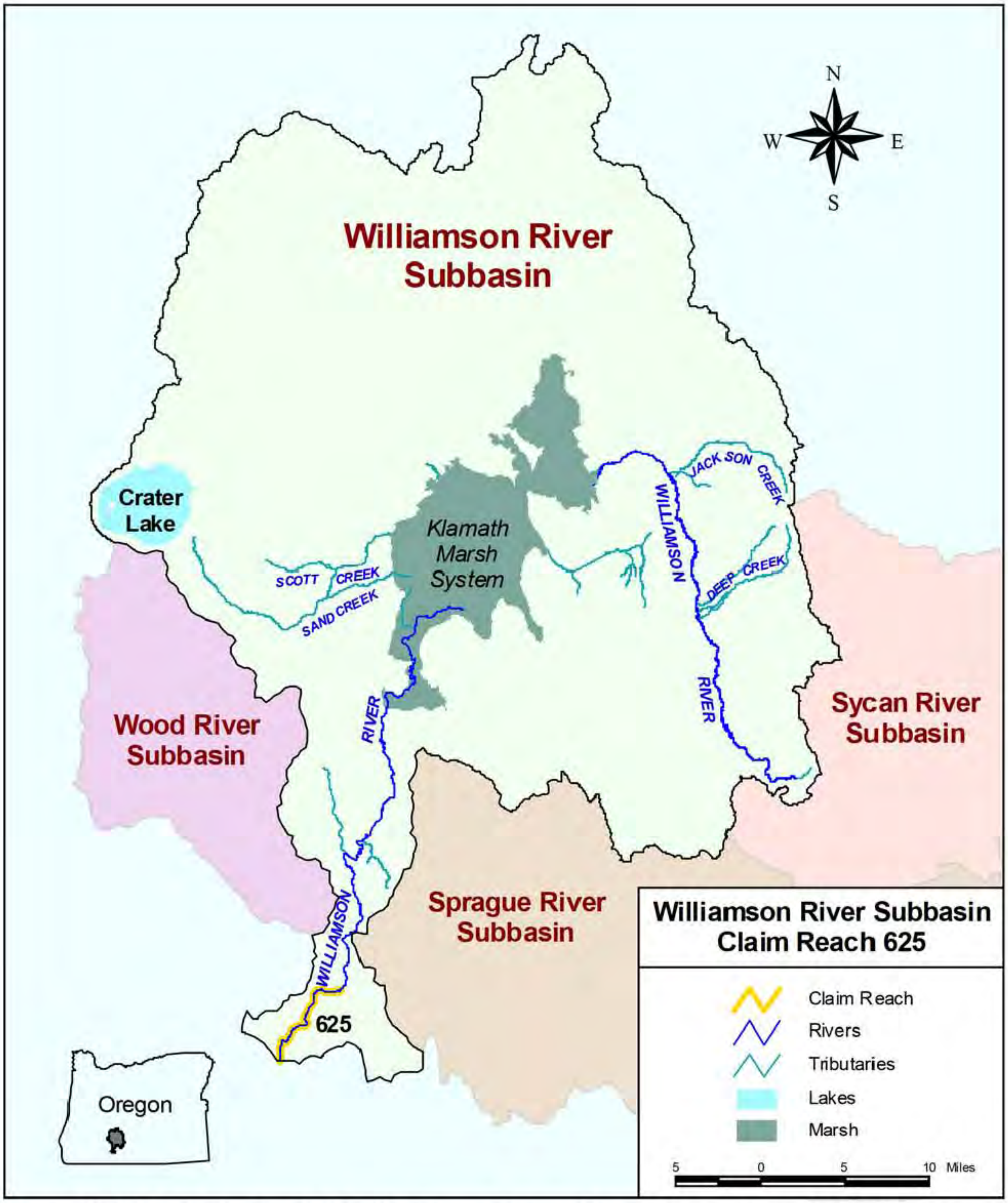


Figure IX-625-1. Claim Reach 625. Williamson River subbasin with claim reach highlighted in yellow.

Figure IX-625-2. Orthographic photograph of Claim Reach 625 (Oregon Imagery Explorer 2007).

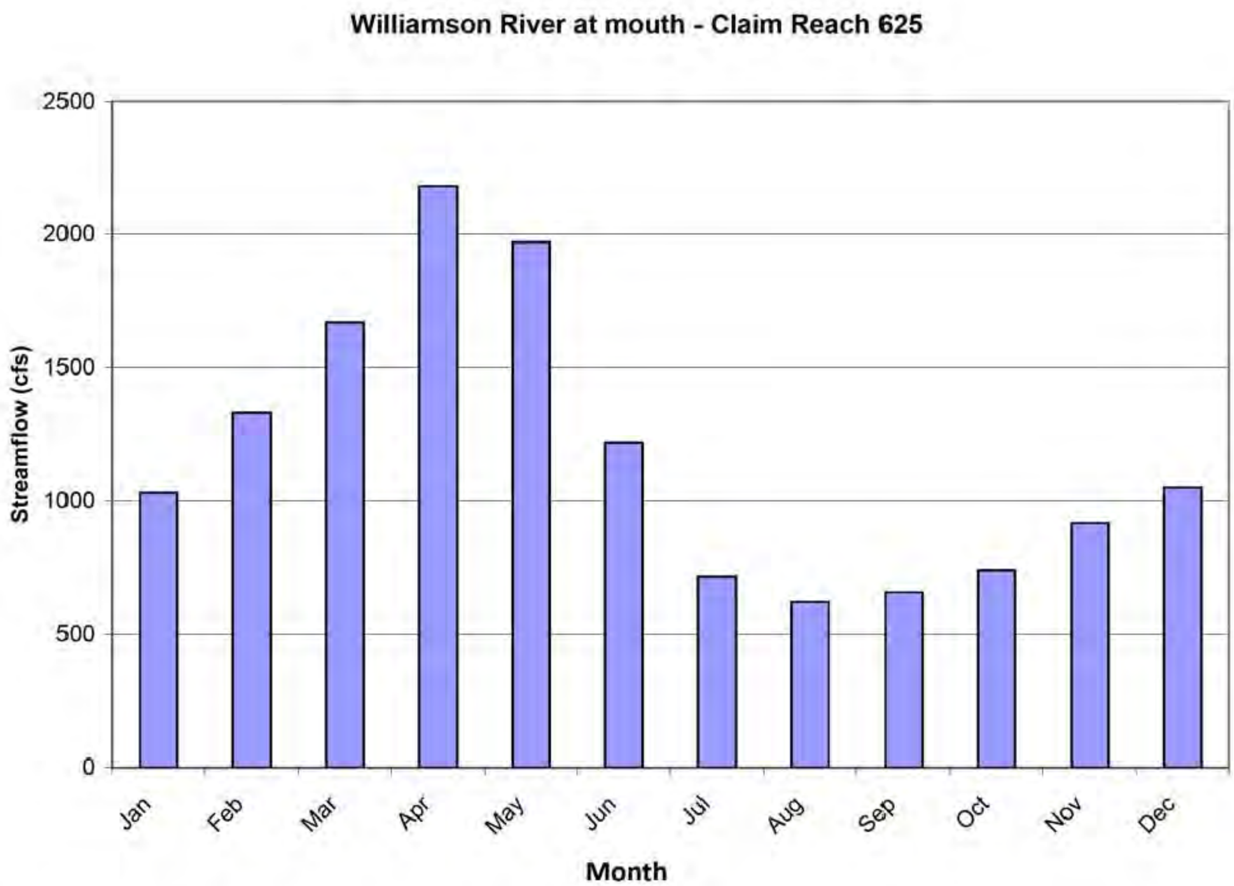


Figure IX-625-3. Williamson River monthly hydrograph (median flow values) at the confluence with Upper Klamath Lake (Claim Reach 625) (Cooper 2004).

267. Are you familiar with this reach of the Williamson River that comprises Claim Reach 625?

Yes. I have visited several portions of Claim Reach 625 several times over the past 20 years including its lowermost point where it enters Upper Klamath Lake; the location where County Road 1334 crosses the river; and in particular, the detailed study site located just below Highway 97. I have also flown over and taken aerial photographs of the entire length of Claim Reach 625.

268. Please describe the stream environment associated with Claim Reach 625.

Based on my observations and information from other sources, the stream environment associated with Claim Reach 625 is as follows: Claim Reach 625 historically included the delta area of the Williamson River's confluence with Upper Klamath Lake, with a complex of wetland types extending over a wide valley-bottom floodplain (DEA 2000). Because of extensive diking and draining that has occurred along portions of the lower Williamson River, existing riparian vegetation is now limited to a relatively narrow floodplain below terraces that rise abruptly from potentially flooded areas (Ex. 277-US-418). Vegetation in the riparian zone is dominated by grasses, interspersed with a few scattered willows. Scattered ponderosa pine occur in upland areas near the river channel, but offer relatively little shade or woody debris recruitment to the river (Dr. Chapin Direct Testimony at question 70).

Fish habitat in Claim Reach 625, consists primarily of several long pools and glides (up to 6,529 ft) separated by relatively short riffles (72 to 427 ft) (Ex. 277-US-418). Most of the riffle habitats are located just below the Highway 97 bridge. Pool depths throughout the reach reportedly range from 13 to 31 feet, and should provide suitable holding areas for Chinook salmon and adfluvial redband trout. The streambed within this pool/glide portion of the Claim Reach is generally dominated by fine substrates consisting of sands and organics; however, gravel substrates suitable for spawning are also present and are located in riffle areas. Visual estimates made by ODFW (Ex. 277-US-418) indicated a total of 37,728 square feet of gravel and cobble present throughout the reach that would be suitable for Chinook salmon spawning. These spawning areas are likely used by adult adfluvial redband trout given their size similarity to Chinook salmon.

The lower portion of Claim Reach 625 is comprised almost entirely of low-gradient, deep, slow moving, run type habitat and has been extensively channelized due to agricultural activities. The channelization of this area resulted in the conversion of an intricate delta that provided extensive fish habitat into a largely single channel system containing relatively little instream cover and a limited riparian zone. As depicted in Figures IV-2 of Section 7, up until just recently (2007), the reach provided relatively little fish habitat and as noted by David Evans & Associates (2005b), conditions that limited possible fish use. For example, larval suckers and juvenile redband trout had essentially no cover except for the immediate vicinity of the shoreline areas of the river.

The Williamson River Delta has become the focus of restoration efforts over the past few years that led to, in October 2007, the restoration of over 2,500 acres of wetlands that are now connected directly to Upper Klamath Lake and that will provide important additional habitats for larval and juvenile shortnose and Lost River suckers (http://www.nature.org/wherewework/northamerica/states/oregon/about/art22854.html). Future efforts will focus on restoration of the lower six miles of the Williamson River resulting in a further increase in fish habitat. Of course, such habitat must be supported by sufficient stream flow.

269. Please describe the target fish species that currently, and in the future will, utilize this reach.

The target fish species that currently occur in this reach include redband trout, Lost River sucker, shortnose sucker, and Klamath largescale suckers. See Figure VII-6 for fish species presence. Spawning of all three sucker species has been documented within the upper portion of the reach (that portion of the reach extending for about 1 mile downstream from the Highway 97 bridge) generally occurring over gravel patches (DEA 2005b). In addition, Claim Reach 625 provides a migratory corridor for adfluvial redband trout and all three sucker species moving to upstream areas to spawn high in the upper basin, and as well for downstream migrating post-spawners and larval and juvenile fish. Juvenile shortnose and Lost River suckers may also use this reach for rearing, with the lake shoreline currently providing the primary rearing habitat for these sucker species (DEA 2005b).

Like sucker species, redband trout spawning habitat is primarily in the riffle areas located in the upper portion of Claim Reach 625 and redband trout fry habitat is currently limited to river shoreline areas that provide some cover. In addition, the entire claim reach serves as a migratory corridor for adfluvial redband trout moving between foraging (feeding) habitat in Upper Klamath Lake and upstream spawning and rearing habitat (DEA 2005b). Adult redband trout that predominantly reside in Upper Klamath Lake also likely use this claim reach to forage and for refuge during periods of high water temperatures and low dissolved oxygen in Upper Klamath Lake.

Numerous other fish species that primarily inhabit Upper Klamath Lake may also use the lower most part of the Williamson River under certain adverse lake conditions (DEA 2005b). These species include the endemic blue chub, Klamath Lake sculpin, slender sculpin, and Klamath Lake lamprey, as well as the native marbled sculpin, speckled dace, tui chub, and Pit-Klamath brook lamprey (Logan and Markle 1993 as cited in DEA 2005b).

Claim Reach 625 will be especially important relative to Chinook salmon upon reintroduction into the Upper Klamath Basin (Hooton and Smith 2008). In addition to providing spawning habitat within the upper portion of the reach, Claim Reach 625 of the Williamson River represents the necessary migration portal for all adult salmon moving into streams to spawn within the Williamson River subbasin, the Sprague River subbasin, and the Sycan River subbasin. The claim reach must also provide the necessary downstream migration portal for all Chinook salmon juveniles and smolts that are moving downstream to the ocean.

270. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 625?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The detailed sampling site for this reach was established in September 1990 and was based on habitat mapping conducted on a section of the river approximately 4,500 feet long (see Figure IX-625-2 illustrating the location of the sampling site on Claim Reach 625). Stream habitat diversity was low and was dominated by run habitat (92%), with some riffles (8%) present OWRD Ex. 2, pages 1858-1886). Because of the monotypic nature of the habitat types (i.e., largely run type habitat), a total of three (3) PHABSIM transects were established and sampled during three separate visits. A summary of the data collection is provided below in Table IX-625-1 and a photograph of transect 1 from the sample site is provided below in Figure IX-625-4.

Table IX-625-1. Dates, habitat types sampled, and number of transects measured during each fie survey completed for Claim Reach 625.

Survey Date	Habitat Type(s) Sampled	Number of Transects
09/19/1990	Run	3
04/04/1991	Run	3
05/12/1993	Run	3

Figure IX-625-4. Lower Williamson River (Claim Reach 625), IFIM/PHABSIM sample site at Transect 1, on April 4, 1991.

OWRD Ex. 2 at 1858 through 1886 includes copies of the field data collected and used to develop the updated Physical Habitat Claim for Claim 625.

271. Is there an updated Physical Habitat Claim for Claim 625?

Yes. The updated Physical Habitat flow values for Claim Reach 625 are based on the data collected (Ex. 277-US-419) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-420 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The updated Physical Habitat flow values for each month are presented in the bottom row of Table IX-625-2. The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flows represent those which I consider sufficient to provide for a healthy and productive habitat in streams within the Williamson River subbasin, including Claim Reach 625, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing target fish species populations at levels at which tribal harvest can occur.

This reach has a number of special qualities: 1) the reach maintains a spring-influenced thermal regime which affords cool water temperatures in the summer months both within the reach and at its downstream terminus within the immediate area of Klamath Lake; 2) the reach is uniquely located in that it represents the first segment of the Williamson River extending from Upper Klamath Lake and provides important coldwater holding and refuge habitats from Upper Klamath Lake during summer months; 3) the reach provides important adfluvial redband trout spawning habitat eleven months out of the year; 4) the reach provides the initial primary, upstream and downstream migratory corridor for adfluvial fish species (Lost River sucker, shortnose sucker, Klamath large scale sucker, and redband trout) from and to Upper Klamath Lake; and 5) the reach is anticipated to support anadromous salmonids upon reintroduction similar to the spawning habitat and migratory support currently provided adfluvial fish species. Because of these special qualities, both individually and in combination, I considered Claim Reach 625 one of the "unique" streams or stream segments in the basin (*see* Section VIII, questions 259 and 260-Final Step Two). As a result, the IFIM/PHABSIM flow was based on providing the greatest amount of potential habitat of the priority species/lifestage.

Table IX-625-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM-based flow for the priority species/lifestage for that month (representing the flow that provides the greatest amount of potential habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); or 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim). The monthly riparian habitat values for the claim reach are described in and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

272. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 625, the IFIM/PHABSIM flows serve as the basis for the updated Physical Habitat flow values in three months (April through June); the incubation flow in no months; the median flow cap in one month (August); and the 1999 claim limits in eight months (July, and September through March). Overall, the updated Physical Habitat flows are less than the 1999 Physical Habitat Claim flow values in four months, and are equal to the 1999 Physical Habitat Claim flow values in eight months.

Table IX-625-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 625, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-a	RT-s	RT-s	RT-s
1999 Physical Habitat Claim Flow Values	650	650	650	900	900	900	650	650	650	650	650	650
100% WUA	873	873	873	873	873	873	873	873	1600	873	873	873
Incubation Flow									413			
Median Flow	1030	1330	1670	2180	1970	1220	715	620	656	740	916	1050
Updated IFIM/PHABSIM-Based Flows	873	873	873	873	873	873	873	873	1600	873	873	873
Updated Physical Habitat Claim	**650**	**650**	**650**	**873**	**873**	**873**	**650**	**620**	**650**	**650**	**650**	**650**

RT-a = adult redband trout; RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

273. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 625.

The IFIM/PHABSIM flows are based on a single target species, redband trout, and two lifestages, adult and spawning. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

October – August

The IFIM/PHABSIM flows for this period are based on redband trout spawning within Claim Reach 625 (Figure VII-6). The IFIM/PHABSIM-based flows that represent 100 percent of the potential amount of redband trout habitat is 873 cfs. For the months of April through June, the IFIM/PHABSIM-based flow is lower than both the median flow and the 1999 claim flow and, therefore, constitutes the updated Physical Habitat flow value for these three months. For the months of July, and October through March, the IFIM/PHABSIM flow exceeds the 1999 claim flow of 650 cfs. Therefore, the 1999 Physical Habitat Claim flow value constitutes the updated Physical Habitat flow for the months of July, and October through March. For the month of August, the median flow of 620 cfs is less than the IFIM/PHABSIM flow and, therefore, constitutes the updated Physical Habitat flow for the month of August (Table IX-625-2).

September

The IFIM/PHABSIM flows for this period are based on redband trout adults that would be rearing, holding, or moving through Claim Reach 625 (Figure VII-6). The IFIM/PHABSIM flow representing 100 percent of the potential amount of redband trout habitat is 1,600 cfs, which exceeds the 1999 claim flow of 650 cfs. Redband trout egg incubation also occurs in this month and incubation flowwas considered. However, the incubation flow for this month (2/3 of 620 cfs, or 413 cfs) was less than both the IFIM-PHABSIM-based flow and the 1999 claim flow. Therefore, the 1999 Physical Habitat Claim flow constitutes the updated Physical Habitat flow for the month of September (Table IX-625-2).

274. Is there a conditional Physical Habitat Claim for Claim 625?

Yes. When anadromous fish are reintroduced, they will likely be present in September (during which Chinook spawning would replace redband trout adult as the priority species), October through November (during which Chinook spawning would replace redband trout spawning as the priority species and lifestage), and December through February (during which Chinook egg incubation would occur) (Figure VII-6).[1]

275. When adjustments were made to the Physical Habitat flow values for the inclusion of Chinook, how many of the updated Physical Habitat flows were based on: the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim flow limit?

Compared to the flow values just provided for the Physical Habitat Claim based on current species, anadromous fish presence requires re-evaluation of the updated Physical Habitat flows in the months of September through February.

With Chinook salmon included as a priority species, the IFIM/PHABSIM flow served as the basis for the updated Physical Habitat flows in three months (April through June); egg incubation in no month; the median flow cap in one month (August); and the 1999 claim limit in eight months (July, and September through March). Overall, the conditional Physical Habitat flow values are less than the 1999 Physical Habitat Claim flow values in four months, and equal to the 1999 Physical Habitat Claim flow values for eight months.

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1 In fact, when reintroduced, it can be expected that Chinook salmon will be migrating into and present in streams of the Upper Klamath Basin from June through November of each year. As explained in Sections VII and VIII, Chinook salmon presence, as adults, will not displace the priority of other target fish species engaged in spawning.

Table IX-625-3. Conditional Physical Habitat Claim and monthly instream flow values for Claim Reach 625, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	CH-s	CH-s	CH-s	RT-s
1999 Physical Habitat Claim Flow Values	650	650	650	900	900	900	650	650	650	650	650	650
100% WUA	873	873	873	873	873	873	873	873	2000	2000	2000	873
Incubation	433	433										433
Median flow	1030	1330	1670	2180	1970	1220	715	620	656	740	916	1050
Conditional IFIM/PHABSIM-Based Flows	873	873	873	873	873	873	873	873	2000	2000	2000	873
Conditional Physical Habitat Claim	**650**	**650**	**650**	**873**	**873**	**873**	**650**	**620**	**650**	**650**	**650**	**650**

RT-s = spawning redband trout; CH-s = Chinook salmon spawning
All values included in this table are presented in cubic feet per second (cfs).

276. Please provide more detail regarding the determination of the monthly flows for the conditional flow values for Claim Reach 625.

As noted above, there are six months for which consideration of Chinook presence will result in modifications to or otherwise impact the priority species and lifestage. These include the months of September through November which reflect the spawning period of Chinook and December through February which reflect the incubation period of Chinook eggs and embryos.

September – November (conditional claim)

Information obtained from Fish Pro (2000), Hamilton et al. (2005), Huntington and Dunsmoor (2006), and Hooton and Smith (2008) predict the use of Claim Reach 625 by spawning Chinook salmon during the period from September through November. The flow that represents 100 percent of the potential amount of Chinook salmon habitat is 2,000 cfs. For each month, this flow is higher than the median flow (656 to 916 cfs), and higher than the 1999 Physical Habitat Claim flow value of 650 cfs. As a result, the conditional Physical Habitat flow values are maintained at the 1999 Physical Habitat Claim flow value level of 650 cfs during the period of September through November (see Table IX-625-3).

December – August (conditional claim)

For this period, the species and lifestage priority remain redband trout spawning. Because Chinook salmon spawning occurred up through November, incubation flows to protect Chinook eggs and embryos (2/3 of 650 cfs or 433 cfs) were considered for three months after (i.e., December through February). However, the incubation flow is less than flows associated with redband trout spawning. Therefore, the conditional Physical Habitat flow values remain as noted above and as previously described for this period (Table IX-625-3).

CLAIM REACH 626 – WILLIAMSON RIVER: HIGHWAY 97 TO SPRAGUE RIVER CONFLUENCE

277. Please describe the stream reach associated with Claim 626.

Claim 626 encompasses the reach of the Williamson River extending from the Highway 97 Bridge upstream approximately 3.7 miles to the Williamson River's confluence with the Sprague River (hereinafter called "Claim Reach 626"). See OWRD Ex. 4 at 13 describing the upper and lower boundaries of the Claim Reach 626; also see Figure IX-626-1 and Figure IX-626-2.

The Williamson River channel within this reach is moderately confined, has low sinuosity and gradient (0.06%), and a channel width that averages approximately 170 feet (Ex. 277-US-417; Ex. 277-US-421). The valley has a narrow but active floodplain and can be characterized as moderately constrained with relatively steep sideslopes close to the channel. Diking and streambank modifications have occurred along most of the western side of the claim reach to protect railroad tracks, agricultural lands, and the Modoc Point Irrigation Ditch. Peak median monthly flow (2,170 cfs) in this reach typically occurs in April, and low median flow (620 cfs) in late summer (Figure IX-626-3).

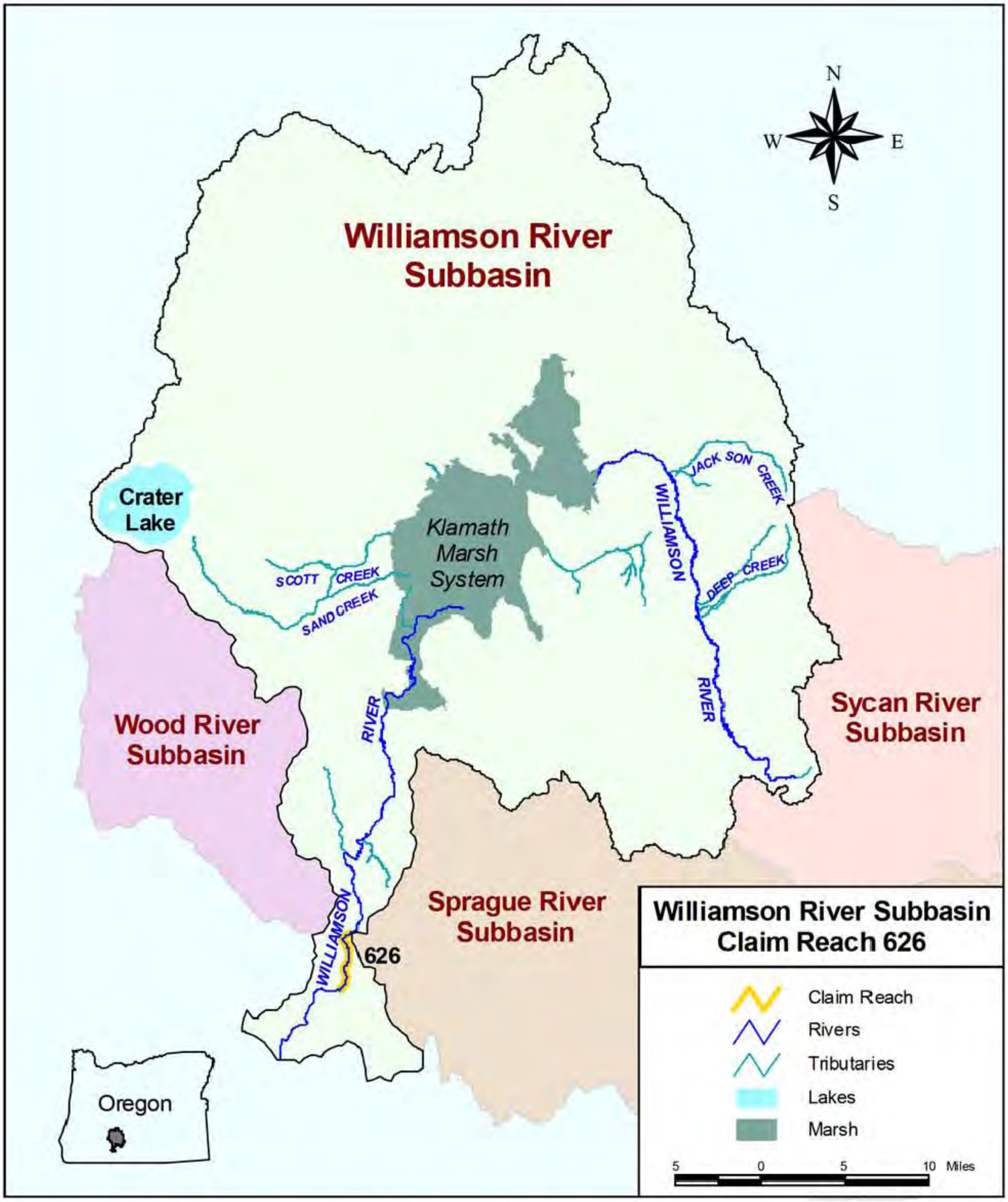

Figure IX-626-1. Claim Reach 626. Williamson River Subbasin with claim reach highlighted in yellow.

Figure IX-626-2. Orthographic photograph of Claim Reach 626 (Oregon Imagery Explorer 2007).

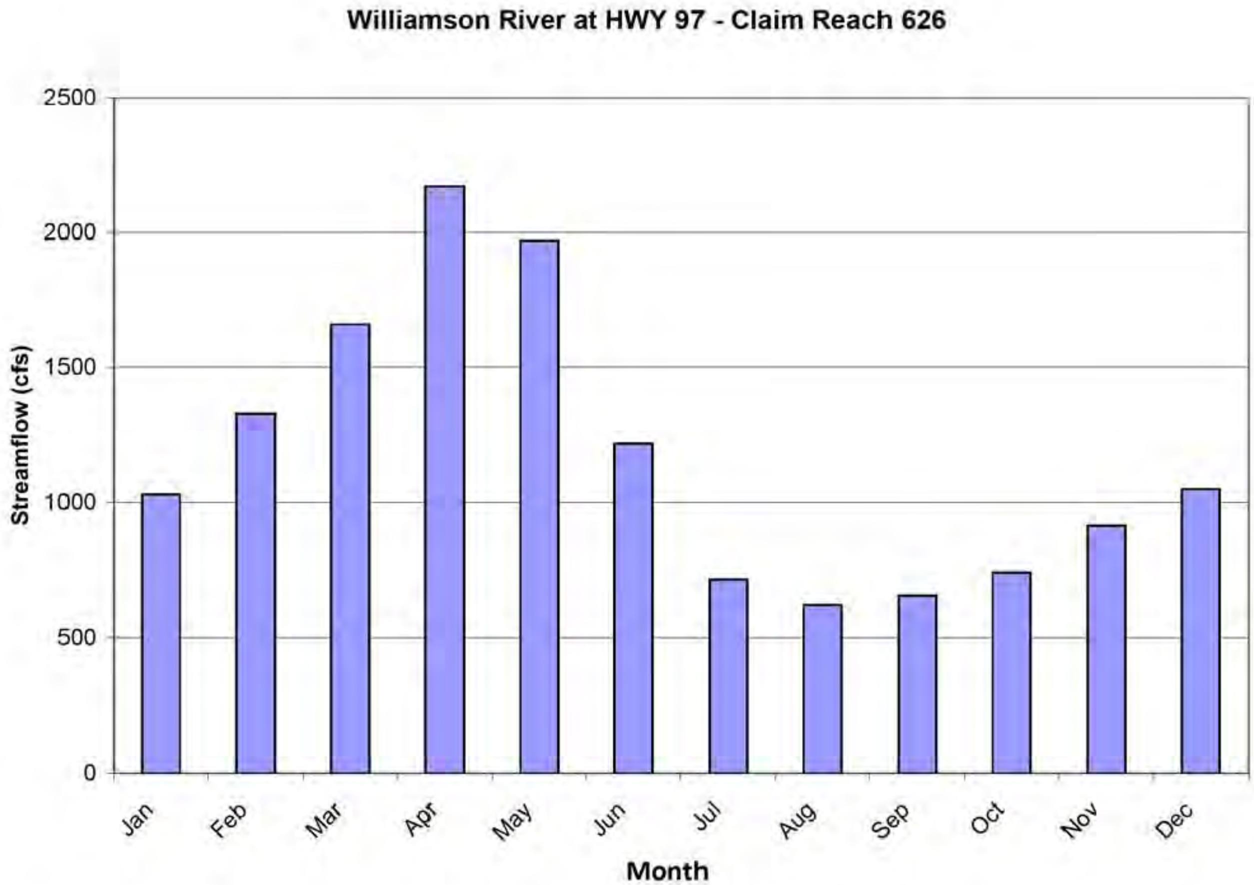

Figure IX-626-3. Williamson River monthly hydrograph (median flow values) at the Highway 97 Bridge (Claim Reach 626) (Cooper 2004).

278. Are you familiar with this reach of the Williamson River that comprises Claim Reach 626?

Yes. I have visited several portions of Claim Reach 626 several times over the past 20 years including its lowermost point where it goes under the Highway 97 Bridge and its uppermost point where the Sprague River enters from the southeast. Most recently, I completed a field reconnaissance of the detailed IFIM/PHABSIM site in June 2006 to check transect locations and survey points and assess overall habitat conditions. I have also flown over and photographed from the air the entire length of Claim Reach 626.

279. Please describe the stream environment associated with Claim Reach 626.

Based on my observations and information, the stream environment associated with Claim Reach 626 is as follows. Riparian vegetation in the lower Williamson River (including Claim Reach 626) has been affected by diking and channel hardening, which essentially means sections of the riverbank have been reinforced with large boulders and riprap to prevent erosion. Existing riparian vegetation is dominated by grasses with patches of willows and alders scattered along the banks. Ex. 277-US-422. The lower 3-mile portion of the 3.7 mile reach has a relatively narrow floodplain and riparian zone. In some places where the floodplain becomes wider, the riparian zone is now in agricultural or cattle pasture. In the upper approximately 0.7 mile of the claim reach, riparian vegetation is comprised of more native species with copious willows and a number of wet meadows. Overall, there is relatively little streamside shade provided by riparian trees (Dr. Chapin Direct Testimony at question 70).

Fish habitat of Claim Reach 626 consists primarily of a series of long pools and runs that are separated by short low-gradient riffles (Ex. 277-US-422). Pool depths range from 14 to 27 feet and provide excellent holding areas for adult adfluvial redband trout, the three sucker species and, when reintroduced, migrating Chinook salmon. The streambed is generally dominated by fine substrates, with 45 percent sand and organics, 8 percent gravel, 23 percent cobble, and 9 percent bedrock. Most spawning sized substrates (i.e., gravels and cobble) within the reach are found in riffles, particularly adjacent to mid-channel gravel bars, which are composed of 38 percent gravel and 33 percent cobble. Visual estimates completed by ODFW (Ex. 277-US-422), indicated a total of 138,176 square feet of gravel and cobble in the reach that would be suitable for Chinook salmon spawning at existing low flows, as well as an additional

7,061 square feet that would be available at high flows. I observed suitable spawning habitat across several of the transects we measured as part of the IFIM/PHABSIM surveys.

Woody debris density in this claim reach is low and was reported at 1.2 pieces per 100 feet of stream length, consisting mostly of sunken logs that presumably came from saw mill storage activities. Most of the woody debris found within the claim reach is located in the upper half mile of the reach where submerged logs are sitting on the bottom of pools (Ex. 277-US-422).

Water temperatures within this reach are heavily influenced by the coldwater flows provided via a number of spring-dominated streams in upstream segments of the Williamson River. However, during the summer months, water temperatures in this reach become elevated due to the inflow of warmer waters provided by the Sprague River. This was documented by the ODFW (Ex. 277-US-422) in August 2004 when temperatures measured in the Williamson River above the Sprague River were 52.7°F, and temperatures below the confluence with the Sprague River within Claim Reach 626 were 60.8°F, a difference of about 8°F. The water temperature in the Sprague River at the time was 70.7°F. Similar results were reported by ODEQ (2002) in their analyses of basin-wide stream temperatures conducted with Forward Looking Infrared (FLIR) imagery in August 1999 (Watershed Sciences 2000). I have provided one of the FLIR images below (Figure IX-626-4) that serves to highlight the differences in water temperatures that can occur between the Sprague and Williamson River during the summer months, and the downstream effects on water temperatures in the Williamson River.

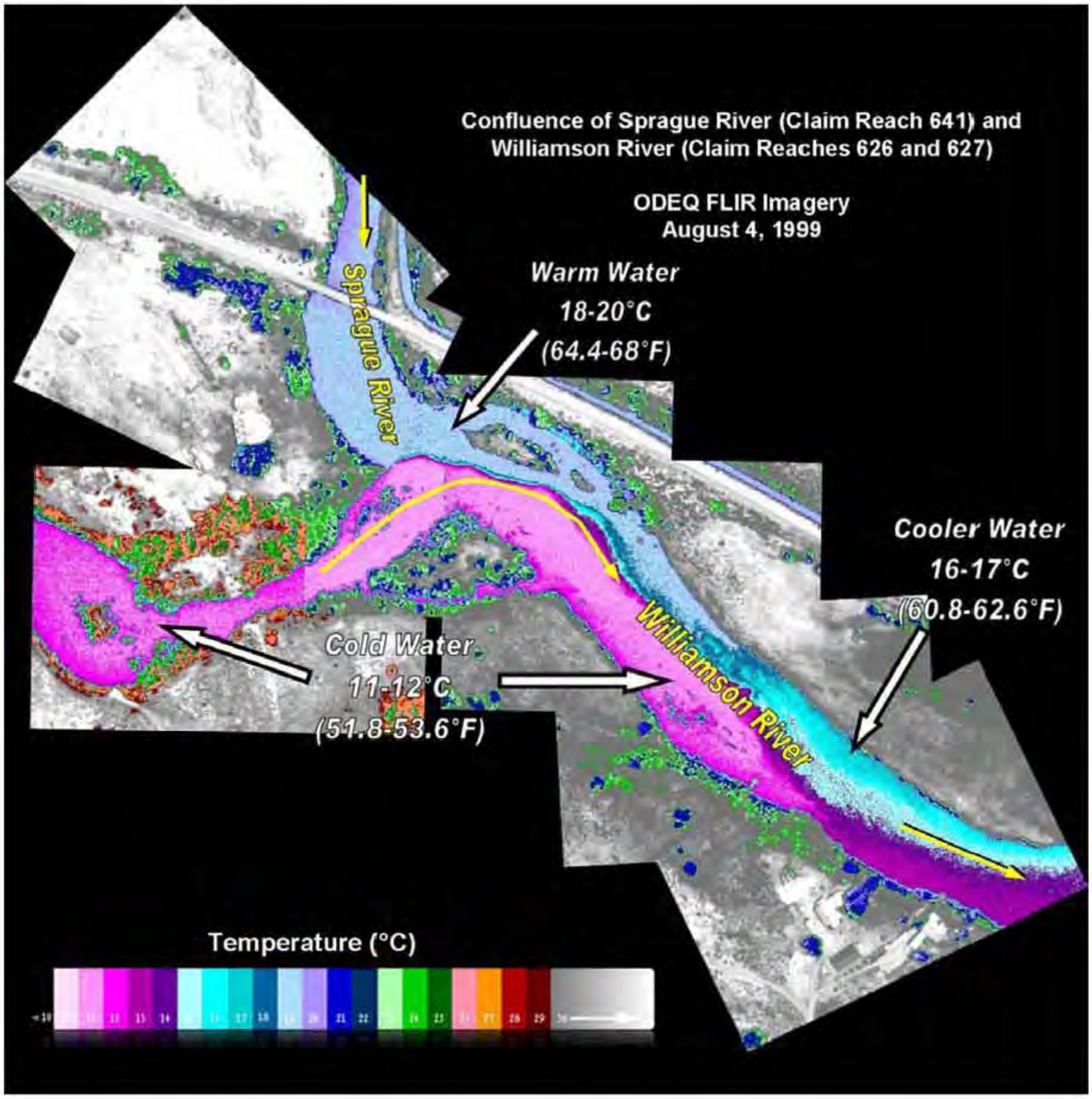

Figure IX-626-4. A mosaic of ODEQ's Forward Looking Infrared (FLIR) imagery showing the confluence of the Williamson River (53.8°F) and Sprague River (70.5°F), taken in August 1999. Temperatures located about 0.25 miles below the confluence were around 60°F (ODEQ 2002).

280. Please describe the target fish species that currently, and in the future will, utilize this reach.

The target fish species that currently occur in this reach include redband trout, Lost River sucker, shortnose sucker, and Klamath largescale suckers. In addition to providing sucker spawning areas, Claim Reach 626 also provides a migratory corridor for all three sucker species moving to upstream areas to spawn in the upper reaches of the Upper Klamath Basin, and as well for downstream migrating sucker post-spawners and larval fish. During electrofishing surveys in 1993 and snorkel surveys in 2003 and 2004, we documented the presence of adult and juvenile redband trout as well as Lost River suckers in Claim Reach 626 (Ex. 277-US-423).

Redband trout also spawn in this reach, with spawning habitat primarily located in riffle areas within the upper portion of Claim Reach 626. Redband trout fry and juvenile rearing habitat is provided along the reach's shoreline areas and in conjunction with pool and run type habitats containing cover. Like downstream Claim Reach 625, the entire Claim Reach 626 serves as a migratory corridor for adfluvial redband trout moving between habitats in Upper Klamath Lake and upstream spawning and rearing habitats. Adult redband trout also likely use this claim reach to forage (feed) and for refuge during periods of high water temperatures and low dissolved oxygen in Upper Klamath Lake, and during elevated water temperatures in the Sprague River. From species documented in nearby reaches of the lower Williamson River subbasin (i.e., Claim Reaches 625, 627 and 628), additional species in this reach, include brown trout, speckled dace, and various sculpin, lamprey, and chub species (Ex. 277-US-424).

Like the downstream Claim Reach 625, Claim Reach 626 would be especially important to Chinook salmon, a species that was historically present and that is planned for reintroduction into the Upper Klamath Basin (Hooton and Smith 2008). In addition to providing salmon spawning habitat within the upper portion of the reach, Claim Reach 626 represents an important component of the upstream migration corridor necessary for adult salmon moving into streams to spawn within the Williamson River subbasin, and also the necessary downstream migration corridor for all Chinook salmon juveniles and smolts moving to the ocean. The cooler water temperatures associated with this reach compared to those in the Sprague River, will likely make it especially important as holding habitat for adult Chinook salmon (especially spring Chinook) destined for the Sprague River subbasin that have arrived after water temperatures in the Sprague River have become elevated and are not suitable for upstream passage. The cooler water temperatures in this reach as well as those in the next upstream Williamson River subbasin reach (Claim reach 627) will provide coldwater refuge habitat during these periods until such time that water temperatures in the Sprague River are reduced and upstream migration can resume.

281. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 626?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The detailed IFIM/PHABSIM sampling site that formed the basis for the updated Physical Habitat Claim was established in May 2004, and was based on habitat mapping conducted on a section of the claim reach extending 4,325 feet (Figure IX-626-2). A diversity of habitat types were present, with run, riffle, and pool habitat types each comprising greater than 10 percent of the total length of the reach habitat mapped. A total of 9 IFIM/PHABSIM transects were established and sampled during three separate site visits (Table IX-626-1). A summary of the data collection is provided below and a photograph of transect 1 from the sample site is provided below in Figure IX-626-5.

Table IX-626-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 626.

Survey Date	Habitat Type(s) Sampled	Number of Transects[1]
05/11/2004	Run, Riffle, Pool	9
06/29/2004	Run, Riffle, Pool	9
08/19/2004	Run, Riffle, Pool	9

[1]Represents total number of transects, consisting of 3 transects per each habitat type.

Figure IX-626-5. Lower Williamson River (Claim Reach 626), IFIM/PHABSIM sample site, at Transect 1 on May 11, 2004.

Ex. 277-US-421 includes copies of the field data collected and used to develop the updated Physical Habitat Claim for Claim 626.

282. Is there an updated Physical Habitat Claim for Claim 626?

Yes. The updated Physical Habitat flows for Claim Reach 626 are based on the data collected (Ex. 277-US-425) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-426 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The updated Physical Habitat flows for each month are presented in the bottom row of Table IX-626-2. The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flows represent those which I consider sufficient to provide for a healthy and productive habitat in streams within the Williamson River subbasin, including Claim Reach 626, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing target fish species populations at levels at which tribal harvest can occur.

This reach has a number of special qualities: 1) the reach maintains a spring-influenced thermal regime which affords cool water temperatures in the summer months both within the reach and below the reach; 2) the reach is uniquely located immediately below an important river confluence (the Williamson and Sprague rivers) and provides important coldwater holding and refuge habitats from the Sprague River during summer months; 3) the reach provides important adfluvial redband trout spawning habitat eleven months out of the year; 4) the reach provides a primary, upstream and downstream migratory corridor for adfluvial fish species (Lost River sucker, shortnose sucker, Klamath large scale sucker, and redband trout) from and to Upper

Klamath Lake; and 5) the reach is anticipated to support anadromous salmonids upon reintroduction similar to the spawning habitat and migratory support currently provided adfluvial fish species. Because of these special qualities, both individually and in combination, I considered Claim Reach 626 one of the "unique" streams or stream segments in the basin (*see* Section VIII, questions 259 and 260-Final Step Two). As a result, the IFIM/PHABSIM flow was based on providing the greatest amount of potential habitat of the priority species/lifestage.

Table IX-626-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM-based flow for the priority species/lifestage for that month (representing the flow that provides 100 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); and 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim). The monthly Riparian Habitat Claims for Claim Reach 626 are described in and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

283. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 626, the basis for the updated Physical Habitat flows was the IFIM/PHABSIM flows in three months (April through June); the incubation flow in no month; the median flow cap in one month (August); and the 1999 claim limit in eleven months (September through July), three of which (for the months of April through June) corresponded to the IFIM/PHABSIM flows. Overall, the updated Physical Habitat flows are less than the 1999 Physical Habitat Claim flow values in one month, and equal to the 1999 Physical Habitat Claim flow values in eleven months.

Table IX-626-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 626, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-a	RT-s	RT-s	RT-s
1999 Physical Habitat Claim Flow Values	650	650	650	700	700	700	650	650	650	650	650	650
100% WUA	700	700	700	700	700	700	700	700	700	700	700	700
Incubation Flow									413			
Median Flow	1030	1330	1660	2170	1970	1220	715	620	656	740	915	1050
Updated IFIM/PHABSIM-Based Flows	700	700	700	700	700	700	700	700	700	700	700	700
Updated Physical Habitat Claim	**650**	**650**	**650**	**700**	**700**	**700**	**650**	**620**	**650**	**650**	**650**	**650**

RT-a = adult redband trout; RT-s = spawning redband trout
All values included in this table are presented in cubic feet per second (cfs).

284. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 626.

The IFIM/PHABSIM flows are based on a single target species, redband trout, and two lifestages, adult and spawning. The discussion below is organized by periods of one or more months that share the same species/lifestage priority and for which the monthly flow values were based on the same rationale.

October – August

The IFIM/PHABSIM flows for this period are based on redband trout spawning within Claim Reach 626 (Figure VII-6). The flow that represents 100 percent of the potential amount of habitat is 700 cfs. For the months of July and October through March, the IFIM/PHABSIM flows are greater than the 1999 claim flows, while in April through June the IFIM/PHABSIM flows and 1999 claim flows are equal. Therefore, the updated Physical Habitat flow values for this reach are the same as the 1999 Physical Habitat Claim flow values for the period October through July. For the month of August, the IFIM/PHABSIM flows are greater than the median flow of 620 cfs. Therefore, the median flow constitutes the updated Physical Habitat flow value for the month of August (Table IX-626-3).

September

The IFIM/PHABSIM flows for this period are based on redband trout adults that would be rearing, holding, or moving through Claim Reach 626 (Figure VII-6). The IFIM/PHABSIM flows representing 100 percent of the potential amount of redband trout habitat is 700 cfs, which is greater than both the median flow (656 cfs) and the 1999 claim flow (650 cfs). Redband trout egg incubation also occurs in this month and incubation was considered. However, incubation flow (2/3 of 620 cfs or 413 cfs) was less than the 1999 claim flow. Therefore, the updated Physical Habitat flow is equal to the 1999 Physical Habitat Claim flow value for the month of September (Table IX-626-2).

285. Is there a conditional Physical Habitat Claim for Claim 626?

Yes. When anadromous fish are reintroduced, they will likely be present in September (when Chinook spawning would replace redband trout adult as the priority species and lifestage), October through November (when Chinook spawning would replace redband trout spawning as the priority species and lifestage), and December through February (when Chinook egg incubation would occur) (Figure VII-6).[1]

286. When adjustments were made to the Physical Habitat flow values for the inclusion of Chinook, how many of the updated Physical Habitat flows were based on: the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim flow limit?

Compared to the flow values just provided for the Physical Habitat Claim based on current species, anadromous fish presence requires re-evaluation of the updated Physical Habitat flows in the months of September through February.

With Chinook salmon included as a priority species, the basis for the updated Physical Habitat flows for Claim Reach 626 was the IFIM/PHABSIM flow in three months (April through June); the incubation flow in no month; the median flow cap in one month (August); and the 1999 claim limit in eleven months (September through July), three of which (for the months of April through June) corresponded to the IFIM/PHABSIM flows. Overall, the conditional Physical Habitat flows are less than the 1999 Physical Habitat Claim flow values in one month, and equal to the 1999 Physical Habitat Claim flow values in eleven months.

[1] In fact, when reintroduced, it can be expected that Chinook salmon will be migrating into and present in streams of the Upper Klamath Basin from June through November of each year. As explained in Sections VII and VIII, Chinook salmon presence, as adults, will not displace the priority of other target fish species engaged in spawning.

Table IX-626-3. Conditional Physical Habitat Claim and monthly instream flow values for Claim Reach 626, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	CH-s	CH-s	CH-s	RT-s
1999 Physical Habitat Claim Flow Values	650	650	650	700	700	700	650	650	650	650	650	650
100% WUA	700	700	700	700	700	700	700	700	1400	1400	1400	700
Incubation	433	433										433
Median Flow	1030	1330	1660	2170	1970	1220	715	620	656	740	915	1050
Conditional IFIM/PHABSIM-Based Flows	700	700	700	700	700	700	700	700	1400	1400	1400	700
Conditional Physical Habitat Claim	**650**	**650**	**650**	**700**	**700**	**700**	**650**	**620**	**650**	**650**	**650**	**650**

RT-s = spawning redband trout; CH-s = Chinook salmon spawning
All values included in this table are presented in cubic feet per second (cfs).

287. Please provide more detail regarding the determination of the monthly flows for the conditional claim for Claim Reach 626.

As noted above, there are six months for which consideration of Chinook presence will result in modifications to or otherwise impact the priority species and lifestage. These include the months of September through November which reflect the spawning period of Chinook and December through February which reflect the incubation period of Chinook eggs and embryos

September – November (conditional claim)

Information obtained from Fish Pro (2000), Hamilton et al. (2005), Huntington and Dunsmoor (2006), and Hooton and Smith (2008) predict the use of Claim Reach 626 by spawning Chinook salmon during the period from September through November. The flow that represents 100 percent of the potential amount of Chinook salmon habitat is 1,400 cfs. This flow is higher than the median flow (656 to 915 cfs), and the 1999 Physical Habitat Claim flow value of 650 cfs. As a result, the conditional Physical Habitat flow values are maintained at the 1999 Physical Habitat Claim flow value of 650 cfs during the period of September through November (see Table IX-626-3).

December – August (conditional claim)

For this period, the species and lifestage priority remain redband trout spawning. Because Chinook salmon spawning occurred through November, incubation flow to protect Chinook eggs and embryos (2/3 of 650 cfs or 433 cfs) was also considered from December to February; however, incubation flows were less than the flows associated with redband trout spawning. Therefore, the conditional Physical Habitat flow values remain as noted above and as previously described for this period (Table IX-626-3).

CLAIM REACH 627 – WILLIAMSON RIVER: SPRAGUE RIVER CONFLUENCE TO SPRING CREEK

288. Please describe the stream reach associated with Claim 627.

Claim 627 encompasses the reach of the Williamson River extending from the river's confluence with the Sprague River upstream about 5 miles to the confluence with Spring Creek, (hereinafter called "Claim Reach 627"). See OWRD Ex. 5 at 13 describing the upper and lower boundaries of the Claim Reach 627; also see Figure IX-627-1 and Figure IX-627-2. Inflow from Spring Creek and the Sprague River at the upper and lower claim reach breaks, respectively, represent the major tributary inputs to the lower Williamson River. The Williamson River channel within Claim Reach 627 is straight with a low gradient (<0.05%) and a moderately confined channel ranging from 90 to 162 feet wide (Ex. 277-US-417; Ex. 277-US-427). The valley has a narrow but active floodplain and can be characterized as moderately constrained with relatively shallow sideslopes close to the channel. Peak median monthly flows (876 cfs) in this reach typically occur in April and low median monthly flows (368 cfs) occur in late summer to early fall (Figure IX-627-3).

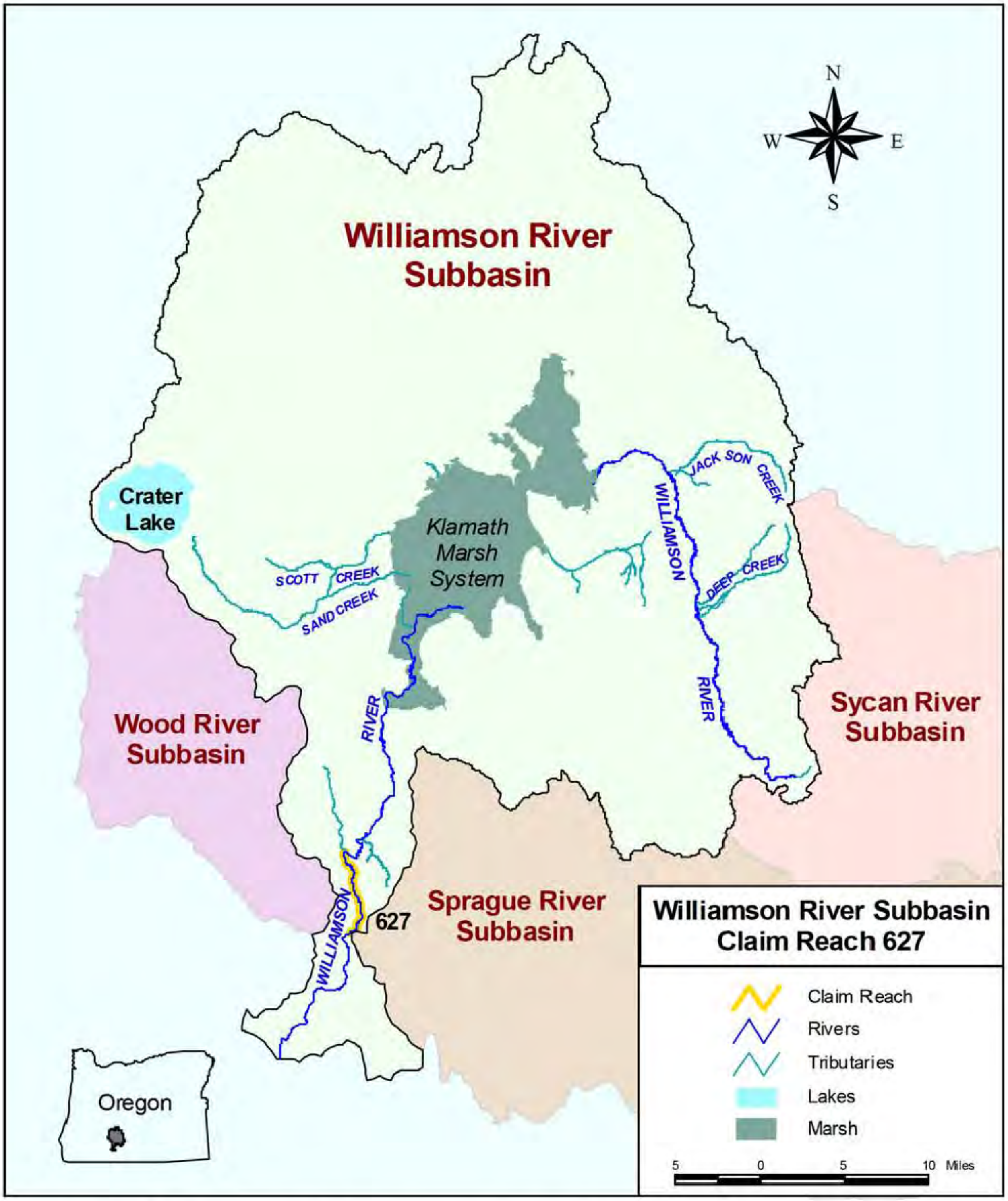

Figure IX-627-1. Claim Reach 627. Williamson River subbasin with claim reach highlighted in yellow.

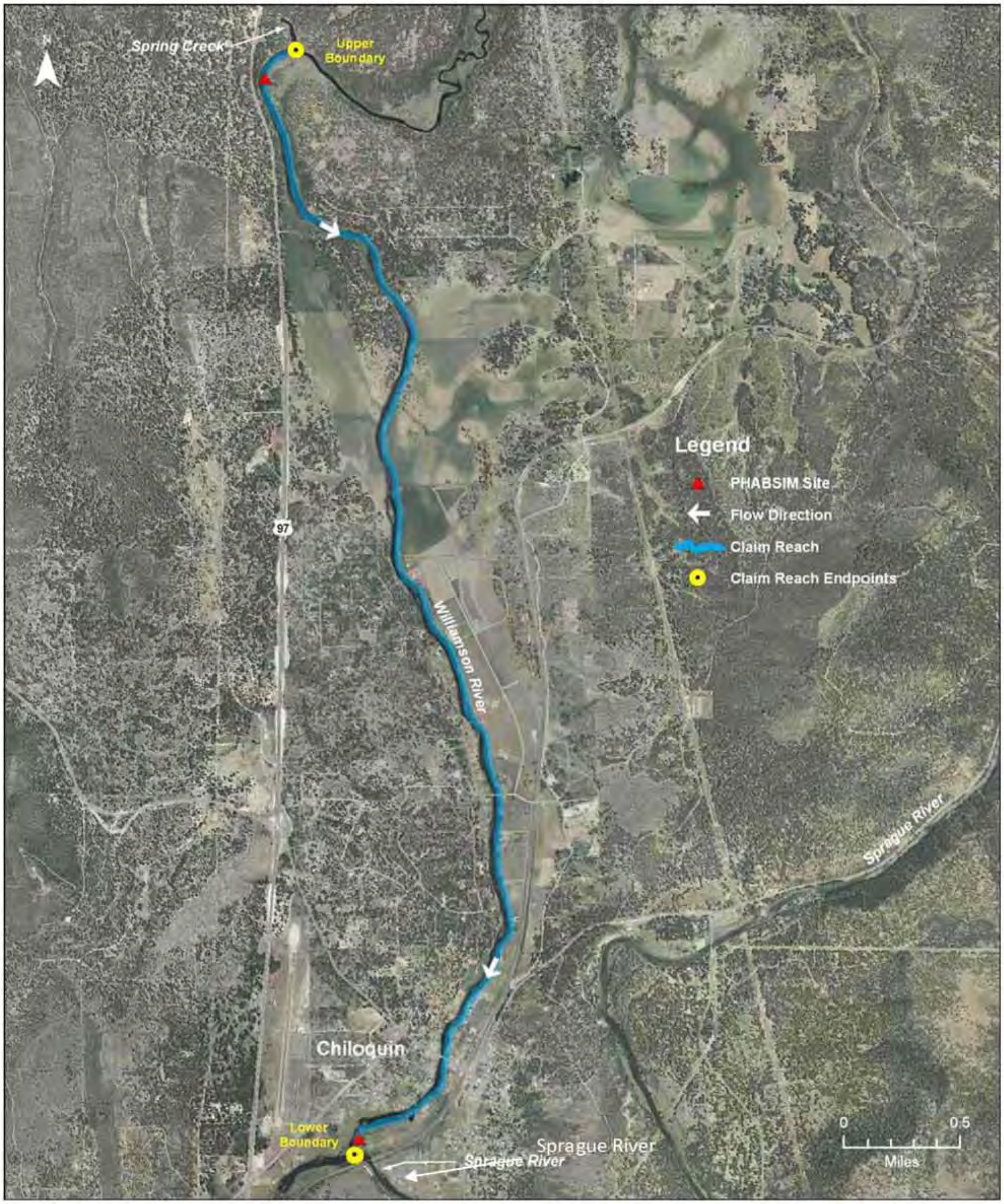

Figure IX-627-2. Orthographic photograph of Claim Reach 627 (Oregon Imagery Explorer 2007).

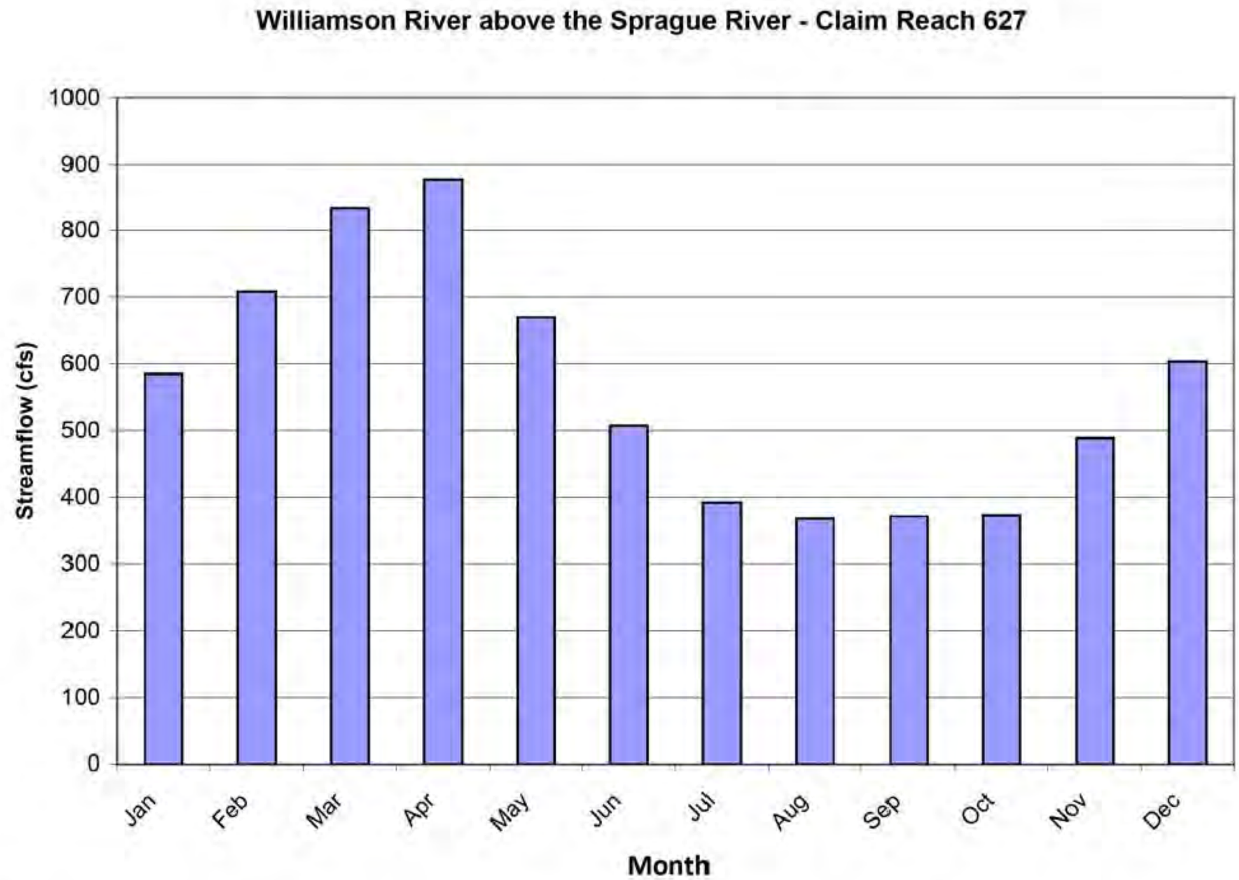

Figure IX-627-3. Williamson River monthly hydrograph (median flow values) above the Sprague River (Claim Reach 627) (Cooper 2004).

289. Are you familiar with this reach of the Williamson River that comprises Claim Reach 627?

Yes. I have visited portions of Claim Reach 627 a number of times over the past 20 years including its lowermost point where the Sprague River enters; the point where Spring Creek enters within Collier State Park; the upper IFIM/PHABSIM site which begins about 300 feet below the confluence of Spring Creek; and the lower IFIM/PHABSIM site located about 500 feet upstream from the confluence with the Sprague River. I have also snorkeled the upper segment of this reach as part of Habitat Suitability Curve data collection activities. Most recently, I completed a field reconnaissance of the two detailed IFIM/PHABSIM sites in June 2006 to check transect locations and assess overall habitat conditions. I have also flown over and photographed from the air the entire length of Claim Reach 627.

290. Please describe the stream environment associated with Claim Reach 627.

Based on my observations and information from other sources, the stream environment associated with Claim Reach 627 is as follows. Riparian vegetation within this reach of the Williamson River is dominated by grasses, shrubs and deciduous trees (willow and aspen). The lower portion (approximately 1.5 miles) of the reach flows through the town of Chiloquin and outlying semi-rural land use, where riparian vegetation has been altered by human development. Nonetheless, areas still exist in this lower portion of the claim reach with dense stands of willow and shrub species within the riparian zone. Progressing upstream approximately 2 – 2.5 miles, the river passes through an area heavily utilized for pasture where the riparian vegetation becomes relatively sparse and there is noticeable bank erosion. Further upstream, about 3-4 miles, the riparian vegetation becomes more diverse and abundant. In the uppermost portion of the reach near Spring Creek, the riparian zone becomes limited to a narrow band paralleling the river (Ex. 277-US-428; Dr. Chapin Direct Testimony at question 70).

Fish habitat of Claim Reach 627 is composed almost exclusively of slow moving, deep water pool/glide type habitats with only one short (approximately 0.5 miles) section with riffle habitat. Near the confluence with the Sprague River, a series of boulder-created cascades and riffles contain some spawning habitat; these boulders also impound a long pool that extends upstream 3.7 miles. With a maximum measured depth of 34 feet, this pool likely provides abundant holding area for adult redband trout and will similarly provide for Chinook salmon when reintroduced. Overall, spawning habitat is sparse within the entire reach, and generally limited to a segment just downstream from Spring Creek (Ex. 277-US-428), as well as the riffle areas near the confluence with the Sprague River.

The majority of the streambed in the claim reach is dominated by fine substrates, with 90 percent sand and organics, 3 percent gravel, 2 percent cobble, and 5 percent bedrock. Several sills formed from natural bedrock are located above the Chiloquin Bridge in the lower mile of the claim reach, including one 0.8 foot high step (Ex. 277-US-428). An estimated 53,820 square feet of gravel and cobble suitable for Chinook salmon spawning is located in a large glide habitat unit located just downstream of Spring Creek (Ex. 277-US-428).

I have observed numerous adult redband trout holding within the reach in preparation for spawning. In addition, several mid-channel bars located in a pool upstream of the Chiloquin Bridge provide small patches of gravel suitable for redband trout and Chinook salmon spawning.

Woody debris density in this reach was low consisting of 1.8 pieces per 100 feet that consisted mostly of sunken logs that presumably came from saw mill storage activities (Ex. 277-US-428). Woody debris did not appear to be influencing channel morphology by storing sediment or causing localized channel bed scour.

One of the most important characteristics of this reach is its cool water temperatures, which are beneficial in providing conditions conducive to salmonid growth and overall health. This temperature is a result of the inflow of Spring Creek, which during the summer low flow period represents the majority of flow in this reach of the Williamson River. The coldwater from Spring Creek has a profound effect on the prevailing water temperatures in this reach of the Williamson and also downstream reaches. For example, in August 2004, the ODFW measured a water temperature in Spring Creek of 47.3°F, water temperature in the Williamson River above

Spring Creek of 63.7ºF, and a water temperature of 48.2ºF in the Williamson River downstream of the confluence (Ex. 277-US-428). Thus, Spring Creek had effectively reduced the water temperature of the Williamson River by almost 25% or 15ºF.

This substantial influence and effect was visually depicted through the use of Forward Looking Infrared (FLIR) imagery completed in August 1999 by Watershed Sciences (2000) as part of the Total Maximum Daily Load (TMDL) analysis conducted for the ODEQ (2002). I have provided a set of images that illustrate the differences in temperatures within the Williamson River above and below the confluence of Spring Creek (Figure IX-627-4). The upper figure depicts the FLIR imagery and shows the < 49.5ºF water from Spring Creek entering at the top left of the figure, the warm 66.4ºF Williamson River water above Spring Creek entering the figure from the top, and the resulting combined flows and lower temperatures in the Williamson River below Spring Creek. Separate temperature bands are noticeable within the reach for over 1.5 miles downstream until the waters become thoroughly mixed, at which time the water temperature was 54ºF. As I mentioned earlier in my testimony, water temperature is one of the most important flow related factors that can influence fish production and population health (*see* Section IV, questions 78, 81, 85, and 92 through 95). The provision of coldwater habitats within this reach is likely one of the critical beneficial ingredients that has allowed the continued existence and successful and healthy propagation of adfluvial redband trout within the Williamson River subbasin.

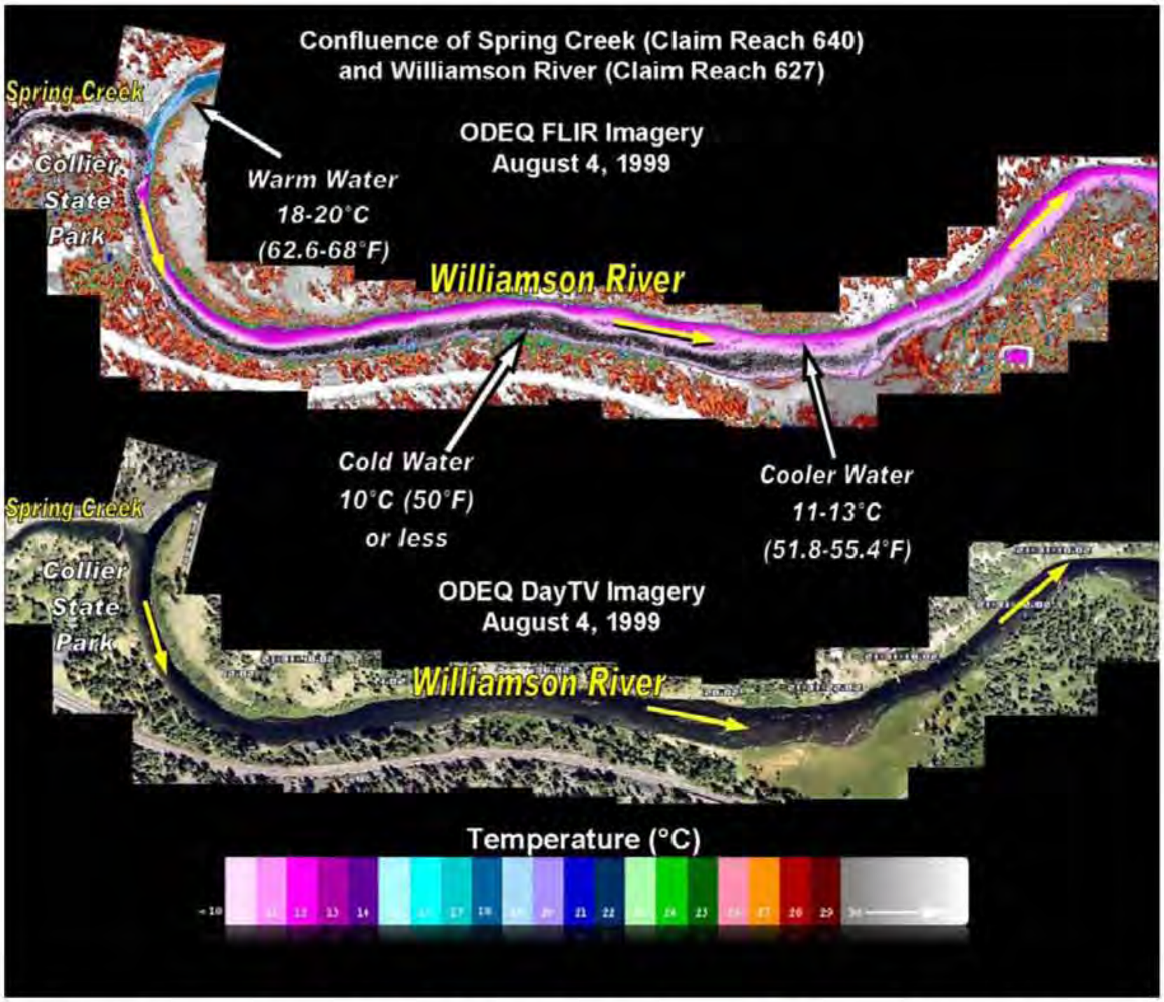

Figure IX-627-4. A mosaic of ODEQ's video and FLIR imagery of the confluence of the Spring Creek (49.6°F) with the Williamson River (66.4°F), taken in August 1999. The mixing zone extends 1.5 mi downstream, where the completely mixed water is around 54°F (Watershed Sciences 2000; ODEQ 2002).

291. Please describe the target fish species that currently, and in the future will, utilize this reach.

The target fish species that currently occur in this reach include redband trout, Lost River sucker, shortnose sucker, and Klamath largescale suckers (*see* Figure VII-6 for fish species presence). In addition to providing spawning, rearing and holding areas, Claim Reach 627 also provides a migratory corridor for adfluvial redband trout moving to upstream areas to spawn, as well for downstream migrating redband post-spawners and larval and juvenile fish. Redband trout spawning habitat is primarily limited to the riffle areas located in the upper portion of the reach. Redband trout fry and juvenile rearing habitat is provided along shoreline areas of the reach and in conjunction with the pool habitats containing cover. Adult redband trout also likely use this claim reach to forage (feed) and for refuge during periods of high water temperatures and low dissolved oxygen in the upper Williamson River (above Spring Creek) and the Sprague River. Non-native brown trout and brook trout have also been documented in this reach, as well as speckled dace and various species of sculpin (DEA 2005a, Ex. 277-US-424). During electrofishing surveys in 1993 and snorkel surveys in 2007, we documented the presence of redband trout (juvenile), brook trout (juvenile) and brown trout (juvenile and adult) within Claim Reach 627 (Ex. 277-US-423).

Like the downstream Claim Reaches 625 and 626, Claim Reach 627 would be important to Chinook salmon, a species that was historically present, and that is planned for reintroduction into the Upper Klamath Basin (Hooton and Smith 2008). In addition to providing salmon spawning habitat, Claim Reach 627 of the Williamson River would represent an important component of the migration corridor for adult salmon moving upstream, and also a migration corridor for Chinook salmon juveniles and smolts moving downstream to the ocean.

292. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 627?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. For this reach, two separate sampling locations were established from which data were collected that formed the basis for the Physical Habitat Claim. The first sampling site was established in September 1990 and habitat mapping was conducted on a section of the claim extending 4,070 feet (Figure IX-627-2). Fish habitat diversity was low in this section of the claim reach, with only run habitat present. As a result, a total of three IFIM/PHABSIM transects were established and sampled during three separate visits (Table IX-627-1). In June 2006, a second site was added to capture habitats within a potential spawning riffle located just upstream of the confluence with the Sprague River (Figure IX-627-2). This site included three additional PHABSIM transects placed on the spawning riffle. These transects were sampled during three separate visits. A summary of the data collection from each site is provided below in Table IX-627-1 and a photograph of transect 2 from the lower sample site is provided below in Figure IX-627-5.

Table IX-627-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 627.

Site and Survey Date	Habitat Type(s) Sampled	Number of Transects
Upper Site: 09/21/1990	Run	3
Upper Site: 04/9/1991	Run	3
Upper Site: 05/12/1993	Run	3
Lower Site: 06/21/2006	Riffle	3
Lower Site: 07/25/2006	Riffle	3
Lower Site: 08/29/2006	Riffle	3

Figure IX-627-5. Lower Williamson River (Claim Reach 627), lower IFIM/PHABSIM sample site, at Transect 2 on June 21, 2006.

OWRD Ex. 2 at 1914 through 1940 and Ex. 277-US-427 include copies of the field data collected and used to develop the updated Physical Habitat Claim for Claim 627.

293. Is there an updated Physical Habitat Claim for Claim 627?

Yes. The updated Physical Habitat flows for Claim Reach 627 are based on the data collected (Ex. 277-US-429) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-430 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The updated Physical Habitat flows for each month are presented in the bottom row of Table IX-627-2. The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flows represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Claim Reach 627, at levels that meet, but do not exceed, the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70 will promote viable and self-renewing target fish species populations at levels at which tribal harvest can occur.

This reach has a number of special qualities: 1) the reach maintains a spring-influenced thermal regime which affords cool water temperatures in the summer months both within the reach and below the reach; 2) the reach is uniquely located immediately above an important river confluence (the Williamson and Sprague rivers) and provides important coldwater holding and refuge habitats from the Sprague River during summer months; 3) the reach provides important adfluvial redband trout spawning habitat eleven months out of the year; 4) the reach provides a primary, upstream and downstream migratory corridor for adfluvial fish species (Lost River sucker, shortnose sucker, Klamath large scale sucker, and redband trout) from and to Upper Klamath Lake; and 5) the reach is anticipated to support anadromous salmonids upon reintroduction similar to the spawning habitat and migratory support currently provided adfluvial fish species. Because of these special qualities, both individually and in combination, I considered Claim Reach 627 one of the "unique" streams or stream segments in the basin (see

Section VIII, questions 259 and 260-Final Step Two). As a result, the IFIM/PHABSIM flow was based on providing the greatest amount of potential habitat of the priority species/lifestage.

Table IX-627-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM-based flow for the priority species/lifestage for that month (representing the flow that provides 100 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); and 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim). The monthly Riparian Habitat Claims for Claim Reach 627 are described and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

294. In light of the derivation process you just described, how many of the monthly Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim flow limit?

For Claim 627, the basis for the updated Physical Habitat flows was the IFIM/PHABSIM flow in seven months (December through June); the incubation flow in no months; the median flow cap in no months; and the 1999 claim limits in five months. Overall, in seven months, the updated Physical Habitat flows for this claim are less than the 1999 Physical Habitat Claim flow values, and equal to the 1999 Physical Habitat Claim flow values in five months.

Table IX-627-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 627, Williamson River subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-a	RT-s	RT-s	RT-s
1999 Physical Habitat Claim Flow Values	631	777	964	1000	783	536	357	357	250	250	250	450
100% WUA	420	420	420	420	420	420	420	420	260	420	420	420
Incubation Flow									238			
Median Flow	585	708	833	876	670	507	392	368	371	373	489	603
Updated IFIM/PHABSIM-Based Flows	420	420	420	420	420	420	420	420	260	420	420	420
Updated Physical Habitat Claim	**420**	**420**	**420**	**420**	**420**	**420**	**357**	**357**	**250**	**250**	**250**	**420**

RT-a = adult redband trout; RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

295. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 627.

The IFIM/PHABSIM flows are based on two lifestages (adult and spawning) of a single target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

October – August

The IFIM/PHABSIM flows for this period are based on redband trout spawning within Claim Reach 627 (Figure VII-6). The flow that represents 100 percent of the potential amount of spawning habitat is 420 cfs. For the months of December through June the IFIM/PHABSIM flows are lower than both the median flows and the 1999 claim flows and, therefore, constitute the updated Physical Habitat flows for these months. For the months of July, August, October, and November, the IFIM/PHABSIM flows are greater than the 1999 claim flows. Therefore, the updated Physical Habitat flows for these months are equal to the 1999 Physical Habitat Claim flow values (Table IX-627-2).

September

The IFIM/PHABSIM flow for this period is based on redband trout adults that would be rearing, holding, or moving through Claim Reach 627 (Figure VII-6). The flow representing 100 percent of the potential amount of adult habitat is 260 cfs. Because September follows a period in which redband trout spawning occurs, redband trout egg incubation flow (2/3 of 357 cfs or 238 cfs) was also considered. The IFIM/PHABSIM flow is greater than the 1999 Physical Habitat Claim flow values, which, in turn, is greater than the incubation flow. Therefore the 1999 Physical Habitat Claim flow values constitute the updated Physical Habitat flow values for the month of September (Table IX-627-2).

296. Is there a conditional Physical Habitat Claim for Claim 627?

Yes. When anadromous fish are reintroduced, they will likely be present in September (when Chinook spawning would replace redband trout adult as the priority species and lifestage), October through November (when Chinook spawning would replace redband trout spawning as the priority species and lifestage), and December through February (when Chinook egg incubation would occur) (Figure VII-6).[1]

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1 In fact, when reintroduced, it can be expected that Chinook salmon will be migrating into and present in streams of the Upper Klamath Basin from June through November of each year. As explained in Sections VII and VIII, Chinook salmon presence, as adults, will not displace the priority of other target fish species engaged in spawning.

297. When adjustments were made to the Physical Habitat flow values for the inclusion of Chinook, how many of the updated Physical Habitat flows were based on: the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim flow limit?

Compared to the flow values just provided for the Physical Habitat Claim based on current species, anadromous fish presence requires re-evaluation of the updated Physical Habitat flows in the months of September through February.

With Chinook salmon included as a priority species, the basis for the updated Physical Habitat flows for Claim Reach 627 was the IFIM/PHABSIM flows in seven months (December through June); the incubation flow in no month; the median flow cap in no month; and the 1999 claim limit in five months (July through September). Overall, the conditional Physical Habitat flows are less than the 1999 Physical Habitat Claim flow values in seven months, and equal to the 1999 Physical Habitat Claim flow values in five months.

Table IX-627-3. Conditional Physical Habitat Claim and monthly instream flow values for Claim Reach 627, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	CH-s	CH-s	CH-s	RT-s
1999 Physical Habitat Claim Flow Values	631	777	964	1000	783	536	357	357	250	250	250	450
100% WUA	420	420	420	420	420	420	420	420	620	620	620	420
Incubation Flow	167	167										167
Median/Flow	585	708	833	876	670	507	392	368	371	373	489	603
Conditional IFIM/PHABSIM-Based Flows	420	420	420	420	420	420	420	420	620	620	620	420
Conditional Physical Habitat Claim	**420**	**420**	**420**	**420**	**420**	**420**	**357**	**357**	**250**	**250**	**250**	**420**

RT-s = spawning redband trout; CH-s = spawning Chinook salmon
All values included in this table are presented in cubic feet per second (cfs).

298. Please provide more details regarding the determination of the monthly flows for the conditional claim for Claim Reach 627?

As noted above, there are six months for which Chinook presence will result in modifications to or otherwise impact the priority species and lifestage. These include the months of September through November which reflect the spawning period of Chinook and December through February which reflect the incubation period of Chinook eggs and embryos.

September – November (conditional claim)

Information obtained from Fish Pro (2000), Hamilton et al. (2005), Huntington and Dunsmoor (2006), and Hooton and Smith (2008) predict the use of Claim Reach 627 for Chinook salmon spawning during the period September through November. The IFIM/PHABSIM flow that represents 100 percent of the potential amount of Chinook spawning habitat is 620 cfs, which is higher than the 1999 Physical Habitat Claim flow values of 250 cfs. As a result, the conditional Physical Habitat flows for this period are equal to the 1999 Physical Habitat Claim flow values (Table IX-627-3.)

December – August (conditional claim)

For the period of December through August, the species and lifestage priority remains redband trout spawning. Because Chinook salmon spawning occurred in prior months, incubation flow to protect Chinook eggs and embryos (2/3 of 250 cfs or 167 cfs) was also considered for the period December through February; however, incubation flows were less than the flows associated with redband trout spawning. Therefore, the conditional Physical Habitat flow values remain as noted above and as previously described for this period (Table IX-627-3).

CLAIM REACH 628 – WILLIAMSON RIVER: SPRING CREEK TO LOWER END OF KIRK CANYON

299. Please describe the stream reach associated with Claim 628.

Claim 628 encompasses the reach of the Williamson River extending from the confluence with Spring Creek upstream for approximately 3 miles to the lower end of Kirk Canyon (hereinafter called "Claim Reach 628"). See OWRD Ex. 6 at 13 describing the upper and lower boundaries of the Claim Reach 628; also see Figure IX-628-1 and Figure IX-628-2. Near the midpoint of the claim reach, Larkin Creek (Claim Reach 634) enters the Williamson River. Within Claim Reach 628, the river channel is moderately sinuous, is low gradient (<0.06%) and averages 67 feet wide (Ex. 277-US-417; OWRD Ex. 2 at 1941-1981). A bedrock sill located just upstream of the IFIM/PHABSIM sample site (Figure IX-628-2) creates a backwater area approximately 1-mile in length. Peak median monthly flow (570 cfs) in this claim reach typically occurs in April and low median monthly flow (64.3 cfs) occurs in late summer to early fall (Figure IX-628-3).

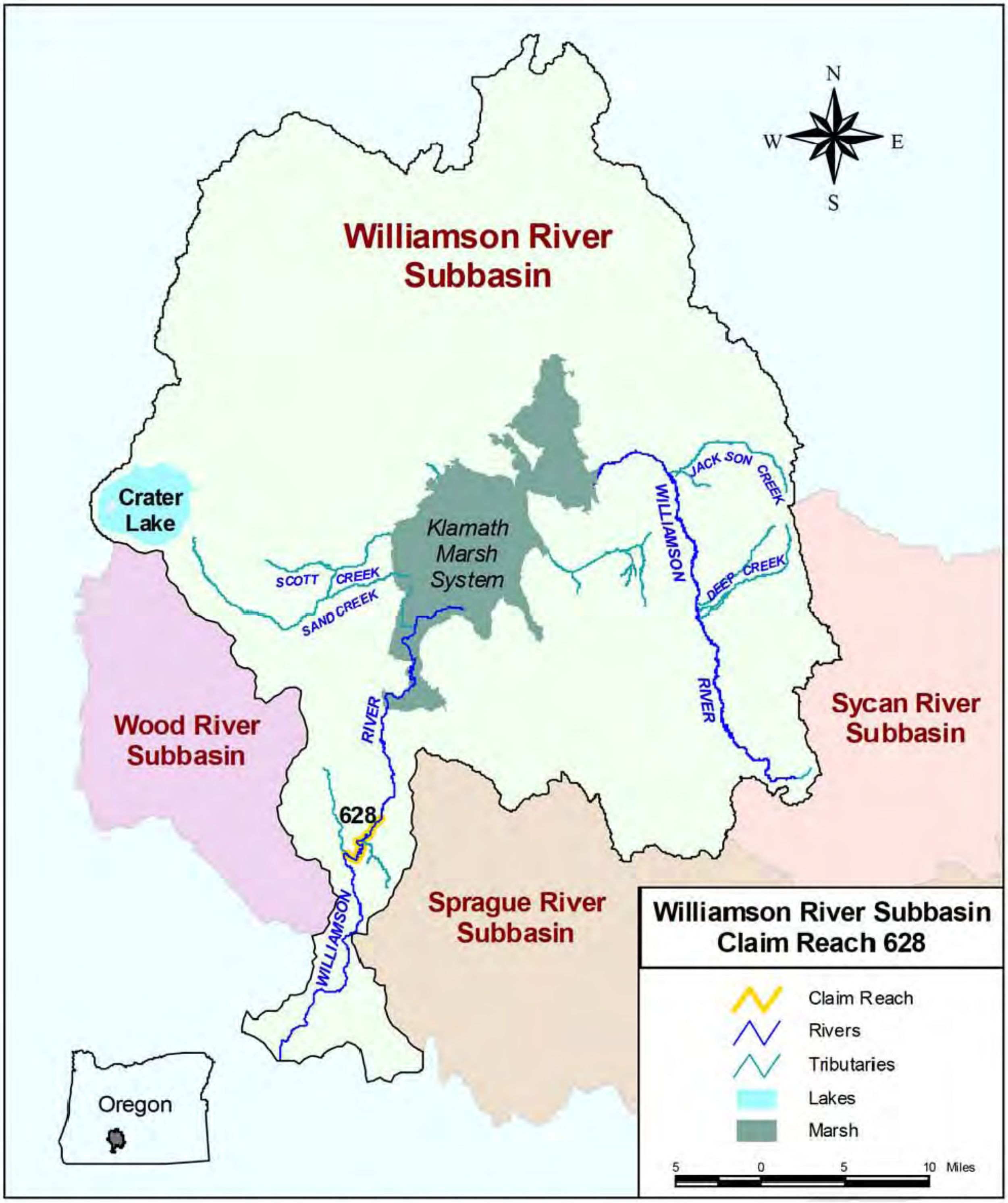

Figure IX-628-1. Claim Reach 628. Williamson River Subbasin with claim reach highlighted in yellow.

Figure IX-628-2. Orthographic photograph of Claim Reach 628 (Oregon Imagery Explorer 2007).

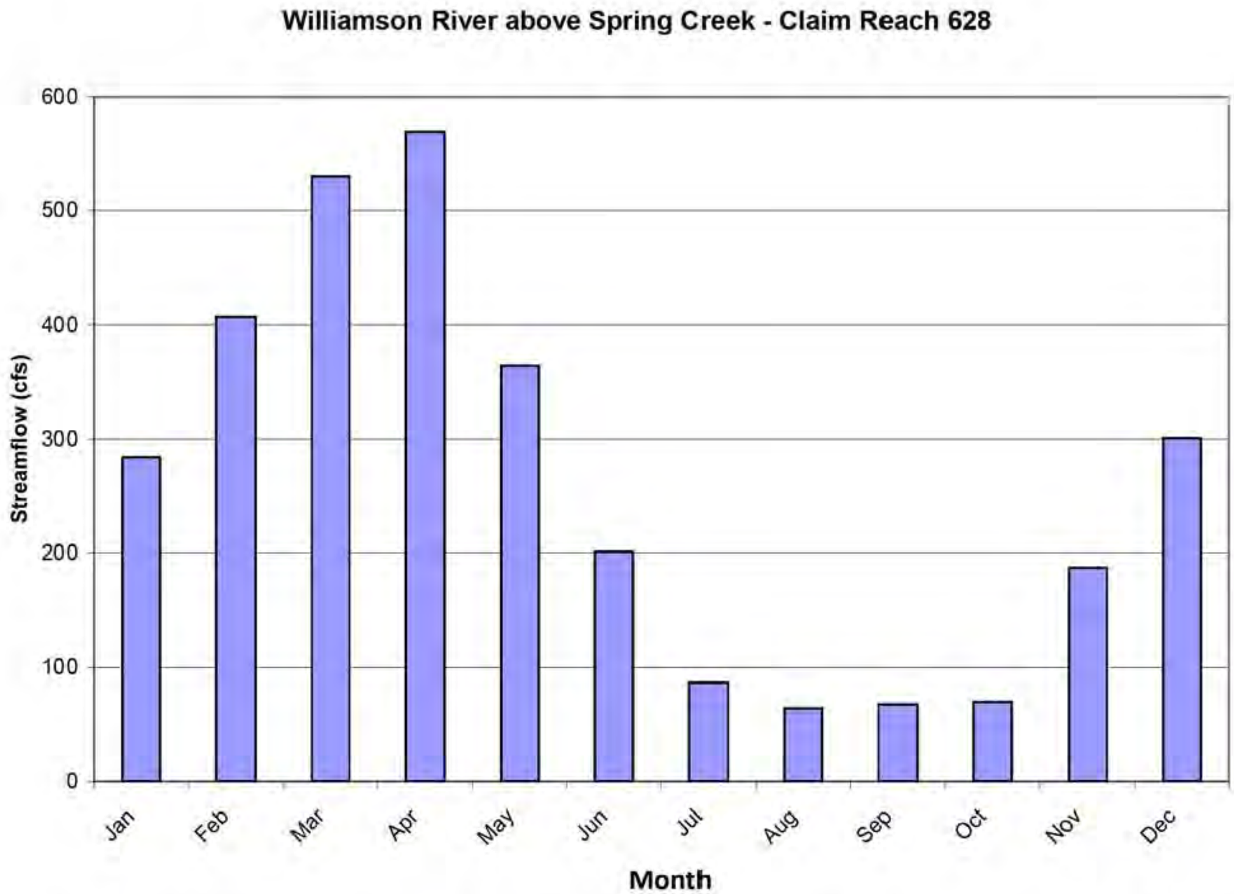

Figure IX-628-3. Williamson River monthly hydrograph (median flow values) above the confluence with Spring Creek (Claim Reach 628) (Cooper 2004).

300. Are you familiar with this reach of the Williamson River that comprises Claim Reach 628?

Yes. I have visited portions of Claim Reach 628 a number of times over the past 20 years including its lowermost point where Spring Creek enters at Collier State Park; at the location where Larkin Creek enters the reach; the upper extent of the reach within Kirk Canyon; as well as several visits to the detailed IFIM/PHABSIM site which is located upstream from where U.S. Forest Service Road 9730 crosses the stream. I have also snorkeled and conducted redd measurements within the upper segment of this reach as part of Habitat Suitability Curve data collection activities. Most recently, I completed a field reconnaissance of the detailed IFIM/PHABSIM site in June 2006 to check transect locations and assess overall habitat conditions. I have also flown over and photographed from the air the entire length of Claim Reach 628.

301. Please describe the stream environment associated with Claim Reach 628.

Based on my observations and information from other sources, the stream environment in and around Claim Reach 628 is as follows. The width of the riparian zone within this reach of the Williamson River varies considerably. Just upstream of the confluence with Spring Creek the riparian zone is relatively narrow. Progressing upstream, the riparian zone widens out into a broad complex of meadows and willows. Willows are abundant along the banks of many portions of this reach, with grasses and sedges forming streambank cover in areas where shrubs are not present (Ex. 277-US-431). The stream is partially shaded by both conifer and deciduous trees (aspen) occupying near channel and floodplain areas. Compared to the three downstream claim reaches of the Williamson River (625, 626, and 627), the riparian vegetation is in better condition (Dr. Chapin Direct Testimony at question70).

Fish habitat of the lower 1.9 miles of the claim reach (from the confluence with Spring Creek upstream) consist primarily of glide and pool habitat with maximum depths of approximately 6-feet. An off-channel pool with an area of 1.2 acres was also identified in the survey area and may provide rearing habitat for salmonids and sucker species. A lack of riffle habitat within this portion of the claim reach provides limited spawning area; channel substrate was dominated by fine particles with 67 percent sand and organics, 3 percent gravel, 5 percent cobble, 8 percent boulder, and 17 percent bedrock (Ex. 277-US-431). Water temperatures in

Claim Reach 628 are comparatively warmer than temperatures in Claim Reach 627, which is below Spring Creek (Claim Reach 640). A water temperature of 66.2°F was measured in Claim Reach 628 in August 2004 (Ex. 277-US-431).

The upper portion of the claim reach has somewhat greater diversity of fish habitat. Results of IFIM/PHABSIM fieldwork completed in 1990 that surveyed a 1,672 foot section of the upper portion of the reach indicated a habitat composition consisting of 59 percent run, 37.4 percent riffle, 2.2 percent pool, and 1.3 percent cascade habitat. The dominant substrate in this section consisted of cobble and boulder. Most of the available cover within the surveyed segment was from overhanging vegetation and woody debris, with some velocity cover provided behind boulder substrates (OWRD Ex. 2 at 1941-1981).

302. Please describe the target fish species that currently, and in the future will, utilize this reach.

The target fish species that currently occur in this reach include redband trout and Klamath largescale suckers. In addition to providing spawning, rearing and holding areas, the upper end of Claim Reach 628 nears the upper extent of habitat within the Williamson River subbasin accessible to adfluvial fish species migrating from Upper Klamath Lake. The area just above Claim Reach 628 (lower end of Claim Reach 629) is used extensively for spawning by redband trout. Thus, Claim Reach 628 represents an important migratory corridor for these fish to reach these upper spawning areas in the Williamson River subbasin. Likewise, the reach is important to allow downstream migrating post-spawners and juvenile fish moving downstream to Upper Klamath Lake.

Redband trout fry and juvenile rearing habitat is provided along shoreline areas of the reach and in conjunction with the pool habitats containing cover. Non-native brown trout and brook trout have also been documented in this reach, as well as speckled dace and various species of sculpin (DEA 2005a, Ex. 277-US-424). During electrofishing surveys in 1993 and snorkel surveys in 2003 and 2007, we documented the presence of large numbers of juvenile and adult redband trout as well as a small number of juvenile and adult brown trout (Ex. 277-US-423).

Just like the downstream reach, Claim Reach 628 is also important relative to Chinook salmon, a species that was historically present and that is planned for reintroduction into the Upper Klamath Basin (Hooton and Smith 2008). In addition to providing spawning habitat within the lower portion of the reach, Claim Reach 628 represents, an important migration corridor for adult salmon moving upstream to spawn within the mainstem river (Claim Reach 629) and in Larkin Creek (Claim Reach 634), and a downstream migration corridor for Chinook salmon juveniles and smolts moving to the ocean.

303. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 628?

The collection of field data for this site followed the general methods and sampling procedures I described in Section VII of my testimony. The detailed sampling site was established in September 1990, and was based on habitat mapping conducted on a section of the claim reach extending 1,672 feet (Figure IX-628-2). A diversity of habitat types was present, with run (59%), riffle (37%), pool (2.2%), and cascade (1.3%). A total of 6 IFIM/PHABSIM transects were established and sampled during three separate site visits (Table IX-628-1). A summary of the data collection is provided below in Table IX-628-1 and a photograph of transect 1 from the IFIM/PHABSIM sample site provided below in Figure IX-628-4.

Table IX-628-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 628.

Survey Date	Habitat Type(s) Sampled	Number of Transects[1]
09/22/1990	Run, Riffle	6
04/10/1991	Run, Riffle	6
05/27/1993	Run, Riffle	6

[1]Represents total number of transects, consisting of 3 transects per each habitat type.

Figure IX-628-4. Lower Williamson River (Claim Reach 628), IFIM/PHABSIM sample site, at Transect 1 on September 22, 1990.

OWRD Ex. 2 at 1941 through 1981 includes copies of the field data collected and used to develop the updated Physical Habitat flow values for Claim 628.

304. Is there an updated Physical Habitat Claim for Claim 628?

Yes. The Physical Habitat flows for Claim Reach 628 are based on the data collected (Ex. 277-US-432) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-433 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The Physical Habitat flows for each month are presented in the bottom row of Table IX-628-2. The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these flows represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Claim Reach 628, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing target fish species populations at levels at which tribal harvest can occur.

This reach has a number of special qualities: 1) the reach maintains a strong spring-influenced thermal regime; 2) the reach is located immediately above Spring Creek and as well, receives the flow from Larkin Creek another spring dominated stream in the Williamson River subbasin; 3) the reach provides important adfluvial redband trout spawning habitat eleven months out of the year; 4) the reach provides a primary, upstream and downstream migratory corridor for adfluvial fish species (redband trout) from Upper Klamath Lake; and 4) the reach is anticipated to support anadromous salmonids upon reintroduction similar to the spawning habitat and migratory support currently provided adfluvial fish species. Because of these special qualities, both individually and in combination, I considered Claim Reach 628 one of the "unique" streams or stream segments in the basin (*see* Section VIII, questions 259 and 260-Final Step Two). As a result, the IFIM/PHABSIM flow was based on providing the greatest amount of potential habitat of the priority species/lifestage.

Table IX-628-2 encapsulates the derivation process of each monthly claim resulting in a flow which was the lesser of 1) the IFIM/PHABSIM based flow for the priority species/lifestage for that month (representing the flow that provides 100 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); or 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim). The monthly Riparian Habitat Claims for Claim Reach 628 are described and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

305. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 628, the basis for the updated Physical Habitat flow values was the IFIM/PHABSIM flows in five months (December through April); the incubation flow in zero months; the median flow cap in one month (July); and the 1999 claim limit in six months (May, June, and August through November). Overall, in six months the updated Physical Habitat flows are less than the 1999 Physical Habitat Claim flow values, and in six months the updated Physical Habitat Claim flow values are equal to the 1999 Physical Habitat Claim flow values.

Table IX-628-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 628, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-a	RT-s	RT-s	RT-s
1999 Physical Habitat Claim Flow Values	150	150	150	150	100	100	92	46	27	60	100	150
100% WUA	110	110	110	110	110	110	110	110	80	110	110	110
Incubation Flow									31			
Median Flow	284	407	530	570	364	201	86.7	64.3	67.7	69.9	187	301
Updated IFIM/PHABSIM-Based Flows	110	110	110	110	110	110	110	110	80	110	110	110
Updated Physical Habitat Claim	**110**	**110**	**110**	**110**	**100**	**100**	**87**	**46**	**27**	**60**	**100**	**110**

RT-a = adult redband trout; RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

306. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 628.

The IFIM/PHABSIM flows are based on two lifestages (spawning and adult) of a single target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

October – August

The IFIM/PHABSIM flows for this period are based on redband trout spawning within Claim Reach 628 (Figure VII-6). The flows that represent 100 percent of the potential amount of habitat are 110 cfs. For the months of December through April, the IFIM/PHABSIM flows are lower than both the median flows and the 1999 flows and, therefore, constitute the updated Physical Habitat flows for these months. For the months of May, June, August, October, and

November, the IFIM/PHABSIM flows are greater than the 1999 flow. Therefore, the updated Physical Habitat flows for these months are equal to the 1999 flows. For the month of July, because the IFIM/PHABSIM flow is greater than the median flow (87 cfs), the median flow constitutes the updated Physical Habitat flow (Table IX-628-2).

September

The IFIM/PHABSIM flow for the month of September is based on redband trout adults that would be rearing, holding, or moving within Claim Reach 628 (Figure VII-6). The flow that represents 100 percent of the potential amount of habitat is 80 cfs. Because redband trout spawning takes place in a previous month, redband trout egg incubation flow (2/3 of 46 cfs or 31 cfs) was also considered for the month of September. Both the IFIM/PHABSIM flow and the incubation flow are greater than the 1999 flow. Therefore, the updated Physical Habitat flow is equal to the 1999 flow (27 cfs) for the month of September (Table IX-628-2).

307. Is there a conditional Physical Habitat Claim for Claim 628?

Yes. When anadromous fish are reintroduced, they will likely be present from September through November, during which Chinook spawning would replace redband trout spawning (Figure VII-6) as a priority species and lifestage, and December through February during which Chinook egg incubation would occur. [1]

[1] In fact, when reintroduced, it can be expected that Chinook salmon will be migrating into and present in streams of the Upper Klamath Basin from June through November of each year. As explained in Sections VII and VIII, Chinook salmon presence, as adults, will not displace the priority of other target fish species engaged in spawning.

308. When adjustments were made to the Physical Habitat flow values for the inclusion of Chinook, how many of the updated Physical Habitat flows were based on: the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim flow limit?

Compared to the flow values just provided for the Physical Habitat Claim based on current species, anadromous fish presence requires re-evaluation of the updated Physical Habitat flows in the months of September through February.

With Chinook salmon included as a priority species, the basis for the updated Physical Habitat flows for Claim Reach 628 was the IFIM/PHABSIM flow in five months (December through April); incubation flow in no months; the median flow cap in one month (July); and the 1999 claim limit in six months (May, June, and August through November). Overall, the conditional Physical Habitat flows are less than the 1999 Physical Habitat Claim flow values in six months and equal to the 1999 Physical Habitat Claim flow values in six months.

309. Please provide more detail regarding the determination of the monthly flows for the conditional claim for Claim Reach 628.

As noted above, there were six months for which inclusion of Chinook would result in modifications to or otherwise impact the priority species and lifestage. These include the months of September through November which reflect the spawning period of Chinook and December through February which reflect the incubation period of Chinook eggs and embryos.

September – November (conditional claim)

Information obtained from Fish Pro 2000, Hamilton et al. (2005), Huntington and Dunsmoor (2006), and Hooton and Smith (2008) predict the use of Claim Reach 628 for Chinook salmon spawning during the months of September through November. The IFIM/PHABSIM flow that represents 100 percent of the potential amount of habitat is 210 cfs.

The IFIM/PHABSIM flow is higher than the 1999 Physical Habitat Claim flow values. Therefore, the conditional Physical Habitat Claim is equal to the 1999 Physical Habitat Claim flow values (see Table IX-628-3).

Table IX-628-3. Conditional Physical Habitat Claim and monthly instream flow values for Claim Reach 628, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	CH-s	CH-s	CH-s	RT-s
1999 Physical Habitat Claim Flow Values	150	150	150	150	100	100	92	46	27	60	100	150
100% WUA	110	110	110	110	110	110	110	110	210	210	210	110
Incubation Flow	67	67										67
Median Flow	284	407	530	570	364	201	86.7	64.3	67.7	69.9	187	301
Conditional IFIM/PHABSIM-Based Flows	110	110	110	110	110	110	110	110	210	210	210	110
Conditional Physical Habitat Claim	**110**	**110**	**110**	**110**	**100**	**100**	**87**	**46**	**27**	**60**	**100**	**110**

RT-s = Redband trout spawning CH-s = Chinook salmon spawning

All values included in this table are presented in cubic feet per second (cfs).

December – August (conditional claim)

For this period, the species and lifestage priority remain redband trout spawning. Because Chinook salmon spawning occurred through November, incubation flow to protect Chinook eggs and embryos (2/3 of 100 cfs or 67 cfs) was also considered from December to February; however, incubation flows were less than flows associated with redband trout spawning. Therefore, the conditional Physical Habitat flow values remain as noted above and as previously described for this period (Table IX-628-3).

CLAIM REACH 629 – WILLIAMSON RIVER: LOWER END OF KIRK CANYON TO KIRK REEF

310. Please describe the stream reach associated with Claim 629.

Claim 629 encompasses the reach of the Williamson River extending from the lower end of Kirk Canyon upstream to Kirk Reef, a distance of about 4 miles (hereinafter called "Claim Reach 629"). See OWRD Ex. 7 at 15 describing the upper and lower boundaries of the Claim Reach 629; also see Figure IX-629-1 and Figure IX-629-2. Claim Reach 629 is primarily confined within Kirk Canyon which is characterized by a V-shaped valley with a narrow bottom at the base of steep slopes. The 34-foot wide river channel is relatively straight and has a high gradient (4%) (Ex. 277-US-417; Ex. 277-US-434). Several waterfalls exist within Kirk Canyon that restrict the upstream passage of fish between the lower and upper portions of the claim reach. Peak median flow (541 cfs) in this reach typically occurs in April and low median flow (43.4 cfs) typically occurs in late summer or early fall (Figure IX-629-3). Although the hydrograph for this reach suggests that the channel remains watered year-round under natural flow conditions, this reach currently goes dry during summer months (Conaway 2000; USFS 1998).

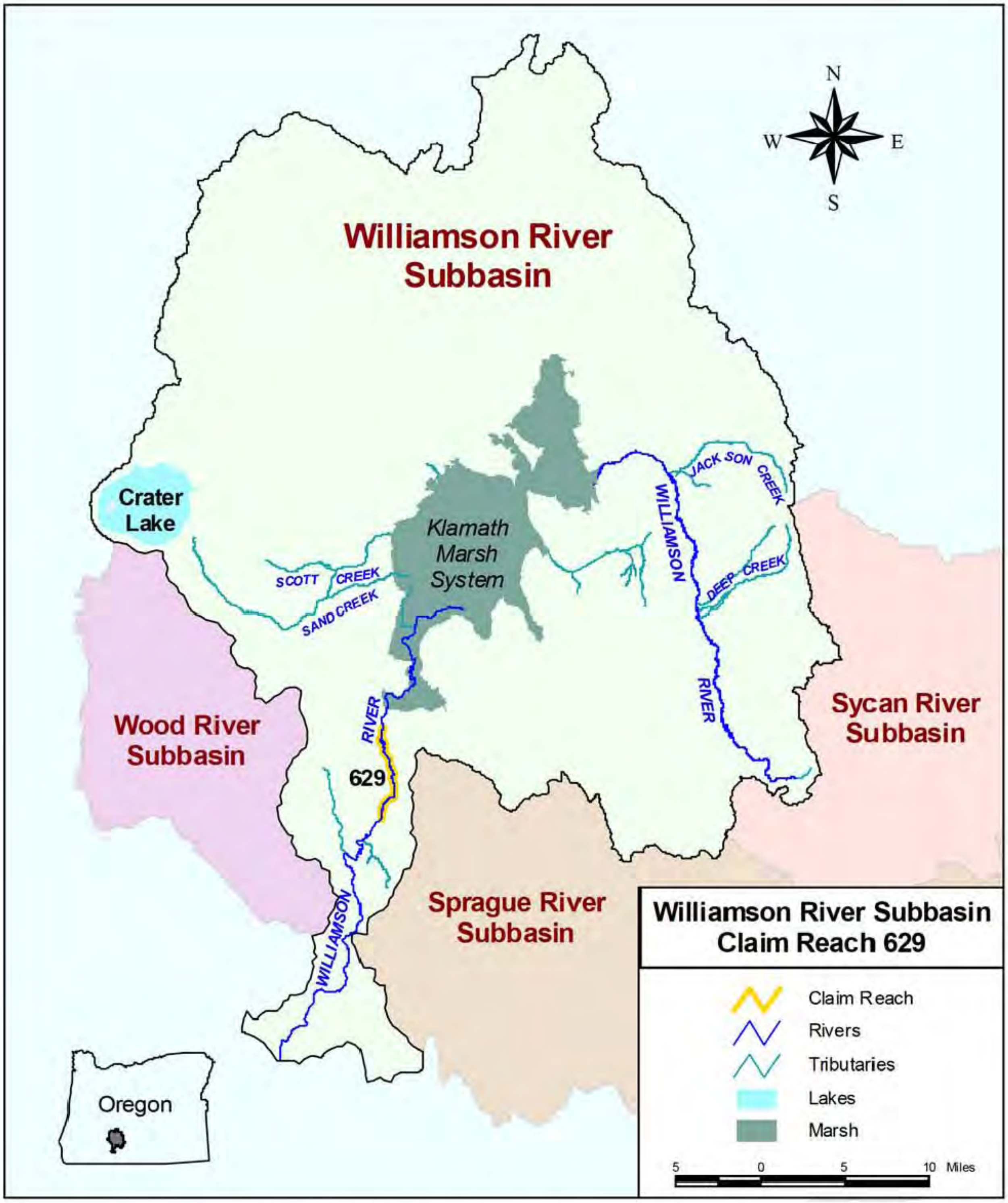

Figure XI-629-1. Claim Reach 629. Williamson River Subbasin with claim reach highlighted in yellow.

Figure IX-629-2. Orthographic photograph of Claim Reach 629 (Oregon Imagery Explorer 2007).

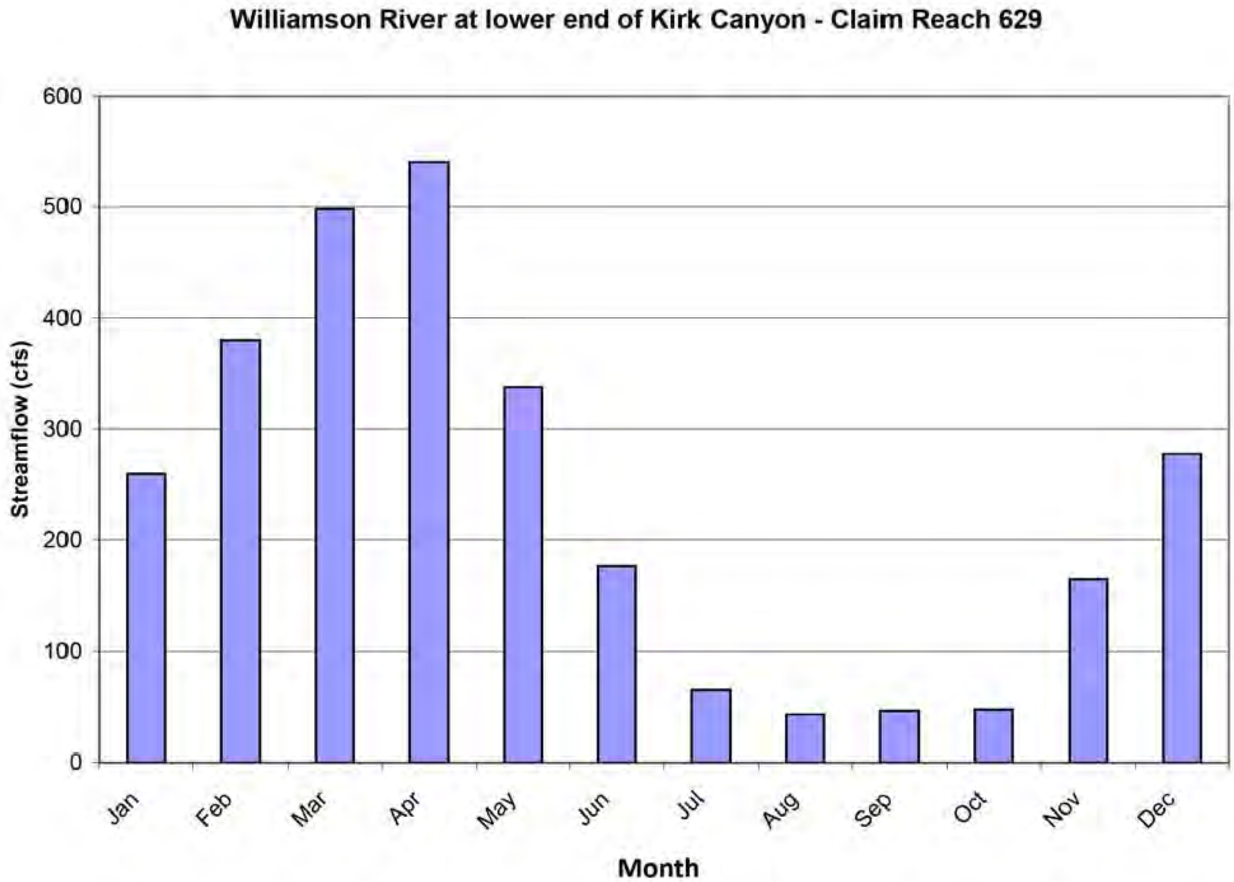

Figure IX-629-3. Williamson River monthly hydrograph (median flow values) at the lower end of Kirk Canyon (Claim Reach 629) (Cooper 2004).

311. Are you familiar with this reach of the Williamson River that comprises Claim Reach 629?

Yes. I have visited portions of Claim Reach 629 a number of times over the past 20 years including its lowermost point within Kirk Canyon where a number of springs contribute flow to the channel; the site of the USGS stream gage located just below USFS Primary Road 43; and the detailed IFIM/PHABSIM site located downstream from the USGS gage. I have been to the Claim Reach during periods of surface flow as well as when portions of the Claim Reach are completely dry. Most recently, I completed a field reconnaissance of the detailed

IFIM/PHABSIM site in June 2006 to check transect locations and assess overall habitat conditions. I have also flown over and photographed from the air the entire length of Claim Reach 629.

312. Please describe the stream environment associated with Claim Reach 629.

Based on my observations and information from other sources, the stream environment in and around Claim Reach 629 is as follows. Emerging springs support riparian vegetation in this reach of the Williamson River from mid-summer through fall, a period when discharge over Kirk Reef has typically been zero in recent years. The riparian area in the lower, canyon portion of this claim reach is constrained by steep valley walls that limit the development of riparian vegetation. Along narrow floodplain areas, most of the riparian vegetation is dominated by grasses with some interspersed shrubs; scattered conifers occur on higher terraces. Within the reach of stream above the canyon and extending to Kirk reef, the riparian zone widens, with grasses becoming dominant. Reed canary grass has invaded the riparian zone in many portions of this reach, resulting in low vegetation diversity (Dr. Chapin Direct Testimony at question 70).

Fish habitat in this section of the Williamson River generally consists of medium-gradient to high-gradient riffle and run habitats. In the vicinity of the instream flow sample site, habitat was dominated by cascades (72%), with some run (17%), riffle (9%), and run/glide (3%) habitat present (Ex. 277-US-434). Substrates were dominated by cobble and boulder, which provided the majority of instream cover. In the lower portion of the reach a pair of unnamed springs enter the Williamson River along the east bank. These springs, and other unmapped springs like them, substantially cool the lower Williamson River, and provide an area highly utilized for spawning by redband trout (ODEQ 2002, Ex. 277-US-434). This cooling influence and effect was visually depicted through the use of Forward Looking Infrared (FLIR) imagery that was completed in August 1999 by Watershed Sciences (2000) as part of the Total Maximum Daily Load (TMDL) analysis conducted for the ODEQ (2002). I have provided a set of images (one illustrating the temperature gradients and one a regular photograph) that illustrate the dramatic differences in temperatures within the Williamson River above and below these springs (Figure IX-629-4). The lower figure depicts the FLIR imagery and shows the cool water (11-12°C; 52°F) water from the springs entering from the top right of the figure, the warm Williamson River water (22°C, 72°F) above the springs, and the resulting combined flows and lower temperatures in the Williamson River below the springs (18°C; 64°F). The provision of springs and coldwater habitats within this lower segment of the reach is likely the major reason that adfluvial redband trout consistently migrate to and spawn within this area.

313. Please describe the target fish species that currently, and in the future will, utilize this reach.

The target fish species that currently occur in this reach include redband trout and Klamath largescale suckers. Two forms of redband trout are present within this reach and utilize different reach segments. Resident redband trout are found throughout Claim Reach 629; however, the lower end of Claim Reach 629 represents the upper extent of habitat within the Williamson River subbasin accessible to adfluvial redband trout migrating from Upper Klamath Lake. Redband trout fry and juvenile rearing habitat is provided along shoreline areas of the river and in conjunction with pool habitats containing cover. Additional species documented in nearby reaches of the lower Williamson River subbasin (i.e., Claim Reaches 627 and 628) are also likely to be in Claim Reach 629 and include non-native species of brown trout, speckled dace, sculpin species, lamprey species, and chub species (Ex. 277-US-424). During snorkel surveys in 1998, adult and juvenile redband and brown trout were documented (Ex. 277-US-423).

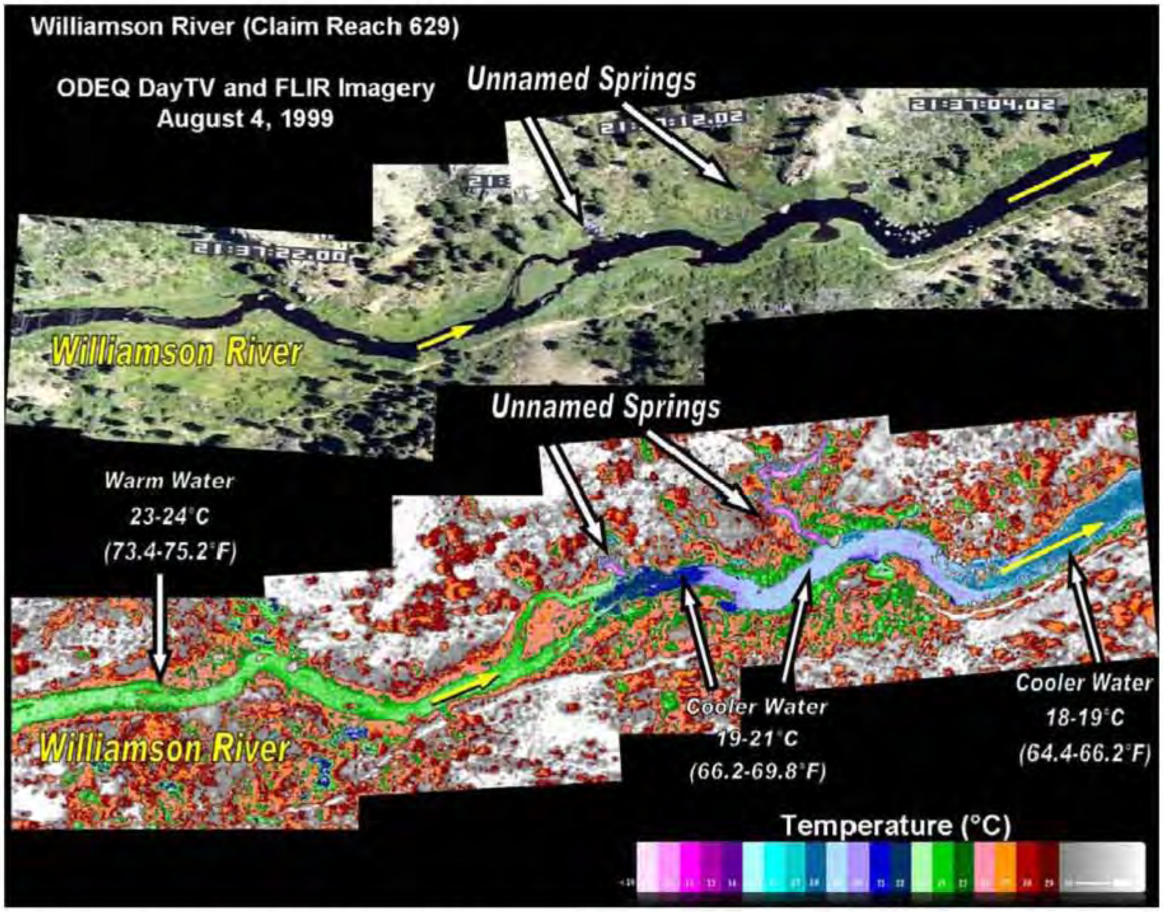

Figure IX-629-4. A mosaic of ODEQ's FLIR and video imagery of unnamed springs (52° F) emptying into the Williamson River (74.3° F), taken in August 1999. FLIR images show significant cooling of the Williamson River downstream from these springs (64.4-67° F) (Watershed Sciences 2000; ODEQ 2002).

314. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 629?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The detailed IFIM/PHABSIM sampling site that formed the basis for the updated Physical Habitat flow was established in April 2004 and was based on habitat mapping conducted on a section of the claim reach extending 860 feet (Figure IX-629-2).

Fish habitat types were dominated by cascades (72%), runs (17%), riffles (9%), and a few run/glides (3%) (Ex. 277-US-434). A total of 6 PHABSIM transects were established and sampled during three separate site visits (Table IX-629-1). A summary of the data collection is provided below in Table IX-629-1 and a photograph of transect 3 from the IFIM/PHABSIM sample site is provided below in Figure IX-629-5.

Table IX-629-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 629.

Survey Date	Flow (cfs)	Habitat Type(s) Sampled	Number of Transects[1]
04/13/2004	166.6	Run, Cascade	6
05/12/2004	63.6	Run, Cascade	6
05/04/2005	48.5	Run, Cascade	6

[1]Represents total number of transects, consisting of 3 transects per each habitat type.

Figure IX-629-5. Lower Williamson River (Claim Reach 629), IFIM/PHABSIM sample site, at Transect 3 on April 13, 2004.

Ex. 277-US-434 includes copies of the field data collected and used to develop the updated Physical Habitat flow values for Claim 629.

315. Is there an updated Physical Habitat flow claim for Claim 629?

Yes. The updated Physical Habitat flows for Claim Reach 629 are based on the data collected (Ex. 277-US-435) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-436 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The updated Physical Habitat flows for each month are presented in the bottom row of Table IX-629-2. The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flows represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Claim Reach 629, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing target fish species populations at levels at which tribal harvest can occur.

This reach has a number of special qualities: 1) the lower extent of the reach maintains a spring-influenced thermal regime which affords cool water temperatures in the summer months both within the reach and below the reach; 2) the reach provides important adfluvial redband trout spawning habitat eleven months out of the year; and 3) the reach provides a primary, upstream and downstream migratory corridor for adfluvial fish species (redband trout) from Upper Klamath Lake. Because of these special qualities, both individually and in combination, I considered Claim Reach 629 one of the "unique" streams or stream segments in the basin (*see* Section VIII, questions 259 and 260-Final Step Two). As a result, the IFIM/PHABSIM flow was based on providing the greatest amount of potential habitat of the priority species/lifestage.

Table IX-629-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM-based flow for the priority species/lifestage for that month (representing the flow that provides 100 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); or 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim). The monthly Riparian Habitat flow values for Claim Reach 629 are described and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

316. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 629, the basis for the updated Physical Habitat flows was the IFIM/PHABSIM flows in no months; the incubation flow in no months; the median flow cap in two months (August and October); and the 1999 claim limit in ten months (November through July and September). Overall, in two months the updated Physical Habitat flows are less than the 1999 Physical Habitat Claim flow values, and in ten months the updated Physical Habitat flows are equal to the 1999 Physical Habitat Claim flow values.

Table IX-629-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 629, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-a	RT-s	RT-s	RT-s
1999 Physical Habitat Claim Flow Values	100	100	100	67	67	60	60	46	27	55	55	100
100% WUA	350	350	350	350	350	350	350	350	350	350	350	350
Incubation Flow									29			
Median Flow	260	380	498	541	338	177	65.7	43.4	46.4	47.9	165	278
Updated IFIM/PHABSIM Based Flows	350	350	350	350	350	350	350	350	350	350	350	350
Updated Physical Habitat Claim	**100**	**100**	**100**	**67**	**67**	**60**	**60**	**43**	**27**	**48**	**55**	**100**

RT-a = adult redband trout; RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

317. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 629.

The IFIM/PHABSIM flows were based on two lifestages (spawning and adult) of a single target species, redband trout. The discussion below is therefore organized by periods of one or more months that share the same species/lifestage priority.

October – August

Redband trout spawning was identified as the priority species/lifestage for October through August (Figure VII-6). The IFIM/PHABSIM flows that provide 100 percent of the potential amount of habitat for this period are 350 cfs. For the months or November through July, this flow is higher than the 1999 Physical Habitat Claim flow values. Therefore, the updated Physical Habitat flow values remained the same as the 1999 flow for the months of November through July. For the months of August and October, the IFIM/PHABSIM flows of 350 cfs are higher than the median flows (43 cfs for August and 48 cfs for October). Therefore, the updated Physical Habitat flows for the months of August and October were adjusted to the median flows for these months (see Table IX-629-2).

September

Adult redband trout was identified as the priority species/lifestage for September (Figure VII-6). The IFIM/PHABSIM flows that provide 100 percent of the potential amount of habitat for this period are 350 cfs. This flow is higher than the 1999 Physical Habitat flow value of 27 cfs. Therefore, the updated Physical Habitat flow remained the same as the 1999 flow, or 27 cfs (see Table IX-629-2).

Because redband trout spawning takes place in August, redband trout egg incubation flow (2/3 of 43 cfs or 29 cfs) was also considered for the month of September. However, both the IFIM/PHABSIM flow and the incubation flow are greater than the 1999 flow. Therefore, the updated Physical Habitat flow is equal to the 1999 flow (27 cfs) for the month of September (Table IX-629-2).

318. Would any of the Physical Habitat flows just noted differ if Chinook salmon were present within Claim 629?

As noted above, only a relatively short segment of this reach will be accessed by Chinook salmon when they are reintroduced; however, I do not consider the habitat conditions within the short segment to be conducive to Chinook salmon production. As a result, no conditional claims were developed for this reach.

CLAIM REACH 631 – WILLIAMSON RIVER: KLAMATH MARSH TO DEEP CREEK

319. Please describe the stream reach associated with Claim 631.

Claim 631 encompasses the reach of the Williamson River (hereinafter called "Claim Reach 631") upstream of the Klamath Marsh extending approximately 20.2 miles from the Klamath Marsh to its confluence with Deep Creek downstream. See OWRD Ex. 9 at 19 describing the upper and lower boundaries of the Claim Reach 631; also see Figure IX-631-1 and Figure IX-631-2. Several perennial and intermittent tributaries, including Deep Creek (Claim Reach 639), Aspen Creek, Irving Creek (Claim Reach 638), Jackson Creek (Claim Reach 637), and Jack Creek, join the Williamson River within Claim Reach 631 (Figure IX-631-1).

Physically, this section of the upper Williamson River is low-gradient, and possesses a meandering channel, averaging approximately 40 feet wide (Ex. 277-US-417; Ex. 277-US-437). The reach is relatively unconfined and located in a wide valley bottom that exhibits some signs of entrenchment (i.e., down-cutting) within its floodplain. Historically, the Williamson River spread over a wide delta area where it entered Klamath Marsh, but the natural channel has been significantly diked and diverted (DEA 2005a).

Most of the tributaries in this portion of the Williamson River originate from Yamsay Mountain and Booth Ridge and flow only during spring snowmelt (DEA 2005a). Additionally, several springs exist within the reach which contribute flow to the river (USFS 1996b). Peak median monthly flow (164 cfs) in this claim reach typically occurs in May and low median monthly flows (65.2 cfs) typically occur in late summer or early fall (Figure IX-631-3).

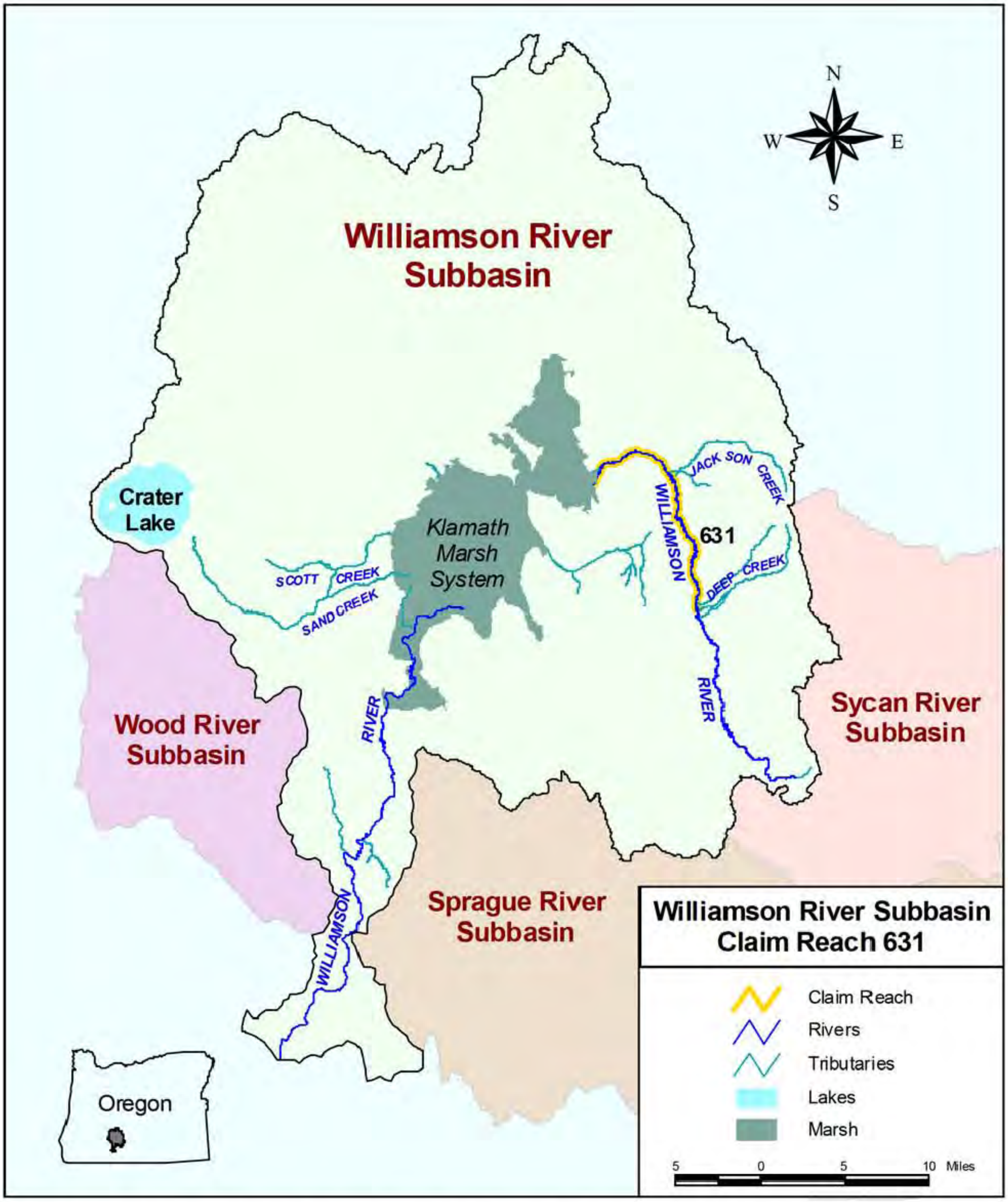

Figure IX-631-1. Claim Reach 631. Upper Williamson River subbasin with claim reach highlighted in yellow.

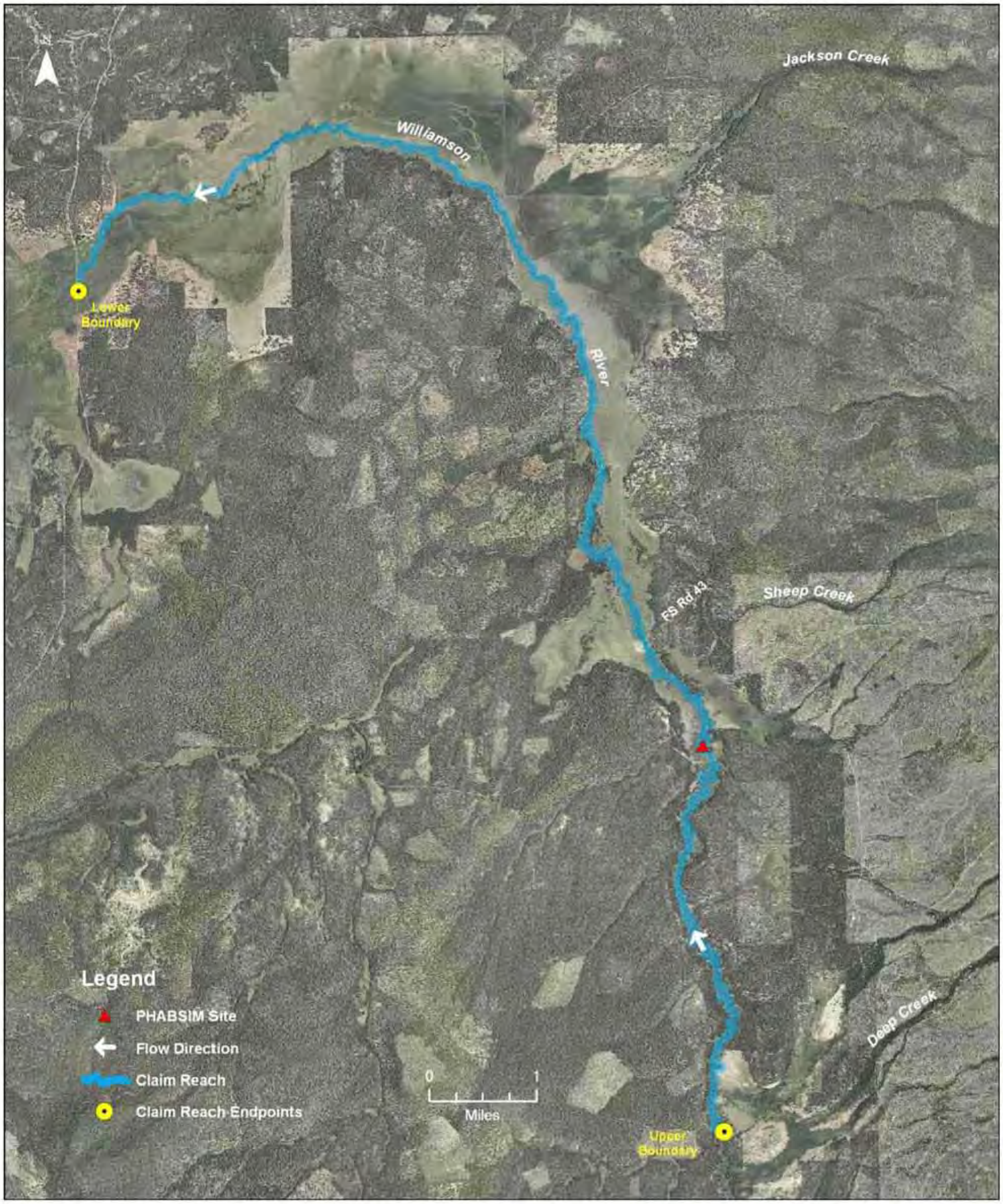

Figure IX-631-2. Orthographic photograph of Claim Reach 631 (Oregon Imagery Explorer 2007).

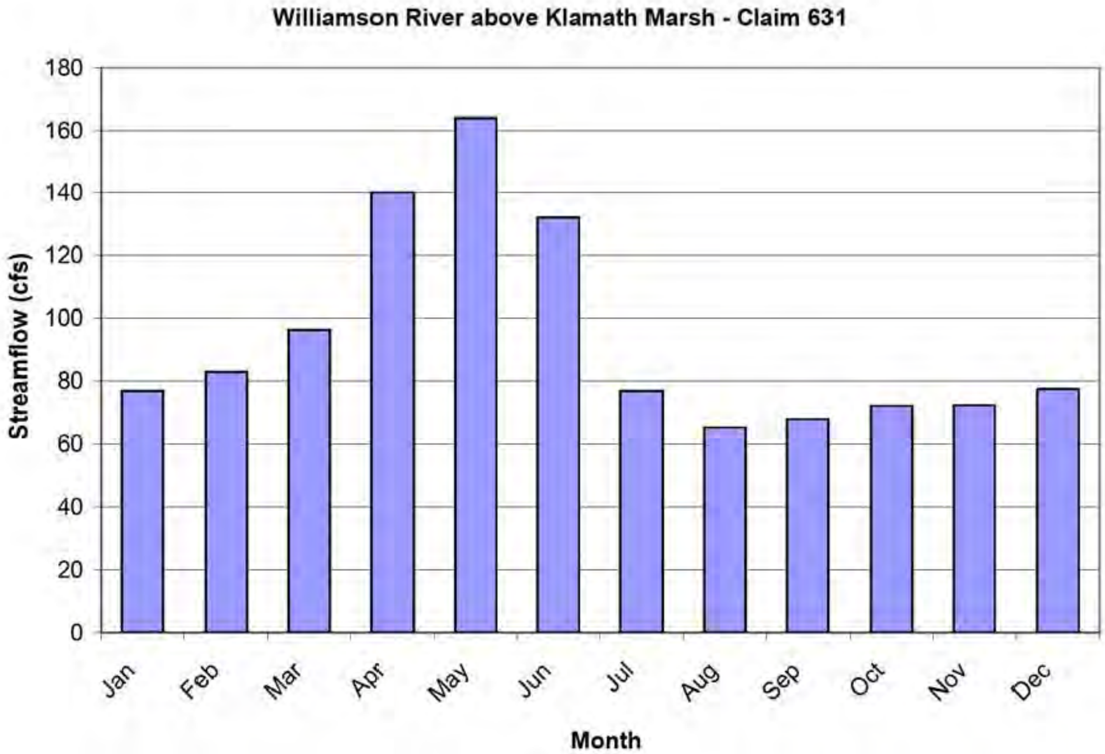

Figure IX-631-3. Upper Williamson River monthly hydrograph (median flow values) at the downstream most end of the reach (Claim Reach 631) under natural flow conditions (Cooper 2004).

320. Are you familiar with this reach of the Williamson River that comprises Claim Reach 631?

Yes. I have visited portions of Claim Reach 631 several times over the past 20 years including where Forest Service Road 43 crosses the river, and, in particular, the detailed study site located just upstream. The downstream half of the claim reach (downstream of Sheep Creek) is inaccessible due to private property restrictions. Most recently, I completed a field reconnaissance of the detailed IFIM/PHABSIM site in June 2006 to check transect locations and survey points and assess overall habitat conditions. I have also flown over and photographed from the air the entire length of Claim Reach 631.

321. Please describe the stream environment associated with Claim Reach 631.

Based on my observations and information from other sources, the stream environment in and around Claim Reach 631 is as follows. Claim Reach 631 has a broad floodplain supporting riparian vegetation. The stream meanders across a low gradient meadow and marshy area, with the meadows dominated by grasses and forbs (broad-leaved herbaceous plants), and the marsh areas near the stream channel or within abandoned channels or meander scars dominated by sedges, rushes, and grasses. Scattered willows exist on the floodplain but relatively few willows exist on the channel banks (Dr. Chapin Direct Testimony at question 70). Riparian characteristics of this reach have been documented for watershed assessments of the Upper Williamson River by the USFS (1996b) and David Evans and Associates (2005a). These assessments both report considerable riparian degradation due to bank erosion, channel cutting, water diversion, and other effects of land-use related to cattle grazing and pasture use. Historical evidence also exists indicating that this claim reach was dominated by extensive stands of willow over a broad riparian zone prior to use of the land for cattle grazing and pasture (USFS 1996b; DEA 2005a).

With respect to fish habitat in the stream, redband trout spawning habitat is limited in the reach since channel substrates are dominated by silt and sand. Overall, habitat diversity is low with only run/glide and pool habitat types present within the samping site (Ex. 277-US-437). Lack of cool water habitat in the summer is most likely the current limiting factor for redband trout within the claim reach (USFS 1998). Water diversions on Jackson, Irving, Aspen, and Deep creeks have reduced the inflow of cold water to this portion of the Williamson River, and likely influence water temperatures during the summer months. The 20-mile section between

Deep Creek and the Klamath Marsh is characterized as currently having marginal rearing and adult holding habitat (USFS 1998).

322. Please describe the target fish species that currently utilize this reach.

Redband trout and Klamath largescale suckers are the target species for this reach, and appear to use the claim reach extensively during the months of October through June when water temperatures are cooler. Other fish species present in Claim Reach 631 include speckled dace, fathead minnow, and various species of sculpin, chub, and lamprey (DEA 2005a; Kostow 2002). Currently, no proposed, candidate, or listed threatened or endangered fish species exists within the upper Williamson River subbasin (USFS 1998; Ex. 277-US-424). During electrofishing surveys in 1993 and snorkel surveys in 2003, 2006, and 2007 adult and juvenile redband trout as well as Klamath largescale suckers were documented in Claim Reach 631(Ex.277-US-423).

323. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 631?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The detailed sampling site for this reach was established in April 2004 and was based on habitat mapping conducted on a section of the claim extending approximately 2000 feet (Figure IX-631-2 and Figure IX-631-4). Stream habitat diversity was relatively low, dominated by pool (42%) and run/glide habitat (58%). A total of six PHABSIM transects were established and sampled during three separate visits (Table IX-631-1) and standard sampling protocol was applied.

Table IX-631-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 631.

Survey Date	Habitat Type(s) Sampled	Number of Transects[1]
04/14/2004	Pool, Run/Glide	6
06/26/2004	Pool, Run/Glide	6
08/20/2004	Pool, Run/Glide	6

[1]Represents total number of transects, consisting of 3 transects per each habitat type.

Figure IX-631-4. Upper Williamson River (Claim Reach 631), IFIM/PHABSIM sample site, at Transect 2 on June 26, 2004.

Ex. 277-US-437 includes copies of the field data collected and used to develop the updated Physical Habitat flow values for Claim 631.

324. Is there an updated Physical Habitat Claim for Claim 631?

Yes. The updated Physical Habitat flow values for Claim Reach 631 are based on the data collected (Ex. 277-US-438) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-439 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The Physical Habitat flow values for each month are presented in the bottom row of Table IX-631-2.

The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flows represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Claim Reach 631, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70 will promote viable and self-renewing populations at levels at which tribal harvest can occur.

Table IX-631-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM based flow for the priority species/lifestage for that month (representing the flow that provides 90 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); or 3) the flow in the 1999 Physical Habitat Claim (representing the upper limit to the claim). The monthly Riparian Habitat Claim for Claim Reach 631 are described and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

325. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim Reach 631, the basis for the updated Physical Habitat flow values was the IFIM/PHABSIM flows in four months (February through May); the incubation flow in no months; the median flow cap in no months; and the 1999 claim limit in eight months (June through January). Overall, in four months the updated Physical Habitat flows are less than the 1999 Physical Habitat Claim flow values and in eight months the updated Physical Habitat flows are equal to the 1999 Physical Habitat Claim flow values.

Table IX-631-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 631, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-a	RT-s	RT-s	RT-s	RT-s	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a
1999 Physical Habitat Claim Flow Values	70	78	90	90	90	90	74	64	64	66	68	70
90% WUA	125	58.8	58.8	58.8	58.8	125	125	125	125	125	125	125
Incubation Flow						39						
Median Flow	76.9	82.8	96.3	140	164	132	76.9	65.2	67.9	72.1	72.3	77.5
Updated IFIM/PHABSIM-Based Flows	125	58.8	58.8	58.8	58.8	125	125	125	125	125	125	125
Updated Physical Habitat Claim	**70**	**59**	**59**	**59**	**59**	**90**	**74**	**64**	**64**	**66**	**68**	**70**

RT-a = adult redband trout; RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

326. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 631.

The IFIM/PHABSIM flows are based on two lifestages (spawning and adult) of a single target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

June – January

Redband trout adult were identified as the priority species and lifestage during the period June through January (Figure VII-6). The flow representing 90 percent of the potential amount of habitat is 125 cfs; however, the IFIM/PHABSIM based flow of 125 cfs for this period is greater than the monthly 1999 Physical Habitat Claim flow values that range from 64 cfs to 90 cfs. Therefore, the updated Physical Habitat flow values for this period are the same as the 1999 Physical Habitat Claim flow values (Table IX-631-2).

Because redband trout spawning takes place in May, redband trout egg incubation flow (2/3 of 59 cfs or 39 cfs) was also considered for the month of June. However, because the IFIM/PHABSIM flow (based on redband trout adult) is greater than the incubation flow and the 1999 flow, the updated Physical Habitat flow is equal to the 1999 flow (90 cfs) for the month of June (Table IX-631-2).

February – May

Redband trout spawning was identified as the priority species and lifestage during the period February through May (Figure VII-6). The flow representing 90 percent of the potential amount of habitat is 59 cfs. The IFIM/PHABSIM based flow of 59 cfs for this period is less than both the monthly 1999 flow values that range from 78 cfs to 90 cfs and the median flows.

Therefore, the updated Physical Habitat flow values for this reach are equal to the IFIM/PHABSIM flow of 59 cfs (Table IX-631-2).

327. Would any of the Physical Habitat flows just noted differ if Chinook salmon were present within Claim 631?

No known evidence exists that Chinook salmon was found within this claim reach. Therefore, no conditional Physical Habitat Claim was developed for this Claim Reach.

CLAIM REACH 632 – WILLIAMSON RIVER: DEEP CREEK - WICKIUP SPRINGS

328. Please describe the stream reach associated with Claim 632.

Claim 632 encompasses the reach of the Williamson River extending for approximately 6.6 miles from Wickiup Springs downstream to the confluence with Deep Creek (hereinafter called "Claim Reach 632"). See OWRD Ex. 10 at 13 describing the upper and lower boundaries of the Claim Reach 632; also see Figure IX-632-1 and Figure IX-632-2. Several tributaries join the Williamson River in this reach, including Sand Creek, Haystack Draw, Telephone Draw, and Deep Creek (Claim Reach 639) (Figure IX-632-1). Claim Reach 632 is similar to Claim Reach 631 with a low-gradient, meandering pattern, and an average width of approximately 49 feet (Ex. 277-US-417, Ex. 277-US-440).

Groundwater discharge occurs directly into the claim reach at several large springs, with Wickiup Spring being the largest single spring-based contributor (DEA 2005a; USFS 1998; Gannett et al. 2007). Peak median monthly flow (85-89 cfs) in this reach typically occurs in April and May and low median monthly flow (54 cfs) typically occurs in late summer or early fall (Figure IX-632-3).

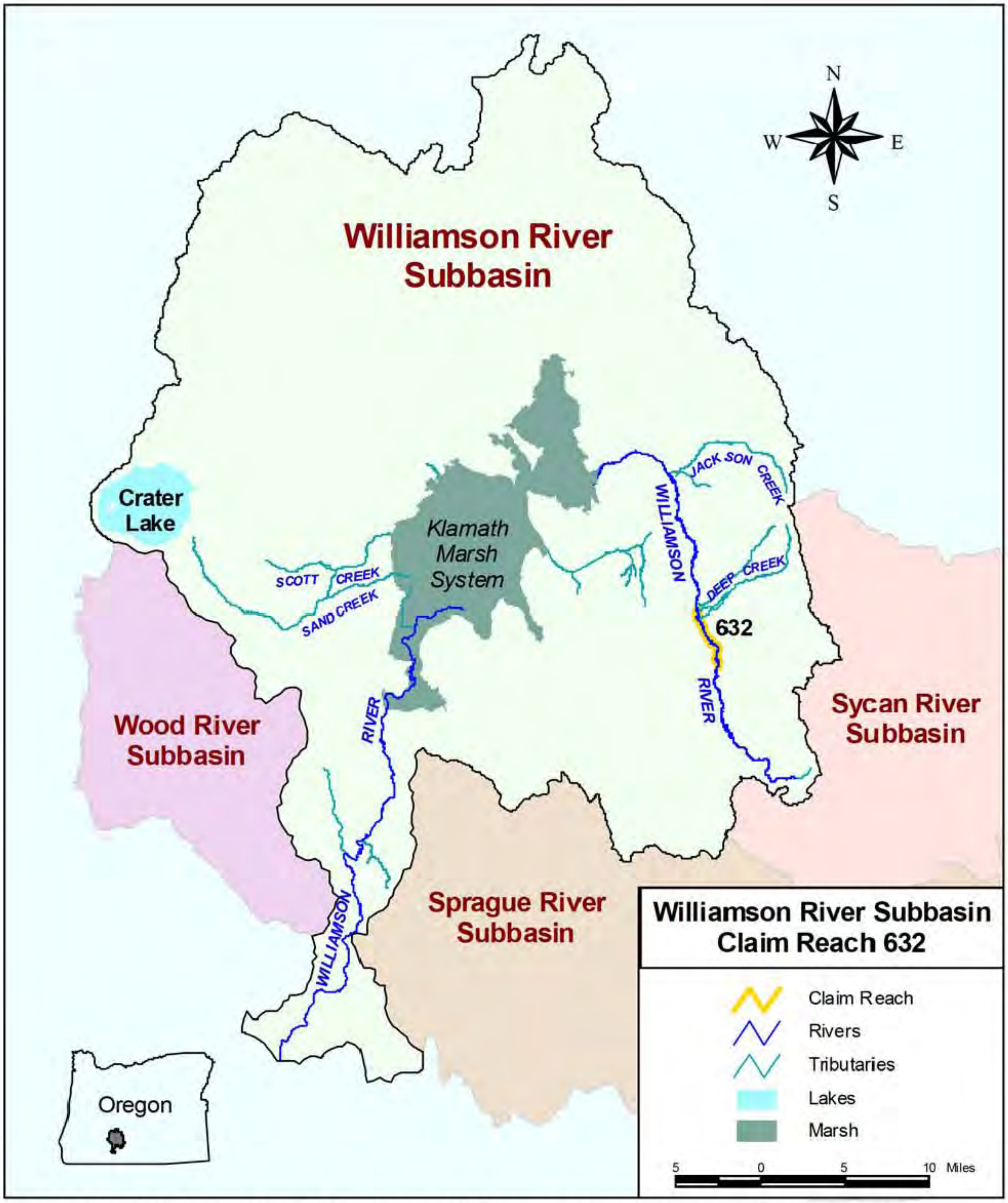

Figure IX-632-1. Claim Reach 632. Upper Williamson River subbasin with claim reach highlighted in yellow.

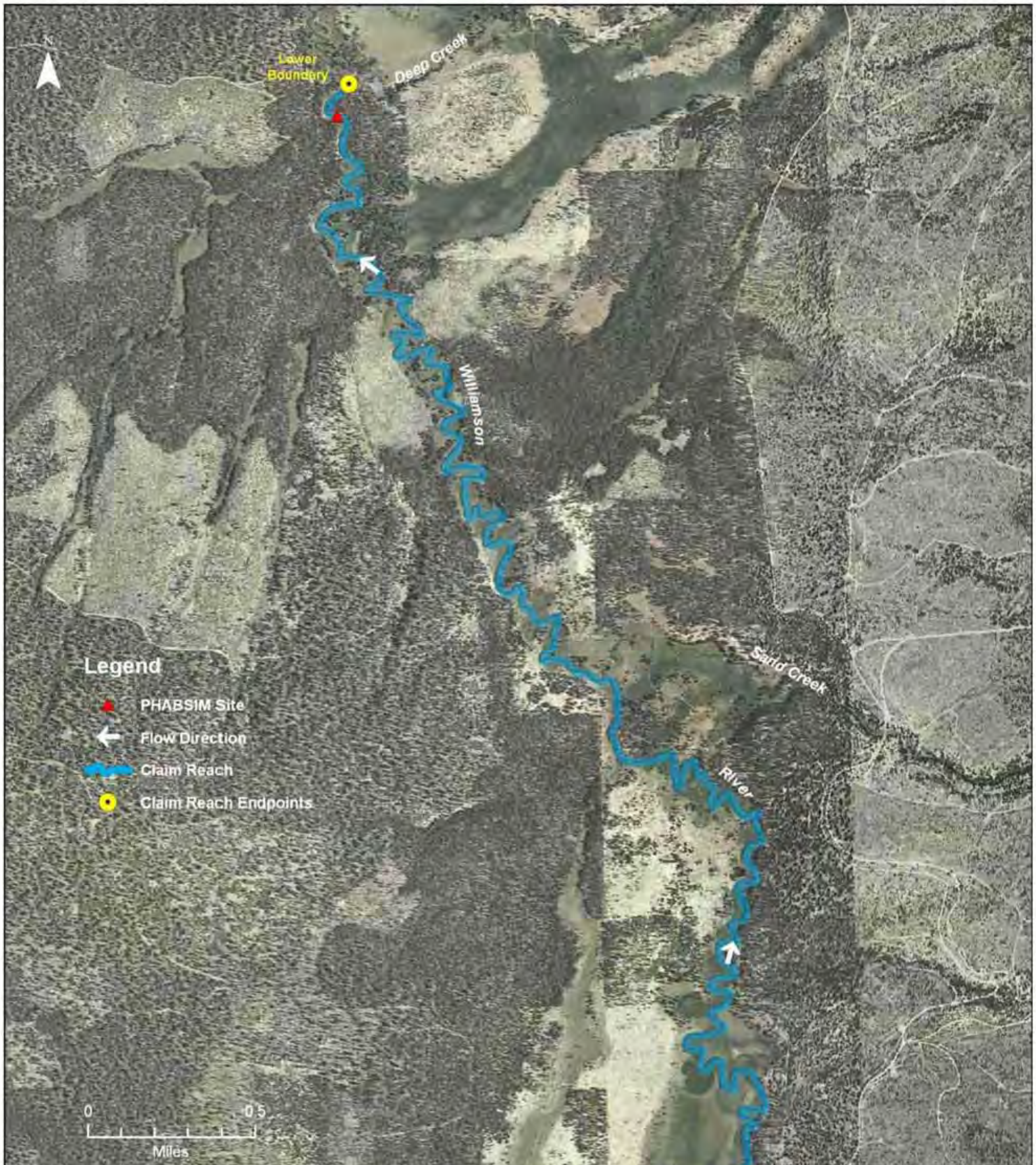

Figure IX-632-2. Orthographic photograph of Claim Reach 632 (Oregon Imagery Explorer 2007).

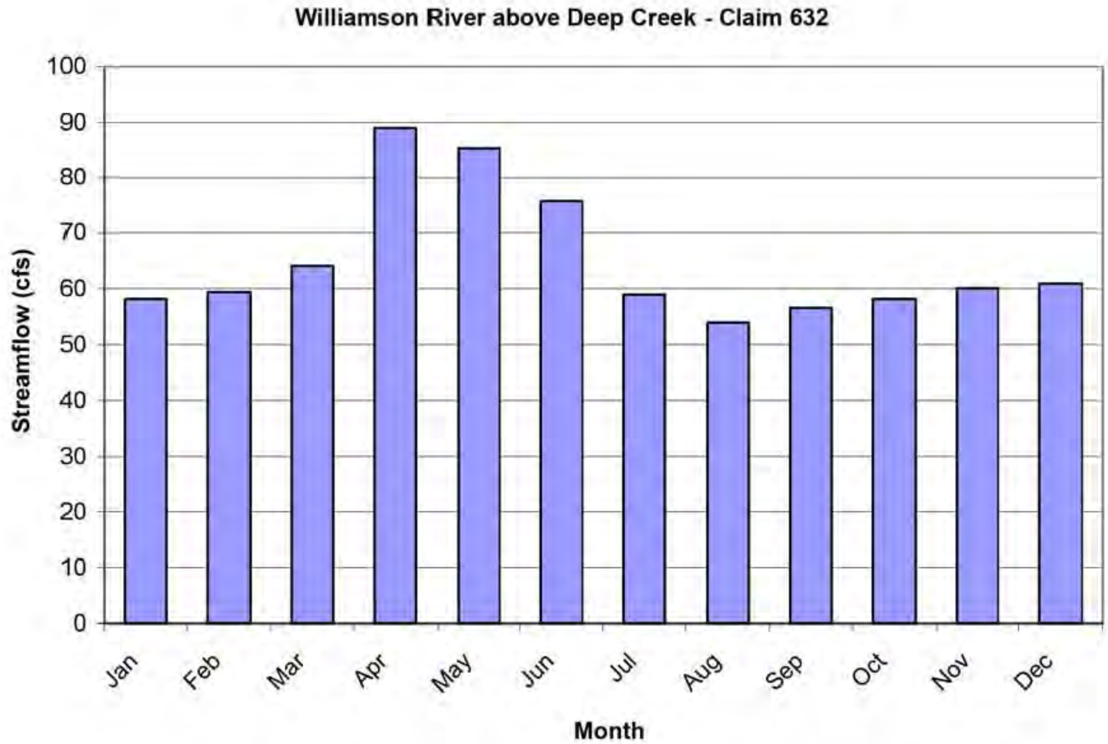

Figure IX-632-3. Upper Williamson River monthly hydrograph (median flow values) at the downstream most extent of Claim Reach 632 under natural conditions (Cooper 2004).

329. Are you familiar with this reach of the Williamson River that comprises Claim Reach 632?

Yes. I have visited portions of Claim Reach 632 several times over the past 20 years including at the road access point, and, in particular, the detailed study site located just upstream from the confluence of Deep Creek. Most recently, I completed a field reconnaissance of the detailed IFIM/PHABSIM site in June 2006 to check transect locations and survey points and assess overall habitat conditions. I have also flown over and photographed from the air portions of Claim Reach 632.

330. Please describe the stream environment associated with Claim Reach 632.

Based on my observations and information from other sources, the stream environment in and around Claim Reach 632 is as follows. Although the claim reach is run-off dominated, its flow is influenced by substantial spring water. The stream meanders across a broad floodplain generally characterized by low gradient meadow and marshy areas. Meadows are dominated by grasses and forbs (broad-leaved herbaceous plants). Marshy areas are present in low areas near the stream channel or within abandoned channels or meander scars and are dominated by sedges, rushes, and grasses (Dr. Chapin Direct Testimony at question 70). Scattered willows occur on the floodplain, but do not occur regularly on the channel banks. A riparian assessment conducted for the Upper Williamson Watershed Assessment (DEA 2005a) reported considerable riparian degradation in the lower portion of the reach due to bank erosion, channel incisement, water diversion, and other effects of land-use related to cattle grazing and pasture. Historical evidence indicates this claim reach was dominated by extensive stands of willow over a broad riparian zone prior to use of the land for cattle grazing and pasture (DEA 2005a).

Claim Reach 632 contains a 1,500 foot section that represents the largest single concentration of redband trout spawning habitat in the upper Williamson River subbasin (USFS 1996b). Additional smaller spawning areas are found at the mouth of Deep Creek and near Wickiup Springs. Elsewhere in Claim Reach 632, stream gradients are low and substrates are made up almost entirely of pumice sand, creating poor spawning habitat.

The highest quality rearing habitat in the upper Williamson River subbasin is also likely located within Claim Reach 632 (USFS 1996b). Cold water springs provide important cool water habitat during the summer months. In the upstream half of the claim reach, undercut banks and aquatic plants are prevalent and provide protective cover. In the downstream half, the riparian environment is much degraded with slumping streambanks due to a lack of riparian vegetation. The occurrence of high water temperatures due to water diversions and the loss of riparian shading likely limit salmonid populations in this reach during low-flow summer conditions when fish are crowded into the limited cool water habitats. During cooler times of the year, fish likely range further downstream, but the upper Williamson River downstream of Deep Creek (see Claim 631) is characterized as marginal rearing habitat, due to the degraded channel conditions (USFS 1996b).

331. Please describe the target fish species that currently utilize this reach.

The target fish species that inhabit this reach are redband trout and Klamath largescale suckers. Redband trout currently utilize higher quality upper reach habitat year-round and only use the degraded lower reach during the cooler months (USFS 1998). During snorkel surveys in 1998, we documented the presence of adult and juvenile redband trout (Ex. 277-US-423).

Other fish found in this claim reach are brook trout, speckled dace, fathead minnows, blue chub, and lamprey (USFS 1998, Ex. 277-US-424).

332. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 632?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The detailed sampling site for this reach was established in April 2004 and was based on habitat mapping conducted on a section of the river approximately 2,100 feet long (Figure IX-632-2). Stream habitat diversity was low, dominated by run/glide habitat (89%) with some pool habitat (11%) present. A total of six (6) PHABSIM transects were established and sampled during three separate visits. A summary of the data collection is provided below in Table IX-632-1 and a photograph of transect 3 from the sample site is provided in Figure IX-632-4.

Table IX-632-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 632.

Survey Date	Habitat Type(s) Sampled	Number of Transects[1]
04/14/2004	Pool, Run/Glide	6
06/26/2004	Pool, Run/Glide	6
08/20/2004	Pool, Run/Glide	6

[1]Represents total number of transects, consisting of 3 transects per each habitat type.

Figure IX-632-4. Upper Williamson River (Claim Reach 632), IFIM/PHABSIM sample site, looking downstream at Transect 3 on June 26, 2004.

Ex. 277-US-440 includes copies of the field data collected and used to develop the updated Physical Habitat flow values for Claim 632.

333. Is there an updated Physical Habitat Claim for Claim 632?

Yes. The updated Physical Habitat flow values for Claim Reach 632 are based on the data collected (Ex. 277-US-441) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-442 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The Physical Habitat flow values for each month are presented in the bottom row of Table IX-632-2.

The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, the updated Physical Habitat flows represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Claim Reach 632, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing populations at levels at which tribal harvest can occur.

Table IX-632-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM-based flow for the priority species/lifestage for that month (representing the flow that provides 90 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); or 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim).

334. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 632, the basis for the updated Physical Habitat flow values was the IFIM/PHABSIM flows in eight months (June through January); the incubation flow in no months; the median flow cap in no months; and the 1999 claim cap in four months (February through May). Overall, in eight months the updated Physical Habitat flows are less than the 1999 Physical Habitat Claim flow values; in four months the updated Physical Habitat Claim flows are equal to the 1999 Physical Habitat Claim flow values.

Table IX-632-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 632, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-a	RT-s	RT-s	RT-s	RT-s	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a
1999 Physical Habitat Claim Flow Values	58	58	58	58	58	58	58	57	57	58	58	58
90% WUA	52	67	67	67	67	52	52	52	52	52	52	52
Incubation Flow						38.6						
Median Flow	58.1	59.4	64.1	89.0	85.4	75.7	58.9	54.0	56.5	58.1	60.1	60.9
Updated IFIM/PHABSIM-Based Flows	52	67	67	67	67	52	52	52	52	52	52	52
Updated Physical Habitat Claim	**52**	**58**	**58**	**58**	**58**	**52**	**52**	**52**	**52**	**52**	**52**	**52**

RT-a = adult redband trout, RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

335. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 632.

The IFIM/PHABSIM flows are based on two lifestages (spawning and adult) of a single target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

June – January

The IFIM/PHABSIM flows for this period are based on redband trout adults that would be rearing, holding or moving through this reach (Figure VII-6). The flows that represent 90 percent of the potential amount of redband trout habitat are 52 cfs. The IFIM/PHABSIM flows are lower than both the median flows and the 1999 claims. Therefore, the IFIM/PHABSIM-based flows constitute the updated Physical Habitat flows for the period June through January

(Table IX-632-2). Because redband trout spawning takes place in May, redband trout egg incubation flows (2/3 of 58 cfs or 38.6 cfs) were also considered for the month of June; however, the IFIM/PHABSIM based flows for adult redband trout are greater than the incubation flows. Therefore, the IFIM/PHABSIM based flows constitute the updated Physical Habitat flow for the month of June (Table IX-632-2).

February – May

The IFIM/PHABSIM flows for this period are based on redband trout spawning within this reach (Figure VII-6). The flows that represent 90 percent of the potential amount of redband trout habitat are 67 cfs. The IFIM/PHABSIM flows are higher than the 1999 claims. Therefore, the updated Physical Habitat flows remain equal to the 1999 Physical Habitat Claim flow values, or 58 cfs, for the period of February through May (Table IX-632-2).

336. Would any of the Physical Habitat flows just noted differ if Chinook salmon were present within Claim 632?

No known evidence exists that Chinook salmon was found within this claim reach. Therefore, no conditional Physical Habitat Claim was developed for this Claim Reach.

CLAIM REACH 633 – WILLIAMSON RIVER: - WICKIUP SPRINGS - HEAD OF THE RIVER SPRING

337. Please describe the stream reach associated with Claim 633.

The Claim 633 stream reach is located on the Williamson River in the upper Williamson River subbasin. The claim reach extends approximately 8.4 miles from Head of the River Spring to Wickiup Springs (hereinafter called "Claim Reach 633"). See OWRD Ex. 11 at 13 describing the upper and lower boundaries of the Claim Reach 633; also see Figure IX-633-1 and Figure IX-633-2. This section of the Williamson River flows through a wide, unconfined, slightly meandering channel in a broad floodplain valley (Ex. 277-US-417). Approximately 1.5 river miles upstream of Wickiup Springs, the river has been dammed and diverted into a series of small ponds.

Access to this claim reach was prohibited by property owners. Aerial photography analysis indicates channel widening occurs approximately one river mile upstream of Wickiup Springs. It is reasonably assumed that the channel condition is relatively homogeneous through this section, and the widening is due to groundwater contribution from Wickiup Springs, and irrigation returns from the Yamsay Ranch (USFS 1998). Peak median monthly flows (52.7 cfs) in this reach typically occur in April and May and low median monthly flows (33.6 cfs) typically occur in late summer or early fall (Figure IX-632-3).

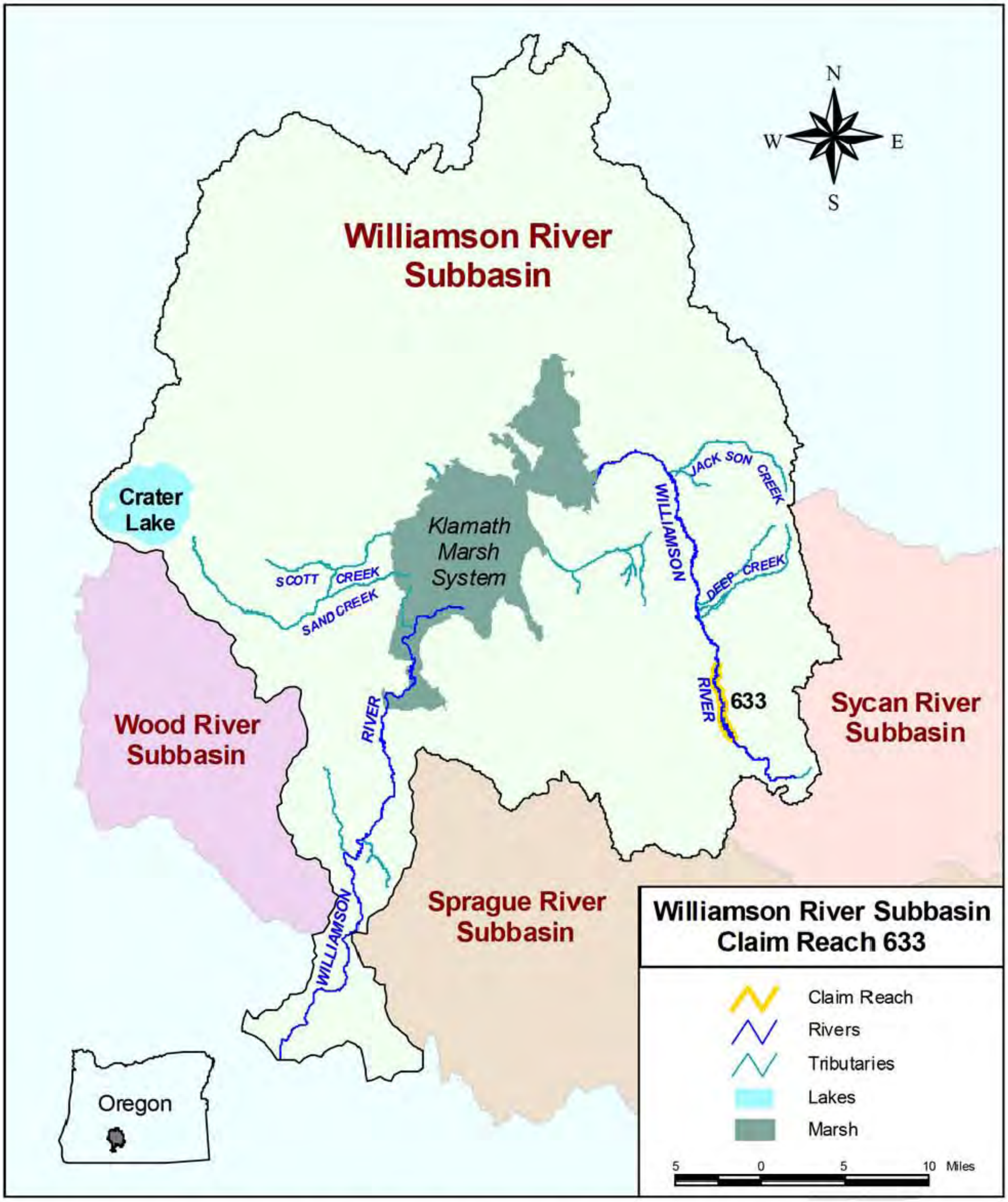

Figure IX-633-1. Claim Reach 633. Upper Williamson River subbasin with claim reach highlighted in yellow.

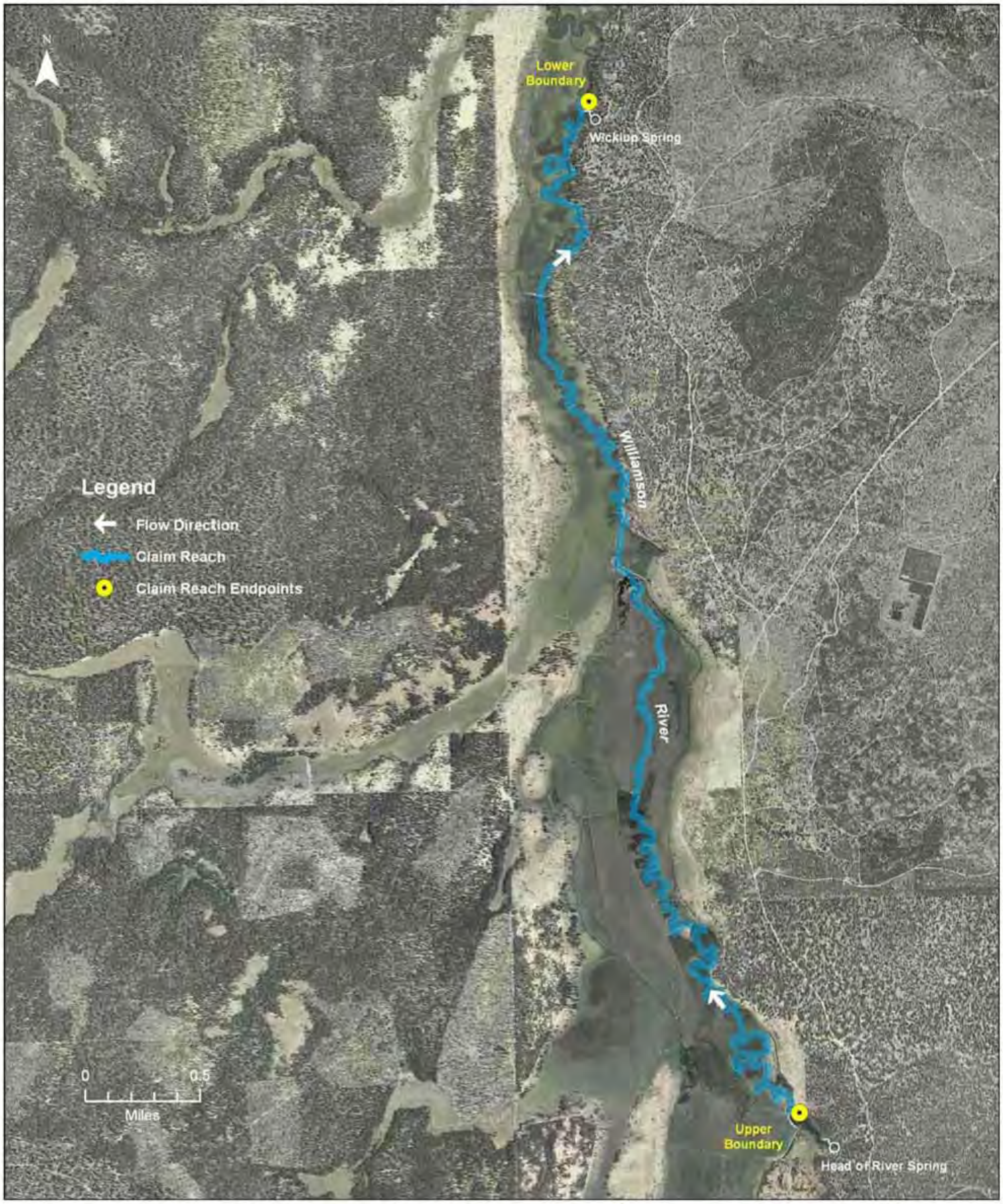

Figure IX-633-2. Orthographic photograph of Claim Reach 633 (Oregon Imagery Explorer 2007).

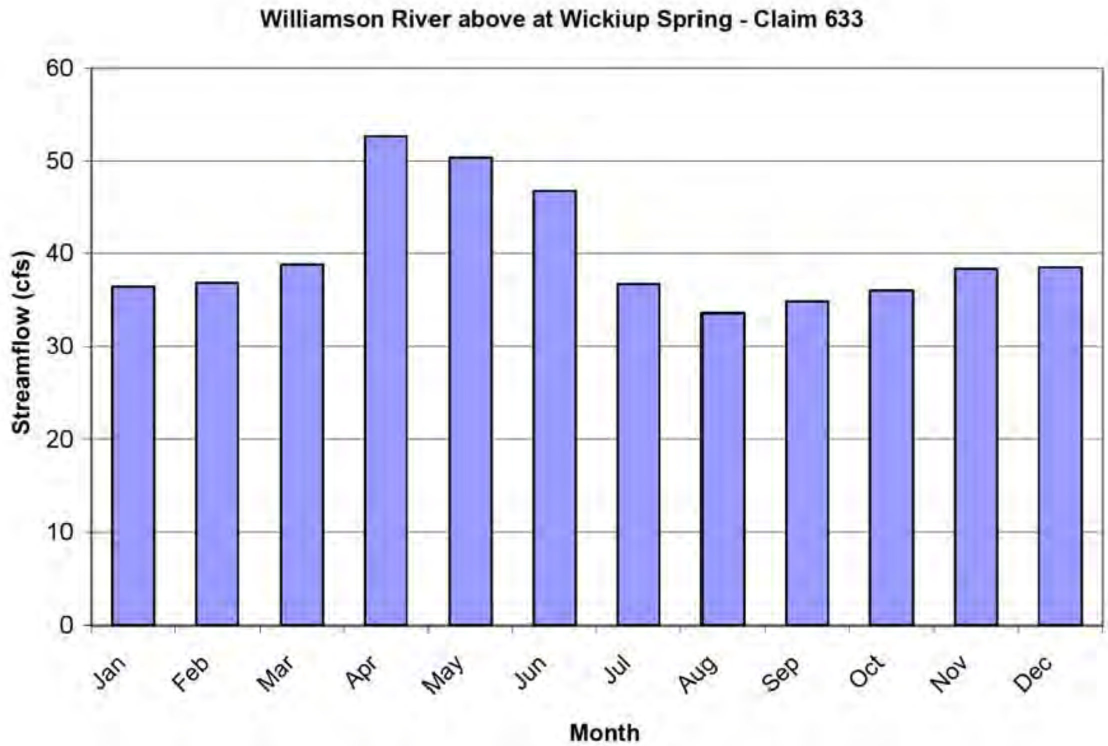

Figure IX-633-3. Upper Williamson River monthly hydrograph (median flow values) at the downstream most extent of Claim Reach 633 (Cooper 2004).

338. Are you familiar with this reach of the Williamson River that comprises Claim Reach 633?

Although I am familiar with the reach in terms of fish species presence and general habitat characteristics as summarized by available information, access restrictions prevented me from actually visiting the site. For this reason, we utilized the Tennant method in deriving the updated Physical Habitat flow values.

339. Please describe the stream environment associated with Claim Reach 633.

Based on my observations and information from other sources, the stream environment in and around Claim Reach 633 is as follows. Claim Reach 633 is a spring-dominated stream with nearly all of the flow contributed from the headwater spring and several lesser springs located throughout the claim reach. The stream appears to meander across a broad low-gradient meadow and marshy area. At several locations within the reach, the river appears to have been diverted into a series of ponds. The meadow areas adjacent to the claim reach appear to be dominated by grasses and forbs (broad-leaved herbaceous plants). Marshy areas near the stream channel and where spring flow enters the claim reach appear to be dominated by sedges, rushes, and grasses. Scattered willows seem to occur on the floodplain, but do not occur regularly on the channel banks. Riparian assessment conducted for the Upper Williamson Watershed Assessment (DEA 2005a) reports considerable riparian degradation in the reach due to bank erosion, channel incision, water diversion, and other effects of land-use related to cattle grazing and pasture. Historical evidence indicates this claim reach was dominated by extensive stands of willow over a broad riparian zone prior to use of the land for cattle grazing and pasture (DEA 2005a).

Because of private property restrictions, very little publicly available information exists on fish species composition or the condition of fish habitat within the claim reach. Brook trout and redband trout are reported to be present within the reach and are the species described by the Yamsi Ranch fly fishing lodge (www.yamsiflyfishing.com).

Wickiup Springs located at the downstream most extent of the claim reach supplies important spawning habitat for redband trout and most likely represents the functional upstream end of summertime trout habitat (USFS 1998). The stream gradient in this claim reach is very low and the substrate is mostly volcanic ash. Review of aerial photographs indicates that a significant portion of the natural stream flow has been diverted into canals and ponds. One larger dam located within this claim reach has trapped sediment and created a large shallow water area where water warms during the summer (USFS 1998).

The groundwater originating at the head of the Williamson River contains high concentrations of both phosphorus and nitrogen, resulting in the watershed's high aquatic primary production (e.g. aquatic macrophites, invertebrates, algae) (USFS 1998). Aquatic biological productivity in the remainder of the watershed is generally low because the chemistry of most of the groundwater in the watershed exhibits low nitrogen concentrations typical of the local geology (USFS 1998).

340. Please describe the target fish species that currently, and in the future will, utilize this reach.

Redband trout are the target fish species that resides throughout the eight mile reach between the Head of the River Spring and Wickiup Spring. As noted above, brook trout are also found within this reach.

341. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 633?

Due to access restrictions, we were unable to collect field data within this claim reach. Therefore, the updated Physical Habitat flow values for this reach are based on the Tennant methodology. A detailed description of the Tennant methodology and how I used it for determining instream needs is presented in Section VII.

342. Is there an updated Physical Habitat Claim for Claim 633?

Yes. The updated Physical Habitat flow values for each month are presented in the bottom row of Table IX-633-1. The updated monthly flow values were derived in consideration of the determinations described above, in accordance with the Tennant method, the procedures described in Section VII, and the relevant decision steps described in Section VIII. Ultimately, these updated Physical Habitat flows represent those which I consider sufficient to provide for a healthy and productive habitat within the Williamson River subbasin, including Claim Reach 633, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing populations at levels at which tribal harvest can occur.

Table IX-633-1 encapsulates the derivation process of each monthly claim resulting in a flow which was the lesser of: 1) the Tennant-based flow for the priority species/lifestage for that month as may be conditioned by post-spawning incubation flows (representing 2/3 of the Tennant spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); or 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim).

343. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the tennant-based flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 633, the basis for the updated Physical habitat flows was the Tennant based flows in four months (June and September – November); the incubation flow in no months; the median flow in no months; and the 1999 Physical Habitat flows in eight months (December-May and July and August). Overall, the updated Physical Habitat Claims were less than the 1999 Physical Habitat flows in four months and equal to the 1999 Physical Habitat flows in eight months.

Table IX-633-1. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 633, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-a	RT-s	RT-s	RT-s	RT-s	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a
1999 Physical Habitat Claim Flow Values	10	10	14	14	14	14	10	10	14	14	14	10
Tennant (50% Qaa)		21.7	21.7	21.7	21.7							
Tennant (30% Qaa)	13.0					13.0	13.0	13.0	13.0	13.0	13.0	13.0
Incubation Flow						9.3						
Median Flow	36.4	36.8	38.8	52.7	50.4	46.7	36.7	33.6	34.8	36.0	38.3	38.5
Updated Tennant-Based Flows	13.0	21.7	21.7	21.7	21.7	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Updated Physical Habitat Claim	**10**	**10**	**14**	**14**	**14**	**13**	**10**	**10**	**13**	**13**	**13**	**10**

RT-a = adult redband trout; RT-s = redband trout spawning

All values included in this table are presented in cubic feet per second (cfs).

344. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 633.

The Tennant-derived flow values were based on two lifestages (spawning and adult) of a single target species (redband trout). The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

June – January

Based on information obtained from ODFW, adult redband trout were identified as the priority species and lifestage for this period (Figure VII-6). The Tennant-based flows for this period were equal to 30% of the mean annual flow values (Qaa) or 13.0 cfs. For the months of June and September through November, this flow is lower than both the median monthly flow and the 1999 claim. Therefore, the updated Physical Habitat flow values for this reach are equal to the Tennant-based flow of 13.0 cfs for the months of June and September through November (Table IX-633-1).

Because redband trout spawning takes place in May, redband trout egg incubation flow (2/3 of 14 cfs or 9.3 cfs) was also considered for the month of June. However, because the Tennant-based flow (based on redband trout adult) is greater than the incubation flow, the updated Physical Habitat flow remained equal to the Tennant-based flow for the month of June (Table IX-633-1).

For the months of July, August, December, and January, the Tennant-based flow of 13.0 cfs is greater than the 1999 claim of 10 cfs. Therefore, the updated Physical Habitat flows remain equal to the 1999 Physical Habitat Claim flow values of 10 cfs for the months of July, August, December, and January (Table IX-633-1).

February – May

Based on information obtained from ODFW, spawning redband trout was identified as the priority species and lifestage for this period (Figure VII-6). The Tennant-based flows for this period were equal to 50% of the mean annual flow (Qaa) or 21.7 cfs. The Tennant-based flow values were higher than the 1999 Physical Habitat Claim flow values. Therefore, the updated Physical Habitat flows remain equal to the 1999 Physical Habitat Claim flow values for the period February through May (Table IX-633-1).

345. Would any of the Physical Habitat flows just noted differ if Chinook salmon were present within Claim 633?

No known evidence exists that Chinook salmon were found within this claim reach. Therefore, no conditional Physical Habitat Claim was developed for this Claim Reach.

CLAIM 634 – LARKIN CREEK

346. Please describe the stream reach associated with Claim 634.

Claim Reach 634 extends the entire length of Larkin Creek from its mouth where it enters the Williamson River upstream about 6800 ft to its headwaters, which arise from a series of springs. Larkin Creek is a spring-dominated stream (hereinafter called "Claim Reach 634"). See OWRD Ex. 12 at 13 describing the upper and lower boundaries of the Claim Reach 634; also see Figure IX-634-1 and Figure IX-634-2. Larkin Creek flows north until it joins the lower Williamson River and drains an area of approximately 4.8 square miles.

Larkin Creek is a low-gradient stream, averaging 6-13 feet wide, and is moderately confined in a wide valley bottom (Ex. 277-US-443). The stream displays a slight sinuosity with some meanders incised slightly into the valley (Figure IX-634-2) (Ex. 277-US-417). As a spring-dominated stream, the hydrology of Larkin Creek is characterized by relatively stable flow levels. Peak median flow (17.8 cfs) typically occurs in March and the low median flow (11.1 cfs) occurs in August (see Figure IX-634-3).

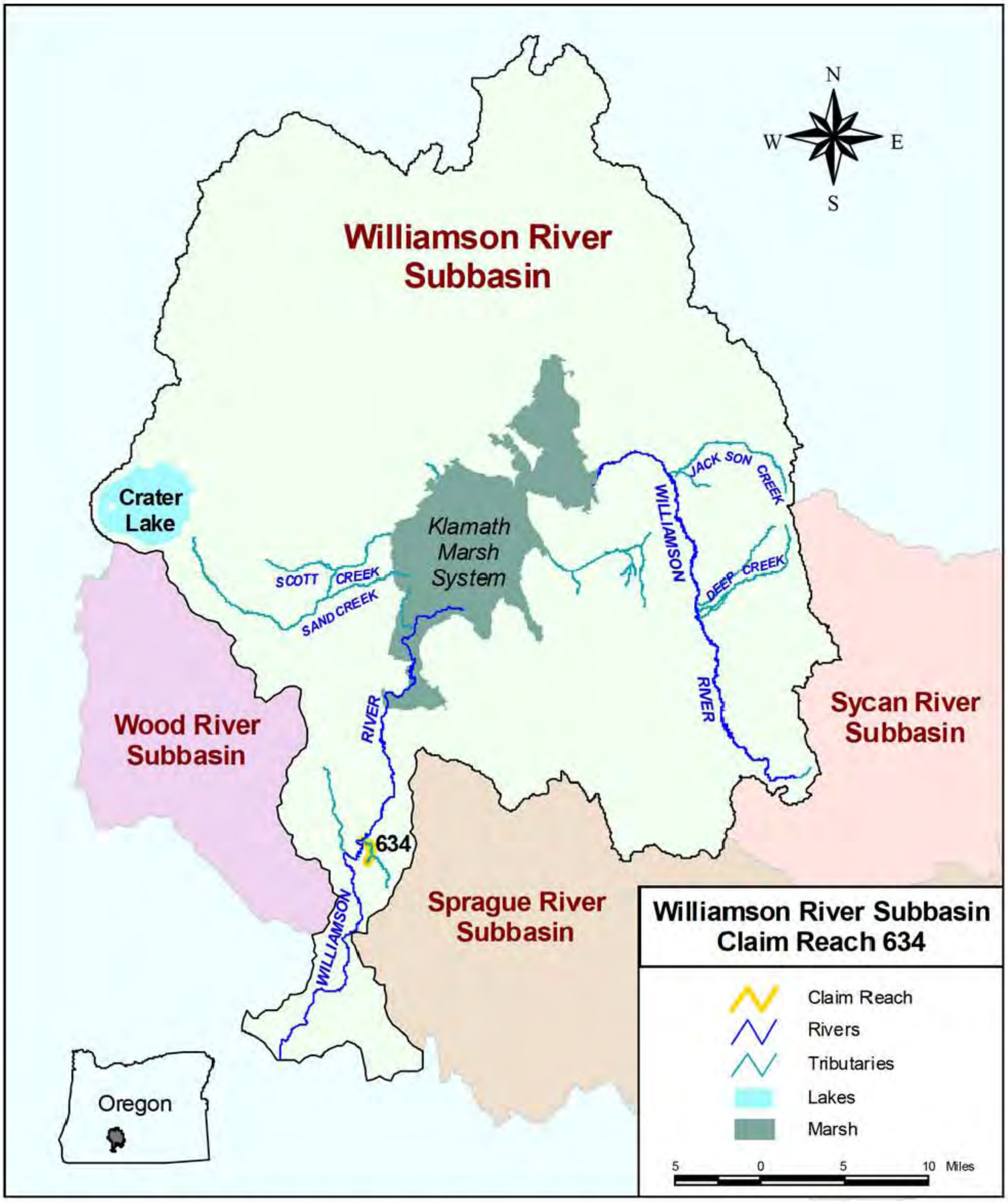

Figure IX-634-1. Claim Reach 634. Larkin Creek, (Williamson River Subbasin) with claim reach highlighted in yellow.

Figure IX-634-2. Orthographic photograph of Claim Reach 634 (Oregon Imagery Explorer 2007).

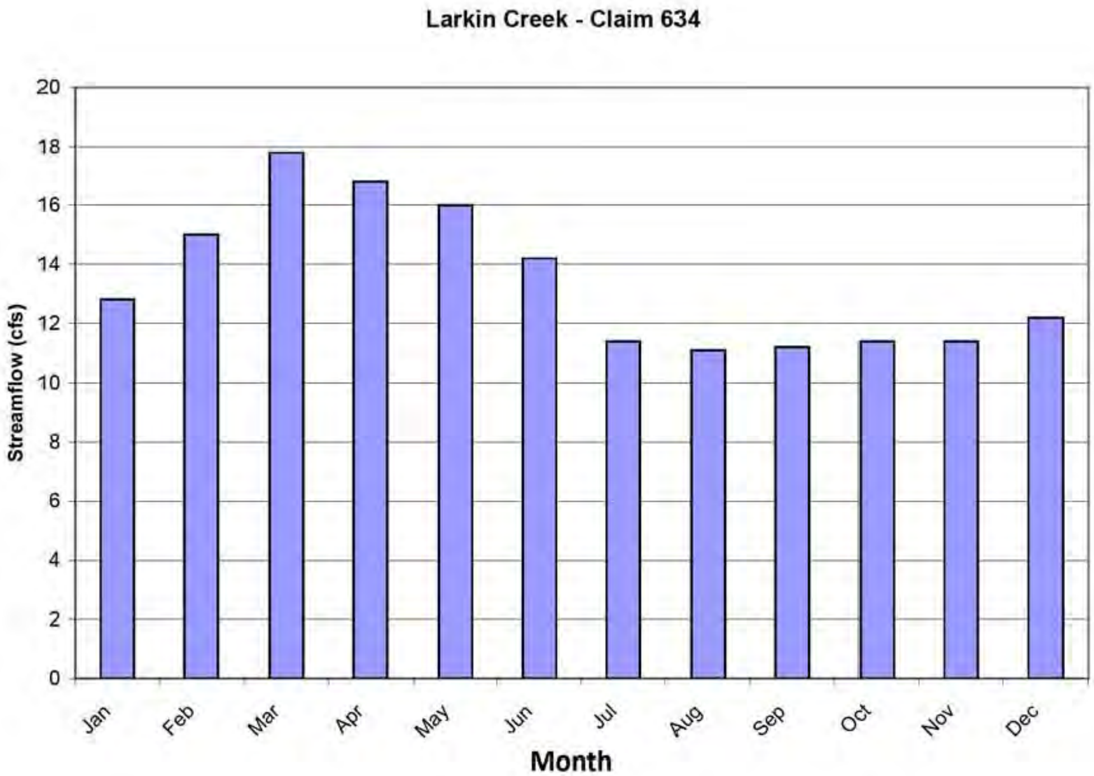

Figure IX-634-3. Larkin Creek (Claim Reach 634) monthly hydrograph (median flow values) under natural flow conditions (Cooper 2004).

347. Are you familiar with this reach of Larkin Creek that comprises Claim Reach 634?

Yes. I have visited portions of this stream numerous times over the past 20 years. My most recent field visit to Larkin Creek was in September 2004 during the collection of aquatic invertebrate samples. I also participated in field activities during one or more of the IFIM/PHABSIM surveys conducted on this stream. I have also flown over and photographed from the air the entire length of Claim Reach 634.

348. Please describe the stream environment associated with Claim Reach 634.

Based on my observations and information from other sources, the stream environment associated with Claim Reach 634 is as follows. Larkin Creek is bordered for most of its length by marshy and shrub riparian vegetation, consisting of sedges and rushes near the stream channel with scattered willows and conifers. The riparian zone is typically about 160 feet wide, but extends up to nearly 300 feet wide at some locations (David Chapin Direct Testimony at question 70). No significant streambank erosion was evident during a 2004 survey conducted by ODFW (Ex. 277-US-444) and I did not observe erosion problems in this reach.

The fish habitats of the lower 1,640 feet of Larkin Creek consist of riffles, runs, and small pools, averaging 8-9 feet wide and 1.5-2.0 feet deep, with gravel and small cobble substrates (Ex. 277-US-443). My observations of this lower section of Larkin Creek indicates that it provides an excellent mix of spawning and rearing habitats and abundant cover in the form of overhanging vegetation, undercut banks, and instream structure (wood, large rocks). Several habitat enhancement structures designed to retain spawning gravels were still present and functioning during my 2004 visit.

The remaining upper portion of Larkin Creek (approximately 5,249 feet to the top of the Claim Reach) consists of a series of pool and glide habitat types averaging 2-3 feet deep and in places up to 100 feet wide. Channel substrate composition in this section consists mostly of sand, silt, and organics. Although no woody debris or spawning habitat was reported in this section of Larkin Creek, the pool and glide habitat provides considerable adult and juvenile rearing and holding habitat (Ex. 277-US-444).

349. Please describe the target fish species that currently, and in the future will, utilize this reach.

The target fish species that currently utilize the claim reach is redband trout (Ex. 277-US-424; Ex. 277-US-445). Both adfluvial redband trout from Upper Klamath Lake, as well as resident redband utilize the lower segment of the stream for spawning and fry/juvenile rearing. The upper segments of the stream provide important juvenile rearing habitats. Other fish species that are currently present in Larkin Creek include non-native species of brown trout, speckled dace and slender sculpin (Anderson 2006; 277-US-445). During snorkel surveys in 1993 and 2003, adult and juvenile redband trout as well as adult and juvenile brown trout were documented (Ex. 277-US-423).

Chinook salmon reportedly historically used the claim reach for spawning and juvenile rearing (Huntington 2004; Huntington and Dunsmoor 2006; Hooton and Smith 2008), and, therefore, will likely use this system again when they are reintroduced.

350. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 634?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The detailed IFIM/PHABSIM sampling site that formed the basis for the updated Physical Habitat flow was established in April 2004, and was based on habitat mapping conducted on a section of the stream approximately 600-feet upstream from the confluence with the Williamson River and extending 1,939 feet upstream (Figure IX-634-2). A diversity of habitat types were present: pool (24%), run (47%), and riffle (29%) (Ex. 277-US-443). A total of nine IFIM/PHABSIM transects were established and sampled during three separate site visits. A summary of the data collection is provided below in Table IX-634-1 and a photograph of a sample site is provided below in Figure IX-634-4.

Table IX-634-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 634 – Larkin Creek.

Survey Date	Habitat Type(s) Sampled	Number of Transects
05/10/2004	Riffle, Run, Pool	9
06/24/2004	Riffle, Run, Pool	9
08/17/2004	Riffle, Run, Pool	9

Figure IX-634-4. Larkin Creek (Claim Reach 634), IFIM/PHABSIM sample site at Transect 3, looking downstream on May 10, 2004.

Ex. 277-US-443 includes copies of the field data collected and used to develop the updated Physical Habitat flow values for Claim 634.

351. Is there an updated Physical Habitat Claim for Claim 634?

Yes. The updated Physical Habitat flows for Claim Reach 634 are based on the data collected (Ex. 277-US-446) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-447 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages.

The updated Physical Habitat flows for each month are presented in the bottom row of Table IX-634-2. The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flows represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Larkin Creek, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing target fish species populations at levels at which tribal harvest can occur.

This reach has a number of special qualities: 1) the stream is spring dominated and maintains a spring-influenced thermal regime which affords a stable flow regime throughout the year and cool water temperatures in the summer months both within the reach and below the reach; 2) if necessary, the reach provides potential coldwater holding and refuge habitats from the Williamson River during summer months; 3) the reach provides important adfluvial redband trout spawning habitat and rearing habitat for juvenile redband trout; and 4) the reach is anticipated to support anadromous salmonids upon reintroduction and will provide spawning habitat and juvenile rearing/rearing habitat similar to that afforded to redband trout. Because of these special qualities, both individually and in combination, I considered Claim Reach 634 one of the "unique" streams or stream segments in the basin (*see* Section VIII, questions 259 and 260-Final Step Two). As a result, the IFIM/PHABSIM flow was based on providing the greatest amount of potential habitat of the priority species/lifestage.

Table IX-634-2 encapsulates the derivation process of each monthly claim resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM based flow for the priority species/lifestage for that month (representing the flow that provides 100 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); or 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim). The monthly Riparian Habitat Claims for the claim reach are described in and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

352. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 634, the basis for the updated Physical Habitat flows was the IFIM/PHABSIM-based flows in three months (November through January); the incubation flow in no months; the median flow cap in two months (July and September); and the 1999 Physical Habitat Claim flow values in seven months (February through June, August, and October). Overall, the updated Physical Habitat flows are less than the 1999 Physical Habitat Claim flow values in five months, and equal to the 1999 Physical Habitat flow values in seven months.

Table IX-634-2. Updated Physical Habitat Claim and Monthly instream flow values for Larkin Creek, Claim 634, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Life Stage	RT-s	RT-j	RT-j	RT-j	RT-j	RT-j	RT-j	RT-j	RT-j	RT-j	RT-s	RT-s
1999 Physical Habitat Claim Flow Values	12	10	13	13	13	13	12	10	13	9	9	12
100% WUA	8	22	22	22	22	22	22	22	22	22	8	8
Incubation Flow		5.3	5.3									
Median Flow	12.8	15.0	17.8	16.8	16.0	14.2	11.4	11.1	11.2	11.4	11.4	12.2
Updated IFIM/PHABSIM-Based Flows	8	22	22	22	22	22	22	22	22	22	8	8
Updated Physical Habitat Claim	**8.0**	**10**	**13**	**13**	**13**	**13**	**11**	**10**	**11**	**9.0**	**8.0**	**8.0**

RT-s = redband trout spawning; RT-j = redband trout juvenile

All values included in this table are presented in cubic feet per second (cfs).

353. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 634.

The IFIM/PHABSIM flows were based on two lifestages (spawning and juvenile) of one of the target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

November – January

The IFIM/PHABSIM flows for this period are based on redband trout spawning (Figure VII-6). The IFIM/PHABSIM flow representing 100 percent of the potential amount of habitat is 8 cfs. This flow is lower than both the median flows and the 1999 claim limit. Therefore, the IFIM/PHABSIM-based flows constitute the updated Physical Habitat flow values for the period November through January (Table IX-634-2).

February – October

The IFIM/PHABSIM flows for this period are based on juvenile redband trout (Figure VII-6). The IFIM/PHABSIM flow representing 100 percent of the potential amount of habitat is 22 cfs. For the months of February through June, August, and October, the IFIM/PHABSIM flow is higher than the 1999 Physical Habitat Claim flow values of 9 to 13 cfs. Therefore, the 1999 Physical Habitat Claim flow values constitute the updated Physical Habitat flow for the months of February through June, August, and October. For the months of July and September, the IFIM/PHABSIM flow is higher than the median flow (11.2 to 11.4 cfs). Therefore, the median flow constitutes the updated Physical Habitat flow for the months of July and September (Table IX-634-2). Because redband trout spawning takes place in January, redband trout egg incubation flow (2/3 of 8 cfs or 5.3 cfs) was also considered for the months of February through March. However, the IFIM/PHABSIM based flow for juvenile redband trout is greater than the incubation flow and is likewise greater than the 1999 flow. Therefore, the updated Physical Habitat flow is equal to the 1999 flow (10 to 13 cfs) for the months of February and March (Table IX-634-2).

354. Is there a conditional Physical Habitat Claim for Claim 634?

Yes. When anadromous fish are reintroduced, they will likely be present in the months of February through October during which Chinook juvenile would replace redband trout juvenile as the priority species/lifestage (Figure VII-6). The IFIM/PHABSIM sampling identified a limited amount (625 sq ft per 1,000 ft at 100% WUA) of suitable habitat for Chinook spawning within the claim reach. Therefore, for the months of February through October, I assumed that the use of Claim Reach 634 by Chinook salmon would be limited to juvenile rearing. For all other months (November through January), redband trout spawning remained the priority species and lifestage

355. When adjustments were made to the Physical Habitat flow values for the inclusion of Chinook, how many of the updated Physical Habitat flows were based on: the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim flow limit?

Compared to the flow values just provided for the Physical Habitat Claim based on current species, anadromous fish presence requires re-evaluation of the updated Physical Habitat flows in all months.

With Chinook salmon included as a priority species, the basis for the updated Physical Habitat flows was the IFIM/PHABSIM flows in three months (November through January); the incubation flows in no months; the median flow cap in two months (July and September); and the 1999 claim flow limit in seven months (February through June, August, and October). Overall, in five months, the conditional Physical Habitat flow values are less than the 1999 Physical Habitat claim flow values. In seven months, the conditional Physical Habitat flow values are equal to the 1999 Physical Habitat flows.

356. Please provide more detail regarding the determination of the monthly flows for the conditional claim for Claim Reach 634.

As noted above, there were nine months for which consideration of Chinook would result in modifications to or otherwise impact the priority species and lifestage. These are the months of February through October during which juvenile Chinook would be present. Although Chinook salmon spawning may occur within some areas of Claim Reach 634 during the months of September through November, the IFIM/PHABSIM sampling captured little suitable Chinook salmon spawning habitat. Therefore, Chinook juvenile was used as the basis for the claims in September and October, and redband spawning in November.

Table IX-634-3 Conditional Physical Habitat Claim and monthly instream flow values for Larkin Creek, Claim Reach 634, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Life Stage	RT-s	CH-j	CH-j	CH-j	CH-j	CH-j	CH-j	CH-j	CH-j	CH-j	RT-s	RT-s
1999 Physical Habitat Claim Flow Values	12	10	13	13	13	13	12	10	13	9	9	12
100% WUA	8	22	22	22	22	22	22	22	22	22	8	8
Incubation Flow		5.3	5.3									
Median Flow	12.8	15.0	17.8	16.8	16.0	14.2	11.4	11.1	11.2	11.4	11.4	12.2
Updated IFIM/PHABSIM-Based Flows	8	22	22	22	22	22	22	22	22	22	8	8
Conditioal Physical Habitat Claim	**8.0**	**10**	**13**	**13**	**13**	**13**	**11**	**10**	**11**	**9.0**	**8.0**	**8.0**

RT-s = spawning redband trout; CH-j= Chinook salmon juvenile
All values included in this table are presented in cubic feet per second (cfs).

November – January (conditional claim)

For this period, the species and lifestage priority remain redband trout spawning and the conditional updated Physical Habitat flow values remained as noted above (Table IX-634-3)

February - October (conditional claim)

Information on periodicity predicts that upon reintroduction, juvenile Chinook salmon will use Claim Reach 634 during the months of February through October (Figure VII-6). The IFIM/PHABSIM-based flow that provides 100 percent of the potential amount of Chinook salmon juvenile habitat is 22 cfs (Table IX-634-3). The IFIM/PHABSIM flow is higher than both the median flows and the 1999 Physical Habitat Claim flow values. For the months of

February through June, August, and October, the 1999 claim is less than the median flow and, therefore, constitutes the conditional updated Physical Habitat flow value for these months. For the months of July and September, the median flow is less than the 1999 claim. Therefore, the median flow constitutes the conditional updated Physical Habitat flow value for the months of July and September. (Table IX-634-3).

CLAIM REACH 635 – SAND CREEK

357. Please describe the stream reach associated with Claim 635.

The Claim 635 stream reach is located in the upper Williamson River subbasin on the western edge of the Klamath Marsh system and is comprised of the approximately 18-mile long section of Sand Creek (hereinafter called "Claim Reach 635"). See OWRD Ex. 13 at 19 describing the upper and lower boundaries of the Claim Reach 635; also see Figure IX-635-1 and Figure IX-635-2. The upper portion of Sand Creek (upstream-most 9 miles) flows through a deep, vertical-walled canyon. The middle portion (approximately 5.7 miles) is a low-gradient channel that is moderately entrenched as it flows through a wide valley floor (USFS 1996a, DEA 2005a). The lower portion of the channel (downstream-most 3 miles) is largely unconfined and slightly entrenched with a valley slope of 1.0 percent (Ex. 277-US-417). Within this lower portion, Sand Creek loses approximately half of its flow to Scott Creek via the Sand Creek Diversion Canal. The sum of the flows of Sand Creek and Scott Creek are used to irrigate pasture lands in the northwestern portions of Klamath Marsh (USFS 1998).

The western half of Claim Reach 635 is beyond the territorial boundary of the former Klamath Reservation; however, this boundary point does not constitute a physical barrier for fish movement purposes (*see* Section IV, questions 88-91). Sand Creek shows a pronounced snowmelt hydrograph (DEA 2005a). Under natural flow conditions, peak median flow (63.9 cfs) in this reach typically occurs in April and May and the low median flow (17.3 cfs) in late summer or early fall (Figure IX-635-3). Historically, Sand Creek likely connected to the Klamath Marsh and Williamson River during wet years (USFS 1996a).

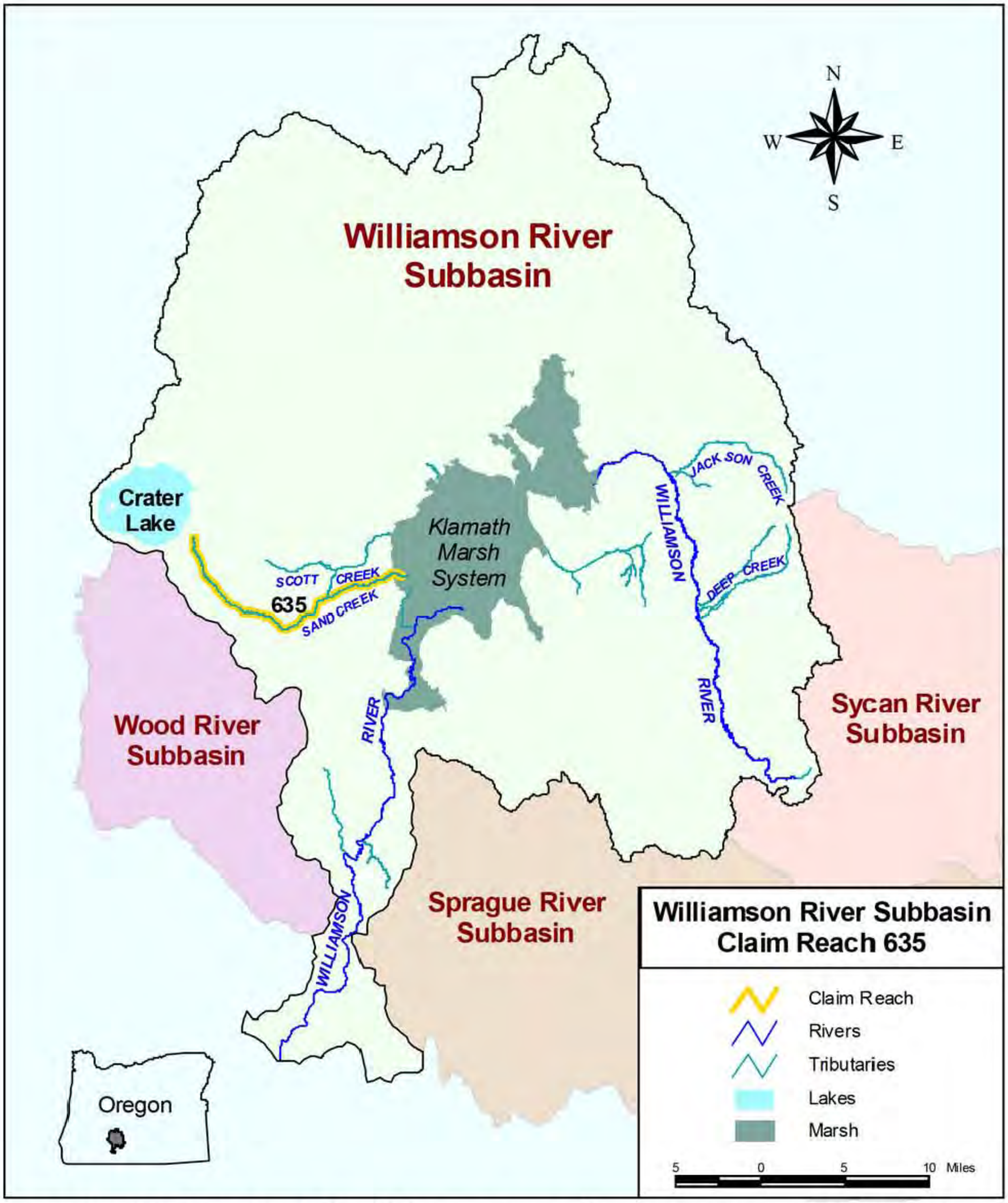

Figure IX-635-1. Claim Reach 635. Williamson River subbasin with claim reach highlighted in yellow.

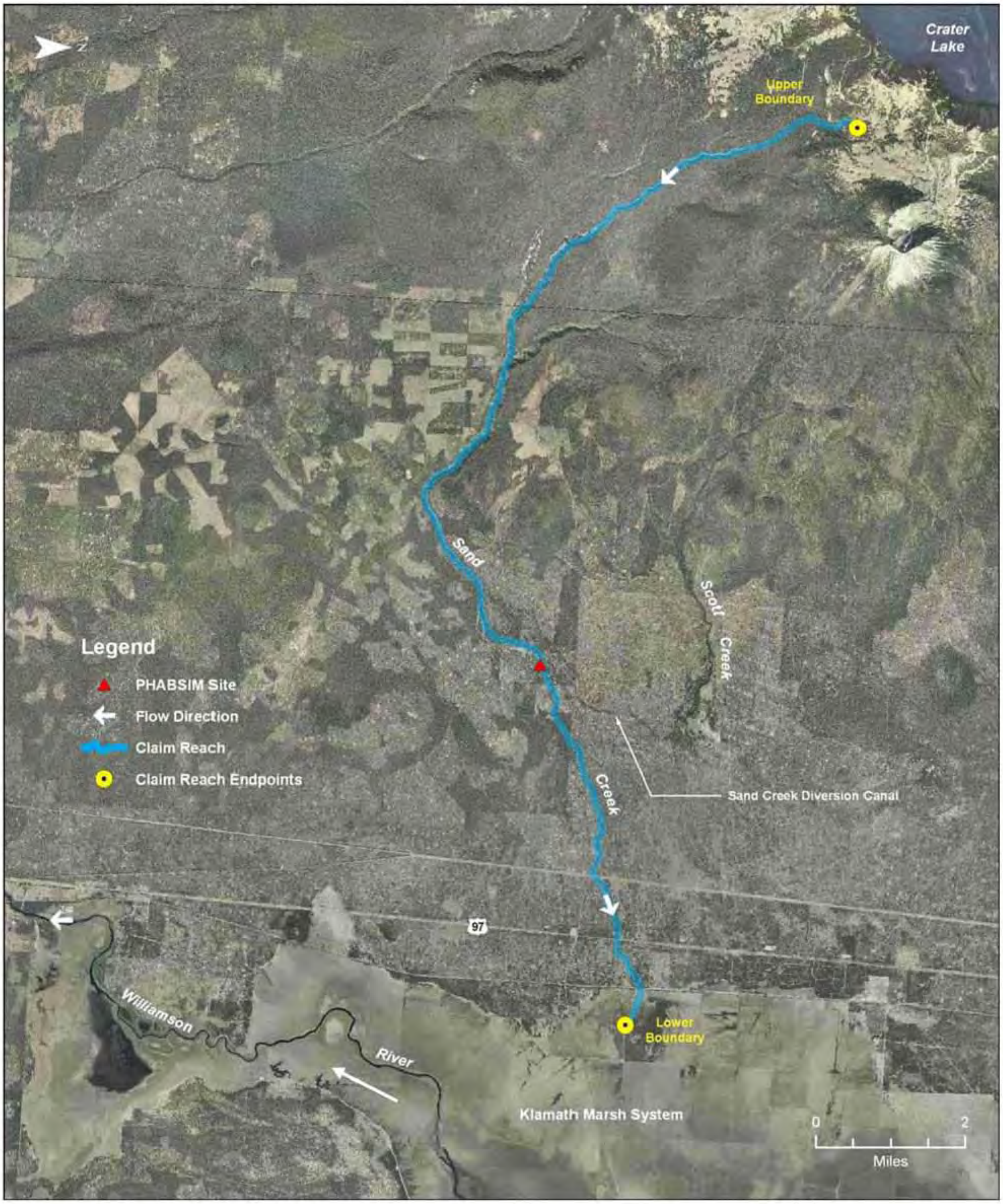

Figure IX-635-2. Orthographic photograph of Claim Reach 635 (Oregon Imagery Explorer 2007).

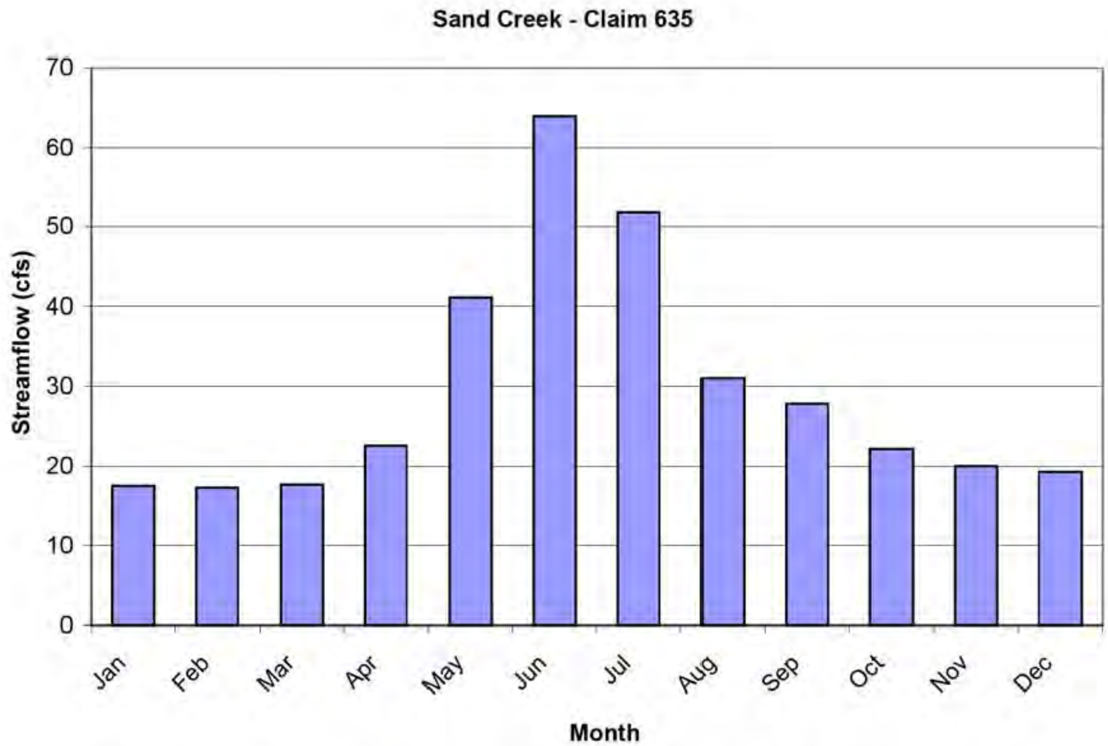

Figure IX-635-3. Sand Creek monthly hydrograph (median flow values) at the confluence with the Klamath Marsh (Claim Reach 635) (Cooper 2004).

358. Are you familiar with this reach of the Williamson River that comprises Claim Reach 635?

Yes. I have visited portions of Claim Reach 635 several times over the past 20 years and in particular the detailed study site.

359. Please describe the stream environment associated with Claim Reach 635.

Based on my observations and information from other sources, the stream environment associated with Claim Reach 635 is as follows. Sand Creek flows primarily through forested uplands with conifers of varying stages of growth on terraces bordering the floodplain (USFS 1996a). Much of the forest outside of Crater Lake National Forest has been harvested in the past. Within the floodplain along the stream, there are typically abundant shrubs, such as willow, along with grasses, sedges, and forbs (Dr. Chapin Direct Testimony at question 70). Although most of the upper portion of the claim reach is in a steep canyon, the floodplain is dominated by willows. The steep canyon area of the upper portion of Sand Creek provides large inputs of small pumice material to the stream, the highly mobile nature of which has probably resulted in the extremely low pool frequency observed in this section of Sand Creek (USFS 1996a). Because of the steep canyon walls, the stream is well shaded, which helps to maintain cool stream temperatures. Stream channel complexity and structure in the channel is provided by a few scattered pieces of large woody debris or collapsed slabs of welded pumice (USFS 1996a).

Downstream of the canyon, the middle portion of Sand Creek is moderate-to-steep, with fish habitat provided by pool-riffle sequences, and large woody debris and riparian vegetation contributing to channel form (USFS 1998). An extensive riparian corridor contributes large woody debris for channel forming processes, cover for aquatic organisms, and an input of organic matter in the form of leaf fall (DEA 2005a). This middle portion of Sand Creek also possesses stable undercut banks and abundant spawning gravel substrate (DEA 2005a).

In the lower portion of the stream as it approaches Highway 97, the riparian zone narrows considerably; often little shrub cover exists and upland plant species encroach to the channel banks. This lower section of Sand Creek is largely comprised of run habitat, and has experienced a decrease in fish habitat quality through the loss of riparian cover, channelization, and diversion of stream flow (DEA 2005a). Despite these alterations, this section does contain some undercut banks, some clear and cool spring-sourced water, and abundant gravel substrates (DEA 2005a).

In October, 2005 a fish habitat survey was conducted along a 4,141-ft section of Sand Creek near the Klamath Tribes old reservation boundary. Habitat in this section was diverse, consisting of 56% riffle, 24% pool, and 20% run. Large woody debris was abundant and contributed to the formation of many of the pools and creation of cover. Spawning sized gravels were also abundant, comprising 77% of the substrate and contributing to an estimated 1,508 square feet of potential spawning area (Ex. 277-US-448).

360. Please describe the target fish species that currently, and in the future will, utilize this reach.

Resident redband trout is the target species present within Claim Reach 635. Historically, especially during particularly wet periods, adfluvial redband trout may have been able to access Sand Creek from the Klamath Marsh and the Williamson River (USFS 1998). Except for warm water summertime periods, native redband trout would have likely used the marsh area for juvenile rearing habitat as well as an important feeding area for adults (DEA 2005a). Non-native brook trout and brown trout are also present in Sand Creek. During 1993 and 2007 snorkel surveys in Claim Reach 635, adult redband trout as well as adult and juvenile brook trout and brown trout were documented (Ex. 277-US-423).

361. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 635?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The sampling site was established in May 1993 and habitat mapping was conducted on a section of the claim reach extending 369 feet. Habitat diversity was low in this section, dominated by run habitat (89.7%) with some pool (4.3%) and riffle habitat (6%) present. A total of three (3) PHABSIM transects were established and sampled during three separate visits (Table IX-635-1).

Table IX-635-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 635 – Sand Creek.

Survey Date	Flow (cfs)	Habitat Type(s) Sampled	Number of Transects
05/28/1993	39.2	Run	3
06/25/1993	49.5	Run	3
09/15/1993	23.0	Run	3

Figure IX-635-4. Sand Creek (Claim Reach 635), IFIM/PHABSIM sample site, at Transect 3 on June 25, 1993 at 49.5 cfs.

OWRD Ex. 2 at 2134 through 2166 includes copies of the field data collected and used to develop the updated Physical Habitat flow values for Claim 635.

362. Is there an updated Physical Habitat Claim for Claim 635?

Yes. The updated Physical Habitat flow values for Claim Reach 635 are based on the data collected (Ex. 277-US-449) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-450 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages.

The updated Physical Habitat flow values for each month are presented in the bottom row of Table IX-635-2. The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flow values represent those which I consider sufficient to provide for a healthy and productive habitat within the Williamson River subbasin, including Claim Reach 635, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing populations at levels at which tribal harvest can occur.

Table IX-635-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM-based flow for the priority species/lifestage for that month (representing the flow that provides 90 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); and 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim). The monthly Riparian Habitat

Claims for the Claim Reach 635 are described and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

363. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 635, the basis for the updated Physical Habitat flow values was the IFIM/PHABSIM flows in one month (May); the incubation flow in no months; the median flow cap in eight months (September through April); and the 1999 Physical Habitat Claim flow values in three months (June through August). Overall, in nine months, the updated Physical Habitat flow values were less than the 1999 Physical Habitat Claim flow values and in three months the updated Physical Habitat flow values were equal to the 1999 Physical Habitat Claim flow values.

Table IX-635-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 635, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Life Stage	RT-a	RT-s	RT-s	RT-s	RT-s	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a
1999 Physical Habitat Claim Flow Values	22	22	23	26	50	33	33	30	30	30	29	26
90% WUA	37	39	39	39	39	37	37	37	37	37	37	37
Incubation Flow						26						
Median Flow	17.5	17.3	17.7	22.6	41.1	63.9	51.8	31.0	27.8	22.2	20.0	19.3
Updated IFIM/PHABSIM-Based Flows	37	39	39	39	39	37	37	37	37	37	37	37
Updated Physical Habitat Claim	**18**	**17**	**18**	**23**	**39**	**33**	**33**	**30**	**28**	**22**	**20**	**19**

RT-a = adult redband trout; RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

364. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 635.

The IFIM/PHABSIM flows are based on two lifestages (spawning and adult) of a single target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

June – January

The IFIM/PHABSIM flows for this period are based on adult redband trout that would be rearing, holding or moving through this reach (Figure VII-6). The IFIM/PHABSIM flows that represent 90 percent of the potential amount of adult redband trout habitat are 37 cfs. For the months of June and July, the IFIM/PHABSIM flow is lower than the median flows but higher than the 1999 Physical Habitat Claim flow values. Therefore, the updated Physical Habitat flows were adjusted to the 1999 Physical Habitat Claim flow values for the months of June and July (Table IX-635-2). For the month of August, the IFIM/PHABSIM flow is higher than the median flow, which is likewise higher than the 1999 Physical Habitat Claim flow. Therefore, the updated Physical Habitat flow was also adjusted to the 1999 Physical Habitat Claim flow value for August. For September through January, the IFIM/PHABSIM flow is higher than the median flows for those months, which are lower than the 1999 Physical Habitat Claim flows. Therefore, the updated Physical Habitat flows were adjusted to the monthly median flows for the period September through January (Table IX-635-2).

Because redband trout spawning takes place in May, redband trout egg incubation flows (2/3 of 39 cfs or 26 cfs) were also considered for the month of June. However, the IFIM/PHABSIM based flow for adult redband trout is greater than the incubation flow and is likewise greater than the 1999 flow. Therefore, the updated Physical Habitat flow during this period remains as noted above.

February – May

The IFIM/PHABSIM flows for this period are based on redband trout spawning (Figure VII-6). The IFIM/PHABSIM flow that represents 90 percent of the potential amount of redband trout spawning habitat is 39 cfs. For the months of February through April, the IFIM/PHABSIM flow is higher than the median flows, which are lower than the 1999 Physical Habitat flows. Therefore, the updated Physical Habitat flows were adjusted to the median flows for the months of February through April (Table IX-635-2). For the month of May, the IFIM/PHABSIM flow is lower than both the median flow and the 1999 Physical Habitat Claim flow. Therefore, the IFIM/PHABSIM-based flows constitute the updated Physical Habitat flow values for the month of May (Table IX-635-2).

365. Would any of the Physical Habitat flows just noted differ if Chinook salmon were present within Claim 635?

No known evidence exists that Chinook salmon utilized this claim reach. Therefore, no conditional claim was developed.

CLAIM REACH 636 – SCOTT CREEK

366. Please describe the stream reach associated with Claim 636.

Claim 636 encompasses an approximately 10-mile long section of Scott Creek (hereinafter called "Claim Reach 636") that is located in the upper Williamson River subbasin on the western edge of the Klamath Marsh. See OWRD Ex. 14 at 15 describing the upper and lower boundaries of the Claim Reach 636; also see Figure IX-636-1 and Figure IX-636-2. Scott Creek originates on Mount Scott east of Crater Lake and flows eastward in a small, unconfined channel with an average width of 7.7 feet and a valley slope of 0.7 percent (Figure IX-636-1). Historically, this stream likely connected to the Klamath Marsh and Williamson River in wet, high flow years. Currently, a diversion structure located approximately 2 miles west of Klamath Marsh withdraws all surface flow for irrigation purposes (USFS 1998). Within the lower extent of the claim reach, flow from Scott Creek is diverted into the Sand Creek Diversion Canal, and the sum of flows from Scott and Sand creeks are used to irrigate pasture lands in the northwestern portions of Klamath Marsh (USFS 1998). As a result, Scott Creek does not currently have a direct surface flow connection to the Williamson River.

Approximately one half of Claim Reach 636 lies beyond the western boundary of the former Klamath Reservation. However, the boundary does not constitute a physical barrier for fish movement purposes (*see* Section IV, questions 87-91).

Scott Creek shows a pronounced snowmelt hydrograph (DEA 2005a), with a peak median flow (38.2 cfs) typically occurring in June, and the low median flow (7.5 cfs) typically occurring in January and February (Figure IX-636-3).

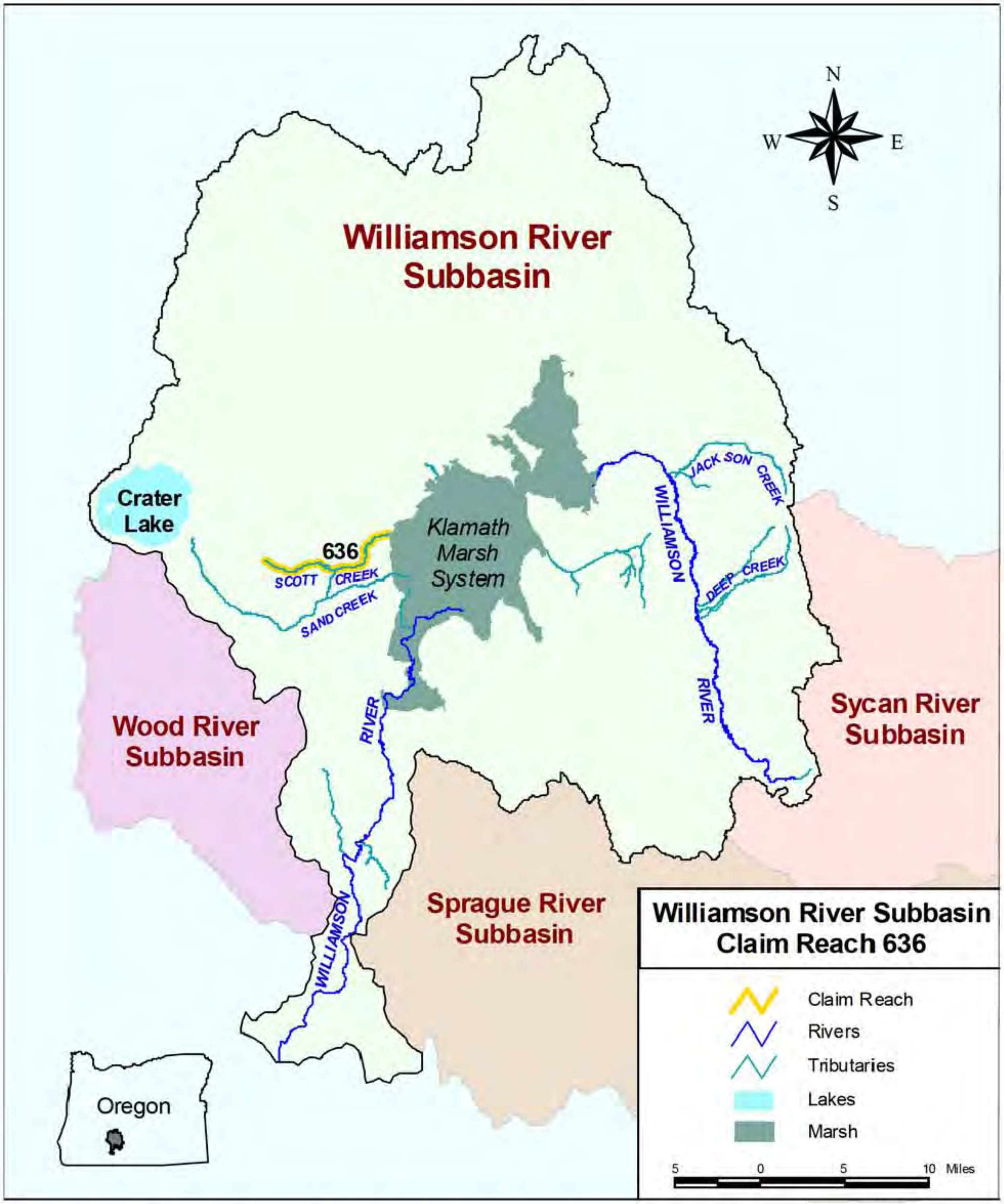

Figure IX-636-1. Claim Reach 636. Williamson River subbasin with claim reach highlighted in yellow.

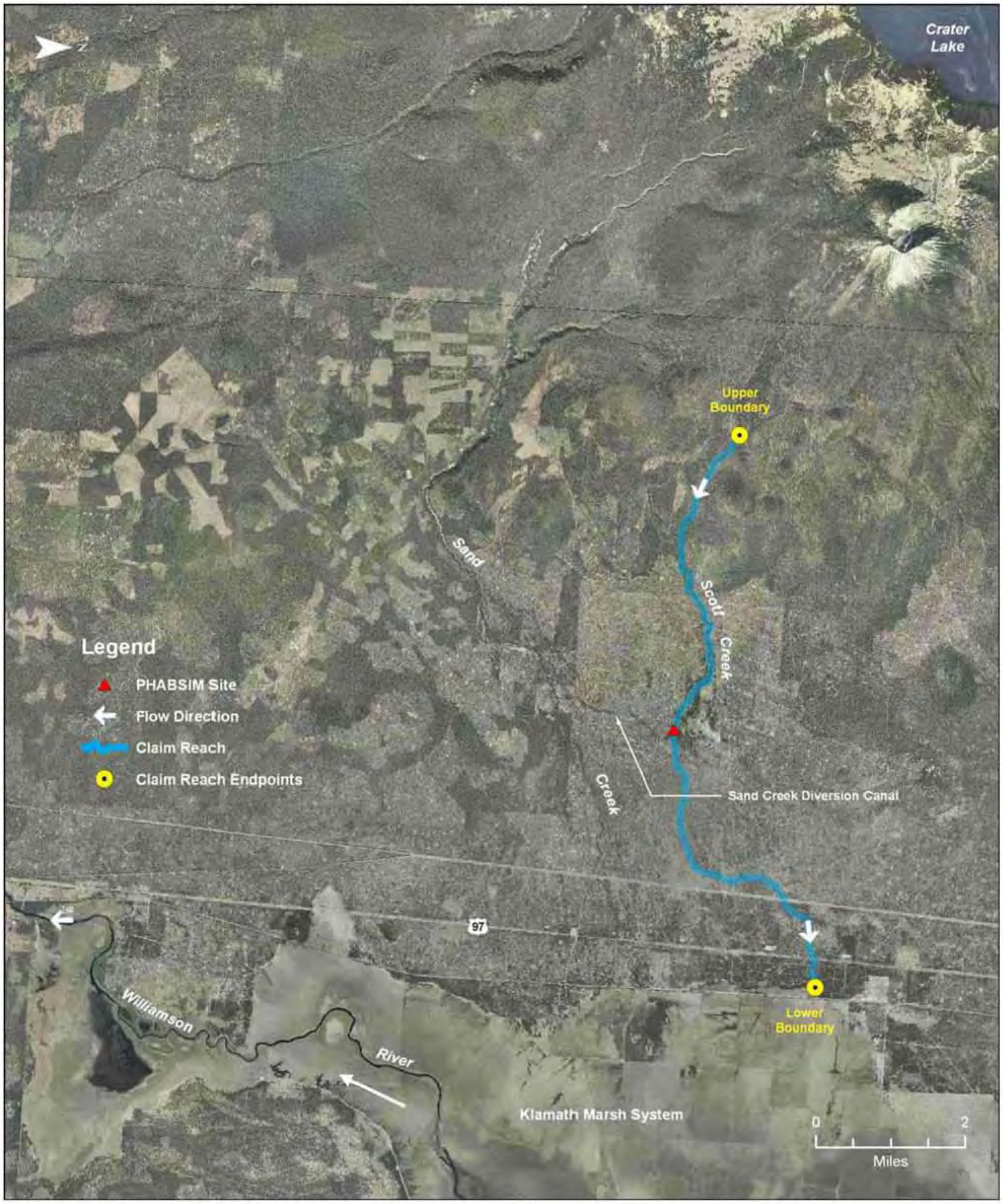

Figure IX-636-2. Orthographic photograph of Claim Reach 636 (Oregon Imagery Explorer 2007).

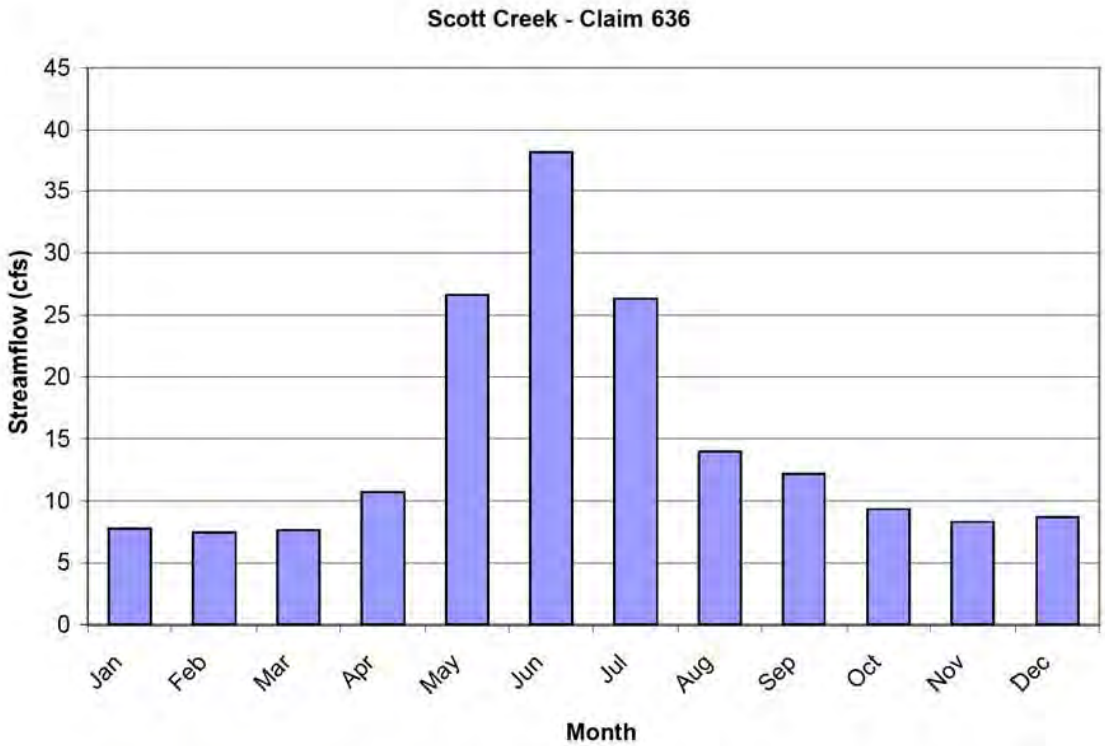

Figure IX-636-3. Scott Creek monthly hydrograph (median flow values) at the confluence with Klamath Marsh (Claim 636) (Cooper 2004).

367. Are you familiar with this reach of the Williamson River that comprises Claim Reach 636?

Yes. I have visited portions of Claim Reach 636 several times over the past 20 years, in particular the detailed study site.

368. Please describe the stream environment associated with Claim Reach 636.

Based on my observations and information from other sources, the stream environment in and around Claim Reach 636 is as follows. Scott Creek has a narrow riparian zone dominated by grasses and forbs with some areas dominated by shrubs. Harvest of streamside trees has been the dominant impact from human activities along this stream and second growth coniferous forest in various size stages occurs on terraces near the stream channel. In the upper portion of the reach (upstream most 1.5 miles), Scott Creek flows within a steep canyon with little opportunity for the development of stream-dependent riparian vegetation. In the middle section of the stream (approximately 3.2 miles), gradients are less, and the stream has a better developed riparian zone. In the lower portion of the reach as the stream approaches Highway 97 (downstream most 5.3 miles), there is little riparian vegetation with mostly upland species bordering the channel (Dr. Chapin Direct Testimony at question 70).

The upper and mid-sections of Scott Creek have moderate-to-steep gradients and have a greater quantity of gravel and larger-sized pumice substrate than the lower portion of Scott Creek, which is dominated by sand substrate (USFS 1996a). Fish habitat in upper and mid-sections of the stream is characterized by pool-riffle habitat, with large woody debris and riparian vegetation the primary factors contributing to channel complexity and form (USFS 1998). In areas with little wood, few pools were observed during habitat surveys (USFS 1996a). The lower section of Scott Creek is largely comprised of run-type habitat, but the quality of fish habitat has been reduced through the loss of riparian cover, channelization, and diversion of stream flow (DEA 2005a). Despite these alterations, lower Scott Creek provides clear and cool water and abundant gravel substrates (DEA 2005a).

An October 2005 fish habitat survey along a 3,700-ft section of Scott Creek in the middle portion of the claim reach near the former Klamath Reservation boundary revealed that habitat in this area was diverse, consisting of 24% riffle, 25% pool, and 51% run by length. Large woody debris was abundant and contributed to the formation of many of the pools and provided abundant cover. Spawning sized gravels were also abundant, comprising 59% of the substrate in this surveyed section. However, only 524 square feet of potential spawning area (1% of total area) was observed (Ex. 277-US-448).

369. Please describe the target fish species that utilize this reach.

Resident redband trout are the target species present within Claim Reach 636. Historically, especially during particularly wet periods, redband trout may have been able to access Scott Creek from the Klamath Marsh and the Williamson River (USFS 1998). Native redband trout would have likely used the marsh area for juvenile and adult rearing habitat except during late summertime, when water temperatures in most of the marsh would probably have been too high (DEA 2005a). Brook trout and brown trout were introduced to Scott Creek during the early 1900s (USFS 1998). During snorkel surveys in 1993 and 2003, adult and juvenile redband trout, adult and juvenile brook trout, and juvenile brown trout were all observed within Claim Reach 636 (Ex. 277-US-423).

370. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 636?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The Scott Creek sampling site was established in May 1993 and habitat mapping was conducted on a section of the claim reach extending 192 feet. Habitat diversity was low, dominated by run habitat (90.9%) with some pool (5.5%) and riffle (3.6%) habitat present. A total of three (3) PHABSIM transects were established in May 1993 and sampled during three separate visits (Table IX-636-1).

Table IX-636-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 636 – Scott Creek.

Survey Date	Flow (cfs)	Habitat Type(s) Sampled	Number of Transects
05/26/1993	13.9	Run	3
06/25/1993	13.5	Run	3
09/19/1993	4.8	Run	3

Figure IX-636-4. Scott Creek (Claim Reach 636), IFIM/PHABSIM sample site, at Transect 1 on June 25, 1993 at 13.5 cfs

OWRD Ex. 2 at 2167 through 2200 includes copies of the field data collected and used to develop the updated Physical Habitat flow values for Claim 636.

371. Is there an updated Physical Habitat Claim for Claim 636?

Yes. The updated Physical Habitat flow values for Claim Reach 636 are based on the data collected (Ex. 277-US-451) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-452 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The updated Physical Habitat flow values for each month are presented in the bottom row of Table IX-636-2. The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flow values represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Claim Reach 636, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70 will promote viable and self-renewing populations at levels at which tribal harvest can occur.

Table IX-636-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM-based flow for the priority species/lifestage for that month (representing the flow that provides 90 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); and 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim).

The monthly Riparian Habitat Claims for the Claim Reach 636 are described and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

372. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

The basis for the updated Physical Habitat flow values was the IFIM/PHABSIM flows in four months (April through July); the incubation flows in no months; the median flow cap in eight months (August through March); and the 1999 Physical Habitat Claim flow values limit in no months. Overall, the updated Physical Habitat flow values were less than the 1999 Physical Habitat flows in all twelve months.

Table IX-636-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 636, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-a	RT-s	RT-s	RT-s	RT-s	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a
1999 Physical Habitat Claim Flow Values	12	11	11	12	16	32	32	30	20	18	17	14
90% WUA	14.8	9.3	9.3	9.3	9.3	14.8	14.8	14.8	14.8	14.8	14.8	14.8
Incubation Flow						6.2						
Median Flow	7.77	7.45	7.63	10.7	26.6	38.2	26.3	14.0	12.2	9.34	8.31	8.69
Updated IFIM/PHABSIM-Based Flows	14.8	9.3	9.3	9.3	9.3	14.8	14.8	14.8	14.8	14.8	14.8	14.8
Updated Physical Habitat Claim	**7.8**	**7.5**	**7.6**	**9.3**	**9.3**	**15**	**15**	**14**	**12**	**9.3**	**8.3**	**8.7**

RT-a = adult redband trout; RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

373. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 636.

The IFIM/PHABSIM flows are based on two lifestages (spawning and adult) of a single target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

June through January

The IFIM/PHABSIM flows for this period are based on adult redband trout that would be rearing, holding or moving through this reach (Figure VII-6). The IFIM/PHABSIM flows that represent 90 percent of the potential amount of redband trout habitat are 14.8 cfs. For the months of June and July, the IFIM/PHABSIM flow is lower than both the 1999 Physical Habitat Claim flows and the median flows and, therefore, constitutes the updated Physical Habitat Claim flow values for those months (Table IX-636-2). For the months of August through November, the IFIM/PHABSIM flow is lower than the 1999 Physical Habitat Claim flows, but higher than the median flows. Therefore the updated Physical Habitat flow was adjusted to the median flow values for those months. For December and January, the IFIM/PHABSIM flow is higher than the 1999 Physical Habitat Claim flows, which are higher than the median flows for those months. Therefore, the updated Physical Habitat flows were adjusted to the monthly median flows for the months of December and January (Table IX-636-2).

Because redband trout spawning takes place in May, redband trout egg incubation flows (2/3 of 9.3 cfs or 6.2 cfs) were also considered for the month of June. However, the IFIM/PHABSIM based flow for adult redband trout is greater than the incubation flow. Therefore the updated Physical Habitat flow values during this period remain as noted above.

February – May

The IFIM/PHABSIM flows for this period are based on redband trout spawning (Figure VII-6). The IFIM/PHABSIM flow that represents 90 percent of the potential amount of redband trout spawning habitat is 9.3 cfs. For the months of February and March, the IFIM/PHABSIM flow is higher than the median flows, which are lower than the 1999 Physical Habitat flows. Therefore, the updated Physical Habitat flows were adjusted to the median flows for the months of February and March (Table IX-636-2). For the months of April and May, the IFIM/PHABSIM flow is lower than both the median flow and the 1999 Physical Habitat Claim flow. Therefore, the IFIM/PHABSIM-based flows constitute the updated Physical Habitat flow values for the months of April and May (Table IX-636-2).

374. Would any of the Physical Habitat flows just noted differ if Chinook salmon were present within Claim 636?

No known evidence exists that Chinook salmon utilized this claim reach. Therefore, no conditional claim was developed.

CLAIM REACH 637 – JACKSON CREEK

375. Please describe the stream reach associated with Claim 637.

Claim 637 encompasses a 10-mile section of Jackson Creek located upstream of the Klamath Marsh in the upper Williamson River subbasin (hereinafter called "Claim Reach 637"). See OWRD Ex. 15 at 15 describing the upper and lower boundaries of the Claim Reach 637; also see Figure IX-637-1 and Figure IX-637-2. Originating on the north side of Yamsay Mountain, Jackson Creek flows north and then west through a narrow, v-shaped valley with an average slope of 3 percent (Figure IX-637-2) (Ex. 277-US-417). Jackson Creek is one of the largest tributaries of the upper Williamson River with an average width of 11.3 feet (OWRD Ex. 2 at 2201-2220). Except during the highest runoff conditions, all surface flow from Claim Reach 637 is currently diverted for agricultural use. Irving Creek (Claim Reach 638) joins Jackson Creek near its historical confluence with the Williamson River. Under natural flow conditions, peak median flow (23.9 cfs) in this reach typically occurs in May and low median flow (4.7-4.9 cfs) occurs in late summer to early fall (Figure IX-637-3).

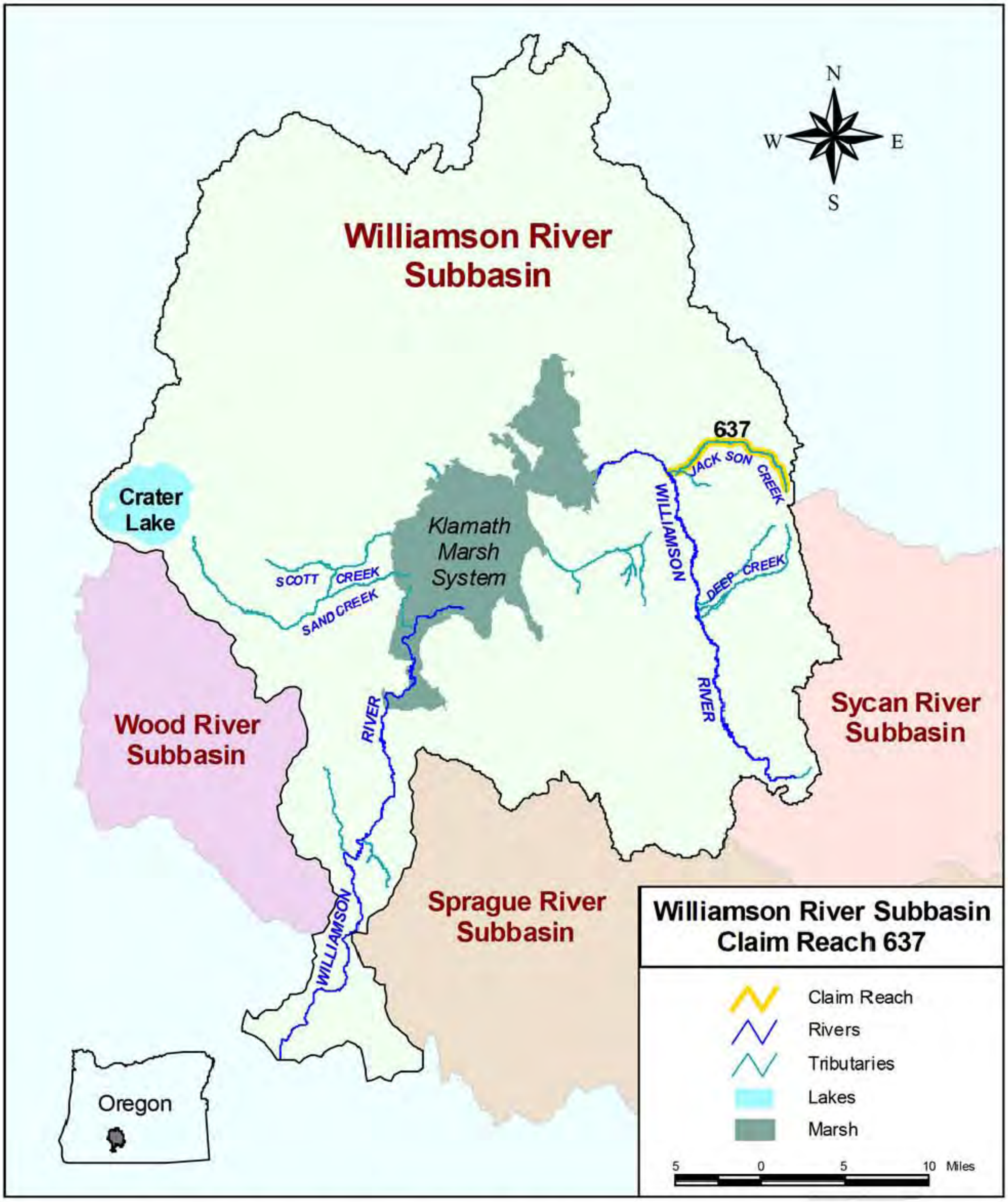

Figure IX-637-1. Claim Reach 637. Williamson River subbasin with claim reach highlighted in yellow.

Figure IX-637-2. Orthographic photograph of Claim Reach 637 (Oregon Imagery Explorer 2007).

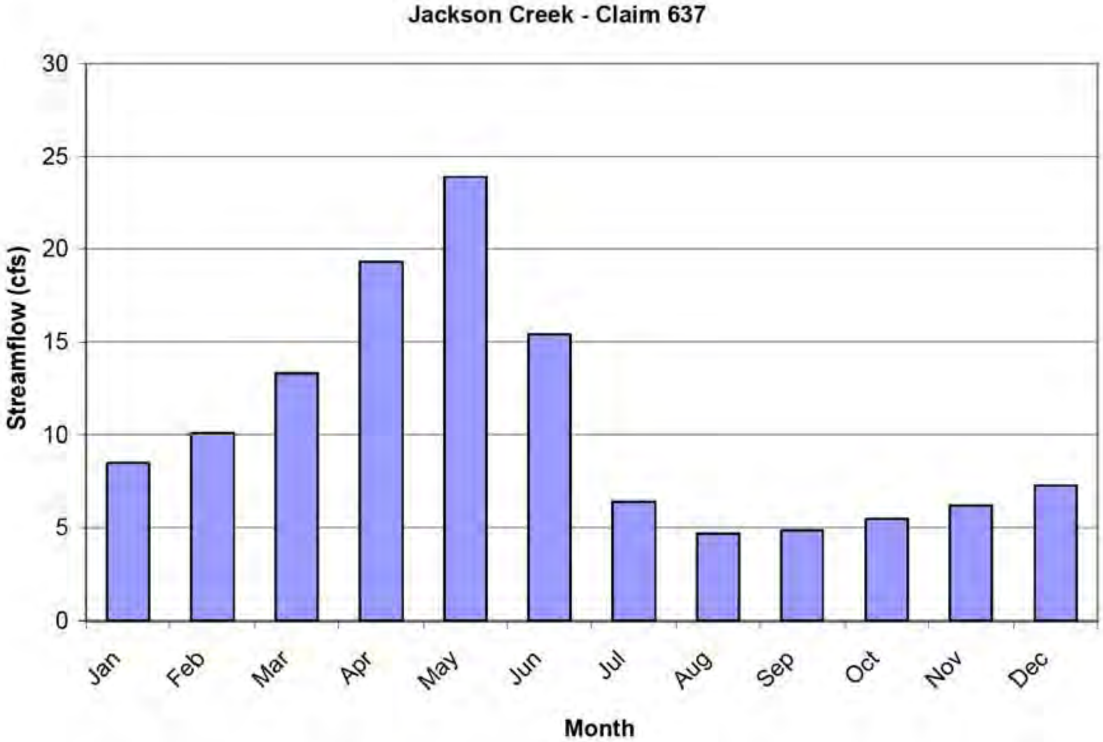

Figure IX-637-3. Jackson Creek monthly hydrograph (median flow values) at the confluence with the Williamson River (Claim Reach 637) (Cooper 2004).

376. Are you familiar with this reach of the Williamson River that comprises Claim Reach 637?

Yes. I have visited portions of Claim Reach 637 several times over the past 20 years including at the road access point, and in particular the detailed study site located about three miles upstream from the confluence with the Williamson River. Most recently, I completed a field reconnaissance of the detailed IFIM/PHABSIM site in June 2006 to check transect locations and survey points and assess overall habitat conditions.

377. Please describe the stream environment associated with Claim Reach 637.

Based on my observations and information from other sources, the stream environment in and around Claim Reach 637 is as follows. There is considerable variation in riparian vegetation along Jackson Creek as a result of varying geomorphic conditions from its headwater area on the slopes of Yamsay Mountain to its alluvial fan as it merges with the floodplain of the Williamson River. At the lower portion of the claim reach, Jackson Creek has a relatively broad floodplain with abundant willows and other shrubs, along with productive herbaceous vegetation composed of sedges, grasses, and forbs. Through most of the reach, however, the stream is confined into a narrow valley that has limited riparian habitat. Shrubs are common along the stream throughout the reach. At the upper portion of the claim reach, the stream has a broader floodplain in some areas that support dense riparian shrubs (Dr. Chapin Direct Testimony at question 70). Although most of the surrounding forest has been harvested, riparian buffers where harvest was excluded have maintained streamside forests. Shade varies from 67 percent in the upper portion of the reach to less than 20 percent at the lower portion (DEA 2005a).

Fish habitat of Jackson Creek is composed of riffles, rapids, and cascades. Stream channel substrate is dominated by gravel, sand, and boulders (Ex. 277-US-453). Abundant spawning habitat has been noted in Jackson Creek (DEA 2005a). As noted above, most of the perennial streams in the upper Williamson River subbasin like Jackson Creek have been completely diverted for agricultural use. The result of these diversions has been to eliminate or severely reduce the surface water connection between tributary streams and the Williamson River. Jackson Creek, along with its main tributary, Irving Creek (Claim Reach 638), has lost all surface connection to the Williamson River except during the highest runoff conditions (USFS 1998). Jackson Creek would most likely be a primary spawning area for redband trout if it were still connected to the river (USFS 1996b).

378. Please describe the target fish species that currently, and in the future will, utilize this reach.

Based on the presence of redband trout in nearby Irving Creek (Claim Reach 638) and the upper Williamson River mainstem (Claim Reach 631), redband trout is the target species for Claim Reach 637. However, during snorkel surveys in 1993, 2006, and 2007 only adult and juvenile brook trout were observed (Ex. 277-US-423). This suggests that either redband trout populations have been temporarily extirpated from the stream due to the introduction and competition with brook trout that has been exacerbated by flow depletions and loss of downstream connectivity, or the numbers of redband trout in the population are extremely low.

379. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 637?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The sampling site was established in September 1990 and habitat mapping was conducted on a section of the claim extending 282 feet (Figure IX-637-2). Habitat diversity was low, dominated by cascade habitat (80.9%) with lesser amounts of pool (7.1%), run (6.0%), and riffle (6.0%) present. A total of 3 PHABSIM transects were established and sampled during three separate visits (Table IX-637-1).

Table IX-637-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 637.

Survey Date	Habitat Type(s) Sampled	Number of Transects
09/19/1990	Cascade	3
04/06/1991	Cascade	3
05/10/1993	Cascade	3

Figure IX-637-4. Jackson Creek (Claim Reach 637), IFIM/PHABSIM sample site, at Transects 1 and 2 on September 19, 1990.

OWRD Ex. 2 at 2201 through 2220 includes copies of the field data collected and used to develop the updated Physical Habitat flow values for Claim 637.

380. Is there an updated Physical Habitat Claim for Claim 637?

Yes. The updated Physical Habitat flow values for Claim Reach 637 are based on the data collected (Ex. 277-US-454) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-455 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The updated Physical Habitat flow values for each month are presented in the bottom row of Table IX-637-2. The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flow values represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Claim Reach 637, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing populations at levels at which tribal harvest can occur.

Table IX-637-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM based flow for the priority species/lifestage for that month (representing the flow that provides 90 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); or 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim).

The monthly Riparian Habitat Claims for the claim reach are described in and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

381. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 637, the basis for the updated Physical Habitat flows was the IFIM/PHABSIM flows in one month (May); the incubation flow in no months; the median flow cap in eight months (June through January); and the 1999 Physical Habitat Claim flow limit in three months (February through April). Overall, the updated Physical Habitat flows for this claim were less than the 1999 Physical Habitat Claim flow values in nine months, and were equal to the 1999 Physical Habitat Claim flow values in three months.

Table IX-637-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 637, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-a	RT-s	RT-s	RT-s	RT-s	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a
1999 Physical Habitat Claim Flow Values	10	9	9	14	23	16	16	15	13	12	12	10
90% WUA	17.5	22.3	22.3	22.3	22.3	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Incubation Flow						14.7						
Median Flow	8.51	10.1	13.3	19.3	23.9	15.4	6.42	4.68	4.85	5.47	6.21	7.30
Updated IFIM/PHABSIM-Based Flows	17.5	22.3	22.3	22.3	22.3	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Updated Physical Habitat Claim	**8.5**	**9.0**	**9.0**	**14**	**22**	**15**	**6.4**	**4.7**	**4.9**	**5.5**	**6.2**	**7.3**

RT-a = adult redband trout; RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

382. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 637.

The IFIM/PHABSIM flows are based on two lifestages (spawning and adult) of a single target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

June – January

The IFIM/PHABSIM flows for this period are based on adult redband trout that would be rearing, holding or moving through this reach (Figure VII-6). The IFIM/PHABSIM flows that represent 90 percent of the potential amount of redband trout habitat are 17.5 cfs, which is higher than the 1999 Physical Habitat Claim flows and the median flows. Because the median flows are less than the 199 Physical Habitat Claim flows, the median monthly flows constitute the updated Physical Habitat flow values for this period (Table IX-637-2).

Because redband trout spawning takes place in May, redband trout egg incubation flows (2/3 of 22 cfs or 14.7 cfs) were also considered for the month of June; however, the IFIM/PHABSIM based flow for adult redband trout is greater than the incubation flow. Therefore, the updated Physical Habitat flow values during this period remain as noted above.

February – May

The IFIM/PHABSIM flows for this period are based on redband trout spawning (Figure VII-6). The IFIM/PHABSIM flow that represents 90 percent of the potential amount of redband trout spawning habitat is 22.3 cfs. For the months of February through April, the IFIM/PHABSIM flow is higher than the 1999 Physical Habitat Claim flow values. Therefore, the 1999 Physical Habitat Claim values constitute the Updated Physical Habitat flows for the

February through April period (Table IX-637-2). For May, the IFIM/PHABSIM flow is lower than both the median flow and the 1999 Physical Habitat Claim flow values. Therefore, the IFIM/PHABSIM based flows constitute the Updated Physical Habitat flow for the month of May (Table IX-637-2).

383. Would any of the Physical Habitat flows just noted differ if Chinook salmon were present within Claim 637?

No known evidence exists that Chinook salmon utilized this claim reach. Therefore, no conditional claim was developed.

CLAIM REACH 638 – IRVING CREEK

384. Please describe the stream reach associated with Claim 638.

Claim 638 encompasses a 2.3-mile reach of Irving Creek which is located above the Klamath Marsh in the upper Williamson River subbasin (hereinafter called "Claim Reach 638"). See OWRD Ex. 16 at 13 describing the upper and lower boundaries of the Claim Reach 638; also see Figure IX-638-1 and Figure IX-638-2. Originating on Yamsay Mountain, Irving Creek is a relatively short, confined stream with an average width of approximately 4 feet (OWRD Ex. 2 at 2261-2299). The creek flows in a northwest direction in a narrow, steep, v-shaped valley with an average slope of 4.6 percent (Figure IX-638-2) (Ex. 277-US-417). Irving Creek is a tributary to Jackson Creek (Claim Reach 637) with the confluence of the two near the historical Jackson Creek and Williamson River confluence; however, all surface flow from Irving and Jackson creeks is currently diverted for agricultural use before reaching the Williamson River, except during the highest runoff conditions (USFS 1998). Under natural flow conditions, peak median flow (5.9 cfs) in this reach typically occurs in May and low median flow (1.7 cfs) occurs in late summer to early fall (Figure IX-638-4).

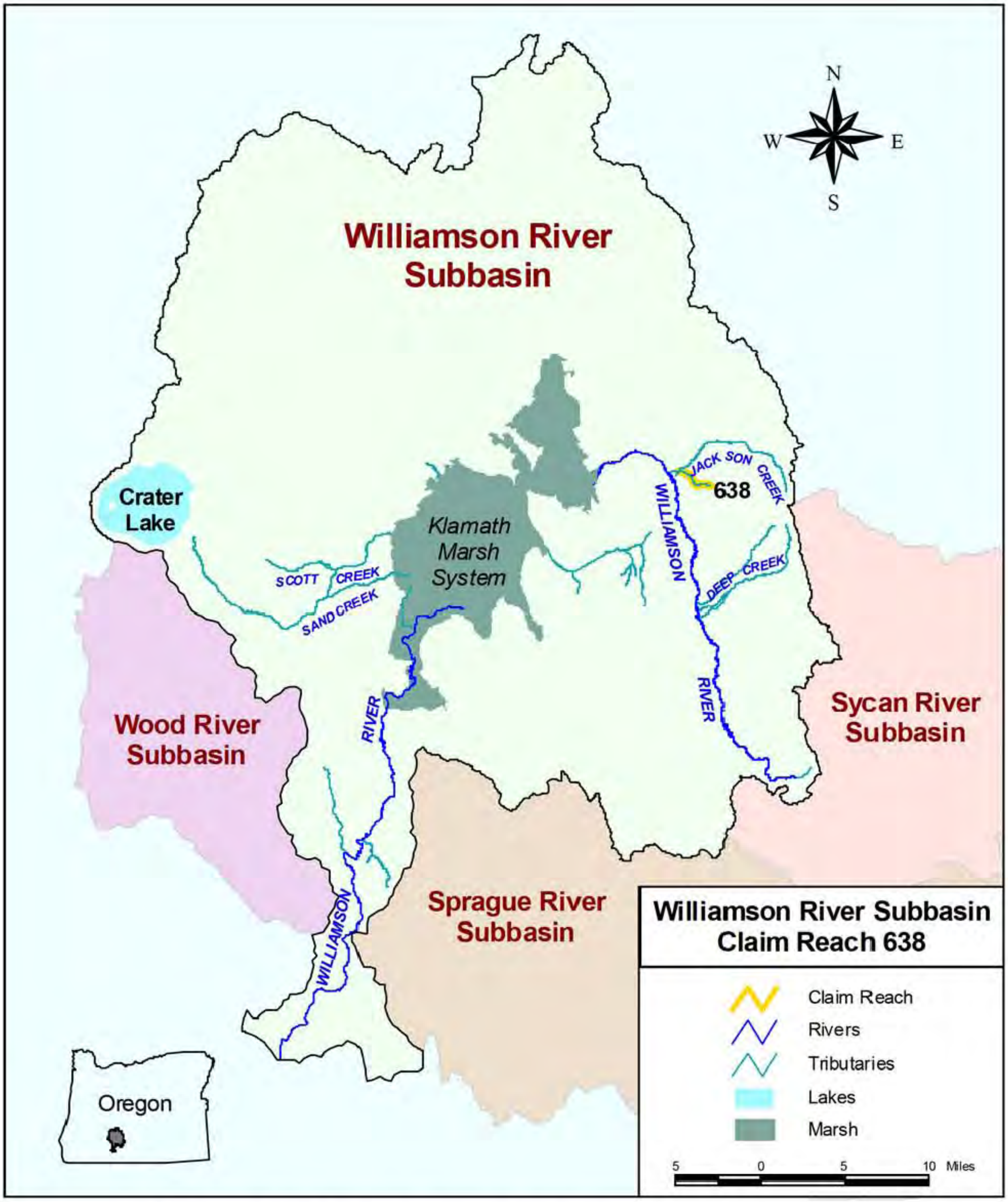

Figure IX-638-1. Claim Reach 638. Williamson River subbasin with claim reach highlighted in yellow.

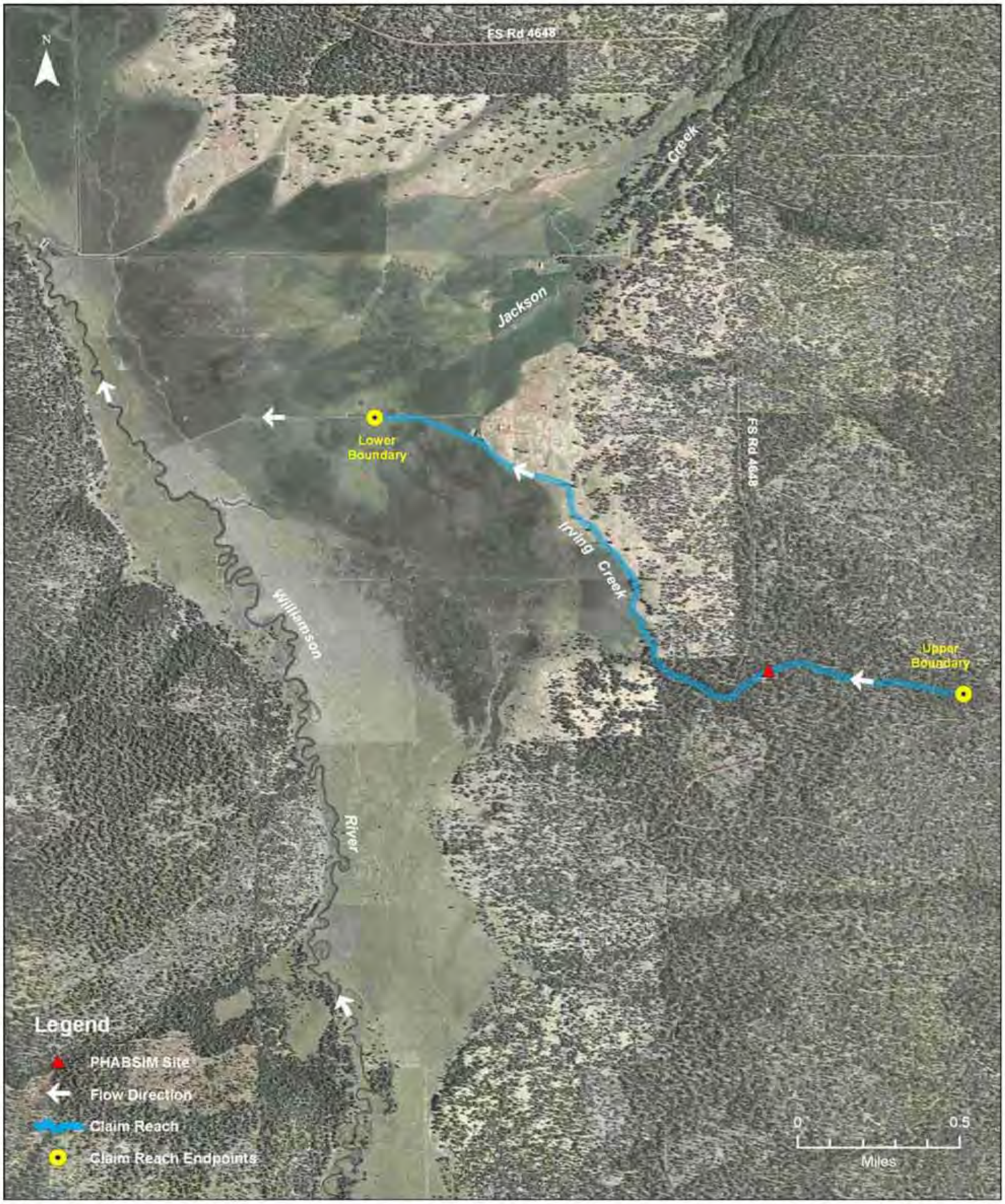

Figure IX-638-2. Orthographic photograph of Claim Reach 638 (Oregon Imagery Explorer 2007).

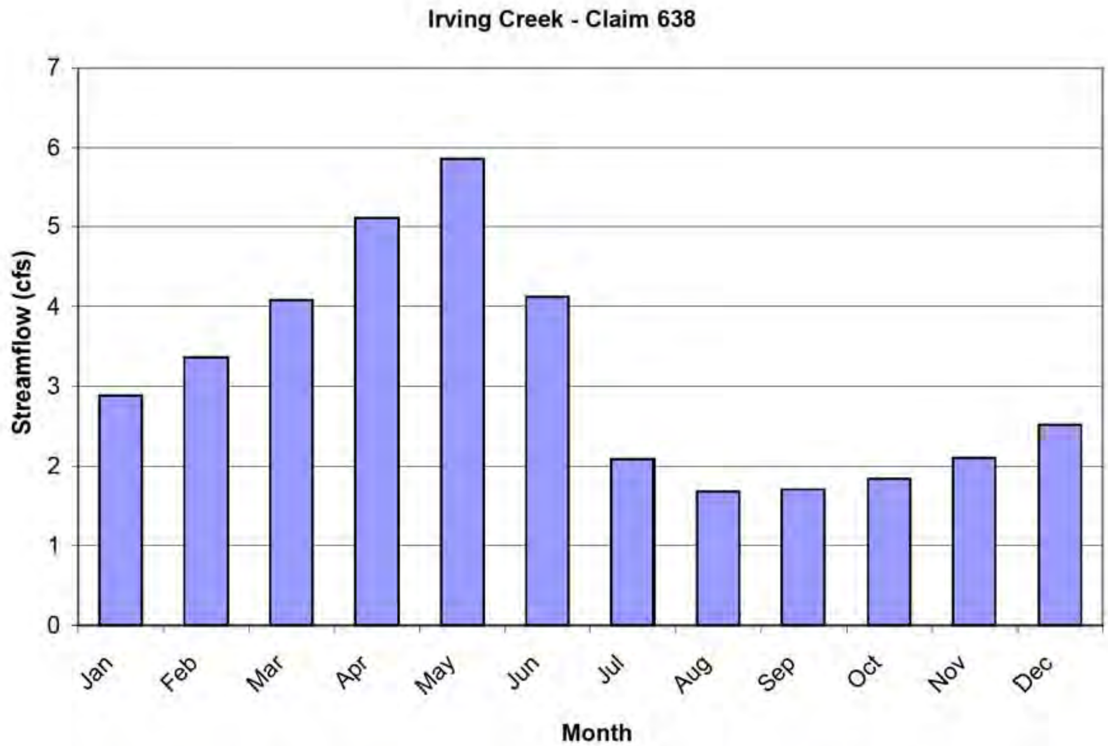

Figure IX-638-3. Irving Creek monthly hydrograph (median flow values) at the confluence with Jackson Creek (Claim Reach 638) (Cooper 2004).

385. Are you familiar with this claim reach which incorporates Irving Creek?

Yes. I have visited portions of Claim Reach 638 several times over the past 20 years including at the Forest Service road 4648 access point, and in particular the detailed study site. Most recently, I completed a field reconnaissance of the detailed IFIM/PHABSIM site in June 2006 to check transect locations and survey points and assess overall habitat conditions.

386. Please describe the stream environment associated with Claim Reach 638.

Based on my observations and information from other sources, the stream environment in and around Claim Reach 638 is as follows. Riparian vegetation along Irving Creek is very limited as a result of its low discharge and confined floodplain. There is some meadow vegetation with scattered shrubs near its confluence with Jackson Creek, but riparian vegetation along most of the stream consists of shrubs along the channel bank in many locations and herbaceous plants at the edge of the channel. Riparian buffers were retained during harvest of surrounding timber, leaving a forested riparian strip that likely provides moderate to high levels of shade over most of the stream reach (Dr. Chapin Direct Testimony at question 70).

Irving Creek is a small spring-fed system consisting almost entirely of run-type habitat. The dominant substrate type is sand with some very limited spawning gravel. With its largely intact riparian zone, Irving Creek could provide an area of cool water refuge to its downstream receiving waters (USFS 1998). Stream channel banks within the claim reach are generally stable. Most of the perennial stream systems in the upper Williamson River subbasin, such as Irving and Jackson creeks, have been diverted for agricultural use. The result of these diversions has been to eliminate or severely reduce the surface water connection between tributaries and the Williamson River. Irving Creek has lost all surface connection to the upper Williamson River except during the highest runoff conditions (USFS 1998).

387. Please describe the target fish species that utilize this reach.

Redband trout are the target fish species found within Claim Reach 638 and its presence in Irving Creek has been documented during snorkel surveys (Ex. 277-US-423).

388. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 638?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The sampling site was established in May 1993 and habitat mapping was conducted on a section of the claim reach extending 125 feet. Habitat diversity was low and run-type habitat was the only habitat type present. A total of three (3) PHABSIM transects were established and sampled during three separate visits (Table IX-638-1).

Table IX-638-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 638 – Irving Creek.

Survey Date	Habitat Type(s) Sampled	Number of Transects
05/10/1993	Run	3
06/23/1993	Run	3
09/19/1993	Run	3

Figure IX-638-4. Irving Creek (Claim Reach 638), IFIM/PHABSIM sample site, at Transect 1 on September 19, 1990.

OWRD Ex. 2 at 2261 through 2299 includes copies of the field data collected and used to develop the updated Physical Habitat flow values for Claim 638.

389. Is there an updated Physical Habitat Claim for Claim 638?

Yes. The updated Physical Habitat flow values for Claim Reach 638 are based on the data collected (Ex. 277-US-456) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-457 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The updated Physical Habitat flow values for each month are presented in the bottom row of Table IX-638-2.

The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flow values represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Claim Reach 638, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing populations at levels at which tribal harvest can occur.

Table IX-638-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of 1) the IFIM/PHABSIM based flow for the priority species/lifestage for that month (representing the flow that provides 90 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); or 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim).

The monthly Riparian Habitat Claims for the claim reach are described in and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

390. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 638, the IFIM/PHABSIM flows serve as the basis for the updated Physical Habitat flow values in no months; the incubation flows served as the basis for the claims in no months; the median flow cap in three months (August through October); and the 1999 Physical Habitat Claim flow values in nine months (November through July). Overall, the updated Physical Habitat flows for this claim are less than the 1999 Physical Habitat Claim flow values in three months and equal to the 1999 Physical Habitat Claim flow values in nine months (August through October).

Table IX-638-2 Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 638, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a
1999 Physical Habitat Claim Flow Values	2	2	2	2	2	2	2	2	2	2	2	2
90% WUA	3	3	3	3	3	3	3	3	3	3	3	3
Incubation Flow												
Median Flow	2.89	3.36	4.08	5.11	5.86	4.12	2.09	1.68	1.71	1.84	2.11	2.52
Updated IFIM/PHABSIM-Based Flows	3	3	3	3	3	3	3	3	3	3	3	3
Updated Physical Habitat Flow Claim	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**1.7**	**1.7**	**1.8**	**2.0**	**2.0**

RT-a = adult redband trout

All values included in this table are presented in cubic feet per second (cfs).

391. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 638.

The IFIM/PHABSIM flows are based on one lifestage (adult) of a single target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority

Although redband trout spawning may occur in Claim Reach 638 during the months of February through May, the IFIM/PHABSIM sampling identified a limited amount (203 sq ft per 1,000 ft using 90% WUA) of suitable habitat for redband trout spawning. Therefore, for the months of February through May, the priority species and lifestage was shifted to redband trout adult.

January - December

The IFIM/PHABSIM flows for this period are based on adult redband trout that would be rearing, holding or moving through this reach (Figure VII-6). The IFIM/PHABSIM flows that represents 90 percent of the potential amount of redband trout habitat is 3 cfs. For the months of November through July, the IFIM/PHABSIM flows are higher than the 1999 Physical Habitat claim flows, which are lower than the median flows. Therefore, the 1999 Physical Habitat claim flows constitute the Updated Physical Habitat flow for the months of November through July (Table IX-638-2). For the months of August through October, the IFIM/PHABSIM flows are higher than the median flows, which are lower than the 1999 Physical Habitat claim flows. Therefore, the median flows constitute the Updated Physical Habitat flow values for the months of August through October.

392. Would any of the Physical Habitat flows just noted differ if Chinook salmon were present within Claim 638?

No known evidence exists that Chinook salmon were found within this claim reach. Therefore, no conditional claim was developed.

CLAIM REACH 639 – DEEP CREEK

393. Please describe the stream reach associated with Claim 639.

Claim 639 encompasses an approximately 10-mile section of Deep Creek, which is located in the upper Williamson River subbasin above the Klamath Marsh (hereinafter called "Claim Reach 639"). See OWRD Ex. 17 at 17 describing the upper and lower boundaries of the Claim Reach 639; also see Figure IX-639-1 and Figure IX-639-2. Originating on the south side of Yamsay Mountain, Deep Creek flows south and then southwest in a narrow, v-shaped valley with an average slope of 5.3 percent (Figure IX-639-1) (Ex. 277-US-417). Deep Creek has an average width of approximately 7 feet (OWRD Ex. 2 at 2221-2260). Under natural flow conditions, peak median flow (15.8 cfs) in this reach typically occurs in May and low median flow (1.4 cfs) typically occurs in August and September (Figure IX-639-3). Deep Creek maintains a surface flow connection to the Williamson River during early spring high flows, before water diversions are activated and likely during periods of above normal precipitation (USFS 1996b, USFS 1998); however, Deep Creek does not maintain a surface flow connection to the Williamson River in late spring, summer, and fall. Deep Creek has much of its flow diverted into the Aspen Creek drainage during the growing season for flood irrigation purposes (USFS 1996b, USFS 1998).

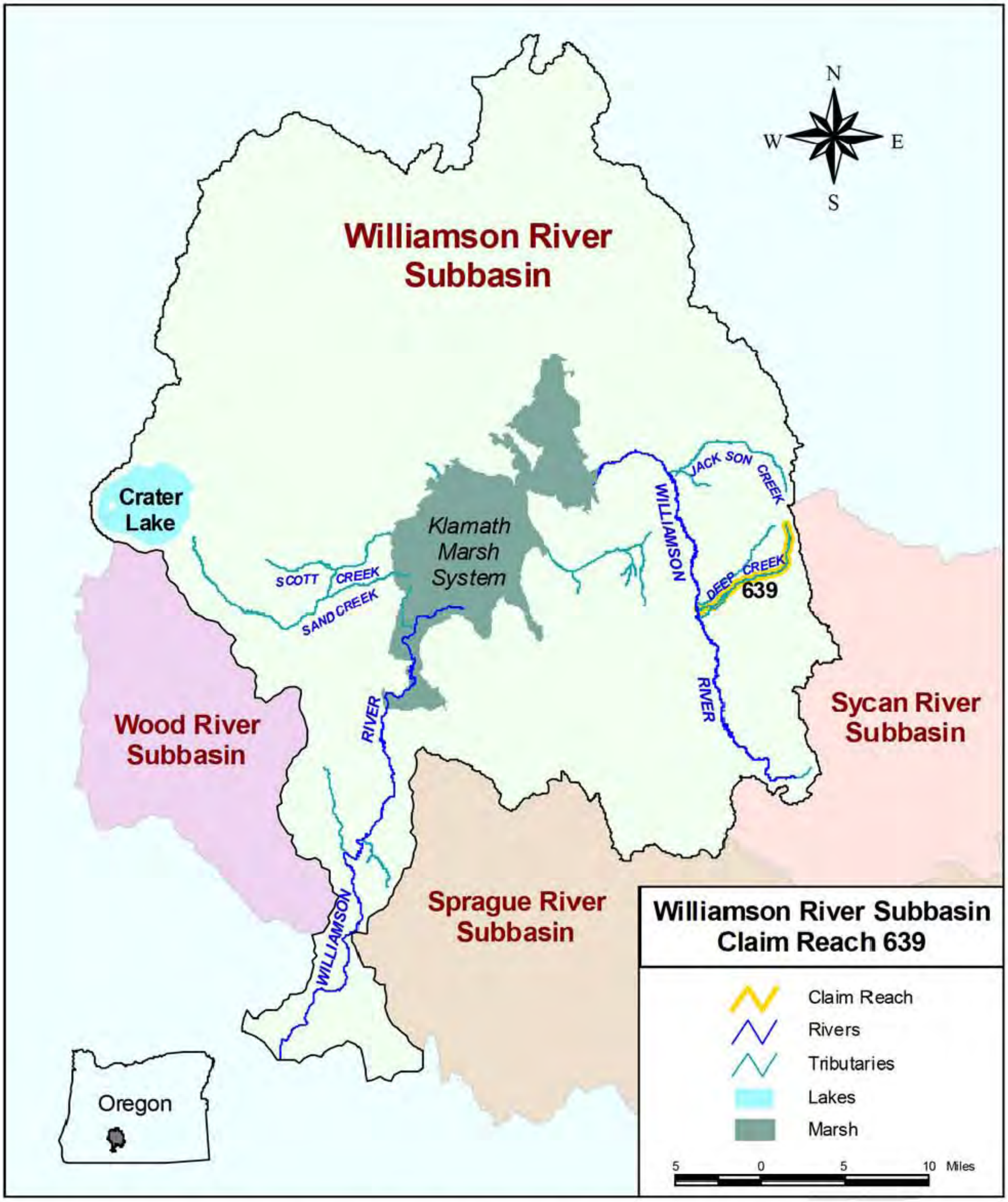

Figure IX-639-1. Claim Reach 639. Upper Williamson River subbasin with claim reach highlighted in yellow.

Figure IX-639-2. Orthographic photograph of Claim Reach 639 (Oregon Imagery Explorer 2007).

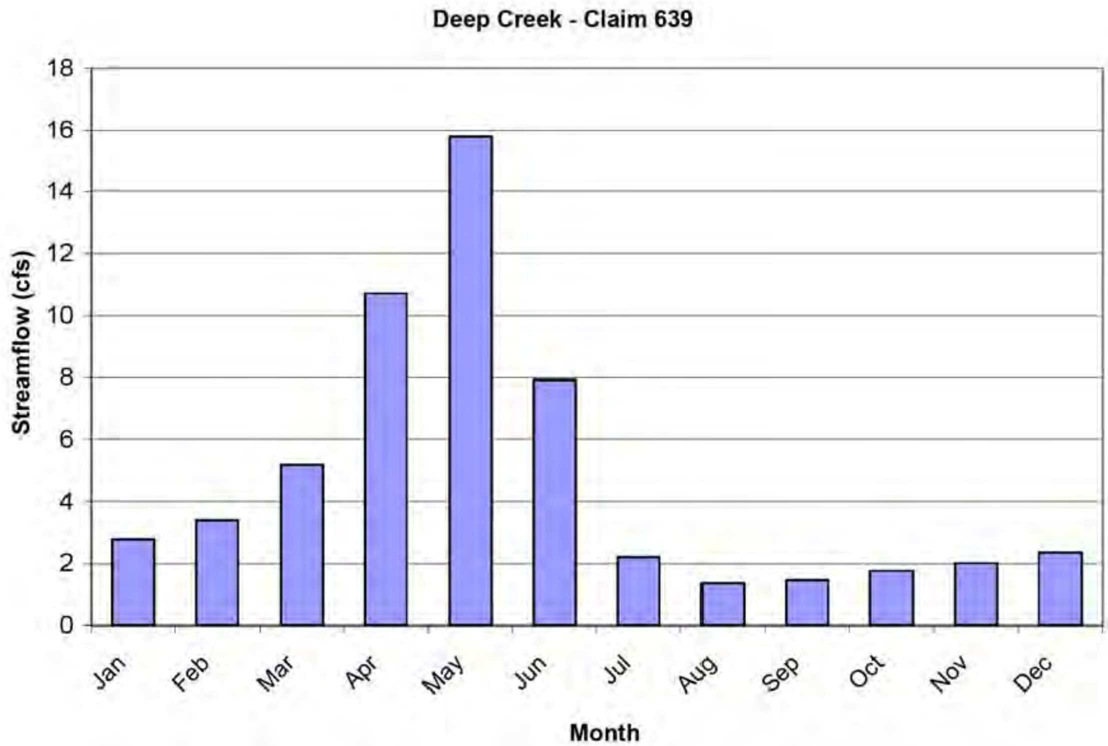

Figure IX-639-3. Deep Creek monthly hydrograph (median flow values) at the confluence with the Williamson River (Claim Reach 639) (Cooper 2004).

394. Are you familiar with this reach of the Williamson River that comprises Claim Reach 639?

Yes. I have visited portions of Claim Reach 639 several times over the past 20 years including at the road access point, and, in particular, the detailed study site. Most recently, I completed a field reconnaissance of the detailed IFIM/PHABSIM site in June 2006 to check transect locations and survey points and assess overall habitat conditions.

395. Please describe the stream environment associated with Claim Reach 639.

Based on my observations and information from other sources, the stream environment associated with Claim Reach 639 is as follows. Deep Creek flows through an extensive meadow area with a few scattered willows near the Williamson River. The riparian area associated with

Deep Creek in the vicinity of the Williamson River has been highly altered as a result of diversions and development of the land as pasture. As a result, proceeding upstream, the band of riparian vegetation along the stream narrows, but has high cover of shrubs and herbaceous vegetation (Dr. Chapin Direct Testimony at question 70). In the upland area of Deep Creek, a forested buffer along the stream was retained during the harvest of timber and greater shade is available to the stream in this area (DEA 2005a).

Fish habitat of Deep Creek is composed of run type habitat, with some small areas of pool and riffle habitats. Substrate is mostly sand, with silt and fine gravel present. Spawning sized gravels are present in Deep Creek which may be very important as a supplement to the limited amount of spawning gravel in the Williamson River. Redband trout have been observed within the claim reach (USFS 1998), and fish surveys of Deep Creek indicate that spawning habitat may be underutilized (USFS 1996b). Throughout the claim reach, bank stability is poor, due to a sparse riparian zone and a poorly developed root system of streambank vegetation.

Most of the perennial stream systems in the upper Williamson River subbasin have been heavily diverted for agricultural use. The result of these diversions has been to eliminate or severely reduce the surface water connection between tributaries and the Williamson River (USFS 1998). Deep Creek is the only tributary in the upper Williamson River subbasin that has a perennial surface water connection to the Williamson River at this time; however, as noted above, Deep Creek has much of its flow diverted into the adjacent Aspen Creek drainage during the growing months (USFS 1998).

396. Please describe the target fish species that utilize this reach.

Resident redband trout is the target fish species present within Claim Reach 639. Redband trout have been reported in Deep Creek up to the Yamsi Camp area, roughly 3.5 miles from the confluence with the Williamson River, but introduced brook trout are the dominant fish species in Deep Creek (USFS 1998). During snorkel surveys in 1993, 2006, and 2007 adult and juvenile redband trout and brook trout were documented (Ex. 277-US-423).

397. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 639?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. The sampling site was established in May 1993 and habitat mapping was conducted on a section of the claim reach extending 172.5 feet. Habitat was dominated by run habitat (93.1%) with little pool (1.7%), riffle (1.7%), or run/glide habitat (3.5%) types present. A total of three (3) PHABSIM transects were established and sampled during three separate visits (Table IX-639-1).

Table IX-639-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 639 – Deep Creek.

Survey Date	Habitat Type(s) Sampled	Number of Transects
05/10/1993	Run	3
06/23/1993	Run	3
09/19/1993	Run	3

Figure IX-639-4. Deep Creek (Claim Reach 639), IFIM/PHABSIM sample site, at Transect 1 on June 23, 1993.

OWRD Ex. 2 at 2221 through 2260 includes copies of the field data collected and used to develop the updated Physical Habitat flow values for Claim 639.

398. Is there an updated Physical Habitat Claim for Claim 639?

Yes. The updated Physical Habitat flow values for Claim Reach 639 are based on the data collected (Ex. 277-US-458) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-459 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The updated Physical Habitat flows for each month are presented in the bottom row of Table IX-639-2.

The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated physical habitat flows represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Claim Reach 639, at levels that meet, but do not exceed the spatial needs of the target fish species. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing populations at levels at which tribal harvest can occur.

Table IX-639-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM-based flow for the priority species/lifestage for that month (representing the flow that provides 90 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); or 3) the 1999 Physical Habitat Claim flow values (representing the upper flow limit to the claim).

399. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 639, the IFIM/PHABSIM flows served as the basis for the updated Physical Habitat flow values in two months (April and May); the incubation flows in no months; the median flow in ten months (June through March); and the 1999 Physical Habitat Claim flows in zero months. Overall, the updated Physical Habitat flows for this claim are less than the 1999 Physical Habitat Claim flow values in all months.

Table IX-639-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 639, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Lifestage	RT-a	RT-s	RT-s	RT-s	RT-s	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a	RT-a
1999 Physical Habitat Claim Flow Values	9	8	9	12	12	20	18	14	13	12	11	10
90% WUA	23.4	5.4	5.4	5.4	5.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4
Incubation Flow						3.6						
Median Flow	2.78	3.39	5.19	10.7	15.8	7.29	2.19	1.37	1.47	1.77	2.02	2.34
Updated IFIM/PHABSIM-Based Flows	23.4	5.4	5.4	5.4	5.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4
Updated Physical Habitat Claim	**2.8**	**3.4**	**5.2**	**5.4**	**5.4**	**7.9**	**2.2**	**1.4**	**1.5**	**1.8**	**2.0**	**2.3**

RT-a = adult redband trout; RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

400. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 639.

The IFIM/PHABSIM flows are based on two lifestages (adult and spawning) of a single target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

June – January

The IFIM/PHABSIM flows for this period are based on adult redband trout rearing, holding, or moving through this reach (Figure VII-6). The IFIM/PHABSIM flows that represent 90 percent of the potential amount of redband trout habitat are 23.4 cfs. The IFIM/PHABSIM flows for this period are all higher than the 1999 Physical Habitat Claim flows, which are likewise higher than the median flows. Therefore, the Updated Physical Habitat Claim flow values were adjusted to the median flows (Table IX-639-2).

Because redband trout spawning takes place in May, redband trout egg incubation flows (2/3 of 5.4 cfs or 3.6 cfs) were also considered for the month of June. However, the IFIM/PHABSIM based flow for adult redband trout is greater than the incubation flow. Therefore, the updated Physical Habitat flow values during this period remain as noted above.

February – May

The IFIM/PHABSIM flows for this period are based on redband trout spawning (Figure VII-6). The IFIM/PHABSIM flow representing 90 percent of the potential amount of redband trout spawning habitat is 5.4 cfs. For the months of February and March, the IFIM/PHABSIM flow is lower than the 1999 Physical Habitat Claim flows, but higher than the median flows. Therefore, the median flows constitute the Updated Physical Habitat flow values for the months of February and March (Table IX-639-2). For the months of April and May, the IFIM/PHABSIM flow is lower than both the 1999 Physical Habitat Claim flows and the median flows. Therefore, the IFIM/PHABSIM based flows constitute the Updated Physical Habitat flow values for April and May (Table IX-639-2).

401. Would any of the Physical Habitat flows just noted differ if Chinook salmon were present within Claim 639?

No known evidence exists that Chinook salmon utilized this claim reach. Therefore, no conditional claim was developed.

CLAIM REACH 640 – SPRING CREEK

402. Please describe the stream reach associated with Claim 640.

Claim 640 encompasses the entire length of Spring Creek extending from its confluence with the Williamson River upstream 2.5 miles to the primary source of spring flow inputs to the system (hereinafter called "Claim Reach 640"). See OWRD Ex. 18 at 13 describing the upper and lower boundaries of the Claim Reach 640; also see Figure IX-640-1 and Figure IX-640-2. Spring Creek represents one of the largest and most stable contributors of flow to the lower Williamson River. Spring Creek flows through a forested valley that is roughly 1.2 miles wide. The stream has a low sinuosity and a narrow floodplain formed by high and abruptly sloping terraces. The lower 0.4 miles of Spring Creek has a gradient of 1.3 percent, whereas the upper 2.1 miles of Spring Creek is nearly flat with a gradient near zero percent. The average active channel width in this claim reach is 175 feet (Ex. 277-US-460).

The drainage area of Spring Creek (8.9 mi^2) comprises only a small portion of the Williamson River basin (1,460 mi^2), yet Spring Creek provides a large contribution (approximately 300 cfs) of flow to the Williamson River, especially during low flow months. This is due to the relatively constant flow inputs for the spring-dominated hydrology of Spring Creek (Conaway 2000). Under natural flow conditions, stable mean monthly flows ranging from 300 to 306 cfs occur in the claim reach year round due to spring contributions (Figure IX-640-3). No major tributaries enter Spring Creek.

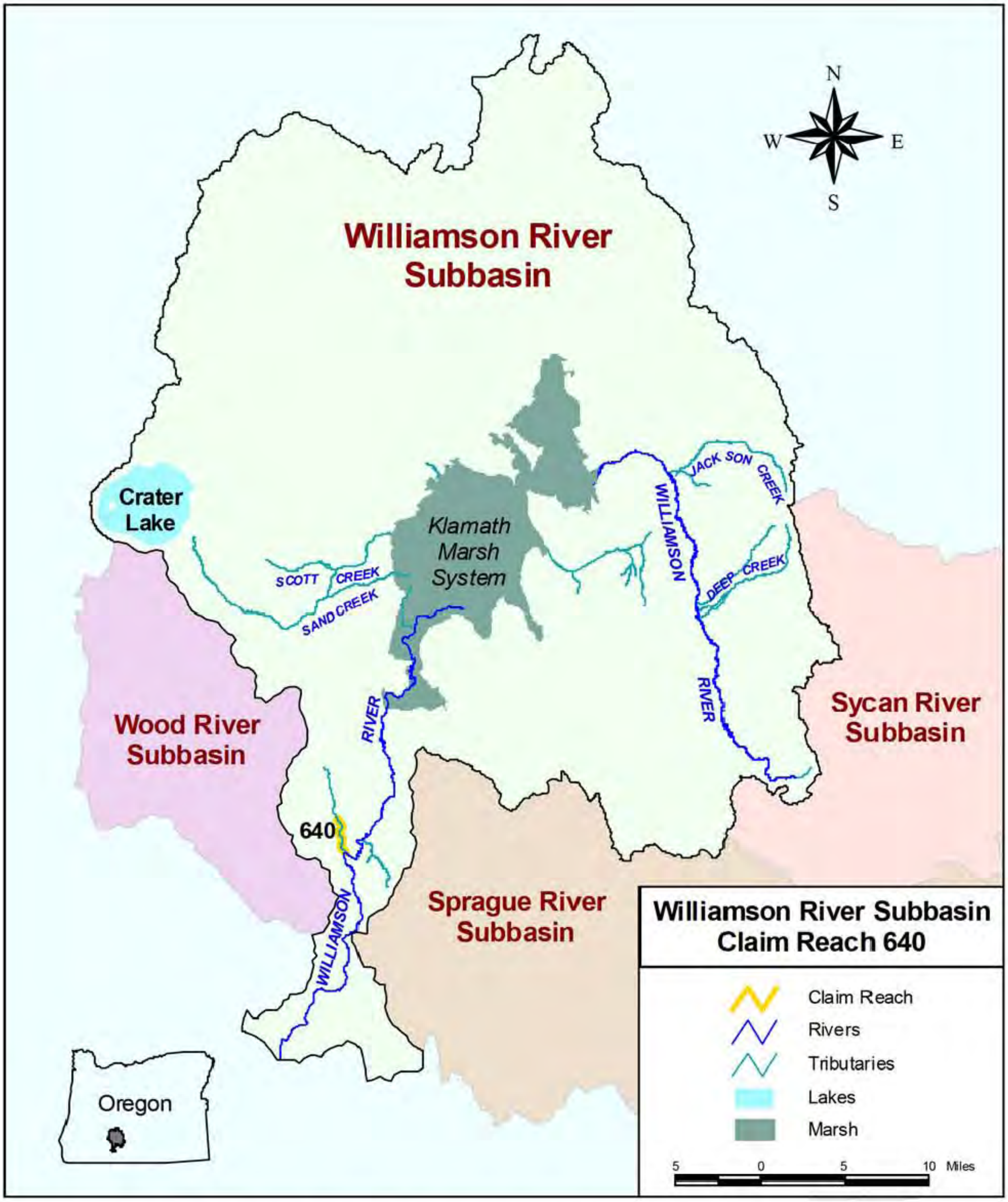

Figure IX-640-1. Claim Reach 640. Williamson River subbasin with claim reach highlighted in yellow.

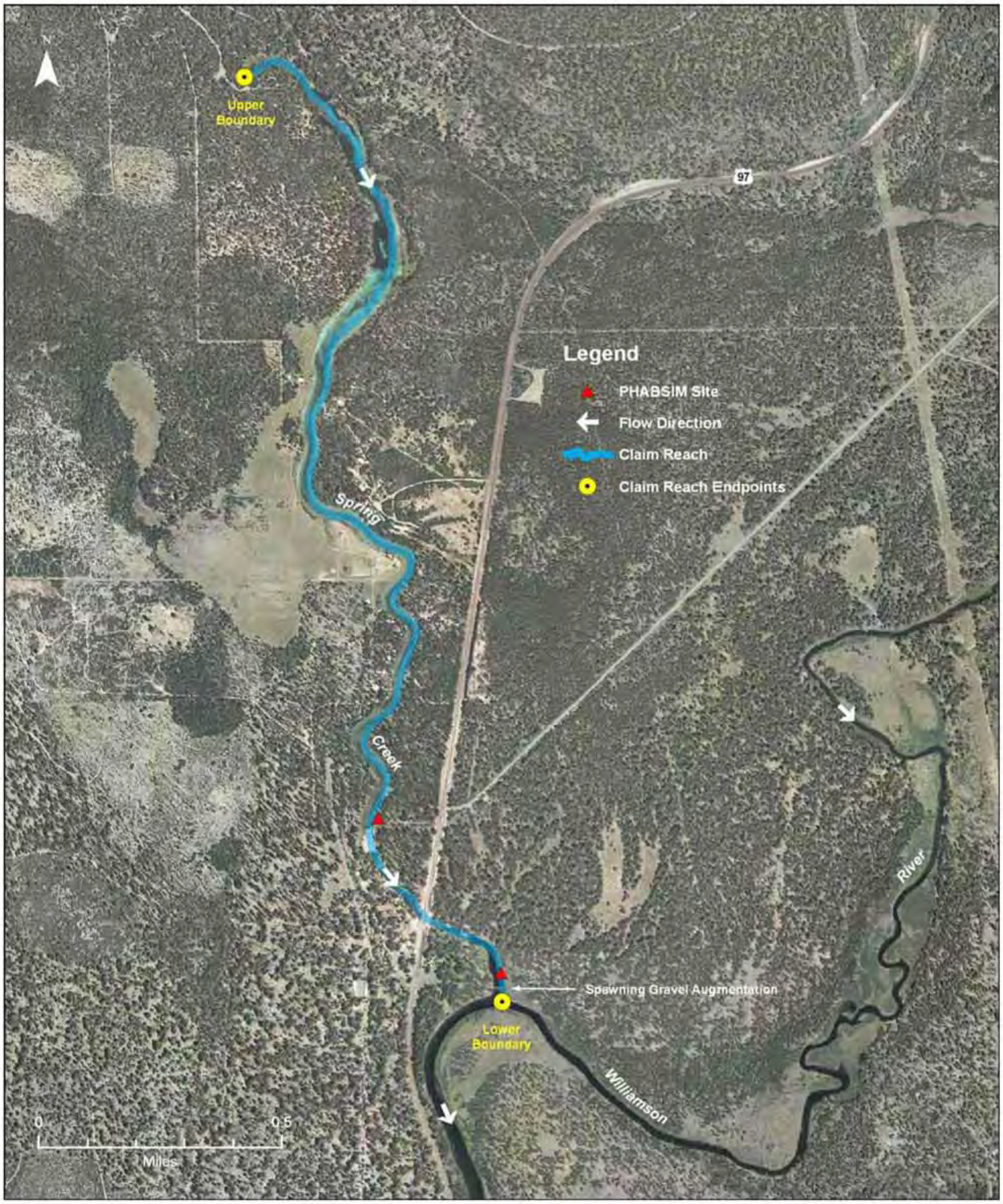

Figure IX-640-2. Orthographic photograph of Claim Reach 640 (Oregon Imagery Explorer 2007).

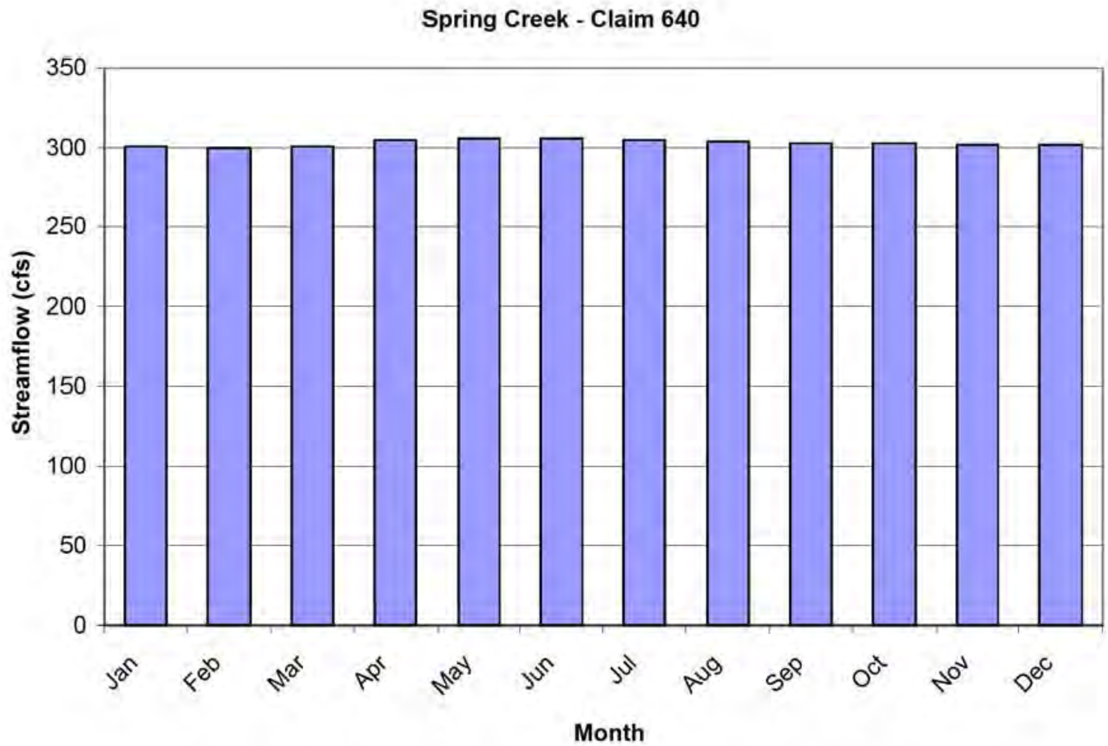

Figure IX-640-3. Spring Creek monthly hydrograph (median flow values) at the confluence with the Williamson River (Claim Reach 640) (Cooper 2004).

403. Are you familiar with this reach of Spring Creek that comprises Claim Reach 640?

Yes. I have visited portions of Claim Reach 640 a number of times over the past 20 years including its lowermost point where Spring Creek enters the Williamson River, and at the very headwaters of the stream located about 2.5 miles upstream. I have also conducted a combined field reconnaissance and snorkel survey along the lower mile of the stream, participated in the collection of aquatic invertebrate samples, and visited and reviewed the IFIM/PHABSIM site on numerous occasions. My most recent visit to the site was in June 2006, when I completed a field reconnaissance to check transect locations and assess overall habitat conditions. I have also flown and aerial photographed the entire length of Claim Reach 640.

404. Please describe the stream environment associated with Claim Reach 640.

Based on my observations and information from other sources, the stream environment in and around Claim Reach 640 is as follows. As a spring-dominated stream, with virtually no overbank flooding, Spring Creek has a narrow floodplain with limited stream-dependent riparian vegetation. Upland vegetation of conifers, grasses, and sagebrush occupy adjacent terraces. The channel bank in portions of the reach has abundant shrub cover, including willows, and there is some extensive meadow vegetation along the stream in the middle portion of the reach. Sedges and other hydrophytic plant species exist along the channel edge throughout the reach (Dr. Chapin Direct Testimony at question 70). Riparian vegetation is in relatively good condition, a likely result of stable flows, few depletions, and the area being protected within Collier State Park (Ex. 277-US-460).

Fish habitat of Claim Reach 640 is composed of riffles (52%), glides (30%), and pools (17%). The average width of lower Spring Creek (0.4 miles upstream from the Williamson River confluence) was reported as 75 feet. With an average pool depth of 11.2 feet and an average glide depth of 3.0 feet, abundant cover exists for juvenile and adult fish. Thirty percent of the streambanks in lower Spring Creek are undercut, which provides additional cover. Upper Spring Creek (extending 2.1 miles upstream) consists of a continuous glide that has an average width of approximately 200 feet, a maximum depth of 11.2 feet, and an average depth of 5.6 feet (Ex. 277-US-460). Given its length/width, depth, and undercut banks, this area provides abundant holding areas for juvenile and adult salmonids (Ex. 277-US-460).

The lower section of Spring Creek contains substrates consisting of 22% sand and organics, 5% gravel, 12% cobble, 6% small boulder, and 54% bedrock (Ex. 277-US-460). Fine substrates were dominant in upper Spring Creek, which consisted of 85% sand and organics and

14% gravel. High quality patches of spawning gravel exist in lower Spring Creek, from the confluence with the Williamson River to 656 feet upstream of the Highway 97 Bridge. Much of this gravel was placed by the ODFW in these locations as a means to increase overall spawning habitat within Spring Creek (USFS 1998). The gravels have been placed on shallow bedrock riffles and are held in place by a series of wire mesh gabions (gabions consist of rectangular shaped wire mesh baskets that are filled with rock materials and held in place by a wire mesh lid; the gabions are linked end to end across the entire width of the stream) (Ex. 277-US-460). The relatively high gradient in lower Spring Creek (1 to 2%) also promotes good intergravel flow through the gravels which is beneficial for egg incubation (Ex. 277-US-460). I have observed redband trout spawning within a variety of areas in Spring Creek, with the highest concentrations of spawning trout occurring in lower Spring Creek in association with the gabions and spawning gravels. ODFW has conducted spawning surveys in Spring Creek for over 30 years and routinely finds high concentrations of spawning fish in the areas with gabions (Ex. 277-US-460).

405. Please describe the target fish species that currently, and in the future will, utilize this reach.

The target fish species that occur in Claim Reach 640 include redband trout and Klamath largescale sucker. Importantly, the redband trout that utilize this system are relatively large adfluvial fish that spend a large proportion of time feeding and growing in Upper Klamath Lake and then migrate upstream into the Williamson River and ultimately into Spring Creek where they spawn. As noted above, the downstream most 1,000 feet of Spring Creek are used extensively by spawning redband trout. The resulting offspring may spend several years within Spring Creek before moving downstream and into Upper Klamath Lake where they will continue to feed and mature. Due to the near constant flows and year-round suitable water temperatures, spawning activity by redband trout has been observed in Spring Creek in every month of the year except September (Figure VII-6). This unique adaptation in the spawning process results in an almost continuous production of young fish in the system. During snorkel surveys in 2003, large numbers of adult (n=136) and juvenile redband trout (n=534) and few adult brown trout (n=6) and brook trout (n=1) were documented (Ex. 277-US-423).

Just like the reaches of the mainstem Williamson River represented by Claim reaches 625 through 628, Claim Reach 640 would also be important relative to Chinook salmon, a species historically present in the basin and that is planned for reintroduction into the Upper Klamath Basin. In addition to providing Chinook spawning habitat within the lower half of the reach, Claim Reach 640 contains substantial juvenile Chinook rearing habitat (deep pools, undercut banks, and large wood). The constant flow and coldwater temperatures afforded by Spring Creek would likely make it especially attractive to Chinook as coldwater refuge habitats during the warm summer months.

406. What field data were collected and used to develop the updated Physical Habitat flow values for Claim 640?

The collection of field data for this site followed the general methods and sampling procedures described in Section VII. Field data collected from two separate sampling locations within the claim reach were used to establish the updated Physical Habitat Claim. The first sampling site was established in September 1997 and habitat mapping was conducted on a section of the claim reach extending 1,500 feet. Habitat diversity was low, with only glide habitat present. A total of three PHABSIM transects were established and sampled during two separate visits (Table IX-640-1), and standard sampling protocol was applied.

In June 2004, an additional site was added to capture habitat within a lower spawning riffle. This site included two additional PHABSIM transects placed on the spawning riffle. These transects were sampled during a single visit. Again, standard sampling protocol was applied. A summary of the data collection from each site is provided in Table IX-640-1 and a photograph from Transect 1 from the spawning area is provided below in Figure IX-640-4.

OWRD Ex. 2 at 2300 through 2318 and Ex. 277-US-461 include copies of the field data collected and used to develop the updated Physical Habitat Claim for Claim 640.

Table IX-640-1. Dates, habitat types sampled, and number of transects measured during each field survey completed for Claim Reach 640 – Spring Creek.

Survey Date	Habitat Type(s) Sampled	Number of Transects
9/23/1997	Glide	3
5/14/1998	Glide	3
6/27/2004	Riffle	2

Figure IX-640-4. Spring Creek (Claim Reach 640), IFIM/PHABSIM sample site, at Spawning Transect 1 on June 27, 2004 at 284.2 cfs.

In addition to the PHABSIM data noted above, five macroinvertebrate samples from Spring Creek were also collected and analyzed using procedures adopted from Oregon's Stream Macroinvertebrate Protocol (OWEB 1999). Samples were also collected from eight other streams in the Upper Klamath River basin. Overall, Spring Creek had the highest density of organisms (> 41,000 organisms per square meter of stream) of all nine streams sampled (range: 4,216 to > 41,000 organisms per square meter) and is indicative of the relatively high productivity of this system (Ex. 277-US-407). Spring Creek was also unique in its assemblages of organisms, having the largest population of a particular species of stonefly (*Rickera sorpta*). As I have previously noted, aquatic invertebrates comprise an important food resource for fish populations, and the high densities of organisms found in Spring Creek are likely important for sustaining the high levels of fish production in this system.

Spring Creek also was one of the streams in which we collected fish habitat utilization data that went into the derivation of site-specific HSC criteria (see Section VII). This included the collection of water depth and velocity measurements over redband trout redds (egg nests), as well as depth and velocity measurements of locations occupied by juvenile redband trout.

407. Is there an updated Physical Habitat Claim for Claim 640?

Yes. The updated Physical Habitat flow values for Claim Reach 640 are based on the data collected (Ex. 277-US-463) and analyzed and the resulting habitat-flow relationships developed for the target fish species and associated life stages. Ex. 277-US-464 contains the final habitat-flow relationships (WUA curves) for all target fish species and associated life stages. The updated Physical Habitat flow values for each month are presented in the bottom row of Table IX-640-2.

The updated monthly flow values were derived in consideration of the determinations described above, and in accordance with the methods and procedures described in Section VII, and the eight decision steps described in Section VIII. Ultimately, these updated Physical Habitat flow values represent those which I consider sufficient to provide for a healthy and productive habitat in the Williamson River subbasin, including Claim Reach 640, at levels that meet, but do not exceed the spatial needs of the target fish species.

The importance of this claim reach for fish production in the Upper Klamath Basin cannot be understated. Spring Creek is a spring dominated system whose channel morphology, substrate characteristics, and interrelationships of ecosystem components have evolved entirely around the provision of stable flows, coldwater temperatures, and good water quality. In addition, Spring Creek is the single largest contributor of coldwater spring flow (approximately 300 cfs continuously year-round, see Figure IX-640-3) to any river in the Upper Klamath Basin. This claim reach's special qualities include: 1) a large spring-dominant flow and thermal regime which affords relatively constant cool water in the summer months throughout the lower-Williamson subbasin (Claim Reach 625 through 627); 2) the reach provides important adfluvial redband trout spawning habitat eleven months out of the year; 3) the reach provides important coldwater holding and refuge habitats from the Williamson River and Sprague River during summer months; and 4) the reach is anticipated to support anadromous salmonids upon reintroduction and will provide spawning and juvenile rearing habitats similar to that currently provided adfluvial redband trout. Because of these special qualities, both individually and in combination, I considered Claim Reach 640 one of the "unique" streams or stream segments in the basin (see Section VIII, questions 259 and 260-Final Step Two). As a result, the IFIM/PHABSIM flow was based on providing the greatest amount of potential habitat of the priority species/lifestage.

I used the IFIM/PHABSIM results to guide the final selection of monthly flows that I conclude are necessary to provide healthy and productive habitats. I further conclude that such flows, when coupled with the Riparian Habitat flows described in Dr. Chapin Direct Testimony at questions 69 and 70, will promote viable and self-renewing populations at levels at which tribal harvest can occur.

Table IX-640-2 encapsulates the derivation process of each monthly flow value resulting in a flow which was the lesser of: 1) the IFIM/PHABSIM-based flow for the priority species/lifestage for that month (representing the flow that provides 100 percent of the potential amount of habitat) as may be conditioned by post-spawning incubation flows (representing 2/3 of the IFIM/PHABSIM spawning-based flow from the previous month); 2) the median flow (representing the hydrologic cap to the claim); and 3) the flow in the 1999 Physical Habitat Claim flow values (representing the upper limit to the claim).

The monthly Riparian Habitat Claims for the Claim Reach 640 are described and supported by Dr. Chapin Direct Testimony at questions 69 and 70.

408. In light of the derivation process you described, how many of the monthly updated Physical Habitat flow values were based on the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim limit?

For Claim 640, the basis for the monthly updated Physical Habitat flows was the IFIM/PHABSIM flows in twelve months; the incubation flow in no months; the median flow cap in no months; and the 1999 Physical Habitat flows in no months. Overall, in all twelve months the updated Physical Habitat flows are less than both the 1999 Physical Habitat Claim flows and the median flows.

Table IX-640-2. Updated Physical Habitat Claim and monthly instream flow values for Claim Reach 640, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Life Stage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-a	RT-s	RT-s	RT-s
1999 Physical Habitat Claim Flow Values	308	308	308	308	308	308	308	308	308	308	308	308
100% WUA	220	220	220	220	220	220	220	220	200	220	220	220
Incubation Flow									147			
Median Flow	301	300	301	305	306	306	305	304	303	303	302	302
Updated IFIM/PHABSIM-Based Flows	220	220	220	220	220	220	220	220	200	220	220	220
Updated Physical Habitat Claim	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**200**	**220**	**220**	**220**

RT-a = adult redband trout; RT-s = spawning redband trout

All values included in this table are presented in cubic feet per second (cfs).

409. You have described the overall process used in the selection of monthly Physical Habitat flow values in Sections VII and VIII. Please provide more detail regarding the specific determination of the monthly flow values for Claim 640.

The IFIM/PHABSIM flows are based on two lifestages (spawning and adult) of a single target species, redband trout. The discussion below is organized by periods of one or more months that share the same species/lifestage priority.

October – August

The IFIM/PHABSIM flows for this period are based on redband trout spawning (Figure VII-6). The flow that represents 100 percent of the potential amount of WUA is 220 cfs. This flow is less than both the median flows and the 1999 claim flows. Therefore, the IFIM/PHABSIM-based flows constitute the updated Physical Habitat flow values for the period October through August (Table IX-640-2).

September

The IFIM/PHABSIM flows for this month are based on redband trout adults that would be rearing, holding, or moving through Claim Reach 640 (Figure VII-6). The flow that represents 100 percent of the potential amount of adult WUA is 200 cfs, which is less than both the median flows and the 1999 claim flow. Therefore, the IFIM/PHABSIM-based flow constitutes the updated Physical Habitat flow value for the month of September (Table IX-640-2).

Because redband trout spawning takes place in August, redband trout egg incubation flows (2/3 of 220 cfs or 147 cfs) were also considered for the month of September; however, the IFIM/PHABSIM based flow for adult redband trout is greater than the incubation flow. Therefore, the updated Physical Habitat flow values during this period remain as noted above.

410. Is there a conditional Physical Habitat Claim for Claim 640?

Yes. When anadromous fish are introduced, they will likely be present in Claim Reach 640 during the months of September through November (during which Chinook spawning would replace redband trout adult and spawning), and December through February (during which Chinook egg incubation would occur) (Figure VII-6). [1]

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[1] In fact, when reintroduced, it can be expected that Chinook salmon will be migrating into and present in streams of the Upper Klamath Basin from June through November of each year. As explained in Sections VII and VIII, Chinook salmon presence, as adults, will not displace the priority of other target fish species engaged in spawning.

Table IX-640-3. Conditional Physical Habitat Claim and monthly instream flow values for Claim Reach 640, Williamson River Subbasin, Oregon.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Species and Life Stage	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	RT-s	CH-s	CH-s	CH-s	RT-s
1999 Physical Habitat Claim Flow Values	308	308	308	308	308	308	308	308	308	308	308	308
100% WUA	220	220	220	220	220	220	220	220	410	410	410	220
Incubation	201	201										201
Median Flow	301	300	301	305	306	306	305	304	303	303	302	302
Conditional IFIM/PHABSIM-Based Flows	220	220	220	220	220	220	220	220	410	410	410	220
Conditional Physical Habitat Claim	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**303**	**303**	**302**	**220**

RT-s = spawning redband trout; CH-s = spawning Chinook salmon

All values included in this table are presented in cubic feet per second (cfs).

411. When adjustments were made to the Physical Habitat Claims for the inclusion of Chinook, how many of the updated Physical Habitat flows were based on: the IFIM/PHABSIM flow; the incubation flow; the median flow cap; and the 1999 claim flow limit?

Compared to the flow values just provided for the Physical Habitat Claims based on current species, anadromous fish presence requires re-evaluation of the updated Physical Habitat flows in the months of September through February.

With Chinook salmon included as a priority species, IFIM/PHABSIM flows serve as the basis for the updated Physical Habitat flows in nine months (December through August); the incubation flow in no months; the median flow in three months (September through November) and the 1999 Physical Habitat Claim flows in no months. Overall, the conditional Physical Habitat Claim flows are less than the 1999 Physical Habitat Claim flow values in all months.

412. Please provide more detail regarding the determination of the monthly flows for the conditional claim for Claim Reach 640.

As noted above, there are six months for which Chinook presence will result in modifications to or otherwise impact the priority species and lifestage. These include the months of September through November which reflect the spawning period of Chinook and December through February which reflect the incubation period of Chinook eggs and embryos.

September – November (conditional claim)

Information obtained from Hamilton et al. (2005), Huntington and Dunsmoor (2006), Hooton and Smith (2008), and FishPro (2000) predict the use of Claim Reach 640 for Chinook salmon spawning during the months of September through November (Figure VII-6). The IFIM/PHABSIM-based flow that represents 100% of the potential amount of Chinook salmon spawning habitat is 410 cfs. This flow is higher than both the median flows and the 1999 Physical Habitat Claim flows during this period. Because the median flows are less than the 1999 Physical Habitat Claim flows, the conditional Physical Habitat flows for this period were adjusted to the median flows (Table IX-640-3).

December – August (conditional claim)

For this period, the species and lifestage priority remain redband trout spawning. Because Chinook salmon spawning occurred through November, incubation flow to protect Chinook eggs and embryos (2/3 of 302 cfs or 201 cfs) was also considered from December to February; however, incubation flows were less than the flows associated with redband trout spawning. Therefore, the conditional Physical Habitat flow values remain as noted above and as previously described for this period (Table IX-640-3).

X. SUMMARY AND CONCLUSION

413. Please summarize your testimony.

In the preceding sections and pages of my testimony, I have described how the Physical Habitat Claims were developed and what the Physical Habitat Claims are for each of the Claim Reaches in the Williamson River subbasin.

Briefly, in section II, I described the Physical Habitat and the Riparian Habitat components of the BIA's water rights claims in the Upper Klamath Basin. In section III, I described the Upper Klamath Basin and, more specifically, the Williamson River subbasin. In section IV, I described the characteristics and components of a healthy and productive fish habitat. In section V, I generally described the methodology used to develop the Physical Habitat Claims, as well as other methodologies that are also available to evaluate habitat:flow relationships. In section VI, I described the current conditions of the streams within the Upper Klamath Basin, with specific examples from the Williamson River subbasin. In section VII, I described the specific steps that were applied to gather reach-specific information in each Claim Reach of the Upper Klamath Basin. In section VIII, I described the final decision-making process that was employed to incorporate all of the information assembled over a two decade period to develop each Physical Habitat Claim. The information gathered and the processes described in sections II through VIII are the foundation I developed to establish the Physical Habitat Claims for each Claim Reach of the Williamson River subbasin. Finally, in section IX, I provided a description of each Claim Reach in the Williamson River subbasin, including a description of the riparian area surrounding the stream and the water habitat within the stream itself, and the flow-related values of each Physical Habitat Claim for each month of the calendar year necessary for a healthy and productive fish habitat, based on the IFIM/PHABSIM or

Tennant methodology and the decision steps described in section VIII.

414. What are your conclusions regarding the flows necessary for a healthy and productive fish habitat?

My conclusion is that the Physical Habitat flow values I have described and the Riparian Habitat flow values described in Dr. Chapin Direct Testimony are those flows necessary to restore and/or maintain a healthy and productive fish habitat. In section IX, I have presented the specific flow values of the Physical Habitat Claims for each month and each Claim Reach. In response to questions 69 and 70 of Dr. Chapin's Direct Testimony, Dr. Chapin presented the specific flow values of the Riparian Habitat Claims for each month and each Claim Reach. These are the non-cumulative flows that are necessary to restore and/or maintain a healthy and productive fish habitat in the Williamson River subbasin.

In sum, my conclusion is that the Physical Habitat flow values I described and the Riparian Habitat flow values described in Dr. Chapin Direct Testimony are those flows necessary to provide a healthy and productive fish habitat.

I have prepared Table X-1 which lists the necessary monthly Physical Habitat flow values and the monthly Riparian Habitat flow values for each Claim Reach of the Williamson River subbasin.

Table X-1. Monthly Physical Habitat and Riparian Habitat flow values for Williamson River Physical Habitat Claims and Riparian Habitat Claims, KBA Case #277

Claim Type	January	February	March	April	May	June	July	August	September	October	November	December
Claim Reach 625												
Physical Habitat Claim flow value	650	650	650	873	873	873	650	620	650	650	650	650
Conditional Physical Habitat flow value	650	650	650	873	873	873	650	620	650	650	650	650
Riparian Habitat Claim base flow value	0	0	1100	1440	1300	805	472	409	433	488	605	0
Riparian Habitat Claim trigger/cap flow value	0	0	2180/4190	2180/4190	2180/4190	0	0	0	0	0	0	0
Claim Reach 626												
Physical Habitat Claim flow value	650	650	650	700	700	700	650	620	650	650	650	650
Conditional Physical Habitat flow value	650	650	650	700	700	700	650	620	650	650	650	650
Riparian Habitat Claim base flow value	0	0	1100	1430	1300	805	472	409	433	488	604	0
Riparian Habitat Claim trigger/cap flow value	0	0	2180/4190	2180/4190	2180/4190	0	0	0	0	0	0	0
Claim Reach 627												
Physical Habitat Claim flow value	420	420	420	420	420	420	357	357	250	250	250	420
Conditional Physical Habitat flow value	420	420	420	420	420	420	357	357	250	250	250	420
Riparian Habitat Claim base flow value	0	0	550	578	442	335	259	243	245	246	323	0
Riparian Habitat Claim trigger/cap flow value	0	0	494/835	494/835	494/835	0	0	0	0	0	0	0
Claim Reach 628												
Physical Habitat Claim flow value	110	110	110	110	100	100	87	46	27	60	100	110
Conditional Physical Habitat flow value	110	110	110	110	100	100	87	46	27	60	100	110
Riparian Habitat Claim base flow value	0	0	350	376	240	133	57	42	45	46	123	0
Riparian Habitat Claim trigger/cap flow value												
Claim Reach 629												
Physical Habitat Claim flow value	100	100	100	67	67	60	60	43	27	48	55	100
Riparian Habitat Claim base flow value	0	0	329	357	223	117	43	29	27	32	109	0
Claim Reach 631												
Physical Habitat Claim flow value	70	59	59	59	59	90	74	64	64	66	68	70
Riparian Habitat Claim base flow value	0	0	64	92	108	87	51	43	45	48	48	0
Riparian Habitat Claim trigger/cap flow value	0	0	150/150	150/150	150/150	0	0	0	0	0	0	0
Claim Reach 632												
Physical Habitat Claim flow value	52	58	58	58	58	52	52	52	52	52	52	52
Riparian Habitat Claim base flow value	0	0	42	59	56	50	39	36	37	38	40	0

Table X-1 (continued). Monthly Physical Habitat and Riparian Habitat flow values for Williamson River Physical Habitat Claims and Riparian Habitat Claims, KBA Case #277

Claim Reach 633												
Physical Habitat Claim flow value	10	10	14	14	14	13	10	10	13	13	13	10
Riparian Habitat Claim base flow value	0	0	26	35	33	31	24	22	23	24	25	0
Claim Reach 634												
Physical Habitat Claim flow value	8.0	10	13	13	13	13	11	10	11	9.0	8.0	8.0
Conditional Physical Habitat flow value	8.0	10	13	13	13	13	11	10	11	9.0	8.0	8.0
Riparian Habitat Claim base flow value	0	0	12	11	11	9.4	7.5	7.3	7.4	7.5	7.5	0
Claim Reach 635												
Physical Habitat Claim flow value	18	17	18	23	39	33	33	30	28	22	20	19
Riparian Habitat Claim base flow value	0	0	12	15	27	42	34	20	18	15	13	0
Riparian Habitat Claim trigger/cap flow value	0	0	187/310	187/310	187/310	0	0	0	0	0	0	0
Claim Reach 636												
Physical Habitat Claim flow value	7.8	7.5	7.6	9.3	9.3	15	15	14	12	9.3	8.3	8.7
Riparian Habitat Claim base flow value	0	0	5.0	7.1	18	25	17	9.2	8.1	6.2	5.5	0
Riparian Habitat Claim trigger/cap flow value	0	0	91/110	91/110	91/110	0	0	0	0	0	0	0
Claim Reach 637												
Physical Habitat Claim flow value	8.5	9.0	9.0	14	22	15	6.4	4.7	4.9	5.5	6.2	7.3
Riparian Habitat Claim base flow value	0	0	8.8	13	16	10	4.2	3.1	3.2	3.6	4.1	0
Riparian Habitat Claim trigger/cap flow value	0	0	96/160	96/160	96/160	0	0	0	0	0	0	0
Claim Reach 638												
Physical Habitat Claim flow value	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.7	1.7	1.8	2.0	2.0
Riparian Habitat Claim base flow value	0	0	2.0	2.0	2.0	2.0	1.4	1.1	1.1	1.2	1.4	0
Claim Reach 639												
Physical Habitat Claim flow value	2.8	3.4	5.2	5.4	5.4	7.9	2.2	1.4	1.5	1.8	2.0	2.3
Riparian Habitat Claim base flow value	0	0	3.4	7.1	10	5.2	1.4	0.9	0.97	1.2	1.3	0
Claim Reach 640												
Physical Habitat Claim flow value	220	220	220	220	220	220	220	220	200	220	220	220
Conditional Physical Habitat flow value	220	220	220	220	220	220	220	220	303	303	302	220
Riparian Habitat Claim base flow value	0	0	199	201	202	202	201	201	200	200	199	0

Further Affiant Sayeth Not.

Dated this 4 day of December, 2009

Dudley W. Reiser, Ph.D.
President, R2 Resource Consultants, Inc.

Subscribed and sworn before me this 4 day of December of 2009

Notary Public: Mario Thomas Valenti

My Commission Expires: 4-18-2013

MARIO THOMAS VALENTI NOTARY Apr 18 2013 PUBLIC STATE OF WASHINGTON

APPENDIX A

Glossary

Accretion
A gradual increase in flow within a river, resulting from tributary inputs or upwelling groundwater.

Acre-foot
The quantity of water required to cover one acre of land to a depth of one foot; equivalent to 43,560 cubic feet of water or 325,851 gallons of water.

Adaptive Management
A structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making simultaneously maximizes one or more resource objectives and, either passively or actively, accrues information needed to improve future management. Adaptive management is often characterized as "learning by doing."

Adfluvial
Fish that spend a part of their life cycle in lakes and return to rivers and streams to spawn.

Adjudication
A court proceeding to determine all rights to the use of water on a particular stream system or ground water basin.

Adult
Sexually mature individuals of a species.

Aggradation
A progressive build up of a channel bed with sediment over several years due to a normal sequence of scour and deposition, as distinguished from the rise and fall of the channel bed during a single flood.

Alluvial
Relating to, composed of, or found in alluvium.

Alluvium
Sediments deposited by erosional processes, usually by streams.

Anadromous
Fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn.**Appropriative rights**
"First in time, first in right" principle of allocating water rights based. Usually involves a user being allowed to take water from a particular source without regard to the contiguity of the land to the source.

Aquatic biota
Collective term describing the organisms living in or depending on the aquatic environment.

Aquatic insect
Insect that spends all or part of its life in water. Of the 29 insect orders, 11 members have some aquatic stages. Most of these have aquatic, immature stages, which usually take place in fresh water, sometimes in brackish water (very few species are truly marine); the adults are terrestrial, but in some orders there are species where all stages (egg, larva, and adult) live in the water. The orders Ephemeroptera (mayflies), Odonata (dragonflies), Plecoptera (stone-flies), Neuroptera (alder flies), Trichoptera (caddis flies), Lepidoptera (butterflies and moths), and Diptera (true flies) have aquatic larvae, but the adults are terrestrial.

Aquatic life use
A beneficial use designation in which the water body provides suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms.

Aquifer
A geologic formation that will yield water to a well in sufficient quantities to make the production of water from this formation feasible for beneficial use; permeable layers of underground rock or sand that hold or transmit groundwater below the water table.

Armoring
The formation of an erosion-resistant layer of relatively large particles on a streambed or bank resulting from removal of finer particles by erosion.

Average Annual Flow
The rate at which water flows through a channel, determined by averaging daily measurements of the flow during one entire year.

Avulsion
A sudden or perceptible change in a river's margin, such as a change in course or loss of banks due to flooding.

Backwater
A small, generally shallow body of water attached to the main channel with little or no current of its own pushed back by a dam or current.

Bank
The sloping land bordering a stream channel that forms the usual boundaries of a channel. The bank has a steeper slope than the bottom of the channel and is usually steeper than the land surrounding the channel.

Bank stability
Resistance of stream banks to erosion.

Bank-full channel depth
The maximum depth of a channel within a rifle segment when flowing at a bank-full discharge.

Bank-full flow
The discharge at which water completely fills a channel; the flow rate at which the water surface is level with the flood plain.

Bank-full width
The width of a river or stream channel between the highest banks on either side of a stream.

Bar
An accumulation of alluvium (gravel or sand) caused by a decrease in water velocity.

Base flow
The component of a flow regime that represents normal flow conditions sustained by groundwater between precipitation events.

Bathymetric
Related to the measurement of water depth within a water body.

Bed
The bottom of the stream channel; may be wet or dry.

Bed forms
Three-dimensional configurations of bed material, which are formed in streambeds by the action of flowing water.

Bed load
The particles in a stream channel that mainly move by bouncing, sliding, or rolling on or near the bottom of the stream.

Bed stability
Occurs when the average elevation of the streambed does not change significantly over time. Aggradation and degradation are the two forms of bed instability.

Bedrock
The solid rock or geologic surface underlying unconsolidated surface materials.

Benthic
Pertaining to the bottom of a body of water, on or within the bottom substrate material.

Benthic macroinvertebrates
Animals without backbones, living in or on the sediments, a size large enough to be seen by the unaided eye, and which can be retained by a U.S. Standard No. 30 sieve (28 openings/inch, 0.595-mm openings). Also referred to as benthos, infauna, or macrobenthos.

Biota
The organisms of a specific region or period considered as a group.

Boulder
Substrate particles larger than 10.0 inches in size, larger than cobble and not attached to bedrock.

Calibration
The validation of specific measurement techniques and equipment, or the comparison between measurements. In the context of PHABSIM, calibration is the process of adjusting input variables to minimize the error between predicted and observed water surface elevations.

Canopy
The overhanging cover formed by branches and foliage of trees and bushes.

Cascade
The steepest of riffle habitats. Unlike rapids, which have an even gradient, cascades consist of a series of small steps of alternating small waterfalls and shallow pools.

Channel
A natural or artificial watercourse that continuously or intermittently contains water, with definite bed and banks that confine all but overbank streamflows.

Channel morphology
The planform, pattern, shape, and structure of a stream channel.

Channelization
Natural or intentional straightening and/or deepening of streams so water moves faster and causes less flooding. Channelization can sometimes exacerbate flooding in other downstream areas.

Cobble
Substrate particles between 3.0 and 10.0 inches in size, larger than gravel and smaller than boulder.

Community
An interacting group of various species in a common location.

Community structure
The make-up or composition of a community. Among the factors that determine the overall structure of a community are the number of species (diversity) within it, the number of each species (abundance) found within it, the interactions among the species, and the ability of the community to return to normal after a disruptive influence.

Confidence interval
The computed interval with a given probability that the true value of the statistic – such as a mean, proportion, or rate – is contained within the interval.

Confined channel
A stream that is vertically contained, by incisement or hillslopes, and does not spread appreciably with increasing streamflow.

Confinement
Ratio of valley width (VW) to channel width (CW). Confined channel VW:CW <2; Moderately confined channel VW:CW 2-4; Unconfined channel VW:CW >4.

Confluence
The junction of two or more streams.

Connectivity
Refers to the movement and exchange of water, nutrients, sediments, organic matter, and organisms within a riverine ecosystem. Connectivity occurs laterally (between the stream and its floodplain), longitudinally (along the stream), vertically (between the stream and groundwater), and temporally.

Constrained channel
Stream channel that is prevented from moving laterally across the floodplain by steep valley sideslopes.

Consumptive use
The quantity of water not available for reuse. Evapotranspiration, evaporation, incorporation into plant tissue, and infiltration into groundwater are some of the reasons water may not be available for reuse.

Control; hydraulic control
A downstream channel feature--a channel constriction, a bedrock outcrop, a gravel bar, woody debris, an artificial structure--in the channel that physically influences the upstream water-surface elevation.

Cover
Protective shelter, objects within or immediately overhanging a stream that fish use to hide from predators.

Crest
The top edge of a dam, dike, spillway, or weir.

Cross-section
A diagram or drawing that shows features of a vertical section of the earth or a water column.

Cubic feet per second (cfs)
A standard measure of the total amount of water passing by a particular location of a river, canal, pipe or tunnel during a one second interval. One cfs is equal to 7.4805 gallons per second, 28.31369 liters per second, 0.028 cubic meters per second, or 0.6463145 million gallons per day (mgd). Also called second-feet.

Current meter
Instrument used to measure the velocity of water flow in a stream, measured in units of length per unit of time, such as feet per second (fps).

Datum
A geometric plane of known or arbitrary elevation used as a point of reference to determine the elevation, or change of elevation, of another plane (see gage datum).

Delta
An alluvial deposit made of rock particles (sediment, and debris) dropped by a stream as it enters a body of water.

Deposition
The laying down of material by erosion or transport by water or air.

Dewater
Remove or drain the water from a stream, pond or aquifer.

Diking
Bank protection accomplished by armoring the bank with erosion-resistant material.

Discharge
The rate of flow, or volume of water flowing past a given place (i.e., a cross section) within a given period of time, traditionally expressed as cubic feet per second (cfs).

Diversion
The act of, or structure built for, partially obstructing the flow of water in a channel in order to direct or alter the course of the water.

Drainage area
An area of land upstream of a particular point where all runoff from rain or snow melt drains downhill to the same outlet such as a river, lake, reservoir, estuary, wetland, sea or ocean. Also known as a catchment area or drainage basin.

Electrofishing
A biological collection method that uses electric current to facilitate capturing fishes.

Embeddedness
A measure of the degree that gravel and larger substrates are surrounded by fine particles (silt and sand).

Emergent vegetation
Rooted plants that can tolerate flooded soil but not extended periods of being completely submerged.

Endangered
Any species which is in danger of extinction throughout all or a significant portion of its range. These species have been given high priority for protection under the federal Endangered Species Act.

Endemic
Unique to or limited to a specific region or drainage.

Ephemeral stream
Stream that flows seasonally or periodically in response to rainfall or snowmelt.

Euphotic zone
Surface layer of an ocean, lake, or other body of water through which light can penetrate. Also known as the zone of photosynthesis.

Fines
Soil particles (sand, silts, clay particles, and organic debris parts) less than 0.25 inches in diameter.

Fish ladder
An artificial waterway composed of a series of stepped pools allowing fish to ascend a vertical gradient, usually built at one end of a dam.

Fish screen
Barrier installed to prevent fish from passing through a diversion structure or turbine.

Flashiness
A measure of a river or stream's tendency to carry a high percentage of its flow volume in large, infrequent events rather than more moderate flows that occur frequently.

FLIR
Forward looking infrared (FLIR) is an imaging technology that senses infrared radiation. Can be used for watershed temperature monitoring.

Flood frequency
How often, on average, a discharge of a given magnitude occurs at a particular location on a stream. Usually expressed as the probability that the discharge will exceed some size in a single year (for example, the 100 year flood has a 1 percent probability of being equaled or exceeded in any one year).

Floodplain
Land next to a river that becomes covered by water when the river overflows its banks.

Flow-duration curve
A graphic presentation of flow values plotted in descending order of magnitude against the percentage of time that a particular flow is equaled or exceeded. For example, the flow that equals the 90th percentile is the flow that 90 percent of all recorded flows for the river will equal or exceed. Also known as a flow exceedance curve.

Fluvial
Of or pertaining to the processes associated with rivers and streams and the deposits and landforms created by them. Also, relative to fish - fish that spend a part of their life cycle in large rivers and migrate to smaller streams and tributaries to spawn.

Foraging habitat
Areas where fish and wildlife search for food.

Fry
A recently hatched fish.

Ft/s
Feet per second, measure of velocity.

Gage datum
Elevation of the zero point of the reference gage from which gage height is determined as compared to sea level.

Gage height
Water-surface elevation referenced to the gage datum.

Gaging station
A specific site on a stream where systematic observations of streamflow or other hydrologic data are obtained.

Glide
Section of stream that has a smooth water surface, laminar flow path, and generally greater depth but no clear scour feature.

Gradient
The slope of the stream channel expressed as a percent of rise per unit length.

Gravel
Substrate particles between 0.25 and 3.0 inches in size, larger than sand and smaller than cobble.

Habitat
The native environment or specific surroundings where a plant or animal naturally grows or lives. Habitat includes physical factors such as temperature, moisture, and light together with biological factors such as the presence of food or predator organisms.

Habitat Suitability Curve (HSC)
A graph/mathematical equation describing the suitability for use by various species/lifestages of fish of areas within a stream channel related to water depth, velocity and substrate.

Headgate
A water control structure at the entrance to a conduit leading to an irrigation canal, flume or powerhouse.

Herbaceous
Herbaceous plants are those that lack woody stems and include broad-leaved plants (often called forbs) and narrow leaved grasses or grass-like plants, such as sedges and rushes.

High flow pulses
The component of an instream flow regime that represents short-duration, in-channel, high flow events following storm events. They maintain important physical habitat features and longitudinal connectivity along the river channel.

Holding area
Area used by fish for rest between periods of activity. Holding areas are generally characterized by low temperatures, cover, flow, or pools formed by rocks, fallen wood, and/or debris.

Hydraulic model
A computer model of a segment of river used to evaluate stream flow characteristics over a range of flows.

Hydraulic roughness
An estimate of the resistance to flow due to energy loss caused by friction between the channel and the water. Chezy's and Manning's roughness are two different ways to express this parameter.

Hydrograph
A chart that measures the amount of water flowing past a point as a function of time.

Hydrology
The study of the movement of water on the earth; includes surface water and groundwater.

Incised
Lowering of the streambed by erosion that occurs when the energy of the water flowing through a stream reach exceeds that necessary to erode and transport the bed material.

Incubation flow
Amount of streamflow considered suitable to promote the successful development and survival of fish eggs throughout their incubation period leading to hatching and emergence from the gravels.

Instream Flow Incremental Methodology (IFIM)
A five phase management and negotiation tool used for water allocation. The five phases are problem identification, study planning, study implementation, alternatives analysis, and problem resolution. Analysis is based on stream channel characteristics, water column dynamics, the historical flow record and target species habitat requirements or management goals. The Physical Habitat Simulation (PHABSIM) computer programs are part of the IFIM process.

Interbasin transfer
The physical transfer of water from one river basin to another.

Intermittent stream
Stream that has areas of surface and subsurface flow.

Interstices
The void or empty portion of rock or soil occupied by air or water.

Irrigation return flow
Water that is not consumptively used by plants and returns to a surface or ground water supply.

Iteroparous
Fish species that reproduce repeatedly during their lifetime.

Juvenile
Fish from one year of age until sexual maturity.

Laminar flow
Flow in which water moves smoothly in parallel layers or sheets. Streamlines are distinct and the flow directions at all points remain unchanged. It is characteristic of groundwater flow but can be used to describe surface waters.

Large Woody Debris (LWD)
Pieces of wood larger than 10 feet long and 6 inches in diameter, in a stream channel. Minimum sizes vary according to stream size and region.

Larval suckers
The young of suckers are called "larvae" when they first hatch because they are extremely small and not fully developed. Most larvae are relatively passive meaning they do not actively swim, hence the importance of flow to transport them downstream to areas of cover and food.

Limiting factor
Factors such as temperature, light, water (space/habitat), or a chemical that limits the existence, growth, abundance, or distribution of an organism.

Macrohabitat
Reach-scale habitat conditions in a section of river controlling longitudinal distribution of aquatic organisms, e.g., channel morphology, streamflow, water quality, temperature.

Macroinvertebrates
Animals without backbones of a size large enough to be seen by the unaided eye and which can be retained by a U.S. Standard No. 30 sieve (28 meshes per inch, 0.595 mm openings).

Macrophyte
Macroscopic plants in the aquatic environment. The most common macrophytes are the rooted vascular plants that are usually arranged in zones in aquatic ecosystems and restricted in their area by the extent of solar penetration through the water and sediment deposition along the shoreline.

Manning's equation
An empirical equation used to estimate the average hydraulic conditions of flow within a channel cross section.

Manning's roughness
A coefficient (n) in Manning's equation that accounts for energy loss due to the friction between the channel and the water. Many hydraulic models use this coefficient to estimate resistance to flow.

Marsh
An area periodically inundated and treeless and often characterized by vegetation such as grasses, cattails, etc.

Mean column velocity
The average velocity of flow measured in a column extending from the surface of the water to the bed of the channel. Often referred to simply as "velocity" or "current velocity."

Meander
A stream reach that includes one complete bend, curve, or loop.

Median particle size
Value for which half the particles in a sample have a greater diameter and half a lesser diameter.

Median streamflow
The rate of discharge of a stream for which there are equal numbers of greater and lesser flow occurrences during a specified period.

Mesohabitat
Basic structural elements of a river or stream such as pools, backwaters, runs, glides, and riffles.

Microclimate
The local climate of a site or habitat.

Microhabitat
Zones of similar physical characteristics within a mesohabitat unit, differentiated by aspects such as substrate type, water velocity, and water depth that control specific locations or home ranges of aquatic organisms.

Mid-channel bar
A gravel or sand deposit formed in the middle of a stream channel, not extending completely across the channel.

Migratory corridor
Stream reaches used by fish to move between habitats.

Native
Species that occur naturally in a drainage (not introduced by humans).

Nonconsumptive use
Using water in a way that does not reduce the amount or supply. Examples include instream flows for fish and aquatic biota, hunting, fishing, boating, water-skiing, swimming, and some power production.

Non-native
Not indigenous to or naturally occurring in a given area. Presence is usually attributed to intentional or unintentional introduction by humans. Non-native species are also termed "exotic"species.

Olfactory imprinting
Process in which juvenile fish become imprinted with and are able to detect ***stream-specific odors imparted to the waters that result from watershed ch***aracteristics such as soils, flora, and fauna. Adult salmon and other fish species are able to differentiate and migrate to specific natal streams via olfaction of their specific odors.

Organics
Any woody material, such as from trees or shrubs, that washes into a stream channel or is deposited on a floodplain area. Organic debris provides important aquatic habitat functions, including nutrient sources and micro-habitats for aquatic insects and fish. Large wood is especially influential to stream morphology.

Phreatophyte(s)
Plants that send their roots into or below the capillary zone to use ground water.

PHABSIM (Physical Habitat Simulation)
PHABSIM is a set of computer programs that provides predictive relationships between flow changes and various physical and hydraulic characteristics that relate to the amounts of habitat of different fish species and life stages. The results of a PHABSIM analysis are generally reported in terms of Weighted Useable Area (WUA) versus flow. PHABSIM represents the computer programs associated with the IFIM process.

Pool
Relatively deep area in a natural stream channel with low velocity and smooth water surface as compared to other portions of the stream.

Pool tailout
Downstream end of a pool where mobile sediments deposit and the depth gradually decreases. Often an area favored by salmonids for spawning.

Productivity
A measure of the ability of an ecosystem to sustain life, including such factors as fertility, climatic conditions, and the available sunlight and water.

Q
Hydrological abbreviation for discharge, usually presented as cfs (cubic feet per second) or cms (cubic meters per second).

Quadrat
A square frame used to sample plant communities. In the high flow riparian study, the quadrat was 1 meter square.

Rating curve
A graph showing the relationship between water surface elevation and discharge of a stream or river at a given location. Also called a stage-discharge curve.

Reaeration
The exchange of gases between the atmosphere and water, a natural process counteracting oxygen depletion in a stream or lake. This process operates to maintain oxygen near the saturation concentration.

Rearing
Rearing is the term used by fish biologists that considers the period of time in which juvenile fish feed and grow. In the case of anadromous fish, the end of the juvenile rearing period culminates when the fish undergo smoltification, a process that results in physiological changes to the fish that readies it for transitioning to saltwater.

Rearing habitat
Areas in rivers or streams where fry, juvenile and adult fish find food and shelter to live and grow.

Recurrence interval
The average time, usually expressed in years, between occurrences of hydrologic events of a specified type (such as exceedance of a specified high flow or non-exceedance of a specified low flow). The term does not imply a regular cyclic occurrence. The recurrence interval for annual events is the reciprocal of the annual probability of occurrence. Thus, the 100-year flood has a 1-percent chance of being exceeded by the maximum peak flow in any year. Also known as a return period.

Refuge
An area protected from disturbance where fish or other animals can find shelter from sudden flow surges or other short-duration disturbances.

Reservoir
A body of water, either natural or artificial, that is used to manipulate flow or store water for future use.

Revetment
A facing of masonry or concrete, used to protect an embankment from erosion or slumping.

Riffle
Shallow rapids in an open stream where the water surface is broken into waves by obstructions wholly or partly submerged.

Riparian habitat
Generally, the zone of direct interaction between terrestrial and aquatic environments. With respect to the Riparian Habitat Maintenance claims, it is the vegetation adjacent to a stream that depends on water from the stream to be in a healthy condition.

Riparian zone
A stream and all the vegetation on its banks that is influenced by the presence of the stream, including surface flow, hyporheic flow and microclimate.

Riprap
Large stones or concrete placed for the purpose of protecting a slope from erosion due to flowing water.

River mile
The distance of a point on a river measured in miles from the river's mouth along the low-water channel.

Rule curve
Operational guides used in water reservoir regulation. They graphically show desired water levels and certain operating rights, entitlements, obligations, and limitations for a reservoir through the year.

Run
A section of stream characterized by deep, fast, low turbulence water.

Run-off dominated streams
Streams that are responsive to precipitation and/or snowmelt. These streams encounter much higher variability in streamflow during the year.

Sand
Substrate particles between 0.002 and 0.25 inches in size, larger than silt and smaller than gravel.

Scour
The erosive action of running water in streams, which excavates and carries away material from the bed and banks. Or, pertaining to a place on a streambed scoured by running water.

Seep
A spot where water contained in the ground oozes slowly to the surface and often forms a pool; a small spring.

Semelparous
Fish species that reproduce only once during their lifetime.

Silt
Substrate particles smaller than 0.002 inches in size.

Sinuosity
The amount of bending, winding and curving in a stream or river.

Spawning
The depositing and fertilizing of eggs by fish and other aquatic life.

Specific conductance
A measure of the ability of water to conduct an electrical current. Specific conductance is related to the type and concentration of ions in solution and can be used for approximating the dissolved solids concentration in water.

Split channel
A river having numerous islands dividing the flow into two channels. The islands and banks are usually heavily vegetated and stable. The channels tend to be narrower and deeper and the floodplain narrower than for a braided system.

Spring-dominated
Streams with a large percentage of the flow originating in springs. As a result, flows may vary only a small amount over the entire year.

Staff gage
A vertically mounted ruler that is be used to measure changes in the water surface of a river, lake or reservoir.

Stage
The elevation, or vertical distance, of the water surface above a datum.

Stage-discharge relationship
The relation between the water-surface elevation, termed stage (gage height), and the volume of water flowing in a channel per unit time.

Substrate
The material composing the streambed, including either mineral or organic matter.

Surface area
Area encompassed by the boundary of a lake or impoundment, as shown on a map or photograph, at a specific water elevation.

Terrace
A relatively level or gently inclined land surface in alluvial valleys that is elevated above an active stream channel in a step-like arrangement of a slope. Terraces are created when a stream incises and abandons its floodplain.

Terrestrial insect
Non-aquatic insects that developed from eggs laid on dry land, usually only getting into the water accidentally while they are in the adult stage of life. Examples are grasshoppers, crickets, ants, cicadas, leafhoppers, beetles, bees, and wasps.

Thalweg
The longitudinal line connecting points of lowest bed elevations along the stream course.

Thalweg depth
The vertical distance of the lowest point of a channel section to the water surface.

Thermal gradient
Temperature difference between two areas.

Thermocline
Generally, a relatively thin layer in a lake that separates an upper warmer zone (epilimnion) from a lower colder zone (hypolimnion).

Threatened
Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. These species have been given protection under the federal Endangered Species Act.

Transect
A predetermined line along which depth, velocity, or other characteristics such as canopy density are counted for monitoring purposes.

Tributary
A stream that contributes its water to another stream or body of water.

Unconfined channel
A stream that can access the floodplain when flows are greater than the normal channel dimensions.

Undercut banks
A bank that has had its base cut away by the water action along man-made and natural overhangs in the stream.

Watershed topographic
Boundary between drainage basins. Often used to describe the land area from which water drains toward a common watercourse in a natural basin.

Weighted Usable Area (WUA)
The area under the surface of a stream, weighted by its suitability, available to a life stage of an aquatic organism (see PHABSIM).

Wetted perimeter
The distance along the bottom and sides of a channel cross-section in contact with the water.

APPENDIX B

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APPENDIX C

Exhibits

277-US-401 Curriculum Vitae of Dudley W. Reiser

277-US-402 (Reiser, et al. 2001) Reiser, D. W., M. E. Loftus, D. Chapin, E. Jeanes, and K. Oliver. 2001. Effects of water quality and lake level on the biology and habitat of selected fish species in Upper Klamath Lake

277-US-403 (Rose and Johnson 1976) Rose, K. and C. Johnson. 1976. The relative merits of the Modified Sag-tape Method for determining instream flow requirements. U.S. Fish and Wildlife Service, Salt Lake City, Utah

277-US-404 (Frest and Johannes 1995) Frest, T. J., and E. J. Johannes. 1995. Freshwater Mollusks of the Upper Klamath Drainage, OR. 1994 yearly report to Oregon Natural Heritage Program. Deixis Consultants, Seattle, WA. v + 95 pp., appendices

277-US-405 (Frest and Johannes 1996) Frest, T. J., and E. J. Johannes. 1996. Freshwater Mollusks of the Upper Klamath Drainage, Oregon. 1995 yearly report to Oregon Natural Heritage Program. Deixis Consultants, Seattle, Washington. v + 118 p., appendices

277-US-406 (Frest and Johannes 1998) Frest, T. J., and E. J. Johannes. 1998. Freshwater Mollusks of the Upper Klamath Drainage, Oregon. 1998 yearly report to Oregon Natural Heritage Program and Klamath Project, USDI Bureau of Reclamation. Deixis Consultants, Seattle, Washington. vii+200 p., appendices

277-US-407 (Nightengale and Reiser 2005) Nightengale, T. and D. W. Reiser. 2005. Comparison of benthic macroinvertebrates in spring- versus run-off-dominated streams in the Upper Klamath basin, Oregon

277-US-408 Memo to Roger Smith re: Scott Creek Fish Kill. June 18, 2001

277-US-409 September Monthly Report, ODFW 2004 (Smith and Tinniswood)

277-US-410 (Smith, *et al.* 2003) Species Periodicity Charts, Williamson River Subbasin, 2003 X Smith, R. W. Tinniswood, and T. Smith. 2003. Unpublished Data, created December 2, 2003, provided by ODFW, Klamath Falls, Oregon.

277-US-411 (Messmer, *et al.* 2000) Fish Periodicity for the Klamath River Basin Messmer, R., R. Smith, T. Smith, and T. Tinniswood. 2000. Unpublished Data, File Name: DEQSteveKirk2000, Provided by ODFW, Klamath Falls, Oregon.

277-US-412 Klamath Tribes' Fish Management Policy

277-US-413 (Bienz and Ziller 1987) Bienz, C. S., and J. S. Ziller. 1987. Status of three lacustrine sucker species (Catostomidae). Completion Report to the U.S. Fish and Wildlife Service, Sacramento, CA

277-US-414 (Ellsworth, *et al.* 2007) Ellsworth, C.M., C.D. Luton, T.J. Tyler, S.P. VanderKooi, and R.S. Shively. 2007. Spawning migration movements of Klamath largescale, Lost River, and shortnose suckers in the Williamson and Sprague rivers, Oregon: Annual Report 2006. Annual report of research to the U.S. Bureau of Reclamation

277-US-415 (Tyler, *et al.* 2007) Tyler, T.J., C.M. Ellsworth, S.P. VanderKooi, and R.S. Shively. 2007. Riverine movements of adult Lost River, shortnose, and Klamath largescale suckers in the Williamson and Sprague rivers, Oregon. 2004 Annual Report. Prepared for U.S. Bureau of Reclamation, Klamath Area Office

277-US-416 Habitat Suitability Criteria (HSC) Curves for Klamath IFIM/PHABSIM Project

277-US-417 Valley Bottom Classifications Upper Klamath Basin IFIM Studies

277-US-418 ODFW Stream Habitat Survey (August 2004) – Williamson River, Reach 1

277-US-419 Excel Spread Sheet – Data Entry Claim Reach 625

277-US-420 WUA Graphs and Flow Quantities Claim Reach 625

277-US-421 Field Log Book Claim Reach 626

277-US-422 ODFW Stream Habitat Survey (August 2004) – Williamson River, Reach 2

277-US-423 Summary of Fish Presence Surveys 1993-2007

277-US-424 Fish Survey Report 1994

277-US-425 Excel Spread Sheet – Data Entry Claim Reach 626

277-US-426 WUA Graphs and Flow Quantities Claim Reach 626

277-US-427 Field Log Book Claim Reach 627

277-US-428 ODFW Stream Habitat Survey (August 2004) – Williamson River, Reach 3

277-US-429 Excel Spread Sheet – Data Entry Claim Reach 627

277-US-430 WUA Graphs and Flow Quantities Claim Reach 627

277-US-431 ODFW Stream Habitat Survey (August 2004) – Williamson River, Reach 4

277-US-432 Excel Spread Sheet – Data Entry Claim Reach 628

277-US-433 WUA Graphs and Flow Quantities Claim Reach 628

277-US-434 Field Log Book Claim Reach 629

277-US-435 Excel Spread Sheet – Data Entry Claim Reach 629

277-US-436 WUA Graphs and Flow Quantities Claim Reach 629

277-US-437 Field Log Book Claim Reach 631

277-US-438 Excel Spread Sheet – Data Entry Claim Reach 631

277-US-439 WUA Graphs and Flow Quantities Claim Reach 631

277-US-440 Field Log Book Claim Reach 632

277-US-441 Excel Spread Sheet – Data Entry Claim Reach 632

277-US-442 WUA Graphs and Flow Quantities Claim Reach 632

277-US-443 Field Log Book Claim Reach 634

277-US-444 ODFW Stream Habitat Survey (August 2004) – Larkin Creek

277-US-445 USFS Stream Survey - Larkin Creek

277-US-446 Excel Spread Sheet – Data Entry Claim Reach 634

277-US-447 WUA Graphs and Flow Quantities Claim Reach 634

277-US-448 Stream Survey Report (2006)

277-US-449 Excel Spread Sheet – Data Entry Claim Reach 635

277-US-450 WUA Graphs and Flow Quantities Claim Reach 635

277-US-451 Excel Spread Sheet – Data Entry Claim Reach 636

277-US-452 WUA Graphs and Flow Quantities Claim Reach 636

277-US-453 ODFW Stream Report (1991) – Jackson Creek

277-US-454 Excel Spread Sheet – Data Entry Claim Reach 637

277-US-455 WUA Graphs and Flow Quantities Claim Reach 637

277-US-456 Excel Spread Sheet – Data Entry Claim Reach 638

277-US-457 WUA Graphs and Flow Quantities Claim Reach 638

277-US-458 Excel Spread Sheet – Data Entry Claim Reach 639

277-US-459 WUA Graphs and Flow Quantities Claim Reach 639

277-US-460 ODFW Stream Habitat Survey (August 2004) – Spring Creek

277-US-461 Field Log Book Claim Reach 640

277-US-462 Intentionally Left Blank

277-US-463 Excel Spread Sheet – Data Entry Claim Reach 640

277-US-464 WUA Graphs and Flow Quantities Claim Reach 640