2

Name
By
Address

OREGON DEPARTMENT OF FISH AND WILDLIFE
4034 FAIRVIEW INDUSTRIAL DRIVE SE
SALEM, OR 97302-1142

Priority 12-1-16

County Hood River WM# 3

RELATED FILES

Application No. ~~IS~~ 88322

Permit No.

Certificate No.

Date

DENIED

MISFILED

WITHDRAWN

CANCELLED

Volume	Page

FEES PAID

Date	Amount	Receipt No.
12-1-17	$810.00	125326
12-1-17	$810.00	125340
	Cert. Fee	

FEES REFUNDED

Date	Amount	Receipt No.

DEVELOPMENT Date

Completion

Extended to

Final Proof received

Proposed Cert. Mailed

ASSIGNMENTS

Date	To Whom	Address

REMARKS 04 ISWR Application Hood Basin EFK Hood DS reach

MAP LOCATION

Rev. 04/03

MCCARTY Patricia E * WRD

From: MCCARTY Patricia E * WRD
Sent: Monday, January 22, 2018 2:11 PM
To: STEVENSON Anna P; FAUCERA Danette L; ZATTA Jaclyn D
Cc: STEVENSON Anna P; MCCARTY Patricia E * WRD
Subject: RE: New ISWRs Protests and administrative hold

Hi Anna,
OWRD will take no action on the listed applications before April 20, 2018.

Sincerely,
Patricia McCarty
Protest Program Coordinator
Oregon Water Resources Department
503-986-0820

From: Anna Pakenham Stevenson [mailto:Anna.P.Stevenson@state.or.us]
Sent: Thursday, January 18, 2018 10:03 AM
To: FAUCERA Danette L; ZATTA Jaclyn D; MCCARTY Patricia E * WRD
Cc: STEVENSON Anna P
Subject: New ISWRs Protests and administrative hold

Hello Patricia,
I wanted to let you know that ODFW reached out to the protestants associated with the new ISWR applications in the Hood and Sandy Basins (IS-88322, IS-88323, IS-88326, IS-88327, IS-88328, IS-88329, IS-88330, IS-88331, IS-88334, IS-88335, IS-88337, IS-88355, IS-88332, IS-88333, and IS-88336). We have requested meetings with these groups to discuss their concerns pertinent to ODFW aspects of the applications and if a resolution can be found. To allow time for this conversation ODFW is requesting from OWRD a 90-day administrative hold on these applications. We will be sure to let you know how those discussions proceed. Please let me know if you need further information.

Have a great day,
Anna

Anna Pakenham Stevenson
ODFW Water Program Manager
503-947-6084 (office)
971-718-2058 (cell)
anna.p.stevenson@state.or.us

Oregon
Kate Brown, Governor

Water Resources Department
North Mall Office Building
725 Summer St NE, Suite A
Salem, OR 97301
Phone (503) 986-0900
Fax (503) 986-0904
www.wrd.state.or.us

December 4, 2017

WaterWatch of Oregon, Inc.
213 SW Ash St., Ste. 208
Portland, OR 97204

Re: Receipt of protests on Applications IS-88322, IS-88323, IS-88330, IS-88332 in the name of Oregon Department of Fish and Wildlife

Dear WaterWatch,

Enclosed are the following receipts: #125340 for check #13412, #125342 for check #13410, #125341 for check #13411, and #125344 for check #13409, all in the amount of $810.00 in payment of the fees to file the protests to the Proposed Final Orders on the above applications. I will review the protests and contact you regarding the concerns raised.

Please contact me directly with any questions.

Sincerely,

Patricia McCarty

Patricia McCarty
Protest Program Coordinator
Water Right Services Division
503-986-0820
patricia.e.mccarty@oregon.gov

STOEL RIVES LLP

760 SW Ninth Ave., Suite 3000
Portland, OR 97205
T. 503.224.3380
F. 503.220.2480
www.stoel.com

HAYLEY K. SILTANEN
D. 503.294.9295
hayley.siltanen@stoel.com

December 1, 2017

BY HAND DELIVERY

Tom Byler
Director
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, OR 97301-1271

Re: Protests to PFOs Issued for Water Right Application Nos. IS-88322, IS-88323, IS-88326, IS-88327, IS-88328, IS-88329, IS-88330, IS-88331, IS-88332, IS-88333, IS-88334, IS-88335, IS-88336, IS-88337, and IS-88355

Dear Director Byler:

Please find enclosed protests of the above-referenced instream water right applications and required filing fees.

This firm represents East Fork Irrigation District, Oregon Farm Bureau Federation, Hood River County Farm Bureau, and Columbia Gorge Fruit Growers in connection with protests of application numbers IS-88322, IS-88327, IS-88334, and IS-88335.

This firm represent Oregon Farm Bureau Federation, Hood River County Farm Bureau, and Columbia Gorge Fruit Growers in connection with protests of application numbers IS-88323, IS-88328, IS-88330, IS-88332, IS-88333, and IS-88336.

This firm represent Oregon Farm Bureau Federation, Wasco County Farm Bureau, and Columbia Gorge Fruit Growers in connection with protests of application numbers IS-88326, IS-88329, IS-88331, and IS-88337.

Finally, this firm represents Oregon Farm Bureau Federation and Clackamas County Farm Bureau in connection with protest of application number IS-88355.

Please contact David Filippi at (503) 294-9529 or david.filippi@stoel.com if you have any questions regarding this letter or the above-listed protests.

Sincerely,

Hayley K. Siltanen

Enclosures
cc (via email):
John Buckley
Mary Anne Cooper
Randy Kiyokawa
Ken Polehn
Mike Doke
Matt Bunch

STATE OF OREGON
WATER RESOURCES DEPARTMENT
725 Summer St. N.E. Ste. A
SALEM, OR 97301-4172
(503) 986-0900 / (503) 986-0904 (fax)

RECEIPT # 125326 INVOICE # _____

RECEIVED FROM: Stoel Rives LLP
BY: _____

APPLICATION	S88322
PERMIT	
TRANSFER	

CASH: ☐ CHECK:# ☒ 907921 ☐ OTHER: (IDENTIFY) _____

TOTAL REC'D $ 810.00

1083 TREASURY 4170 WRD MISC CASH ACCT

0407 COPIES $
_____ OTHER: (IDENTIFY) _____ $

0243 I/S Lease ____ 0244 Muni Water Mgmt. Plan ____ 0245 Cons. Water ____

4270 WRD OPERATING ACCT 47235

MISCELLANEOUS
0407 COPY & TAPE FEES $
0410 RESEARCH FEES $
0408 MISC REVENUE: (IDENTIFY) _____ $
TC162 DEPOSIT LIAB. (IDENTIFY) _____ $
0240 EXTENSION OF TIME $

WATER RIGHTS:	EXAM FEE		RECORD FEE
0201 SURFACE WATER	$	0202	$
0203 GROUND WATER	$	0204	$
0205 TRANSFER	$		

WELL CONSTRUCTION	EXAM FEE		LICENSE FEE
0218 WELL DRILL CONSTRUCTOR	$	0219	$
LANDOWNER'S PERMIT		0220	$

0223 OTHER (IDENTIFY) Protest Fees $810.00

0536 TREASURY 0437 WELL CONST. START FEE

0211 WELL CONST START FEE $ CARD #
0210 MONITORING WELLS $ CARD #
_____ OTHER (IDENTIFY) _____

0607 TREASURY 0467 HYDRO ACTIVITY LIC NUMBER

0233 POWER LICENSE FEE (FW/WRD) $
0231 HYDRO LICENSE FEE (FW/WRD) $
_____ HYDRO APPLICATION $

____ TREASURY OTHER / RDX

FUND _____ TITLE _____
OBJ. CODE _____ VENDOR # _____
DESCRIPTION _____ $

RECEIVED
OVER THE COUNTER

RECEIPT: 125326 DATED: 12-1-17 BY: _____

Distribution – White Copy - Customer, Yellow Copy - Fiscal, Blue Copy - File, Buff Copy - Fiscal

STOEL RIVES LLP
ATTORNEYS AT LAW
760 SW Ninth Ave., Suite 3000
Portland, OR 97205-2584

State of Oregon Water Resources D

SUPPLIER NUMBER	CHECK NUMBER	CHECK DATE
16765	907921	11-30-17

INVOICE NUMBER	INVOICE DATE	DESCRIPTION	AMOUNT
SR112917-1	11-29-17	FILING FEE-PROTEST OF IS-88322	810.00
		TOTAL	810.00

Please detach at perforation before depositing check

RECEIVED
DEC 01 2017
OWRD

STATE OF OREGON
WATER RESOURCES DEPARTMENT
WATER RIGHTS DIVISION

Before the Director of the Water Resources Department

In the Matter of Water Right Application IS-88322 in the name of Oregon Department of Fish and Wildlife	)	**PROTEST OF EAST FORK IRRIGATION DISTRICT, OREGON FARM BUREAU FEDERATION, HOOD RIVER COUNTY FARM BUREAU AND COLUMBIA GORGE FRUIT GROWERS AND REQUEST FOR CONTESTED CASE**

On October 17, 2017, the Oregon Water Resources Department (the "Department") issued a proposed final order ("PFO") recommending approval of water right application IS-88322 (the "Application") filed by Oregon Department of Fish and Wildlife ("ODFW") on December 1, 2016. The PFO is attached hereto as Exhibit A, and the Application is attached hereto as Exhibit B. Pursuant to ORS 537.170 and OAR 690-077-0043, East Fork Irrigation District ("EFID"), Oregon Farm Bureau Federation ("OFB"), Hood River County Farm Bureau ("HRFB"), and Columbia Gorge Fruit Growers ("CGFG") (collectively, "Protestants") protest the PFO and request a contested case hearing. Approval of the Application would limit the ability of Protestants and their members to respond to instream and out-of-stream water resources demands in the Hood River basin, and the Application is contrary to extensive cooperative planning efforts undertaken by Protestants and their members.

1. Protestants' Name, Address, and Telephone Number

The Protestants' contact information is as follows:

John Buckley
Manager, East Fork Irrigation District
P.O. Box 162
Odell, OR 97044
(541) 490-6127 (telephone)

Mary Anne Cooper
Public Policy Counsel, Oregon Farm Bureau Federation
1320 Capitol Street NE, Suite 200
Salem, OR 97301
(503) 399-1701 (telephone)

Randy Kiyokawa
President, Hood River County Farm Bureau
1320 Capitol Street NE, Suite 200
Salem, OR 97301
(503) 399-1701 (telephone)

Mike Doke
Executive Director, Columbia Gorge Fruit Growers
P.O. Box 168
Odell, OR 97044
(541) 387-4769 (telephone)

Orders, notices, and other correspondence concerning this matter should be sent to legal counsel representing Protestants in this matter as follows:

David Filippi
Hayley Siltanen
Stoel Rives LLP
760 SW Ninth Avenue, Suite 3000
Portland, OR 97205
(503) 294-9529 (telephone)
david.filippi@stoel.com (email)
hayley.siltanen@stoel.com (email)

2. Protestants' Interest in the PFO

a. EFID's Interests

EFID is an irrigation district duly formed in 1913 under Oregon's Irrigation District Law, ORS chapter 545. Today, EFID serves over 900 customers and provides irrigation water to roughly 9,500 irrigated acres located in the Hood River Valley, Oregon. Of the permitted and certificated water rights held by EFID, water rights for approximately 8,500 acres have a priority date of 1895, and water rights for the remaining lands have priority dates in the 1960s and 1970s. EFID diverts water from a single point on the East Fork of Hood River, located south of Toll Bridge Park. Water is then transported from the point of diversion to EFID's patrons through a series of lined and unlined canals. EFID's primary goal is to provide irrigation water efficiently and equitably, at the least cost to its patrons.

In addition to serving its patrons, EFID has taken an active role in local water planning and conservation efforts. In partnership with the U.S. Bureau of Reclamation and the Hood River County Water Planning Group, EFID completed the Hood River Basin Study, which assessed the current and future water supply and demand in the Hood River basin. On its own initiative, EFID continues to reduce water loss by converting open, unlined canals and ditch systems to buried pipelines.

b. OFB and HRFB's Interests

OFB is a voluntary, grassroots, nonprofit organization representing Oregon's farmers and ranchers in the public and policymaking arenas. As Oregon's largest general farm organization, its primary goal is to promote educational improvement, economic opportunity, and social advancement for its members and the farming, ranching, and natural resources industry. Today, OFB represents over 7,000-member farm families professionally engaged in the industry and has a total membership of over 60,000 Oregon families. HRFB is the voice of agriculture in Hood River County, representing over 180 member farm families across Hood River County.

c. CGFG's Interests

CGFG is a non-profit organization of 440 growers and 20 shippers of tree fruit in the Mid-Columbia area, including Hood River County and Wasco County. The Mid-Columbia area in which CGFG's members operate produces more than 225,000 tons of cherries, apples and pears each year. CGFG encourages and promotes the fruit industry through legislation, research, education and marketing and supports growers through the exchange of information regarding sound practices and regulations. In so doing, CGFG aims to work cooperatively with other industries and organizations.

d. Injury to the Protestants' Interests

Water is essential for agriculture across the Hood River basin. In recent years, the water supply from the East Fork of Hood River has been barely sufficient or insufficient to meet irrigators' needs during the late summer and fall months. The instream water rights proposed to be granted in the PFO could severely curtail Protestants' and their members' ability to utilize their water rights as needed to successfully manage their operations and adapt to changing circumstances. The instream water rights could also limit Protestants' and their members' ability to apply for new water rights in the Hood River basin in the future and to access the water already reserved for future multipurpose storage in the basin. Protestants were among the primary proponents of the recent extension of the Hood River basin reservation, and the instream filing has the potential to limit future use of and access to that water.

3. Argument

a. The Department wrongly determined that ODFW established a presumption that the Application is in the public interest.

An application for an instream water right is presumed to be in the public interest when each of the following criteria is met:

"(a) The proposed use is allowed in the applicable basin program established pursuant to ORS 536.300 and 536.340 or given a preference under 536.310(12);
"(b) Water is available;
"(c) The proposed use will not injure other water rights; and
"(d) The proposed use complies with the rules of the Commission."

OAR 690-077-0033(1). If any one of the above-listed criteria is not satisfied, the presumption that the proposed instream use is in the public interest must be reversed. OAR 690-077-0033(2)(a).

Here, the public interest presumption is not established, because the proposed instream use has the potential to injure other water rights and the proposed use does not comply with the rules of the Water Resources Commission ("Commission"). Given that the criteria at OAR 690-077-0033(1) are not satisfied, the Department erred by failing either to deny the Application or to make "specific findings" that the Application will not impair or be detrimental to the public interest. *See* OAR 690-077-0037(2).

i. The Application will impair other water rights.

To establish a presumption that a proposed instream use is in the public interest, the Department must determine that the proposed use will not impair other water rights. Specifically, ORS 537.334(2) requires that an instream water right "not take away or impair any permitted, certificated or decreed right to any waters or to the use of any waters vested prior to the date the in-stream water right is established[.]" (Emphasis added.) In this case, the Department wrongly concluded that the Application will not impair existing water rights on the sole basis that "the proposed use is junior in priority and by operation of the prior appropriation doctrine will not injure other water rights." PFO, at 3. As discussed in more detail in the pages that follow, the Application has the potential to impair not only future water right applications pursuant to the existing reservation, but the Application also has the potential to impair existing water rights that may be subject to future transfer applications or other proposed modifications, as well as other water-right related activities, whether related to storage, aquifer recharge, aquifer storage and recovery, etc. In addition, the Protestants are concerned that the establishment of the instream water rights as proposed in the Application, without appropriate findings in the final order or conditions in the final certificate, could undermine and result in impairment to existing water rights in other state and federal environmental reviews and permitting processes.

ii. The Application does not comply with the Commission's rules, because ODFW did not provide written documentation of compliance with OAR 635-400-0020.

The Commission's rules require ODFW to provide written documentation of compliance with the "requirements contained in [ODFW's] administrative rules for instream water rights, including application of the required methods to determine the requested flows." *See* OAR 690-077-0020(4)(k). Among the administrative rules with which ODFW must comply is OAR 635-400-0020, which provides standards for selection of streams or stream reaches for instream water right applications. In the Department's Initial Review of the Application, the Department asked ODFW to "provide additional documentation of how it has complied with its own administrative rules for instream water rights . . . specifically those found in OAR 635-400-0020." Based on a review of the Application case file, it does not appear that ODFW provided evidence of compliance with OAR 635-400-0020. On that basis, the Application does not comply with the Commission's rules as required by OAR 690-077-0033(1)(a).

b. The Department violated its rules by failing to adequately consider factors necessary to determine whether the public interest presumption was overcome.

Even assuming that the Department correctly determined that the Application satisfies the criteria necessary to establish a public interest presumption, the Department erroneously failed to evaluate whether the presumption was overcome. Pursuant to OAR 690-077-0037(3), if the Department determines that the criteria for the public interest presumption are satisfied, the Department must "further evaluate the proposed use, any comments received, information available in its files or received from other interested agencies and any other available information to determine whether the public interest presumption is overcome." OAR 690-077-0037(3)(a). Such evaluation requires the Department to consider, "at minimum," the following factors:

"(A) Threatened, endangered or sensitive species;
"(B) Water quality, with special attention to sources either listed as water quality limited or for which total maximum daily loads have been set under Section 303(d) of the federal Clean Water Act and sources which the Environmental Quality Commission has classified as outstanding resource waters as defined in OAR 340-041-0002(42);
"(C) Fish or wildlife;
"(D) Recreation;
"(E) Economic development; and
"(F) Local comprehensive plans, including supporting provisions such as public facilities plans."

OAR 690-077-0037(3)(b).

In this case, the PFO suggests that the Department did not properly "further evaluate the proposed use . . . to determine whether the public interest presumption is overcome." *See* OAR 690-077-0037(3). The Department's statement that, "[b]ased on an evaluation of the proposed use, the comments received, information available in its files or received from other interested and any other available information, . . . the proposed use will not impair or be detrimental to the public interest," is conclusory and does not address the above-listed factors. *See* Protest, at 3. Specifically, the PFO fails to evaluate the likely effect of the Application on economic development. *See* OAR 690-077-0037(3)(b)(E). As discussed more fully in Part 3.c, the Application would further constrain the already limited supply of available irrigation water in the Hood River basin, which is necessary to sustain the Hood River basin's agriculture-based economy. The Department erred by not considering the effect of additional water supply constraints on agricultural users.

In addition, the PFO does not contain any indication that the Department meaningfully considered public comments, including the April 20, 2017 letter submitted by EFID, attached hereto as Exhibit C. Although the Department need not address every comment individually, the

Department nevertheless must "consider all comments received[.]" OAR 690-077-0037(1). The Department's conclusions in the PFO are unchanged from the Department's Initial Review, and the PFO does not include any response to concerns voiced by EFID in its comment letter. Thus, there is no evidence that the Department considered EFID's comments.

Because the PFO does not include any discussion of the effect of the Application on the factors listed at OAR 690-077-0037(3)(b), including economic development, and because there is no evidence that the Department considered the public comments submitted on the Application, the Department failed to comply with the requirements of OAR 690-077-0037.

c. The proposed instream use would be detrimental to the public interest because it limits the ability of agricultural users to secure future water rights and to develop needed storage.

If a proposed use "may impair or be detrimental to the public interest according to standards described in ORS 537.170(8)," the public interest presumption is overcome, and an application must be denied or conditioned to prevent harm to the public interest. OAR 690-077-0037(4)(b). Several of the standards listed in ORS 537.170(8) apply to evaluation of the Application.[1] Especially relevant here, ORS 537.170(8) requires the Department to consider whether a proposed use "[c]onserv[es] the highest use of the water for all purposes, including irrigation, . . ." and provides for "[t]he maximum economic development of the waters involved." ORS 537.170(8)(a),(b).

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[1] ORS 537.170(8) lists, in full, the following standards:

"(a) Conserving the highest use of the water for all purposes, including irrigation, domestic use, municipal water supply, power development, public recreation, protection of commercial and game fishing and wildlife, fire protection, mining, industrial purposes, navigation, scenic attraction or any other beneficial use to which the water may be applied for which it may have a special value to the public.

"(b) The maximum economic development of the waters involved.

"(c) The control of the waters of this state for all beneficial purposes, including drainage, sanitation and flood control.

"(d) The amount of waters available for appropriation for beneficial use.

"(e) The prevention of wasteful, uneconomic, impracticable or unreasonable use of the waters involved.

"(f) All vested and inchoate rights to the waters of this state or to the use of the waters of this state, and the means necessary to protect such rights.

"(g) The state water resources policy formulated under ORS 536.295 to 536.350 and 537.505 to 537.534."

The economy of Hood River County is primarily dependent on irrigated agriculture.[2] Because the Application would impair the ability of agricultural users to secure irrigation water, today and in the future, ORS 537.170(8) weighs against approval of the Application.

i. The Department must consider potential future uses of water when evaluating the public interest.

As a threshold matter, the Department must consider potential future water uses when evaluating whether the Application is detrimental to or impairs the public interest. Previously, the Department *expressly rejected* the argument that "[p]otential future uses of water are not properly to be considered in deciding whether to allow an Instream Water Right."[3] The Department explained that, because the public interest factors at ORS 537.170(8) are "very broad," potential future uses of water *must* be considered when determining whether a proposed instream water right will impair or be detrimental to the public interest. *Id.*

ii. The Application blocks future appropriations for landowners who are already seeking water rights.

In this case, the proposed instream use could affect potential future uses of water in several ways. First, approval of the Application would prevent landowners who are already seeking water rights from securing water rights in the future. The demand for water rights stems from the fact that the Hood River Basin is closed to new appropriations of water. Because new water rights are unavailable, EFID maintains a Wait List for landowners within EFID's boundaries who are seeking new or additional water rights. Currently, EFID's Wait List includes over 40 landowners seeking water rights for roughly 115 acres. If the Application is approved, and should water rights be cancelled in the future, such cancellation would not make water available for new appropriations. Instead, the cancelled water rights would be swallowed up by the instream rights proposed in the Application. Thus, the Application significantly reduces the ability of landowners already seeking water rights to secure water rights in the future.

iii. The Application precludes future appropriation for storage, counter to the recommendations in Oregon's 2017 Integrated Water Resources Strategy and the Hood River Basin Study.

The proposed instream use further injures the public interest by limiting future appropriations from the East Fork of the Hood River for storage. This outcome conflicts with the recommendations in Oregon's 2017 Integrated Water Resources Strategy (the "Water

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[2] U.S. Dep't of the Interior, Bureau of Reclamation, Hood River Basin Study, at ES-2 (Nov. 2015) (hereinafter, "Basin Study").

[3] Memorandum from Paul R. Cleary, Director, to Water Resources Commission, 6 (June 7, 2002) (Agenda Item E: Considerations of Exceptions and Issuance of Final Order on Water Right Application 70606 in the Name of Oregon Department of Fish and Wildlife).

Resources Strategy") and in the locally-developed Hood River Basin Study (the "Basin Study"), both of which recognize storage as an important tool for satisfying water resource needs.

The Water Resources Strategy recognizes that, "[i]ncreasingly, water users are relying on tools such as water conservation, re-use, transferring existing water rights, and water storage to meet their needs during the summer months." *Id.* at 16. For that reason, the Water Resources Strategy concludes that "[s]toring water, via built and natural systems, will be an important tool to meet Oregon's water needs." *Id.* at 59. To help meet future instream and out-of-stream water needs, the Water Resources Strategy recommends improving water-use efficiency and conservation and improving access to built storage. *Id.* at 95.

The need for increased storage is similarly recognized at a local level in the Basin Study. The Basin Study is the product of collaborative efforts by the U.S. Bureau of Reclamation and the Hood River County Water Planning Group (the "Planning Group"), who worked together to assess current and future water supply and demand in the Hood River basin and adjacent areas, and to identify a range of potential strategies to address any projected imbalances. Basin Study, at ES-1. Planning Group members included the Hood River Watershed Group, Columbia Gorge Fruit Growers Association, Hood River County Soil and Water Conservation District, multiple water districts, environmental groups, local resource specialists, Confederated Tribes of Warm Springs Oregon, Natural Resources Conservation Service, and a number of irrigation districts, including EFID. *Id.* at ES-3.

The Basin Study determined that, "[i]f no action is taken, potable and irrigation demands will continue to increase and exacerbate water imbalances in the future, particularly during the summer months." *Id.* at ES-7. To address water demand challenges, the study evaluated three categories of actions: water conservation, groundwater recharge, and surface water storage. *Id.* Ultimately, the Basin Study concluded that "no single alternative will satisfy all of the water resource needs," but that "due to the projection that summer streamflows are expected to get lower, a priority could be given to projects in the basin that have the ability to increase summer streamflow." *Id.* at ES-10. Beyond conservation strategies (e.g., conversion of sprinkler systems to micro- or drip-irrigation), which are not independently sufficient to satisfy all water needs, the Basin Study's top recommendation for safeguarding water resources related to increased storage. *Id.* at ES-10, 103.

The Application runs counter to the recommendations in the Water Resources Strategy and in the Basin Study because it inhibits EFID's ability to appropriate water for future storage. As EFID has stated in its Water Management and Conservation Plan:

> "The District needs a reservoir for storage of water to use in the late season. The reservoir would also act as a settling area, with the potential of providing cleaner water to the District patrons. The reservoir would be used in late season when the East Fork

Hood River has very low flow and the water quality may be poor."[4]

Approval of the Application could prevent future development of a reservoir and cause the loss of benefits associated with increased storage, which include: increased flows during low water months, water supply security for irrigators, and improved water quality. For those reasons, the Application is detrimental to the public interest.

iv. The Application contradicts the Commission's renewal of water reservations in the Hood River basin.

Finally, approval of the Application does not align with the Commission's recent decision to extend reservations for future economic development in the Hood River basin. In 2016, the Commission voted to extend reservations for the West Fork Hood River subbasin, East Fork Hood River subbasin, Neal Creek subbasin, Mosier Creek subbasin, Eightmile Creek subbasin and Fifteenmile Creek subbasin of the Hood River basin for an additional 20 years.[5] Reservations for future economic development are intended "to ensure sufficient surface water will be available in the future to meet expected needs." OAR 690-504-0100(1). Although water rights developed from the reservations in the Hood River basin have a priority date of November 6, 1992, which would make them senior to instream rights proposed in the Application, approval of the Application still has the potential to frustrate the purpose of the reserved rights. Specifically, water right permit applications to store reserved water must undergo public interest review. OAR 690-504-0100(6). Approval of the Application would likely increase the difficulty of successfully applying for reserved water rights in the future.

d. The amount of water requested in the Application for instream use is not supported by substantial evidence.

The monthly streamflow quantities[6] requested in the Application are not supported by substantial evidence, because the study relied on by ODFW does not identify, with sufficient certainty, flow levels necessary to support fish life.

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[4] East Fork Irrigation District Water Management & Conservation Plan, 41 (2011).

[5] Meeting Minutes, Joint Water Resources Commission and Environmental Quality Commission Meeting Hermiston, Oregon, 4 (Aug. 18, 2016).

[6] The amount of water allocable to an instream water right is limited to the estimated natural average flow ("ENAF") occurring from the drainage system, except where periodic flows that exceed the natural flow are significant for the applied public use. OAR 690-077-0015(4). To the extent that ENAF quantities specified in the PFO differ from ENAF quantities previously calculated by the Department for East Fork of the Hood River, the Department has the burden of justifying the change. For example, as discussed in the Protest of Water Right Application IS-88329, the Department previously calculated different ENAF quantities for the South Fork Mill Creek than the ENAF quantities specified in the Proposed Final Order for that application.

To determine requested instream amounts, ODFW relied on the Hood River Tributaries Instream Flow Study prepared by Normandeau Associates, Inc. in 2014 (the "Flow Study"). The Flow Study considered four streams: Green Point Creek, Neal Creek, East Fork Hood River, and West Fork Hood River. Flow Study, at 48. As acknowledged in the study, the streams "vary in size and respond differently to hydrologic events," and "the hydraulic habitat characterized by each instream flow study will vary differently in response [to] climatic induced changes in flow." *Id.* In addition, the Flow Study found that higher flows are not always better for fish. *Id.* Specifically, the Flow Study concluded that *low* flows were favorable for adult and juvenile salmonids in the East Fork of the Hood River. *Id.*

In its concluding discussion, the Flow Study acknowledges:

> "Even when considering only a single species, the index of hydraulic habitat for different life-stages will response to differently to changing flow and *no one flow will be the best for all life-stages*."

Id. (emphasis added). Finally, the Flow Study acknowledges that habitat mapping was limited to one mile of stream for each stream reach and recommends:

> "for a flow prescription in any of these streams, additional habitat mapping and potentially additional transects will be required to determine the applicability of the AWS/flow relationship to reaches no habitat mapped in the study."

Id. at 49. Because the Flow Study concludes that recommended flow levels vary significantly from stream-to-stream, and additional information is required for stream reaches that were not mapped (which includes the majority of the stream reach covered by the Application), ODFW's requested streamflows are not supported by substantial evidence.

e. ODFW failed to identify EFID in the Application.

As a final matter, ODFW wrongly failed to identify EFID in the Application. If a stream reach that is the subject of an instream water right application is located within the boundaries of an irrigation or water district, the Department requires the applicant to provide contact information that irrigation or water district. The reach of the East Fork of the Hood River described in the Application is located within EFID's boundaries. Therefore, ODFW erred by not identifying EFID in the Application.

4. Protest Filing Requirements

This Protest is timely filed. Any person may submit a written a protest to the PFO within 45 days from the date of publication of the PFO in the Department's Weekly Notice. OAR 690-077-0043(6). The Department published notice of the PFO on October 17, 2017. Therefore, this protest must be filed on or before December 1, 2017.

Protestants have included with this Protest the protest fee of $810. *See* ORS 536.050(j).

Protestants have complied with the provisions of OAR 690-077-0043 and OAR 690-002-0030. The Protest is in writing and signed by the Protestant or the Protestant's attorney. OAR 690-002-0030(1). The Protest also includes:

"(a) The name, address and telephone number of the protestant;
"(b) A description of the protestant's interest in the proposed final order and, if the protestant claims to represent the public interest, a precise statement of the public interest represented;
"(c) A detailed description of how the action proposed in the proposed final order would impair or be detrimental to the protestant's interest;
"(d) A detailed description of how the proposed final order is in error or deficient and how to correct the alleged error or deficiency;
"(e) Any citation of legal authority supporting the protest, if known[.]"

OAR 690-077-0043(1).

5. Conclusion and Request for Contested Case Hearing

For the reasons set forth above, the Department should either deny the Application or condition approval of the Application to subordinate instream rights to water rights for irrigation use.

DATED: December 1, 2017

Respectfully submitted,

David Filippi, OSB No. 965095
Hayley Siltanen, OSB No. 164825
Of Attorneys for East Fork Irrigation District, Oregon Farm Bureau Federation, Hood River County Farm Bureau, and Columbia Gorge Fruit Growers

CERTIFICATE OF SERVICE

I hereby certify that on December, 2017 I caused the original and one copy of the foregoing **Protest of East Fork Irrigation District, Oregon Farm Bureau Federation, Hood River County Farm Bureau, and Columbia Gorge Fruit Growers; Request for Contested Case Hearing** to be served by hand delivery to the following address:

Director Tom Byler
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1271

I hereby certify that on December 1, 2017, I served a copy of the foregoing **Protest of East Fork Irrigation District, Oregon Farm Bureau Federation, Hood River County Farm Bureau, and Columbia Gorge Fruit Growers; Request for Contested Case Hearing** to the following addresses by the method indicated below:

Anna Pakenham Stevenson (*Via US Mail & Email*)
Oregon Department of Fish and Wildlife
4034 Fairview Industrial Drive SE
Salem, Oregon 97302-1142
anna.p.stevenson@state.or.us

DATED: December 1, 2017

David Filippi, OSB No. 96509
Hayley Siltanen, OSB No. 164825
Of Attorneys for East Fork Irrigation District, Oregon Farm Bureau Federation, Hood River County Farm Bureau, and Columbia Gorge Fruit Growers

STATE OF OREGON

WATER RESOURCES DEPARTMENT

RECEIPT # 125340

725 Summer St. N.E. Ste. A
SALEM, OR 97301-4172
(503) 986-0900 / (503) 986-0904 (fax)

INVOICE # _____

RECEIVED FROM: Waterwatch of Oregon, Inc.

BY: _____

APPLICATION	IS-88322
PERMIT	
TRANSFER	

CASH: ☐ CHECK:# ☒ 13412 ☐ OTHER: (IDENTIFY) _____

TOTAL REC'D $ 810.00

1083 TREASURY 4170 WRD MISC CASH ACCT

0407 COPIES $ _____

_____ OTHER: (IDENTIFY) _____ $ _____

0243 I/S Lease _____ 0244 Muni Water Mgmt. Plan _____ 0245 Cons. Water _____

4270 WRD OPERATING ACCT

47235

MISCELLANEOUS

0407	COPY & TAPE FEES	$
0410	RESEARCH FEES	$
0408	MISC REVENUE: (IDENTIFY) _____	$
TC162	DEPOSIT LIAB. (IDENTIFY) _____	$
0240	EXTENSION OF TIME	$

WATER RIGHTS:

		EXAM FEE		RECORD FEE
0201	SURFACE WATER	$	0202	$
0203	GROUND WATER	$	0204	$
0205	TRANSFER	$		

WELL CONSTRUCTION

		EXAM FEE		LICENSE FEE
0218	WELL DRILL CONSTRUCTOR	$	0219	$
	LANDOWNER'S PERMIT		0220	$

0223 OTHER (IDENTIFY) Protest Fees 810.00

0536 TREASURY 0437 WELL CONST. START FEE

0211	WELL CONST START FEE	$	CARD #
0210	MONITORING WELLS	$	CARD #

_____ OTHER (IDENTIFY) _____

0607 TREASURY 0467 HYDRO ACTIVITY LIC NUMBER

0233	POWER LICENSE FEE (FW/WRD)		$
0231	HYDRO LICENSE FEE (FW/WRD)		$
_____	HYDRO APPLICATION		$

_____ TREASURY OTHER / RDX

FUND _____ TITLE _____

OBJ. CODE _____ VENDOR# _____

DESCRIPTION _____ $ _____

RECEIVED
OVER THE COUNTER

RECEIPT: 125340 DATED: 12/1/17 BY: Carlos O. Turner

Distribution – White Copy - Customer, Yellow Copy - Fiscal, Blue Copy - File, Buff Copy - Fiscal

WATERWATCH OF OREGON, INC.

VENDOR NO: 3 NAME: Water Resources Department CHECK DATE: 11/28/2017 13412

REFERENCE NUMBER	INVOICE DATE	GROSS AMOUNT	DISCOUNT TAKEN	NET AMOUNT PAID
PROTEST 88332	11/28/2017	810.00	0.00	810.00
TOTAL ▼		810.00	0.00	810.00

RECEIVED
DEC 01 2017
OWRD

WATERWATCH

PROTECTING NATURAL FLOWS IN OREGON RIVERS

December 1, 2017

Water Rights Section
Water Resources Department
725 Summer St N.E., Suite "A"
Salem, OR 97301-1271

RE: Protest of Proposed Final Order for Application IS 88322 (East Fork Hood River), In the Name of Oregon Department of Fish and Wildlife

Dear Water Rights Section,

WaterWatch of Oregon files this protest to the Proposed Final Order (PFO) for application IS 88322 in the name of the Oregon Department of Fish and Wildlife, along with the $810 protest fee, pursuant to ORS 537.153, OAR 690-310-160 and OAR Chapter 690, Division 2. While WaterWatch supports the issuance of the instream water right, for the reasons outlined below, we oppose the PFO and proposed certificate as drafted.

Required Protest Elements:

I. Name, telephone number, address of the Protestant

WaterWatch of Oregon, Inc.
213 SW Ash Street, Suite 208
Portland, OR 97204
Phone: 503.295.4039
Fax: 503.295.2791
Contact: Kimberley Priestley, kjp@waterwatch.org

II. Interests of Protestant

Protestant WaterWatch of Oregon ("WaterWatch") is a non-profit river conservation group that has invested time and money protecting and restoring in-stream flows and surface waters in Oregon, including areas that would be affected by the Proposed Final Order ("PFO"). WaterWatch has over 1000 individual and organizational members, many of whom care about and regularly use and enjoy rivers and streams in the Hood River basin, and who would be affected by the proposed use in their recreational, fishing, and other activities.

WaterWatch and its members have invested time and money promoting sound water law and policy, including water law and policy that allows the establishment of instream water rights to protect water instream, and the protection of these rights in the manner as envisioned and as mandated by the Instream Water Rights Act. WaterWatch does this by participating in the water allocation and reallocation processes, participating in policy making work groups and task forces; and working in the

Oregon legislature and on rules advisory committees, all with the goal of ensuring that the water laws are properly implemented to achieve the sustainable and beneficial use of Oregon's waterways. In addition, WaterWatch also represents the public's interest in protecting Oregon's waterways resources for public uses, including maintaining aquatic habitats. WaterWatch does this by participating in the water permitting process, including reviewing and filing protests, as appropriate, as well as participating in the previously mentioned forums.

For the reasons below, WaterWatch and its members and the public interest will be detrimentally affected, adversely affected and aggrieved, and practically affected by the PFO as drafted.

II. The PFO Would Impair And Be Detrimental To Protestant's and the Public's Interests

1. Issuance of the permit consistent with the PFO would impair and be detrimental to WaterWatch's interest and the public's interest in ensuring Oregon's water laws are properly implemented including, but not limited to, the Instream Water Rights Act.

2. Issuance of the permit consistent with the PFO would impair and be detrimental to WaterWatch's interest and the public's interest in ensuring that Oregon Water Resources Department (OWRD) administrative rules are supported by statute.

3. Issuance of the permit would impair and be detrimental to WaterWatch's interest and the public's interest in ensuring that instream water rights are issued in the amounts necessary for the public use requested by the Oregon Department of Fish and Wildlife (ODFW).

4. Issuance of the permit would impair and be detrimental to WaterWatch's interest and the public's interest in ensuring that aquatic species, including fish listed under either the Federal or State Endangered Species Act, are adequately protected.

IV. How The PFO Is In Error And Deficient And How To Correct The Errors And Deficiencies

WaterWatch supports the issuance of the instream water right for the amounts requested in ODFW's application; however, we oppose the PFO and proposed certificate as drafted. The PFO and the proposed certificate are in error and deficient, and are not in the public interest, for reasons including the following:

1. The PFO and Proposed Certificate propose to approve the instream water right in monthly amounts less than requested by ODFW in a manner that is inconsistent with the Instream Water Right Act.

The PFO proposes to limit the flow amounts requested by ODFW for the East Fork Hood River instream water right to the estimated average natural flow (ENAF) in the months of September and October.

OWRD may only approve an instream water right for a lesser quantity of water than is applied for in instances where the reduction is consistent with the intent of "ORS 537.332 to 537.360" (the Instream Water Rights Act). ORS 537.343(1). Further, if OWRD reduces or rejects the instream water right as

requested, or otherwise conditions the instream water right, "the director shall include a statement of findings that sets forth the basis for the reduction, rejection or conditions." ORS 537.343(2).

The PFO fails to comply with the statute on both of these counts.

a. The PFO's limitation of the ODFW requested flow amounts to ENAF is not consistent with the intent of ORS 537.332 to 537.360.

First, the PFO's reduction of ODFW's requested flow quantities to ENAF is not consistent with the intent of the Instream Water Rights Act as required by ORS 537.343(1). The language of the Instream Water Rights Act very clearly directs the state to issue instream water rights in the amount necessary to protect the public use applied for by ODFW. Instream flow means the minimum quantity of water necessary to support the public use requested by an agency. ORS 537.332(2). A public use includes but is not limited to conservation, maintenance and enhancement of aquatic and fish life, wildlife, fish and wildlife habitat and any other ecological values. ORS 537.332(5)(b). Public uses are beneficial uses under Oregon law. ORS 537.334(1). For instream water rights for fish and/or wildlife, the request shall be for the quantity of water necessary to support those public uses as recommended by ODFW. ORS 537.336(1).

ENAF is not representative of biological needs of fish. ENAF is simply an "average" of flow for a given month (as derived from historical records) that has no relation to any biological determination. An average is "an estimate or approximate representation of an arithmetic mean." *Webster's Third New International Dictionary* 1930 (unabridged ed. 2002). In other words, sometimes flows are above the average, sometimes they are below. By statute, instream water rights are to be set for the quantity of water necessary to support the public use applied for; whether they coincide with an "average" flow or not is of no relevance either to the biological needs of the fish or to the statutory directive to issue water rights in the amounts necessary to support the public uses applied for.

Based on the language of the Act, it is clear that the "intent" of the Instream Water Rights Act, as it relates to fish, is to protect those flows needed for the public purpose applied for, which includes all life stages. Flow needs for fish are developed by ODFW, the State's experts on the biological needs of fish. From a biological point of view it is illogical and insufficient to limit an ODFW requested amount to ENAF; doing so could rob fish of the flows they need when the flows in any given river or stream are in fact above ENAF. The PFO's limiting of the instream water right to ENAF is not consistent with either the language or intent of the Instream Water Rights Act.[1]

b. The PFO fails to include an adequate statement of findings that sets forth the basis for the reduction.

ORS 537.343(2) requires the OWRD, if it reduces or rejects the instream water right as requested or otherwise conditions the instream water right, to include a statement of findings that sets forth the basis for the reduction, rejection, or conditions.

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[1] The statute states that the Director has the final authority in determining the level of instream flow but that authority is qualified and limited by the term "necessary to protect the public use". ORS 537.343(2). In other words, while the OWRD makes the final decision, the statute requires that the final flows as recommended by OWRD be set at the level of instream flow necessary to protect the public use.

Pursuant to this statute, the PFO must make findings and provide reasoning about the reductions from the requested amounts. The PFO is deficient because it fails to do this. Rather, the PFO simply refers to the Division 77 rules[2] for the premise that the amount allowable to an instream water right is limited to ENAF occurring from the drainage system, except where periodic flows are significant for the applied public use, and, presumably because of this, water is not available in the times and amounts requested. See PFO, Finding of Fact #7.

This is not adequate for a number of reasons. First, the cited provision of the Division 77 rules is not supported by statute (*see* Section IV(2) below). But more to the point, simply pointing to a rule in a finding does not meet the directives of the statute to set forth the basis for the reduction. As noted in Section IV(1)(a) above, the OWRD can only reduce the requested amounts if the reduction is consistent with the intent of the Instream Water Rights Act. The Instream Water Rights Act demands that instream water rights be applied for and set at a level of instream flow necessary to protect the public interest. Thus, any reduction in flow from the amounts requested by ODFW must be justified by findings that provide evidence that this biological directive is met under the reduced flows as proposed in the PFO. See ORS 537.343(1) and (2), ORS 537.332.[3]

The PFO contains no such findings. Thus, the PFO is inconsistent with the statute, is not supported by any evidence in the record, and is not supported by substantial evidence or by substantial reason. *See* ORS 183.482(8)(c); ORS 183.484(5)(c).

To correct the deficiencies in the PFO as noted in subsections (a) and (b) above, the OWRD should issue the instream water rights in the quantities requested by ODFW for all months of the year.

2. The PFO and Proposed Certificate rely on a rule provision in Division 77 that is inconsistent with the Instream Water Rights Act and thus exceeds the statutory authority of the agency.

As noted, the PFO proposes to limit the flow amounts requested by ODFW for the East Fork Hood River instream water right to the estimated average natural flow (ENAF) in the months September and October.

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[2] OAR 690—077-0015(4).

[3] By its plain language, the statute requires "findings," which indicates that OWRD must provide some analysis of the basis of the OWRD's reduction. Instead, the OWRD's Finding of Fact #7 regurgitates rule language, much like the Water Resources Commission in *Diack v. City of Portland*, 306 Or 287 (1988). In *Diack*, petitioners challenged the Commission's conclusory findings under the surface water public interest factors of ORS 537.170. *Id.* at 299-300. The Supreme Court of Oregon ruled that the conclusory findings in the Commission's order were insufficient and remanded the order for an analysis of the law and facts. See *id.* at 301:

> "[T]he [Commission's statement of findings] does not adequately explain how the Commission applied the public interest criteria set out in [ORS 537.170]. It is little more than a regurgitation of the statutory language, without analysis. On remand, the Commission should explain more fully its application of the public interest criteria, pointing to the facts that it believes (if it still does) permit it to make the 'ultimate' findings and the conclusions it draws from them."

This PFO is similarly lacking in reasoned analysis under governing statute.

In doing so, the OWRD is relying on OAR 690-077-0015(4) as support for this restriction. Finding of Fact #7. This provision of rule states:

> If natural streamflow or natural lake levels are the source for meeting instream water rights, the amount allowed during any identified time period for the water right shall not exceed the estimated average natural flow or level occurring from the drainage system, except where periodic flows that exceed the natural flows or level are significant for the public use applied for. An example of such an exception would be high flow events that allow for fish passage or migration over obstacles.

As noted in Section IV(1) above, the OWRD is statutorily limited in its ability to issue instream water rights in amounts less than ODFW requests to instances where (1) the reduction is consistent with the intent of the Instream Water Rights Act, and (2) the OWRD makes statement of findings that sets forth the basis of the reduction. ORS 537.343(1) and (2).

As discussed previously, the PFO reduction of ODFW requested flows based on ENAF is inconsistent with statute. To the extent the rule allows such a reduction (as OWRD claims), the rule suffers from the same flaw and is thus invalid. Furthermore, the existing statutory framework makes it very clear that in the limited occasions that the OWRD can in fact reduce requested amounts as allowed under ORS 537.343, these reductions must be specific to the facts of the application at hand. There is no statutory authority that allows *carte blanche* limitation on the issuance of all instream water rights in flow amounts equal to ENAF. As such, OAR 690-077-0015(4)'s overarching limit to all agency applied instream water rights based on the "estimated average natural flow" (ENAF) is contrary to statute, and as such exceeds statutory authority. *See* ORS 183.400(4)(b) (agency rules that conflict with a statute are invalid to the extent the rule exceeds statutory authority).

To correct this error, the OWRD must issue the instream water right in the quantity requested by ODFW. The agency should also strike subsection 0015(4) from the Division 77 rules because the provision is invalid for conflicting with statute. ORS 183.400(2); ORS 183.400(4)(b).

3. The PFO and Proposed Certificate do not apply OAR 690-077-0015(4) correctly.

As noted, OAR 690-077-0015(4) is invalid because it conflicts with statute. But, even if it were not, the OWRD's application in this instance is in error. Specifically, the rules provide that ODFW's requested flows must be limited to ENAF in any instream water right "except where periodic flows that exceed the natural flows or level are significant for the public use applied for."

ODFW serves as the State of Oregon's expert on the needs of fish. The public uses to be served by this instream water right include water for fish and wildlife migration, spawning, nesting, brooding, egg incubation, larval or juvenile development, juvenile and adult rearing and aquatic life. *See* IS-88322 Application at 1. ODFW relied upon an IMFM/PHABSIM study to determine the requested amounts for spawning and incubation, fry, juvenile and adult rearing and passage flows. *Id.* at 2. The recommended flows in the instream water right application are specific to each species and life stages according to the appropriate time periods. *Id.*

In a nutshell, ODFW's requested flow numbers reflect the flows needed to support the public use of fish and wildlife, *i.e.*, those flow numbers are "significant for the public use applied for," ENAF on the

other hand, is simply a hydrological calculation based on a mathematical average that has no bearing on the biological needs of fish. As such, ENAF is neither relevant nor significant to the needs of fish and is in no way "significant for the public use applied for." The only flows "significant to the public use applied for"—here water for fish and wildlife migration, juvenile and adult rearing—are those flows requested by ODFW.

Under the rule construct, all ODFW flow requests that exceed ENAF are significant for the public use applied for, as these are the flows that the State of Oregon's experts determined were needed for the named life stages. Thus, even if the rule were valid (which it is not), OWRD has not complied with it. To do so, OWRD would have needed to issue the instream water right in the amounts applied for by ODFW as these flows numbers are "significant for the public use applied for." OAR 690-077-0015(4).

To correct this error, the OWRD should issue the instream water right in the quantities requested by ODFW.

4. The Proposed Certificate proposes to limit the "additive" effect of the instream water right in a manner that is inconsistent with the Instream Water Rights Act.

The draft certificate contains a condition of use that is inconsistent with the Instream Water Rights Act, namely:

> The instream flow allocated pursuant to this water right is not in addition to other instream flows created by a prior water right or designated minimum perennial stream flow.

Application IS-88322, Proposed Certificate at 2.

This condition limits the amount of flow that can be protected by IS-88322 regardless of whether another prior right is a state applied instream water right or a transfer. Regardless, there is nothing in statute that would support limiting the instream water right in either instance.

As to state applied instream water rights, by statute, ODFW's requests are for the quantity of water necessary to support those public uses as recommended by ODFW. ORS 537.336(1). Under this construct, if a state instream water right existed and then ODFW applied for another state instream water right in the same reach, the additional flow protection requested by ODFW would reflect the quantity of water necessary to support public uses. There is nothing in statute that would preclude ODFW from applying for additional flow protection and there is absolutely nothing in the Instream Water Rights Act that would allow the OWRD to condition IS-88322 in this manner. To the contrary, ORS 537.343 limits the ability of the OWRD to condition instream water rights to only those conditions that are consistent with the Instream Water Rights Act, and for which the OWRD can make specific findings as to the basis of the conditions. Conditioning this water right with a blanket statement that does not consider the facts of the application or existing water instream rights is not supported by statute.[4]

Moreover, even if the OWRD could make findings supporting the proposed condition as "consistent with the intent of the Instream Water Rights Act", OWRD's ability to condition the water right in

[4] It is unclear if OWRD is relying on OAR 690-077-0015(4), (5) and/or (11) to support this condition. If so, there is no statutory authority for the limitations in these rules.

relation to multiple instream water rights is only applicable to those that are agency applied under ORS 537.341. Instream water rights that are transferred or leased instream under ORS 537.348 are not subject to any limitations other than those that would apply when applying the requirements for the transfer of a water right under ORS 540.505 to 540.585 (i.e. injury). ORS 537.348.

To correct this error, OWRD should strike the noted condition from the Certificate. Additionally, OWRD should strike OAR 690-077- 0015 subsections (4), (5) and (11) from the Division 77 rules as invalid for conflicting with statute. ORS 183.400(2); ORS 183.400(4)(b).

5. The Proposed Certificate proposes to subordinate the instream water right to human consumption in a manner that is inconsistent with the Instream Water Rights Act.

As noted previously, the OWRD's ability to condition an instream water right is limited to instances where the condition (1) is consistent with the intent of "ORS 537.332 to 537.360" (the Instream Water Rights Act), and (2) the WRD includes include a statement of findings that sets forth the basis for the reduction, rejection, or conditions. ORS 537.343(1) & (2).

The draft certificate contains a condition of use that states: "For purposes of water distribution, this instream right shall not have priority over human consumption." Application IS-88322, Proposed Certificate at 2.

There is no statutory authority that allows for this limitation. While the statute does outline select precedence of uses and emergency water shortage provisions, human consumption absent a drought declaration is not one of them. *See* ORS 537.352; ORS 537.354. The PFO does not comply with the statute and OWRD has exceeded statutory authority in conditioning the instream water right as proposed.

To correct this error, OWRD should strike the noted condition from the Certificate.

6. The PFO is defective because it fails to find that water is available in the amounts requested by ODFW.

The PFO states that water beyond ENAF is not available in the times and amounts requested. PFO, Finding of Fact # 7. This is in error for two reasons.

First, while we agree that the permitting statutes require that the OWRD find that water is available for the proposed use, we believe the OWRD was in error in how it applied the state's water allocation policy. The state's water allocation policy, read as a whole, is clearly focused on protecting streams against further depletion. *See* OAR 690-410-070. Specifically, the water allocation policy makes clear that the waters of the state shall be protected from over-appropriation by new out of stream users of surface water or new uses of groundwater. OAR 690-410-070(1). To achieve this, OAR 690-410-070(2)(a) states:

> "The surface waters of this state shall be allocated to new out-of-stream uses only during months or half-month periods when the allocations will not contribute to over-appropriation. However, when a stream is over-appropriated, some additional uses may be allowed where public interest in those uses is high and uses are conditioned to protect instream values[.]" (emphasis added)

In other words, the water availability restrictions under this rule apply to out-of-stream diversions. The allocation policy is not designed to restrict instream water rights. The Division 77 rules corroborate this interpretation by directing that "the amount of appropriation for out-of-stream purposes shall not be a factor in determining the amount of an instream water right." OAR 690-77-0015(3). To try and restrict water that remains instream via a rule that is supposed to apply to consumptive uses of surface water is in error and, frankly, makes no sense.

Second, even if the Division 410 rules did apply to instream applications, instream water rights would easily meet the "exception" to the water availability rule which states that, notwithstanding that a stream is over-appropriated, additional uses can be approved where the public interest is high and uses are conditioned to protect instream values. See OAR 690-410-070(2)(a). Clearly, instream water rights that are held in trust for all Oregonians to protect water instream easily meet both of these hurdles for the WRD to make the finding of "water is available" in the amounts requested.

This defect can be cured by finding that water is available in the amounts requested by ODFW.

7. The PFO is defective because it contains incorrect Conclusions of Law

The PFO makes incorrect Conclusions of Law, including but not limited to the following:

> When issuing certificates, ORS 537.343(1) authorizes the Department to include provisions or restrictions concerning the use, control or management of the water to be appropriated from the project. The draft permit is conditioned accordingly.

This is an incorrect recitation of law. While the OWRD does have broad authority to condition applications for out of stream uses under ORS 537.190, the Instream Water Rights is very specific in limiting how the OWRD can reduce, reject or condition instream water rights.

ORS 537.349 mandates: "Except as provided in ORS 537.343, the Water Resources Department shall process a request received under ORS 537.336 for a certificate for an instream water right in accordance with the provisions for obtaining a permit to appropriate water under ORS 537.140 to 537.252" (emphasis added).

In turn, ORS 537.343 limits the ability of the OWRD to reduce, reject or condition an instream water right. Specifically, OWRD can only reject, reduce or condition an instream water right if it consistent with the intent of ORS 537.332 to 537.360 (the Instream Water Rights Act). ORS 537.343(1). Moreover, the OWRD must include a statement of findings that sets forth the basis for the conditions. *Id* at (2). Thus, the processing of state applied instream water rights are distinguishable from the processing of all other water right applications. For instream water right applications the state has limits to its ability to condition, reject or reduce instream water rights. Conditions must be consistent with the intent of the Instream Water Rights Act, and the OWRD must make specific findings setting forth the basis of the conditions .

As noted in this Protest, the OWRD has exceeded statutory authority in reducing and conditioning the instream water right. This Conclusion of Law is similarly defective as it proclaims authority to condition and or restrict the instream water right in a manner that is not consistent with statute.

To correct this defect, the FO should correctly state the law and, as outlined elsewhere in this Protest, apply it accordingly.

8. The PFO is defective because it fails to analyze the application in light of the many public interest factors that would support the issuance of the instream water rights in the amount requested by ODFW.

In looking at this application, the OWRD failed to analyze a number of public interest factors that would support issuing the instream water right in the amount that ODFW requested. The public interest factors that OWRD failed to address includes, but is not limited to:

- The Hood River Basin supports five fish species protected by the Federal Endangered Special Act: Bull trout, spring chinook, fall chinook, summer steelhead, and winter steelhead. Flow is listed as a limiting factor for these fish.
- OAR 690-410-030(d) states that protecting streamflows which are needed to support public uses is a high priority for the state. Public use is defined as, among other things, protection and enhancement of fish life, wildlife and fish and wildlife habitat and any other ecological values. OAR 690-400-010(13).
- OAR 690-410-030(1) states that benefits are provided by water remaining where it naturally occurs. Protecting streamflows which are needed to support public uses is a high priority of the state.
- The 2012 Integrated Water Resources Strategy directs the state to apply for instream water rights to protect both base and elevated flows.[5]
- As noted, the Division 77 rules state that the amount of appropriation for out-of-stream purposes shall not be a factor in determining the amount of an instream water right.

To correct this defect, the FO should make findings of facts reflecting these public interest factors.

9. The PFO is defective because it relies on a rule and application requirement that is not supported by statute

The Instream Water Rights Act requires that, except for as provided in ORS 537.343, the Water Resources Department shall process a state instream water right application in accordance with the provisions for obtaining a permit to appropriate water under ORS 537.140 to 537.252. ORS 537.349. The statutory for obtaining a permit to appropriate water under ORS 537.140 to 537.252 do not require the notification of local county governments—either before or after filing an application.

The OWRD's application form for Instream Water Rights exceeds statutory authority in that it requires ODFW to notify affected local governments of the "intent" to file an instream water right application. This provision of the application is presumably reliant on OAR 690-077-0020(4)(j). There is nothing in statute that would require a notice of intent to local governments in advance of filing the application. OWRD is exceeding statutory authority by requiring this of ODFW.

[5] WRC 2012 Integrated Water Resources Strategy, Page 100.

To cure this defect, OWRD should strike the second half of the first sentence of Finding of Fact # 9, and strike OAR 690-077-0020(4)(j) as invalid for being inconsistent with statute. Moreover, Instream Water Right Applications forms should be modified going forward so the requirement for advance notice is struck from the application.

Conclusion: WaterWatch supports the issuance of the intream water right in the amounts requested by ODFW. The amounts proposed under the PFO and Proposed Certificate reduce ODFW requested flows to ENAF in the months of September and October in a manner inconsistent with statute. The Proposed Certificate also imposes conditions of use that are not supported by statute. As noted in this Protest, the proposed reductions in flow and limiting conditions are inconsistent with statute and exceed agency authority.

How the deficiencies can be corrected: As noted in the body of this Protest, the deficiencies can be corrected by issuing the instream water right in the amounts requested by ODFW without conditions of use subordinating the right to human consumption and restricting additive value. Additionally, the OWRD (or the court) should strike the sections of the Division 77 rules which are inconsistent with statute, including but not limited to OAR 690-077-0015(4), OAR 690-077-0015(5), OAR 690-077-0015(11), 690-077-0020(4)(j) and OAR 690-077-0031. Finally, the FO should correct the Findings of Fact and Conclusions of Law as noted in the body of the Protest.

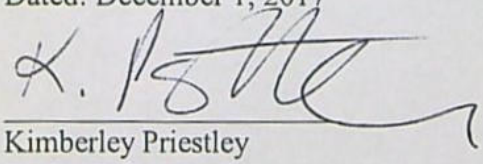
Reservation: WaterWatch reserves the right to raise and/or respond to any additional issues and arguments not reasonably ascertainable on the currently available record, including but not limited to, issues raised by other Protestants which are not ascertainable at this time.

V. Citation of Legal Authority
Applicable legal authorities, where known, are cited above.

VI. Protest Fee
The required fee of $810.00 is included with this protest.

VII. Request For Hearing
Protestant requests a contested case hearing.

Dated: December 1, 2017



Kimberley Priestley
Senior Policy Analyst
WaterWatch of Oregon

Certificate of Service

I certify that on this date, a copy of the foregoing protest was served on each of the following by the method indicated:

APPLICANT:

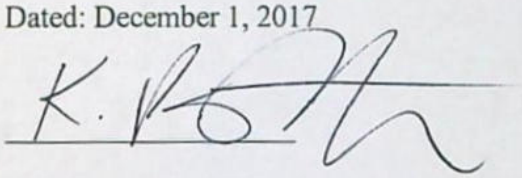
Oregon Department of Fish and Wildlife
Attn: Anna Pakenham Stevenson
4034 Fairview Industrial Dr. SE
Salem, OR 97302-1142

By placing in the US Postal Mail, first class postage prepaid, from Portland, Oregon

Water Rights Section
Oregon Water Resources Department
725 Summer St. NE, STE A
Salem, OR 97301-1266

By hand messenger

Dated: December 1, 2017



Kimberley Priestley
WaterWatch of Oregon
213 SW Ash St., STE 208
Portland, OR 97204
Ph: 503.295.4039
Fax: 503.295.2791
kimberley@waterwatch.org

Oregon Water Resources Department
Water Right Services Division

Water Right Application IS-88322 in the name of Oregon Department of Fish & Wildlife	)))	PROPOSED FINAL ORDER

Summary: The Department proposes to issue an order approving Application IS-88322 and issue a certificate consistent with the attached draft certificate.

Authority
The application is being processed in accordance with Oregon Revised Statute (ORS) 537.140 to 537.250 and 537.332 through 537.360, and Oregon Administrative Rule (OAR) Chapter 690, Division 77 and Hood Basin Program Division 504. These statutes and rules can be viewed on the Oregon Water Resources website: http://www.oregon.gov/owrd/pages/law/index.aspx

The Department's main page is http://www.oregon.gov/OWRD/pages/index.aspx

The Department shall presume that a proposed use will not impair or be detrimental to the public interest if:

(a) The proposed use is allowed in the applicable basin program established pursuant to ORS 536.300 and 536.340 or given a preference under ORS 536.310(12);
(b) Water is available; OAR 690-077-0015(4)
(c) The proposed use will not injure other water rights; and
(d) The proposed use complies with the rules of the Commission. OAR 690-077-0033(1)

All four criteria must be met for a proposed use to be presumed to not impair or be detrimental to the public interest. When the criteria are met and the presumption is established, or if the proposed use can be modified or conditioned to meet the presumption criteria, the Department must further evaluate the proposed use, any comments received, information available in its files or received from other interested agencies and any other available information to determine whether the presumption is overcome. OAR 690-077-0037(3).

If the Department determines that the presumption is established and not overcome the Department shall issue a proposed final order recommending issuance of the certificate subject to any appropriate modifications or conditions.

FINDINGS OF FACT

Application History

1. On December 1, 2016, Oregon Department of Fish & Wildlife filed a complete application for the following water use:

   Use of Water: Public use, specifically fish life and wildlife.
   County: Hood River County
   Location: EAST FORK HOOD RIVER, TRIBUTARY TO THE HOOD RIVER, BEGINNING AT APPROXIMATELY RIVER MILE 6.2 (45.5451, -121.5814) (SENW, SECTION 28, TOWNSHIP 1N, RANGE 10E, WM): CONTINUING DOWNSTREAM TO

THE MOUTH AT APPROXIMATELY RIVER MILE 0.0 (45.6053, -121.6333) (NWNE, SECTION 1, TOWNSHIP 1N, RANGE 9E, WM) HOOD RIVER COUNTY
Source of Water: East Fork Hood River in Hood River Basin
Amount of Water (in cubic feet per second "CFS") requested by month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
180	210	210	210	210	210	150	150	175	175	180	180

2. On March 17, 2017, the Department mailed the applicant notice of its Initial Review, determining that "Some percentage of the water applied for has been determined allocable for the purposes identified in this application." The applicant did not notify the Department to stop processing the application within 14 days of that date.

3. On March 21, 2017, the Department gave public notice of the initial review in its weekly notice. The public notice included a request for comments, and information for interested persons about obtaining future notices and a copy of the Proposed Final Order.

4. Written comments were received from WaterWatch of Oregon and the East Fork Irrigation District. The Department has carefully considered the comments.

5. This Proposed Final Order confirms the preliminary findings made in the initial review.

Presumption Criteria (a) Consistency with Basin Program

6. "Fish life" is a classified use allowed under the Hood River Basin Program (OAR 690-504-0000(1)). ORS 537.343(1); OAR 690-077-0039(2)

Presumption Criteria (b) Water Availability

7. An assessment of surface water availability was completed and a copy of this assessment is in the file. The amount of out-of-stream appropriations is not a factor in determining the amount of an instream water right. OAR 690-077-0015(3). The amount allocable to an instream water right is limited to the estimated average natural streamflow occurring from the drainage system, except where periodic flows that exceed the natural flow are significant for the applied public use. OAR 690-077-0015(4). The table below compares the estimated average natural flow (EANF) of the East Fork of Hood River on a monthly basis (in CFS) to the requested flows in the application. The last row is the allowable amount and the amount in the proposed certificate. Water is not available in the times and amounts requested. ORS 537.343(1); OAR 690-077-0039(2)(c)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EANF	325	351	340	359	392	367	272	197	169	160	201	282
Flows Requested	180	210	210	210	210	210	150	150	175	175	180	180

Allowable amount	180	210	210	210	210	210	150	150	169	160	180	180

Presumption Criteria (c) Injury Determination

8. The proposed use is junior in priority and by operation of the prior appropriation doctrine will not injure other water rights. ORS 537.343(1); OAR 690-077-0039(2)(d)

Presumption Criteria (d) Whether the use complies with rules of the Commission

9. The Department placed the application on the Department's Public Notice for a 30-day comment period. Consistent with OAR 690-077-0031, copies of the notice were sent to the planning departments of affected local governments with a request that a copy of said notice be posted in a conspicuous location in the county courthouse. No land use information was received by the Department during the initial review 30 day public comment period. Pursuant to OAR 690-077-0031(5) the Department may presume the proposed instream water right is compatible with the comprehensive land use plans and land use regulations of affected local governments.

10. The proposed use complies with rules of the Water Resources Commission not otherwise described above.

Whether the proposed use would impair or be detrimental to the public interest as provided in ORS 537.170

11. Based on an evaluation of the proposed use, the comments received, information available in its files or received from other interested agencies and any other available information, the Department has determined that the proposed use will not impair or be detrimental to the public interest as provided in ORS 537.170. OAR 690-077-0039(2)(e)

Determination of Presumption that a proposed surface water use will not impair or be detrimental to the public interest

12. Based on the review of the presumption criteria (a)-(d) above, and Finding of Fact #9, #10 and #11, the Department finds that a rebuttable presumption has been established. 537.343(1); OAR 690-077-0039(2)(g)

CONCLUSIONS OF LAW

The proposed use would not impair or be detrimental to the public interest.

When issuing certificates, ORS 537.343(1) authorizes the Department to include provisions or restrictions concerning the use, control and management of the water to be appropriated for the project. The attached draft permit is conditioned accordingly.

PROPOSED ORDER

The Department recommends approval of Application IS-88322 and issuance of a certificate consistent with the attached draft certificate.

DATED October 17, 2017

Dwight French, Water Rights Services Division Administrator, for
Thomas M. Byler, Director

Protests

Under the provisions of ORS 537.153(7), the Proposed Final Order may be protested. Protests must be received in the Water Resources Department no later than **December 1, 2017**. Protests must be in writing, and must include the following:

- Your name, address, and telephone number;
- A description of your interest in the Proposed Final Order, and, if you claim to represent the public interest, a precise statement of the public interest represented;
- A detailed description of how the action proposed in the Proposed Final Order would impair or be detrimental to your interest;
- A detailed description of how the Proposed Final Order is in error or deficient, and how to correct the alleged error or deficiency;
- Any citation of legal authority to support your protest, if known;
- To affect the department's determination that the proposed use in this application will, or will not, impair or be detrimental to the public interest ORS 537.153(6) requires that a protest demonstrate by a preponderance of evidence any of the following: (a) One or more of the criteria for establishing the presumption are, or are not, satisfied; or (b) The specific aspect of the public welfare, safety and health under ORS 537.525 that would be impaired or detrimentally affected, and specifically how the identified aspect of the public welfare, safety and health under ORS 537.525 would be impaired or be adversely affected;
- If you are the applicant, the protest fee of $410 required by ORS 536.050; and
- If you are not the applicant, the protest fee of $810 required by ORS 536.050 and proof of service of the protest upon the applicant.
- If you are the applicant, a statement of whether or not you are requesting a contested case hearing.

Requests for Standing

Under the provisions of ORS 537.153(7) persons other than the applicant who support a Proposed Final Order can request standing for purposes of participating in any contested case proceeding on the Proposed Final Order or for judicial review of a Final Order.

Requests for standing must be received in the Water Resources Department no later than **December 1, 2017**. Requests for standing must be in writing, and must include the following:

- The requester's name, mailing address and telephone number;
- If the requester is representing a group, association or other organization, the name, address and telephone number of the represented group;
- A statement that the requester supports the Proposed Final Order as issued;
- A detailed statement of how the requester would be harmed if the Proposed Final Order is modified; and
- A standing fee of $230. If a hearing is scheduled, an additional fee of $580 must be submitted along with a petition for party status.

After the protest period has ended, the Director will either issue a Final Order or schedule a contested case hearing. The contested case hearing will be scheduled only if a protest has been submitted and either:

- upon review of the issues, the director finds that there are significant disputes related to the proposed use of water, or
- the applicant requests a contested case hearing within 30 days after the close of the protest period.

If you do not request a hearing within 30 days after the close of the protest period, or if you withdraw a request for a hearing, notify the Department or the administrative law judge that you will not appear or fail to appear at a scheduled hearing, the Director may issue a Final Order by default. If the Director issues a Final Order by default, the Department designates the relevant portions of its files on this matter, including all materials that you have submitted relating to this matter, as the record for purpose of proving a *prima facie* case upon default.

You may be represented by an attorney at the hearing. Legal aid organizations may be able to assist a party with limited financial resources. Generally, partnerships, corporations, associations, governmental subdivisions or public or private organizations are represented by an attorney. However, consistent with OAR 690-002-0020 and OAR 137-003-0555, an agency representative may represent a partnership, corporation, association, governmental subdivision or public or private organization if the Department determines that appearance of a person by an authorized representative will not hinder the orderly and timely development of the record in this case.

Notice Regarding Service Members: Active duty service members have a right to stay proceedings under the federal Service Members Civil Relief Act. 50 U.S.C. App. §§501-597b. You may contact the Oregon State Bar or the Oregon Military Department for more information. The toll-free telephone number for the Oregon State Bar is: 1 (800) 452-8260. The toll-free telephone number of the Oregon Military Department is: 1 (800) 452-7500. The Internet address for the United States Armed Forces Legal Assistance Legal Services Locator website is: http://legalassistance.law.af.mil

This document was prepared by R. Craig Kohanek. If you have any questions about any of the statements contained in this document I can be reached at 503-986-0823.

If you have questions about how to file a protest or a request for standing, please refer to the respective sections in this Proposed Final Order entitled "Protests" and "Requests for Standing". If you have previously filed a protest and want to know its status, please contact Patricia McCarty at 503-986-0820.

If you have other questions about the Department or any of its programs please contact our Customer Service Group at 503-986-0801. Address all other correspondence to: Water Rights Section, Oregon Water Resources Department, 725 Summer St NE Ste A, Salem OR 97301-1266, Fax: 503-986-0901.

STATE OF OREGON

COUNTY OF HOOD RIVER

PROPOSED CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

OREGON WATER RESOURCES DEPARTMENT
725 SUMMER STREET NE, STE A
SALEM, OR 97301

The specific limits for the use are listed below along with the conditions of use.

APPLICATION FILE NUMBER: IS-88322

SOURCE OF WATER: EAST FORK HOOD RIVER, TRIBUTARY TO THE HOOD RIVER

COUNTY: HOOD RIVER

BENEFICIAL USE: PUBLIC USE, SPECIFICALLY FISH LIFE AND WILDLIFE

DATE OF PRIORITY: DECEMBER 1, 2016

To be maintained in:

> EAST FORK HOOD RIVER, TRIBUTARY TO THE HOOD RIVER, BEGINNING AT APPROXIMATELY RIVER MILE 6.2 (45.5451, -121.5814) (SENW, SECTION 28, TOWNSHIP 1N, RANGE 10E, WM): CONTINUING DOWNSTREAM TO THE MOUTH AT APPROXIMATELY RIVER MILE 0.0 (45.6053, -121.6333) (NWNE, SECTION 1, TOWNSHIP 1N, RANGE 9E, WM) HOOD RIVER COUNTY.

The right is established under Oregon Revised Statute 537.341

The following conditions apply to the use of the water under this certificate:

1. The right is limited to not more than the amounts, in cubic feet per second, during the time periods listed below:

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
180	210	210	210	210	210	150	150	169	160	180	180

The water right holder shall measure and report the instream flow along the reach of the stream or river described in the certificate as may be required by the standards for instream water right reporting of the Water Resources Commission.

For purposes of water distribution, this instream right shall not have priority over human consumption.

The instream flow allocated pursuant to this water right is not in addition to other instream flows created by a prior water right or designated minimum perennial stream flow.

The flows are measured at the lower end of the stream reach to protect necessary flows throughout the reach.

Issued _____

DRAFT

_____

Dwight French
Water Right Services Division Administrator, for
Thomas M. Byler, Director
Oregon Water Resources Department

Print Report

Oregon Water Resources Department
Attribute Report

Report Date: May 25, 2017

General:

TRSQQ:	WM1.00N9.00E1NENW WM1.00N9.00E1NWNE WM1.00N9.00E1NENE WM1.00N9.00E1SWNE WM2.00N9.00E36SESW WM2.00N9.00E36SWSE WM2.00N9.00E36SESE WM1.00N9.00E1SENE
DLC:	-
Latitude:	45.6053000000
Longitude:	-121.6333858307
Buffer (ft):	1320
Elevation (ft):	833
Basin Name:	Hood
Basin Plan:	1-Hood River
County:	Hood River
WM District:	3
WM Region:	NORTH CENTRAL
ODFW Region, District:	High Desert, Mid-Columbia District
Irrigation District AOI:	-
Irrigation District, Other:	-
Dams (Permit):	-
Water Rights:	Platcard for WM1.00N9.00E1 Platcard for WM1.00N9.00E1 Platcard for WM1.00N9.00E1 Platcard for WM1.00N9.00E1 Platcard for WM2.00N9.00E36 Platcard for WM2.00N9.00E36 Platcard for WM2.00N9.00E36 Platcard for WM1.00N9.00E1
Well Logs:	Logs for WM1.00N9.00E1 Logs for WM1.00N9.00E1 Logs for WM1.00N9.00E1 Logs for WM1.00N9.00E1

Logs for WM2.00N9.00E36
Logs for WM2.00N9.00E36
Logs for WM2.00N9.00E36
Logs for WM1.00N9.00E1

Rules:

Withdrawn Authority:	-
Groundwater Retricted:	-
GW Retricted Subunit:	-
GW ODEQ Management Area:	-
GW Umatilla Muni Wells (5mile):	-
Rule 4D:	Rules apply
Division 33 (Area, Watershed, species):	**UPPER COLUMBIA**, *East Fork Hood River*, Bull Trout, Coho Salmon, Redband Trout, Coastal Cutthroat Trout, Chinook Salmon, Steelhead
	UPPER COLUMBIA, *West Fork Hood River*, Coho Salmon, Chinook Salmon, Coastal Cutthroat Trout, Steelhead, Redband Trout
	UPPER COLUMBIA, *Hood River*, Bull Trout, Coho Salmon, Redband Trout, Coastal Cutthroat Trout, Chinook Salmon, Steelhead
Irrigation Season of Use:	**Hood River** Adj. Status: Adjudicated Subarea: undefined Irr. Season: Apr 15 to Oct 1 Duty: 3 Rate: 1/80
Water Quality Limited Pollutant 2012:	**Hood River** R. Mile: 0 to 14.6 HUC4: 17070105 Pollutant: Iron Season: NaN Uses: Aquatic life Status: Cat 5: Water quality limited, 303(d) list, TMDL needed Action: No status change
	Hood River R. Mile: 0.7 to 14.6 HUC4: 17070105 Pollutant: Copper Season: NaN

Uses: Aquatic life; Human health
Status: Cat 5: Water quality limited, 303(d) list, TMDL needed
Action: No status change

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Chromium
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: Added to database

West Fork Hood River
R. Mile: 0 to 4.6
HUC4: 17070105
Pollutant: Thallium
Season: NaN
Uses: Human health
Status: Cat 5: Water quality limited, 303(d) list, TMDL needed
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Phosphate Phosphorus
Season: NaN
Uses: Aquatic life
Status: Cat 3B: Insufficient data, potential concern
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: BHC gamma (Lindane)
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 3: Insufficient data
Action: No action

Hood River
R. Mile: 4.6 to 14.6
HUC4: 17070105
Pollutant: Temperature
Season: NaN
Uses: Salmonid fish rearing; Anadromous fish passage
Status: Cat 4A: Water quality limited, TMDL approved
Action: No action

Hood River

R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Ammonia
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Copper
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No status change

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Dieldrin
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Arsenic
Season: NaN
Uses: Human health; Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: Status modification - Attaining criteria/uses

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Nickel
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No status change

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Barium
Season: NaN
Uses: Human health

Print Report

Oregon Water Resources Department
Attribute Report

Report Date: May 25, 2017

General:

TRSQQ:	WM1.00N9.00E1NENW WM1.00N9.00E1NWNE WM1.00N9.00E1NENE WM1.00N9.00E1SWNE WM2.00N9.00E36SESW WM2.00N9.00E36SWSE WM2.00N9.00E36SESE WM1.00N9.00E1SENE
DLC:	-
Latitude:	45.6053000000
Longitude:	-121.6333858307
Buffer (ft):	1320
Elevation (ft):	833
Basin Name:	Hood
Basin Plan:	1-Hood River
County:	Hood River
WM District:	3
WM Region:	NORTH CENTRAL
ODFW Region, District:	High Desert, Mid-Columbia District
Irrigation District AOI:	-
Irrigation District, Other:	-
Dams (Permit):	-
Water Rights:	Platcard for WM1.00N9.00E1 Platcard for WM1.00N9.00E1 Platcard for WM1.00N9.00E1 Platcard for WM1.00N9.00E1 Platcard for WM2.00N9.00E36 Platcard for WM2.00N9.00E36 Platcard for WM2.00N9.00E36 Platcard for WM1.00N9.00E1
Well Logs:	Logs for WM1.00N9.00E1 Logs for WM1.00N9.00E1 Logs for WM1.00N9.00E1 Logs for WM1.00N9.00E1

Logs for WM2.00N9.00E36
Logs for WM2.00N9.00E36
Logs for WM2.00N9.00E36
Logs for WM1.00N9.00E1

Rules:

Withdrawn Authority:	-
Groundwater Retricted:	-
GW Retricted Subunit:	-
GW ODEQ Management Area:	-
GW Umatilla Muni Wells (5mile):	-
Rule 4D:	Rules apply
Division 33 (Area, Watershed, species):	**UPPER COLUMBIA**, *East Fork Hood River*, Bull Trout, Coho Salmon, Redband Trout, Coastal Cutthroat Trout, Chinook Salmon, Steelhead
	UPPER COLUMBIA, *West Fork Hood River*, Coho Salmon, Chinook Salmon, Coastal Cutthroat Trout, Steelhead, Redband Trout
	UPPER COLUMBIA, *Hood River*, Bull Trout, Coho Salmon, Redband Trout, Coastal Cutthroat Trout, Chinook Salmon, Steelhead
Irrigation Season of Use:	**Hood River** Adj. Status: Adjudicated Subarea: undefined Irr. Season: Apr 15 to Oct 1 Duty: 3 Rate: 1/80
Water Quality Limited Pollutant 2012:	**Hood River** R. Mile: 0 to 14.6 HUC4: 17070105 Pollutant: Iron Season: NaN Uses: Aquatic life Status: Cat 5: Water quality limited, 303(d) list, TMDL needed Action: No status change
	Hood River R. Mile: 0.7 to 14.6 HUC4: 17070105 Pollutant: Copper Season: NaN

Uses: Aquatic life; Human health
Status: Cat 5: Water quality limited, 303(d) list, TMDL needed
Action: No status change

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Chromium
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: Added to database

West Fork Hood River
R. Mile: 0 to 4.6
HUC4: 17070105
Pollutant: Thallium
Season: NaN
Uses: Human health
Status: Cat 5: Water quality limited, 303(d) list, TMDL needed
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Phosphate Phosphorus
Season: NaN
Uses: Aquatic life
Status: Cat 3B: Insufficient data, potential concern
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: BHC gamma (Lindane)
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 3: Insufficient data
Action: No action

Hood River
R. Mile: 4.6 to 14.6
HUC4: 17070105
Pollutant: Temperature
Season: NaN
Uses: Salmonid fish rearing; Anadromous fish passage
Status: Cat 4A: Water quality limited, TMDL approved
Action: No action

Hood River

R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Ammonia
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Copper
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No status change

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Dieldrin
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Arsenic
Season: NaN
Uses: Human health; Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: Status modification - Attaining criteria/uses

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Nickel
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No status change

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Barium
Season: NaN
Uses: Human health

Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Lead
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Antimony
Season: NaN
Uses: Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Fecal Coliform
Season: NaN
Uses: Water contact recreation
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Sedimentation
Season: NaN
Uses: Salmonid fish spawning; Salmonid fish rearing; Resident fish and aquatic life
Status: Cat 3: Insufficient data
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Parathion
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River

Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Lead
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Antimony
Season: NaN
Uses: Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Fecal Coliform
Season: NaN
Uses: Water contact recreation
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Sedimentation
Season: NaN
Uses: Salmonid fish spawning; Salmonid fish rearing; Resident fish and aquatic life
Status: Cat 3: Insufficient data
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Parathion
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River

R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Chlorophyll a
Season: NaN
Uses: Aesthetics; Livestock watering; Water supply; Fishing; Water contact recreation
Status: Cat 3: Insufficient data
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Chloride
Season: NaN
Uses: Aquatic life
Status: Cat 3: Insufficient data
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Pesticides
Season: NaN
Uses: Resident fish and aquatic life; Anadromous fish passage; Drinking water
Status: Cat 3: Insufficient data
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Alkalinity
Season: NaN
Uses: Aquatic life
Status: Cat 3B: Insufficient data, potential concern
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: pH
Season: NaN
Uses: Resident fish and aquatic life; Water contact recreation
Status: Cat 3: Insufficient data
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Thallium

Season: NaN
Uses: Human health
Status: Cat 5: Water quality limited, 303(d) list, TMDL needed
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Manganese
Season: NaN
Uses: Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Zinc
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No status change

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: pH
Season: NaN
Uses: Salmonid fish rearing; Resident fish and aquatic life; Anadromous fish passage; Water contact recreation; Salmonid fish spawning
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Lead
Season: NaN
Uses: Aquatic life
Status: Cat 5: Water quality limited, 303(d) list, TMDL needed
Action: Status modification - Added to 303(d) list

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Beryllium
Season: NaN
Uses: Human health; Drinking water
Status: No criteria

Action: Delisted - Criteria change or use clarification

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: pH
Season: NaN
Uses: Water contact recreation; Resident fish and aquatic life
Status: Cat 5: Water quality limited, 303(d) list, TMDL needed
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: pH
Season: NaN
Uses: Water contact recreation; Salmonid fish spawning; Anadromous fish passage; Resident fish and aquatic life; Salmonid fish rearing
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: E. Coli
Season: NaN
Uses: Water contact recreation
Status: Cat 3: Insufficient data
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Cadmium
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No status change

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Fecal Coliform
Season: NaN
Uses: Water contact recreation
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River

R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: E. Coli
Season: NaN
Uses: Water contact recreation
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Ammonia
Season: NaN
Uses: Aquatic life
Status: Cat 3: Insufficient data
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Cadmium
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No status change

West Fork Hood River
R. Mile: 0 to 14
HUC4: 17070105
Pollutant: Dissolved Oxygen
Season: NaN
Uses: Salmon and steelhead spawning
Status: Cat 3: Insufficient data
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Aquatic Weeds Or Algae
Season: NaN
Uses: Water contact recreation; Aesthetics; Fishing
Status: Cat 3: Insufficient data
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Selenium
Season: NaN
Uses: Aquatic life; Human health

Status: Cat 2: Attaining some criteria/uses
Action: No status change

Hood River
R. Mile: 0.7 to 14.6
HUC4: 17070105
Pollutant: Chlorpyrifos
Season: NaN
Uses: Aquatic life
Status: Cat 3B: Insufficient data, potential concern
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Zinc
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No status change

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Alkalinity
Season: NaN
Uses: Aquatic life
Status: Cat 3B: Insufficient data, potential concern
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Chlorophyll a
Season: NaN
Uses: Aesthetics; Livestock watering; Water contact recreation; Fishing; Water supply
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Antimony
Season: NaN
Uses: Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River

R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Dissolved Oxygen
Season: NaN
Uses: Cold-water aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Silver
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No status change

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Malathion
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 4.6 to 14.6
HUC4: 17070105
Pollutant: pH
Season: NaN
Uses: Resident fish and aquatic life; Anadromous fish passage; Salmonid fish rearing; Water contact recreation; Salmonid fish spawning
Status: Cat 2: Attaining some criteria/uses
Action: No action

Hood River
R. Mile: 10.5 to 14.6
HUC4: 17070105
Pollutant: Dissolved Oxygen
Season: NaN
Uses: Salmon and steelhead spawning
Status: Cat 3: Insufficient data
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Iron

Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No status change

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Dieldrin
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Chlorophyll a
Season: NaN
Uses: Aesthetics; Water supply; Water contact recreation; Fishing; Livestock watering
Status: Cat 3: Insufficient data
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Malathion
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Thallium
Season: NaN
Uses: Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Beryllium
Season: NaN
Uses: Human health; Drinking water
Status: No criteria
Action: Delisted - Criteria change or use clarification

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: Flow Modification
Season: NaN
Uses: Resident fish and aquatic life; Salmonid fish spawning; Salmonid fish rearing
Status: Cat 3: Insufficient data
Action: Status modification

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Arsenic
Season: NaN
Uses: Human health; Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No status change

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Nickel
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No status change

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Chloride
Season: NaN
Uses: Aquatic life
Status: Cat 3: Insufficient data
Action: No action

Hood River
R. Mile: 0 to 14.6
HUC4: 17070105
Pollutant: E. Coli
Season: NaN
Uses: Water contact recreation
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105

Pollutant: Silver
Season: NaN
Uses: Aquatic life
Status: Cat 5: Water quality limited, 303(d) list, TMDL needed
Action: Status modification - Added to 303(d) list

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Selenium
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No status change

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Manganese
Season: NaN
Uses: Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Phosphate Phosphorus
Season: NaN
Uses: Aquatic life
Status: Cat 3: Insufficient data
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Biological Criteria
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Barium
Season: NaN
Uses: Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Chlorpyrifos
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Chromium
Season: NaN
Uses: Aquatic life
Status: Cat 2: Attaining some criteria/uses
Action: Added to database

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Chlorophyll a
Season: NaN
Uses: Fishing; Aesthetics; Livestock watering; Water supply; Water contact recreation
Status: Cat 3: Insufficient data
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: Dissolved Oxygen
Season: NaN
Uses: Cold-water aquatic life
Status: Cat 3: Insufficient data
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105
Pollutant: BHC gamma (Lindane)
Season: NaN
Uses: Aquatic life; Human health
Status: Cat 2: Attaining some criteria/uses
Action: No action

West Fork Hood River
R. Mile: 0 to 14.4
HUC4: 17070105

Pollutant: Temperature
Season: NaN
Uses: Salmonid fish rearing; Anadromous fish passage
Status: Cat 4A: Water quality limited, TMDL approved
Action: No action

Fish Habitat 2014:

Species: Bull trout
Anad. Run: NA
Life History: Unknown
Habitat Use: Migration
Basis: UndocObsFish
Stream: Hood River
Origin: Native
Pop. Sustained: Native
Source Agcy: ODFW

Species: Steelhead
Anad. Run: Summer
Life History: Anadromous
Habitat Use: Spawning
Basis: UndocObsFish
Stream: Hood River
Origin: Native
Pop. Sustained: Mixed
Source Agcy: ODFW

Species: Redband trout
Anad. Run: NA
Life History: AnadRes
Habitat Use: ResidentMultipleUses
Basis: IndivProfOpinion
Stream: Hood River
Origin: Native
Pop. Sustained: WildNatural
Source Agcy: ODFW

Species: Coho salmon
Anad. Run: NA
Life History: Anadromous
Habitat Use: Spawning
Basis: UndocObsFish
Stream: Hood River
Origin: Native
Pop. Sustained: Mixed
Source Agcy: ODFW

Species: Chinook salmon
Anad. Run: Fall
Life History: Anadromous
Habitat Use: Spawning
Basis: ConcurProfOpinion
Stream: West Fork Hood River

Origin: Native
Pop. Sustained: Native
Source Agcy: ODFW

Species: Steelhead
Anad. Run: Winter
Life History: Anadromous
Habitat Use: Spawning
Basis: ConcurProfOpinion
Stream: Hood River
Origin: Native
Pop. Sustained: Mixed
Source Agcy: ODFW

Species: Chinook salmon
Anad. Run: Fall
Life History: Anadromous
Habitat Use: Spawning
Basis: ConcurProfOpinion
Stream: Hood River
Origin: Native
Pop. Sustained: Native
Source Agcy: ODFW

Species: Coho salmon
Anad. Run: NA
Life History: Anadromous
Habitat Use: Spawning
Basis: ConcurProfOpinion
Stream: West Fork Hood River
Origin: Native
Pop. Sustained: Unknown
Source Agcy: ODFW

Species: Coastal cutthroat trout
Anad. Run: Unknown
Life History: AnadRes
Habitat Use: Spawning
Basis: ConcurProfOpinion
Stream: Hood River
Origin: Unknown
Pop. Sustained: Unknown
Source Agcy: ODFW

Species: Coho salmon

Anad. Run: NA
Life History: Anadromous
Habitat Use: Spawning
Basis: ConcurProfOpinion
Stream: West Fork Hood River
Origin: Native
Pop. Sustained: Mixed
Source Agcy: ODFW

Species: Redband trout
Anad. Run: NA
Life History: AnadRes
Habitat Use: ResidentMultipleUses
Basis: IndivProfOpinion
Stream: West Fork Hood River
Origin: Native
Pop. Sustained: WildNatural
Source Agcy: ODFW

Species: Chinook salmon
Anad. Run: Spring
Life History: Anadromous
Habitat Use: Spawning
Basis: ConcurProfOpinion
Stream: West Fork Hood River
Origin: Native
Pop. Sustained: Mixed
Source Agcy: ODFW

Species: Steelhead
Anad. Run: Winter
Life History: Anadromous
Habitat Use: Spawning
Basis: ConcurProfOpinion
Stream: West Fork Hood River
Origin: Native
Pop. Sustained: Mixed
Source Agcy: ODFW

Species: Steelhead
Anad. Run: Summer
Life History: Anadromous
Habitat Use: Spawning
Basis: UndocObsFish
Stream: West Fork Hood River
Origin: Native

Pop. Sustained: Mixed
Source Agcy: ODFW

Species: Chinook salmon
Anad. Run: Spring
Life History: Anadromous
Habitat Use: Spawning
Basis: ConcurProfOpinion
Stream: Hood River
Origin: Native
Pop. Sustained: Mixed
Source Agcy: ODFW

Is in Deschutes Study Area:	-
Deschutes Zone Impact:	-
Deschutes Zone Overlay:	-
Scenic Water Way:	-

Hydrography:

OWRD Streamcode:	0417400150 - E Fk Hood R
	04174001400020 - Dead Point Cr
	041740 - Hood R
	0417400140 - W Fk Hood R
Waterbody Name:	-
HUC 10:	1707010506 1707010507 1707010505
HUC Watershed:	West Fork Hood River Hood River East Fork Hood River
WAB Wshed Order:	5 2 6 5
WAB Analysis:	W FK HOOD R > HOOD R - AT MOUTH HOOD R > COLUMBIA R - AT RM 0.75 DEAD POINT CR > W FK HOOD R - AT MOUTH E FK HOOD R > HOOD R - AT MOUTH

Streamflow:	OWRD Opportunities: Good ODFW Needs: Moderate Combined Priority: Not a priority
	OWRD Opportunities: Fair ODFW Needs: Highest Combined Priority: Not a priority
	OWRD Opportunities: Fair ODFW Needs: Poor Combined Priority: Not a priority
	OWRD Opportunities: Fair ODFW Needs: Moderate Combined Priority: Not a priority
Gaging Station Data:	14119000, *HOOD R AT WINANS, OR*, Discontinued

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close

Print Report

WATERWATCH

PROTECTING NATURAL FLOWS IN OREGON RIVERS

April 20, 2017

Water Rights Section
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, OR 97301-1271

RE: Comments, Hood River Basin Instream Water Rights Applications, IS 88321, IS 88322, IS 88324, IS 88325, IS 88326, IS 88327, IS 88329, IS 88330, IS 88331, IS 88334, IS 88335, IS 88337

Dear Oregon Water Resources Department,

Thank you for the opportunity to comment on the IRs for ODFW's fourteen applications for instream water rights in the Hood River Basin (IS 88321, IS 88322, IS 88324, IS 88325, IS 88326, IS 88327, IS 88329, IS 88330, IS 88331, IS 88334, IS 88335, IS 88337).

WaterWatch strongly supports the issuance of the fourteen Hood River Basin instream water rights in the amounts requested by ODFW in its applications. That said, we did have some comments/concerns with the IRs as proposed.

1. There is no statutory authority to restrict ODFW requested flow amounts to ENAF

The IRs propose to limit the flow amounts protected by the instream water rights to the estimated average natural flow (ENAF). In all but two of the fourteen applications, this would result in instream protections of less flow than requested by ODFW.[1] The OWRD is relying on OAR 690-077-0015(4) as support for this restriction. As the OWRD is aware, there is currently an ongoing rulemaking regarding Division 77. One of the outstanding issues is the legality of this provision of rule. The Rules Advisory Committee has been advised that this, among other issues, is under review by the Department of Justice. There are two issues related to this rule.

First, there is no statutory authority that allows carte blanch limitation on instream water rights applications. While the Instream Water Right Act does allow the WRD to reduce the amount applied for in an instream water right application by another state agency, this is only allowed upon findings that sets for the basis for the reduction in the specific instance associated with the facts of a specific application. ORS 537.343(2). Moreover, the OWRD can only do this if the conditioning is consistent with the intent of ORS 537.332 to 537.360. To set an overarching limit to all agency applied instream water rights based on an overall "estimated average natural flow" (ENAF) is not supported by statute and is contrary to the intent of the Act to protect water instream for the beneficial uses of fish, wildlife, recreation and pollution abatement. The ENAF flow number has nothing to do with the beneficial use that these rights are supposed to protect and simply provides a false ceiling for the purposes of application processing. As to the IRs, the OWRD simply applied the ENAF to all the applications to reduce the amounts requested by ODFW; OWRD did not make any findings that set the basis for the reduction specific to the circumstances of each of the fourteen applications as is required by statute. The OWRD was in error in this regard.

[1] For IS 88334 and IS 88335 the ENAF is greater than the amount requested thus these are the only two applications where the IR's reflect the amount requested by ODFW.

Second, even if DOJ were to find that the noted section of the Division 77 rules were consistent with statute (which we do not believe is the case), the OWRD appears to be ignoring the whole of the section of rule they cite. The IRs state that:

> "Water allocable for instream use is limited to the average natural flow. Specifically, (OAR 690-077-0015(4)) states "If natural stramflow or natural lake levels are the source for meeting instream water rights, the amount allowed during any identified time period for the water right shall not exceed the estimated average natural flow or level occurring from the drainage system……."

The IRs fail to completely cite OAR 690-077-0015(4) which continues on with:

> …..except where periodic flow or level are significant for the uses applied for. An example of such an exception would be high flow events that allow for fish passage or migration over obstacles.

In other words, even if the DOJ were to determine that a carte blanche ENAF screen could be applied to instream water rights, the OWRD would still need to make findings that the requested amount was not significant for the uses applied for for each individual application in order to reduce the amount requested to ENAF. The OWRD did not do this and thus the IRs are in error.

As a factual matter, the ODFW requested flow numbers are to support the conservation, maintenance and enhancement of aquatic, fish and wildlife. The flows applied for include water for fish and wildlife migration, spawning, nesting, brooding, egg incubation, larval or juvenile development and aquatic rearing and aquatic life. Flows vary based on life cycle and life stage development needs. These flows were determined by ODFW, the state agency with expertise to determine the amount of water needed for fish and wildlife. Thus, even if the OWRD were to apply the above noted provision of the Division 77 rules, it is clear that the flows are significant for the uses applied for. Thus, even under the disputed rule, OWRD analysis should have resulted in a recommendation that the full amount of the water right be approved as the flows are "significant" for the uses applied for. Thus, under both statute and rule the IR is in error.

2. The OWRD erred in its application of the state's water allocation policy

In addition to restricting the flow amounts requested by ODFW by ENAF, the OWRD also applies its water availability screen to the application to further reduce requested amount. While we do not disagree that the permitting statutes require that the WRD find that water is available for the use, we believe the OWRD was in error in how it applied the state's water allocation policy. The state's water allocation policy, read as a whole, is clearly focused on protecting streams against further depletion. See OAR 690-400(11), OAR 690-410-070. Specifically, the water allocation policy makes clear that the waters of the state shall be protected from over-appropriation by new out of stream users of surface water or new uses of groundwater. OAR 690-410-070(1). To achieve this the OAR 690-410-070(2)(a) states:

> The surface waters of this state shall be allocated to new out-of-stream uses only during the months or half month periods when the allocations will not contribute to over-appropriation. However, when a stream is over-appropriated, some additional uses may be allowed where the public interest is those uses is high and uses are conditioned to protect instream values (emphasis added).

In other words, the water availability restrictions under this rule apply to out-of-stream diversions. The allocation policy is not designed to restrict instream water rights. The Division 77 rules corroborate this

interpretation by directing that "the amount of appropriation for out-of-stream purposes shall not be a factor in determining the amount of an instream water right." OAR 690-77-0015(3)[2]. To try to restrict water that remains instream via a rule that is supposed to apply to consumptive uses of surface water is in error, and frankly, makes no sense.

Moreover, even if the Division 410 rules did apply to instream applications, instream water rights would easily meet the "exception" to the rule which is that, notwithstanding that a stream is over-appropriated, additional uses can be approved where the public interest is high and uses are conditioned to protect instream values. See OAR 690-410-070(2)(a). Clearly, instream water rights that are held in trust for all Oregonians to protect water instream easily meet both of these hurdles.

3. **The OWRD fails to analyze the fourteen applications in light of the many public interest factors that would support the issuance of the instream water rights in the amount requested by ODFW.**

In looking at this application, the WRD failed to analyze a number of public interest factors that would support issuance the ODFW applications in the amount requested, which includes, but is not limited to:

- The Hood River Basin supports five fish species protected by the Federal Endangered Special Act.[3] Flow is listed as a limiting factor.
- OAR 690-410-030 (d) states that protecting streamflows which are needed to support public uses is a high priority for the state. Public use is defined as, among other things, protection and enhancement of fish life, wildlife and fish and wildlife habitat and any other ecological values OAR 690-400-010(13).
- The 2012 Integrated Water Resources Strategy directs the state to apply for instream water rights to protect both base and elevated flows.[4]
- As noted, the Division 77 rules state that the amount of appropriation for out-of-stream purposes shall not be a factor in determining the amount of an instream water right.

Conclusion: WaterWatch supports issuance of the fourteen Hood River instream water rights in the amounts requested by ODFW. As to the amounts proposed under the IRs that restrict twelve of the fourteen applications, we do not believe the OWRD has a factual, legal or policy basis upon which to support the restrictions proposed in the IRs.

Thank you for consideration of our comments.

Sincerely,

K. Priestley

Kimberley Priestley
Sr. Policy Analyst

Cc: Laurie Aunan, Governor's Natural Resources Policy Advisor

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[2] The state's water availability model is subtracts out the consumptive uses of water rights, thus would not comport with the Division 77 regarding analysis of out-of-stream rights in relation to instream rights.
[3] Bull trout, spring chinook, fall chinook, summer steelhead and winter steelhead.
[4] WRC 2012 Integrated Water Resources Strategy, Page 100.

April 20, 2017

Ronald C. Kohanek
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, OR 97301

Sent via email to: ron.c.kohanek@oregon.gov

Subject: Instream Water Rights in the Hood Basin, Files IS88321, IS88322, IS88323, IS88324, IS88325, IS88326, IS88327, IS88328, IS88329, IS88331, IS88334, IS88335, IS88337

Dear Oregon Water Resources Department:

East Fork Irrigation District (EFID) is submitting comments on the Hood River Basin instream water right applications Oregon Department of Fish and Wildlife (ODFW) have submitted to Oregon Water Resources Department (OWRD). Hood River is a leader in locally driven watershed planning, and EFID is concerned that in ODFW's efforts to protect instream water throughout Oregon, they failed to engage with the local communities.

Hood River, in partnership with the US Bureau of Reclamation and the Hood River County Water Planning Group (HRCWPG), completed a basin study that assesses the current and future water supply and demand in the Hood River Basin. The HRCWPG included Hood River County, Hood River Watershed Group, Columbia Gorge Fruit Growers Association, Hood River County Soil and Water Conservation District, multiple water districts, environmental groups, local resource specialist, irrigation districts, OWRD, the Confederated Tribes of Warm Springs and the Natural Resources Conservation Service. The collaborative process developed various projects that could address both instream and out-of-stream needs. Additionally, in 2015 the Hood River Water Conservation Strategy, which stemmed from the Hood River Basin Study, identified, quantified and prioritized the opportunities for water conservation and instream flow enhancement in the Hood River Basin.

EFID is concerned that ODFW will upend all the hard work Hood River has put into local planning by attempting to appropriate all remaining water on 14 stream systems in the Hood Basin for instream use without considering the creative options for addressing instream needs development by the community. Unfortunately, it appears to EFID that ODFW is operating in a vacuum which undermines all the efforts already put forth by the basin. Our district has worked well with the Hood River Watershed Group and its many partners in the Hood River Basin. Moving forward, ODFW should involve all stakeholders in the community, especially when the community has water planning groups in place. Meeting with the water stewards of the community would only be beneficial to ODFW in addressing the needs of a specific basin.

Additionally, EFID has some specific concerns with the application pertaining to the East Fork Hood River (EFHR). The district currently has one point of diversion on the EFHR with a single headgate delivery system. The district's water supply comes from the NE slopes of Mt.Hood. EFID is in the process of exploring the possibility of a reservoir site, as an alternate water source to help meet late season water demands when the flow on the river is low. If a reservoir site is built, EFID could potentially capture winter water runoff, drainage or district water, benefiting not only EFID patrons, but the flows of the EFHR during low water months.

Had ODFW engaged with the HRCWPG before applying for instream water rights within the Hood River Basin, they would have a more complete picture of the instream water needs and the well thought out projects the local community plans to implement in order to address those needs. One of the biggest issues EFID has with the instream water rights applied for by ODFW is that they will remove any flexibility the basin has to be creative in addressing all of the water supply demands now and into the future. The Hood River Basin's success in watershed planning illustrates that planning efforts work best when diverse interests develop and implement plans at the local watershed level, with the support from state government. In this instance, ODFW is not working as a collaborative partner, but is operating outside of the process and potentially restricting it. EFID requests that OWRD deny the instream water right applications put forth by ODFW and encourage them to work with the HRCWPG in developing instream protections that will work within the already identified plans.

Thank you for the opportunity for EFID to comment and express our concerns with the Hood River Basin instream water right applications submitted by ODFW. Please do not hesitate to contact me if you have any questions about our comments or would like to discuss this issue further.

Thank-You
John Buckley-District Manager
East Fork Irrigation District
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Oregon
Kate Brown, Governor

Water Resources Department
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Salem, OR 97301
(503) 986-0900
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March 17, 2017

Director
In Care of Anna Pakenham-Stevenson
Oregon Department of Fish and Wildlife
4034 Fairview Industrial Drive SE
Salem, OR 97302-1142

Reference: Instream water rights in the Hood Basin, Files IS 88321, IS 88322, IS 88323, IS 88324, IS 88325, IS 88326, IS 88327, IS 88328, IS 88329, IS 88330, 88331, IS 88334, IS 88335, IS 88337.

Dear Oregon Department of Fish and Wildlife:

THIS IS NOT A WATER RIGHT CERTIFICATE
AND IS SUBJECT TO CHANGE AT THE NEXT PHASE OF PROCESSING

This letter is to inform you of the preliminary analysis of your water right applications. This document, called an "Initial Review", is to inform you of the potential limitations to your proposed instream water right and to describe some of your options. Based on the information you have provided, the Water Resources Department has made the following preliminary determinations:

Please reference the application number when sending correspondence regarding conclusions of this Initial Review. Comments received within the comment period will be evaluated at the next phase of the process.

Initial Review Determinations:

1. The referenced applications are complete and not defective. However, OWRD requests the applicant provide additional information of how it has complied with its own administrative rules for instream water rights, as required by OAR 690-077-0020(4)(k), specifically those found in OAR 635-400-0020.

2. The proposed use is not prohibited, restricted or limited by law except for water availability limitations in certain months as depicted below.

3. The reach proposed in this application for an instream water right is in the Hood Basin.

4. The instream fish life uses and wildlife use are allowed under the Hood Basin Program OAR (690-504-0000(1)).

5. Water allocable for instream use is limited to the estimated average natural flow. Specifically, (OAR 690-077-0015(4) states "If natural streamflow or natural lake levels are the source for meeting instream water rights, the amount allowed during any identified time period for the water right shall not exceed the estimated average natural flow or level occurring from the drainage system …"

6. All amounts of water identified in this document are in cubic feet per second.

7. Summary of determination: Some percentage of the water applied for has been determined allocable for the purpose identified in each application. That volume is shown in the table below titled "Allowable instream use" and if less than the volume shown in "Requested for Fish life and fish habitat" table is limited to the volume shown "Estimated average natural flow" table.

1. Application 88321 **Priority date: 01/01/2016**

Description:

- Eagle Creek, tributary to the Columbia River, beginning at river mile 2.1 (SWNW, S25, T2N, R7E, WM) in Hood River County (45.6278, -121.8988) and continuing downstream to river mile 0.0 (SWNE, S22, T2N, R7E, WM) in Multnomah County (45.6405, -121.9319).

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
70	70	70	120	120	120	70	84	143	143	120	120

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
358	360	271	277	270	158	78.7	54.8	52.5	95.1	240	354

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
70	70	70	120	120	120	70	54.8	52.5	95.1	120	120

2. Application 88322 **Priority date: 01/01/2016**

Description: strike

- East Fork Hood River ~~Creek~~, tributary to the Hood River, beginning at river mile 6.2 (SENW, S28, T1N, R10E, WM) in Hood River County (45.5451, -121.5814) and continuing downstream to river mile 0.0 (NWNE, S1, T1N, R9E, WM) in Hood River County (45.6053, -121.6333).

Based on OWRD's review, the Lat/Long (45.5451, -121.5814) for the start of the reach does not correspond to river mile (RM) 6.2 as indicated in the application. Please verify the QQ in which the start of the reach is located.

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
180	210	210	210	210	210	150	150	175	175	180	180

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
325	351	340	359	392	367	272	197	169	160	201	282

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
~~70~~	~~70~~	~~70~~	~~120~~	~~120~~	~~120~~	150	150	169	160	180	180

180 210 210 210 210 210

3. Application 88323 **Priority date: 01/01/2016**

Description:

- Green Point Creek, tributary to West Fork Hood River, beginning at the confluence of the Green Point Creek and Long Branch Creek at river mile 3.1 (NWNE, S9, T1N, R9E, WM) in Hood River County (45.5914, -121.6987) and continuing downstream to river mile 0.0 (SENW, S12, T1N, R9E, WM) in Hood River County (45.5873, -121.6439).

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
90	120	120	120	120	120	50	80	80	80	120	120

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
93.9	110	107	124	125	64.7	26.8	16.5	16.2	29	65.2	87.9

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
90	110	107	120	120	64.7	26.8	16.5	16.2	29	65.2	87.9

4. Application 88324 **Priority date: 01/01/2016**

Description:

- Confluence of East Herman Creek and Herman Creek, tributary to Columbia River, beginning at river mile 4.2 (NWSW, S15, T2N, R8E, WM) in Hood River County (45.6549, -121.819) and continuing downstream to river mile 0.0 (NESE, S6, T2N, R8E, WM) in Hood River County (45.6834, -121.8616).

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
60	60	60	102	102	102	60	72	122	122	102	72

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
115	124	107	122	135	77.1	33.4	20.7	18.1	32.5	81.5	113

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
60	60	60	102	102	77.1	33.4	20.7	18.1	32.5	81.5	72

5. Application 88325 **Priority date: 01/01/2016**

Description:

- Lindsay Creek, tributary to Columbia River, beginning at the North Lake Dam at river mile 4.2 (NESE, S24, T2N, R8E, WM) in Hood River County (45.6429, -121.757) and continuing downstream to river mile 0.0 (NENE, S5, T2N, R9E, WM) in Hood River County (45.6903, -121.7136).

Based on OWRD's review of the application, if RM 4.2 is the start of the instream reach then it is located in the

SENE of Section 2 not the NESE of Section 24. Please verify the QQ in which the start of the reach is located. IS 72081 is for the same reach of Lindsay Creek and indicates NE SE of Section 24.

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20	20	20	34	34	34	20	20	41	41	34	20

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
18	18.8	16.9	22.7	31.4	17.9	5.7	2.64	3.31	6.22	20	20

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
18	18.8	16.9	22.7	31.4	17.9	5.7	2.64	3.31	6.22	20	20

6. Application 88326 **Priority date: 01/01/2016**

Description:

- Mill Creek, tributary to Columbia River, beginning at the confluence of North Fork and South Fork Mill Creek at river mile 8.1 (SESW, S22, T1N, R12E, WM) in Wasco County (45.5506, -121.3079) and continuing downstream to river mile 0.0 (SWSW, S34, T2N, R13E, WM) in Wasco County (45.5506, -121.3079).

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10	10	15	26	26	26	15	15	10	10	10	10

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
25.8	61	65.1	45.3	25.5	15.4	12.6	10.7	9.72	8.43	10.3	15.8

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10	10	15	26	25.5	15.4	12.6	10.7	9.72	8.43	10	10

7. Application 88327 **Priority date: 01/01/2016**

Description:

- Neal Creek, tributary to Hood River, beginning at the confluence of West Fork Neal Creek and Neal Creek at river mile 5.8 (SESW, S6, T1N, R11E, WM) in Hood River County (45.5951, -121.4995) and continuing downstream to river mile 0.0 (NENE, S14, T2N, R10E, WM) in Hood River County (45.6639, -121.5256).

Based on OWRD's review of the application, the Lat/Long (45.5951, -121.4995) would put the start of the reach in the SWSW of section 6 not the SESW as indicated in the application. Please verify the QQ in which the start of the reach is located.

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
45	45	45	45	45	45	45	45	45	25	25	25

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
26.4	41.9	40.1	27.6	9.98	4.91	2.41	1.95	2.15	2.96	4.8	10.6

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
26.4	41.9	40.1	27.6	9.98	4.91	2.41	1.95	2.15	2.96	4.8	10.6

8. Application 88328 **Priority date: 01/01/2016**

Description:

- Odell Creek, tributary to Hood River, beginning at river mile 4.0 (NESW, S34, T2N, R10E, WM) in Hood River County (45.6121, -121.5587) and continuing downstream to river mile 0.0 (NESW, S14, T2N, R10E, WM) in Hood River County (45.6566, -121.5396).

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20	50	50	50	50	50	20	20	20	20	20	20

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
8.55	15.7	16.3	9.25	.88	.17	.08	.09	.07	.13	.43	2.75

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
8.55	15.7	16.3	9.25	.88	.17	.08	.09	.07	.13	.43	2.75

9. Application 88329 **Priority date: 01/01/2016**

Description:

- South Fork Mill Creek, tributary to Mill Creek, beginning at the Crow Creek Reservoir Dam at river mile 10.1 (NENW, S20, T1S, R11E, WM) in Wasco County (45.474998, -121.451698) and continuing downstream to river mile 0.0 (SESW, S22, T1N, R12E, WM) in Wasco County (45.5506, -121.3079).

Based on OWRD's review of the application, The Lat/Long (45.474998, -121.451698) places the start of the reach in the NWNE of Section 20 not the NENW as indicated in the application. Please verify the QQ in which the start of the reach is located.

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	0	0	17	10	10	7	7	7	0

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
16.2	37.4	40	35.3	20.6	12.1	10.1	8.7	8.3	7.2	7.6	10.2

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	0	0	12.1	10	8.7	7	7	7	0

10. Application 88330 **Priority date: 01/01/2016**

Description:

- West Fork Hood River, tributary to Hood River, beginning at the confluence of Elk Creek and McGee Creek at river mile 14.7 (SWNW, S25, T1S, R8E, WM) in Hood River County (45.4569, -121.7818) and continuing downstream to river mile 0.0 (NWNE, S1, T1N, R9E, WM) in Hood River County (45.6052, -121.6333).

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
150	250	250	250	250	250	150	165	165	165	190	190

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
270	271	263	311	376	290	193	147	139	141	296	303

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
150	250	250	250	250	250	150	147	139	141	190	190

11. Application 88331 **Priority date: 01/01/2016**

Description:

- Fifteenmile Creek, tributary to the Columbia River, beginning at river mile 30.6 (SWSE, S25, T1S, R13E, WM) in Wasco County (45.4504, -121.1198) and continuing downstream to the mouth at river mile 0.0 (SWNW, S31, T2N, R14E, WM) in Wasco County (45.6141, -121.1231).

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
13	13	20	34	34	34	20	20	13	13	13	13

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
62.1	91.6	78	64	65	49.6	12.8	5.9	6.1	7.9	11.2	23.1

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
13	13	20	34	34	34	12.8	5.9	6.1	7.9	11.2	13

12. Application 88334 **Priority date: 01/24/2016**

Description:

- East Fork Hood River, tributary to the Hood River, just above the confluence of Polallie Creek with the East Fork Hood River at river mile 16.8 (SESE, S5, T2S, R10E, WM) in Hood River County (45.4185, -121.5685) and continuing downstream to river mile 6.2 (SENW, S28, T1N, R10E, WM) in Hood River County (45.5451, -121.5814).

Based on OWRD's review of the application, the start of the reach is listed at RM 16.8 miles just above the confluence of Polallie Creek and East Fork Hood River, in the SESE QQ, which is RM 14.3. The application lists the end of the reach at RM 6.2, which is RM 3.6. The listed Lat/Long's seemed more accurate and were used by OWRD. Please verify the RM and the QQ for the start of the reach and end of the downstream reach.

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
175	175	175	175	175	175	110	110	145	145	175	175

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
271	260	260	349	509	409	255	170	163	171	267	269

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
175	175	175	175	175	175	110	110	145	145	175	175

13. Application 88335 **Priority date: 01/24/2016**

Description:

- East Fork Hood River, tributary to the Hood River, at the confluence of Cold Spring Creek and East Fork Hood River at river mile 17.8 (SWSE, S8, T2S, R10E, WM) in Hood River County (45.4048, -121.5703) and continuing downstream to river mile 16.8, just above the confluence with Polallie Creek (SESE, S5, T2S, R10E, WM) in Hood River County (45.4185, -121.5685).

Based on OWRD's review of the application, we ask that ODFW please verify the RM and QQ for the start and end of the reach. OWRD used the Lat/Long to place the start of the reach RM and the end of the reach RM.

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
75	75	75	127	127	127	127	75	75	50	50	75

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
120	106	108	164	290	260	162	101	92	94	140	124

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
75	75	75	127	127	127	127	75	75	50	50	75

14. Application 88337 **Priority date: 01/24/2016**

Description:

- Fifteenmile Creek, tributary to the Columbia River, at the unnamed barrier at river mile 49.4 (NWSW, S28, T2S, R11E, WM) in Wasco County (45.3656, -121.4402) and continuing downstream to river mile 30.6 in Dufur at the Highway 197 crossing, (SWSE, S25, T1S, R13E, WM) in Wasco County (45.4504, -121.1196).

Based on OWRD's review of the application, the start of the reach is in Section 28 in the NWSE. However, RM 49.4 would put the start of the reach in the NWSE of Section 29. OWRD used the Lat/Long to place the start of the upstream reach. Please verify the QQ in which the start of the upstream reach is located.

a. The amount of water requested for instream use:

Requested for Fish life and fish habitat

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10	10	15	26	26	26	15	15	10	10	10	10

Estimated average natural flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
38	47	33	28	34	28	9	4	4	7	11	17

Allowable instream use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10	10	15	26	26	26	9	4	4	7	10	10

The applications can be moved to the next phase of the water rights application review process. Comments received within the comment period will be evaluated at the next phase of the process.

Withdrawal:

If you choose not to proceed, you may withdraw your application. To accomplish this you must notify the Department in writing by March 31, 2016.

To Proceed with Your Application:

If you choose to proceed with an application, you do not have to notify the Department. Your application will automatically be placed on the Department's Public Notice to allow others the opportunity to comment. After the comment period the Department will complete a public interest review and issue a proposed final order.

If you have any question:

Feel free to call Craig Kohanek at (503) 986-0823 if you have questions. Please have the application number(s) available if you call.

APPLICATION FACT SHEET

Application File Numbers: IS 88321, IS 88322, IS 88323, IS 88324, IS 88325, IS 88326, IS 88327, IS 88328, IS 88329, IS 88330, IS 88331, IS 88334, IS 88335, IS 88337.

Applicant: Oregon Department of Fish and Wildlife

Counties: Hood & Wasco

Watermaster: Bob Wood, District 3

Priority Date: December 1, 2016

Sources: 1) Eagle Creek, tributary to the Columbia River; 2) East Fork Hood River Creek, tributary to the Hood River; 3) Green Point Creek, tributary to West Fork Hood River; 4) Confluence of East Herman Creek and Herman Creek; 5) Lindsay Creek, tributary to Columbia River; 6) Mill Creek, tributary to Columbia River; 7) Neal Creek, tributary to Hood River; 8) Odell Creek, tributary to Hood River; 9) South Fork Mill Creek, tributary to Mill Creek; 10) West Fork Hood River, tributary to Hood River; 11) Fifteen Mile Creek, Tributary to Columbia River; 12) East Fork Hood River, tributary to Hood River; 13) East Fork Hood River, tributary to the Hood River 14) Fifteen Mile Creek, Tributary to Columbia River.

Uses: Fish life and wildlife

Quantity:

Basin Name & Number: Hood Basin, #3

Stream Index Reference: OWRD Streamcode: 0400101460 – Eagle Cr, 0417400150 – E Fk Hood R, 04174001400040050 – Long Branch Cr, 0400101500 – Herman Cr, 0400101600 – Lindsay Cr, 04001019000200 – N Fk Mill Cr, 0417400070 – Neal Cr, 0417400090 – Odell Cr, 04001019000190 – S Fk Mill Cr, 0417400140 – W Fk Hood R, 0400101940 – Fifteenmile Cr, 0417400150 – E Fk Hood River, 0417400150 – E Fk Hood River, 1707010503 – Fifteenmile Cr.

PUBLIC NOTICE DATE:

30 DAY COMMENT DEADLINE DATE:

Oregon Water Resources Department
Water Availability Analysis

Main Help
Return Contact Us

Water Availability Analysis

E FK HOOD R > HOOD R - AB M FK HOOD R
HOOD BASIN

Water Availability as of 12/27/2016

Watershed ID #: 189 (Map)
Date: 12/27/2016

Exceedance Level: 50%
Time: 11:22 AM

Download Data

Water Availability

Select any Watershed for Details

Nesting Order	Watershed ID #	Stream Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sto
1	192	HOOD R> COLUMBIA R- AT MOUTH	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	30410575	HOOD R> COLUMBIA R- AT RM 0.75	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes
3	30410513	E FK HOOD R> HOOD R- AT MOUTH	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes
4	**189**	**E FK HOOD R> HOOD R- AB M FK HOOD R**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**No**	**No**	**No**	**No**	**No**	**Yes**	**Yes**

Limiting Watersheds

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

Month	Limiting Watershed ID #	Stream Name	Water Available?	Net Water Available
JAN	189	E FK HOOD R > HOOD R - AB M FK HOOD R	Yes	81.70
FEB	189	E FK HOOD R > HOOD R - AB M FK HOOD R	Yes	97.10
MAR	189	E FK HOOD R > HOOD R - AB M FK HOOD R	Yes	82.80
APR	189	E FK HOOD R > HOOD R - AB M FK HOOD R	Yes	47.60

MAY	189	E FK HOOD R > HOOD R - AB M FK HOOD R	Yes	26.20
JUN	30410575	HOOD R > COLUMBIA R - AT RM 0.75	No	-29.70
JUL	30410575	HOOD R > COLUMBIA R - AT RM 0.75	No	-292.00
AUG	30410575	HOOD R > COLUMBIA R - AT RM 0.75	No	-430.00
SEP	30410575	HOOD R > COLUMBIA R - AT RM 0.75	No	-407.00
OCT	30410575	HOOD R > COLUMBIA R - AT RM 0.75	No	-295.00
NOV	189	E FK HOOD R > HOOD R - AB M FK HOOD R	No	-8.42
DEC	189	E FK HOOD R > HOOD R - AB M FK HOOD R	Yes	33.40
ANN	189	E FK HOOD R > HOOD R - AB M FK HOOD R	Yes	22,100.00

Detailed Reports for Watershed ID #192

HOOD R > COLUMBIA R - AT MOUTH
HOOD BASIN
Water Availability as of 12/27/2016

Watershed ID #: 192 (Map)
Date: 12/27/2016

Exceedance Level: 50%
Time: 11:22 AM

Water Availability Calculation

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	1,260.00	74.30	1,190.00	184.00	170.00	832.00
FEB	1,380.00	77.40	1,300.00	205.00	270.00	828.00
MAR	1,300.00	76.60	1,220.00	183.00	270.00	771.00
APR	1,320.00	125.00	1,200.00	117.00	270.00	808.00
MAY	1,310.00	195.00	1,120.00	111.00	250.00	754.00
JUN	1,040.00	240.00	800.00	79.30	250.00	470.00
JUL	739.00	281.00	458.00	0.00	250.00	208.00
AUG	559.00	239.00	320.00	0.00	250.00	70.40
SEP	511.00	168.00	343.00	0.00	250.00	93.30
OCT	517.00	69.90	447.00	22.20	220.00	205.00
NOV	870.00	71.40	799.00	43.60	100.00	655.00
DEC	1,160.00	73.00	1,090.00	122.00	170.00	795.00
ANN	721,000.00	102,000.00	619,000.00	64,000.00	164,000.00	391,000.00

Detailed Report of Consumptive Uses and Storage

Consumptive Uses and Storages in Cubic Feet per Second

Month	Storage	Irrigation	Municipal	Industrial	Commercial	Domestic	Agricultural	Other	Total
JAN	1.87	0.00	37.10	2.96	0.23	2.16	29.40	0.64	74.30
FEB	2.34	0.00	39.80	2.96	0.23	2.16	29.40	0.64	77.40
MAR	2.47	0.00	38.80	2.96	0.23	2.16	29.40	0.64	76.60
APR	2.27	48.80	38.30	2.96	0.06	2.16	29.40	0.64	125.00
MAY	0.12	114.00	45.20	2.96	0.06	2.16	29.40	0.64	195.00
JUN	0.09	157.00	48.10	2.96	0.06	2.16	29.40	0.64	240.00
JUL	0.06	205.00	40.30	2.96	0.06	2.16	29.40	0.64	281.00
AUG	0.05	167.00	36.50	2.96	0.06	2.16	29.40	0.64	239.00
SEP	0.04	96.80	35.60	2.96	0.06	2.16	29.40	0.64	168.00
OCT	0.05	0.15	34.50	2.96	0.06	2.16	29.40	0.64	69.90
NOV	1.33	0.00	34.90	2.96	0.06	2.16	29.40	0.64	71.40
DEC	1.74	0.00	36.10	2.96	0.06	2.16	29.40	0.64	73.00

Detailed Report of Reservations for Storage and Consumptive Uses

Reserved Streamflow in Cubic Feet per Second

Application #	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RN80401A	39.50	43.00	36.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.60
RN80402A	130.00	136.00	122.00	104.00	111.00	79.30	0.00	0.00	0.00	22.20	41.60	86.10
RN80403A	14.80	25.50	24.30	13.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	4.44
Total	**184.30**	**204.50**	**182.30**	**117.18**	**111.00**	**79.30**	**0.00**	**0.00**	**0.00**	**22.20**	**43.61**	**122.14**

Detailed Report of Instream Flow Requirements

Instream Flow Requirements in Cubic Feet per Second

Application #	Status	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MF191A	CERTIFICATE	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
MF192A	CERTIFICATE	170.00	270.00	270.00	270.00	170.00	170.00	130.00	100.00	100.00	100.00	100.00	170.00
IS83969A	CERTIFICATE	0.00	0.00	0.00	0.00	250.00	250.00	250.00	250.00	250.00	220.00	0.00	0.00
Maximum		**170.00**	**270.00**	**270.00**	**270.00**	**250.00**	**250.00**	**250.00**	**250.00**	**250.00**	**220.00**	**100.00**	**170.00**

Detailed Reports for Watershed ID #30410575

HOOD R > COLUMBIA R - AT RM 0.75

HOOD BASIN

Water Availability as of 12/27/2016

Watershed ID #: 30410575 (Map)

Date: 12/27/2016

Exceedance Level: 50%

Time: 11:22 AM

Water Availability Calculation

Monthly Streamflow in Cubic Feet per Second

Annual Volume at 50% Exceedance in Acre-Feet

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	1,260.00	574.00	686.00	184.00	170.00	332.00
FEB	1,380.00	577.00	803.00	205.00	270.00	328.00
MAR	1,300.00	577.00	723.00	183.00	270.00	271.00
APR	1,320.00	625.00	695.00	117.00	270.00	308.00
MAY	1,310.00	695.00	615.00	111.00	250.00	254.00
JUN	1,040.00	740.00	300.00	79.30	250.00	-29.70
JUL	739.00	781.00	-42.00	0.00	250.00	-292.00
AUG	559.00	739.00	-180.00	0.00	250.00	-430.00
SEP	511.00	668.00	-157.00	0.00	250.00	-407.00
OCT	517.00	570.00	-52.90	22.20	220.00	-295.00
NOV	870.00	571.00	299.00	43.60	100.00	155.00
DEC	1,160.00	573.00	587.00	122.00	170.00	295.00
ANN	721,000.00	464,000.00	283,000.00	64,000.00	164,000.00	117,000.00

Detailed Report of Consumptive Uses and Storage

Consumptive Uses and Storages in Cubic Feet per Second

Month	Storage	Irrigation	Municipal	Industrial	Commercial	Domestic	Agricultural	Other	Total
JAN	1.84	0.00	37.10	2.96	0.23	2.16	29.40	501.00	574.00
FEB	2.30	0.00	39.80	2.96	0.23	2.16	29.40	501.00	577.00
MAR	2.44	0.00	38.80	2.96	0.23	2.16	29.40	501.00	577.00
APR	2.27	48.80	38.30	2.96	0.06	2.16	29.40	501.00	625.00
MAY	0.12	114.00	45.20	2.96	0.06	2.16	29.40	501.00	695.00
JUN	0.09	157.00	48.10	2.96	0.06	2.16	29.40	501.00	740.00
JUL	0.06	205.00	40.30	2.96	0.06	2.16	29.40	501.00	781.00
AUG	0.05	167.00	36.50	2.96	0.06	2.16	29.40	501.00	739.00
SEP	0.04	96.80	35.60	2.96	0.06	2.16	29.40	501.00	668.00
OCT	0.04	0.15	34.50	2.96	0.06	2.16	29.40	501.00	570.00
NOV	1.30	0.00	34.90	2.96	0.06	2.16	29.40	501.00	571.00
DEC	1.71	0.00	36.10	2.96	0.06	2.16	29.40	501.00	573.00

Detailed Report of Reservations for Storage and Consumptive Uses

Reserved Streamflow in Cubic Feet per Second

Application #	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RN80401A	39.50	43.00	36.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.60
RN80402A	130.00	136.00	122.00	104.00	111.00	79.30	0.00	0.00	0.00	22.20	41.60	86.10
RN80403A	14.80	25.50	24.30	13.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	4.44
Total	**184.30**	**204.50**	**182.30**	**117.18**	**111.00**	**79.30**	**0.00**	**0.00**	**0.00**	**22.20**	**43.61**	**122.14**

Detailed Report of Instream Flow Requirements

Instream Flow Requirements in Cubic Feet per Second

Application #	Status	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MF191B	CERTIFICATE	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
MF192B	CERTIFICATE	170.00	270.00	270.00	270.00	170.00	170.00	130.00	100.00	100.00	100.00	100.00	170.00
IS83969B	CERTIFICATE	0.00	0.00	0.00	0.00	250.00	250.00	250.00	250.00	250.00	220.00	0.00	0.00
Maximum		**170.00**	**270.00**	**270.00**	**270.00**	**250.00**	**250.00**	**250.00**	**250.00**	**250.00**	**220.00**	**100.00**	**170.00**

Detailed Reports for Watershed ID #30410513

E FK HOOD R > HOOD R - AT MOUTH
HOOD BASIN

Water Availability as of 12/27/2016

Watershed ID #: 30410513 (Map)
Date: 12/27/2016

Exceedance Level: 50%
Time: 11:22 AM

Water Availability Calculation

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	599.00	18.50	581.00	130.00	0.00	451.00
FEB	630.00	22.30	608.00	136.00	0.00	471.00
MAR	581.00	39.70	541.00	122.00	0.00	419.00
APR	580.00	74.10	506.00	104.00	0.00	402.00
MAY	655.00	137.00	518.00	111.00	0.00	407.00
JUN	626.00	194.00	432.00	79.30	0.00	353.00
JUL	490.00	216.00	274.00	0.00	0.00	274.00
AUG	372.00	194.00	178.00	0.00	0.00	178.00
SEP	331.00	137.00	194.00	0.00	0.00	194.00
OCT	314.00	64.70	249.00	22.20	0.00	227.00
NOV	391.00	22.60	368.00	41.60	0.00	327.00
DEC	535.00	17.30	518.00	86.10	0.00	432.00
ANN	368,000.00	69,000.00	299,000.00	50,000.00	0.00	249,000.00

Detailed Report of Consumptive Uses and Storage

Consumptive Uses and Storages in Cubic Feet per Second

Month	Storage	Irrigation	Municipal	Industrial	Commercial	Domestic	Agricultural	Other	Total
JAN	0.13	0.00	12.00	2.67	0.22	1.46	1.84	0.14	18.50
FEB	0.13	1.13	14.70	2.67	0.22	1.46	1.84	0.14	22.30
MAR	0.11	19.50	13.70	2.67	0.22	1.46	1.84	0.14	39.70
APR	0.11	54.60	13.20	2.67	0.05	1.46	1.84	0.14	74.10
MAY	0.08	111.00	20.10	2.67	0.05	1.46	1.84	0.14	137.00
JUN	0.07	164.00	23.10	2.67	0.05	1.46	1.84	0.14	194.00
JUL	0.05	195.00	15.30	2.67	0.05	1.46	1.84	0.14	216.00
AUG	0.04	177.00	11.50	2.67	0.05	1.46	1.84	0.14	194.00
SEP	0.04	121.00	10.60	2.67	0.05	1.46	1.84	0.14	137.00
OCT	0.04	49.10	9.48	2.67	0.05	1.46	1.84	0.14	64.70
NOV	0.06	6.59	9.83	2.67	0.05	1.46	1.84	0.14	22.60
DEC	0.10	0.00	11.00	2.67	0.05	1.46	1.84	0.14	17.30

Detailed Report of Reservations for Storage and Consumptive Uses

Reserved Streamflow in Cubic Feet per Second

Application #	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RN80402A	130.00	136.00	122.00	104.00	111.00	79.30	0.00	0.00	0.00	22.20	41.60	86.10
Total	**130.00**	**136.00**	**122.00**	**104.00**	**111.00**	**79.30**	**0.00**	**0.00**	**0.00**	**22.20**	**41.60**	**86.10**

Detailed Report of Instream Flow Requirements

Instream Flow Requirements in Cubic Feet per Second

No instream flow requirements were found for this watershed.

Detailed Reports for Watershed ID #189

E FK HOOD R > HOOD R - AB M FK HOOD R
HOOD BASIN

Water Availability as of 12/27/2016

Watershed ID #: 189 (Map)
Date: 12/27/2016

Exceedance Level: 50%
Time: 11:22 AM

Water Availability Calculation

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	325.00	13.70	311.00	130.00	100.00	81.70
FEB	351.00	17.50	333.00	136.00	100.00	97.10

MAR	340.00		34.90	305.00	122.00	100.00	82.80
APR	359.00		57.50	302.00	104.00	150.00	47.60
MAY	392.00		105.00	287.00	111.00	150.00	26.20
JUN	367.00		151.00	216.00	79.30	150.00	-13.20
JUL	272.00		161.00	111.00	0.00	100.00	10.50
AUG	197.00		149.00	47.80	0.00	100.00	-52.20
SEP	169.00		109.00	59.90	0.00	100.00	-40.10
OCT	160.00		60.00	100.00	22.20	150.00	-72.20
NOV	201.00		17.80	183.00	41.60	150.00	-8.42
DEC	282.00		12.50	270.00	86.10	150.00	33.40
ANN	206,000.00		53,900.00	152,000.00	50,000.00	90,600.00	22,700.00

Detailed Report of Consumptive Uses and Storage

Consumptive Uses and Storages in Cubic Feet per Second

Month	Storage	Irrigation	Municipal	Industrial	Commercial	Domestic	Agricultural	Other	Total
JAN	0.08	0.00	9.03	2.42	0.22	1.08	0.83	0.00	13.70
FEB	0.10	1.13	11.70	2.42	0.22	1.08	0.83	0.00	17.50
MAR	0.10	19.50	10.70	2.42	0.22	1.08	0.83	0.00	34.90
APR	0.08	42.80	10.20	2.42	0.05	1.08	0.83	0.00	57.50
MAY	0.09	83.00	17.10	2.42	0.05	1.08	0.83	0.00	105.00
JUN	0.07	126.00	20.10	2.42	0.05	1.08	0.83	0.00	151.00
JUL	0.05	145.00	12.30	2.42	0.05	1.08	0.83	0.00	161.00
AUG	0.04	136.00	8.47	2.42	0.05	1.08	0.83	0.00	149.00
SEP	0.03	97.10	7.57	2.42	0.05	1.08	0.83	0.00	109.00
OCT	0.03	49.10	6.48	2.42	0.05	1.08	0.83	0.00	60.00
NOV	0.04	6.59	6.83	2.42	0.05	1.08	0.83	0.00	17.80
DEC	0.07	0.00	8.03	2.42	0.05	1.08	0.83	0.00	12.50

Detailed Report of Reservations for Storage and Consumptive Uses

Reserved Streamflow in Cubic Feet per Second

Application #	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RN80402A	130.00	136.00	122.00	104.00	111.00	79.30	0.00	0.00	0.00	22.20	41.60	86.10
Total	**130.00**	**136.00**	**122.00**	**104.00**	**111.00**	**79.30**	**0.00**	**0.00**	**0.00**	**22.20**	**41.60**	**86.10**

Detailed Report of Instream Flow Requirements

Instream Flow Requirements in Cubic Feet per Second

Application #	Status	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MF189A	CERTIFICATE	100.00	100.00	100.00	150.00	150.00	150.00	100.00	100.00	100.00	150.00	150.00	150.00
Maximum		**100.00**	**100.00**	**100.00**	**150.00**	**150.00**	**150.00**	**100.00**	**100.00**	**100.00**	**150.00**	**150.00**	**150.00**

Instream Water Right Proposed Final Orders

Proposed Final Order Stage (PFO)
The proposed final order is the Department's penultimate decision on the water use request. The PFO documents the agency's decision through specific findings, including review of comments received. If appropriate, it includes a draft permit specifying any conditions or restrictions on the use. Persons interested in receiving a mailed copy of a PFO must pay a statutorily-required fee of $25. (Any person paying $25 to receive a PFO by mail will also receive a copy of the Final Order when it is issued.) PFO's may be viewed free of charge online at: http://apps.wrd.state.or.us/apps/wr/wrinfo/. Those disagreeing with the Department's decision as expressed in the PFO have 45 days to file a protest.
The protest deadline for proposed final orders appearing in this public notice is 5 p.m., Friday, December 1, 2017.

The protest filing fee is $410 for the applicants and $810 for non-applicants. Detailed requirements for filing a protest are included in the PFO. Persons who support the PFO may file a "standing" fee of $230 to retain the ability to participate in future proceedings relating to an application. Before participation in a hearing is allowed, an additional $580 will be required to request to participate as a party or limited party.

Each person submitting a protest or a request for standing shall raise all reasonably ascertainable issues and submit all reasonably available arguments supporting the person's position by the close of the protest period. Failure to raise a reasonably ascertainable issue in a protest or in a hearing, or failure to provide sufficient specificity to afford the Department an opportunity to respond to the issue, precludes judicial review based on that issue.

App#	IS-88322
County/Basin	Hood River / Hood (4)
Applicant Name	OREGON DEPARTMENT OF FISH AND WILDLIFE 4034 FAIRVIEW INDUSTRIAL DR SE SALEM, OR 97302-1142
Sources/TRSQ40Q160	EAST FORK HOOD RIVER > HOOD RIVER / 1.00N 10.00E 28 SENW
Use/Quantity	INSTREAM USES / 210.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	180	210	210	210	210	210	150	150	169	160	180	180

Stream Reach	River Mile 6.2 to Mouth
Priority Date	12/01/2016
Stage/Status	PFO / PROPOSE TO APPROVE

App#	IS-88323
County/Basin	Hood River / Hood (4)
Applicant Name	OREGON DEPARTMENT OF FISH AND WILDLIFE 4034 FAIRVIEW INDUSTRIAL DR SE SALEM, OR 97302-1142
Sources/TRSQ40Q160	GREEN POINT CREEK > WEST FORK HOOD RIVER / 1.00N 9.00E 9 NWNE
Use/Quantity	INSTREAM USES / 120.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	90	110	107	120	120	64.7	26.8	16.5	16.2	29	65.2	87.9

Stream Reach	River Mile 3.1 to Mouth
Priority Date	12/01/2016
Stage/Status	PFO / PROPOSE TO APPROVE

App#	IS-88326
County/Basin	Wasco / Hood (4)
Applicant Name	OREGON DEPARTMENT OF FISH AND WILDLIFE 4034 FAIRVIEW INDUSTRIAL DR SE SALEM, OR 97302-1142
Sources/TRSQ40Q160	MILL CREEK > COLUMBIA RIVER / 1.00N 12.00E 22 SESW
Use/Quantity	INSTREAM USES / 26.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	10	10	15	26	25.5	15.4	12.6	10.7	9.72	8.43	10	10

Stream Reach	River Mile 8.1 to Mouth
Priority Date	12/01/2016
Stage/Status	PFO / PROPOSE TO APPROVE

App#	IS-88327
County/Basin	Hood River / Hood (4)
Applicant Name	OREGON DEPARTMENT OF FISH AND WILDLIFE 4034 FAIRVIEW INDUSTRIAL DR SE SALEM, OR 97302-1142
Sources/TRSQ40Q160	NEAL CREEK > HOOD RIVER / 1.00N 11.00E 6 SWSW
Use/Quantity	INSTREAM USES / 41.900 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	26.4	41.9	40.1	27.6	9.98	4.91	2.41	1.95	2.15	2.96	4.8	10.6

Stream Reach	River Mile 5.8 to Mouth
Priority Date	12/01/2016
Stage/Status	PFO / PROPOSE TO APPROVE

App#	IS-88328
County/Basin	Hood River / Hood (4)
Applicant Name	OREGON DEPARTMENT OF FISH AND WILDLIFE 4034 FAIRVIEW INDUSTRIAL DR SE SALEM, OR 97302-1142
Sources/TRSQ40Q160	ODELL CREEK > HOOD RIVER / 2.00N 10.00E 34 NESW
Use/Quantity	INSTREAM USES / 16.300 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	8.55	15.7	16.3	9.25	.88	.17	.08	.09	.07	.13	.43	2.75

Stream Reach	River Mile 4.0 to Mouth
Priority Date	12/01/2016
Stage/Status	PFO / PROPOSE TO APPROVE

App#	IS-88329
County/Basin	Wasco / Hood (4)
Applicant Name	OREGON DEPARTMENT OF FISH AND WILDLIFE 4034 FAIRVIEW INDUSTRIAL DR SE SALEM, OR 97302-1142
Sources/TRSQ40Q160	SOUTH FORK MILL CREEK > MILL CREEK / 1.00S 11.00E 20 NENW
Use/Quantity	INSTREAM USES / 12.100 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	0	0	0	0	0	12.1	10	8.7	7	7	7	0

Stream Reach	River Mile 10.1 to Mouth
Priority Date	12/01/2016
Stage/Status	PFO / PROPOSE TO APPROVE

App#	IS-88330
County/Basin	Hood River / Hood (4)
Applicant Name	OREGON DEPARTMENT OF FISH AND WILDLIFE 4034 FAIRVIEW INDUSTRIAL DR SE SALEM, OR 97302-1142
Sources/TRSQ40Q160	WEST FORK HOOD RIVER > HOOD RIVER / 1.00S 8.00E 25 SWNW
Use/Quantity	INSTREAM USES / 250.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	150	250	250	250	250	250	150	147	139	141	190	190

Stream Reach	River mile 14.7 to Mouth
Priority Date	12/01/2016
Stage/Status	PFO / PROPOSE TO APPROVE

App# IS-88331
County/Basin Wasco / Hood (4)
Applicant Name OREGON DEPARTMENT OF FISH AND WILDLIFE
4034 FAIRVIEW INDUSTRIAL DR SE
SALEM, OR 97302-1142
Sources/TRSQ40Q160 FIFTEENMILE CREEK > COLUMBIA RIVER / 1.00S 13.00E 25 SWSE
Use/Quantity INSTREAM USES / 34.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	13	13	20	34	34	34	12.8	5.9	6.1	7.9	11.2	13

Stream Reach River Mile 30.6 to Mouth
Priority Date 12/01/2016
Stage/Status PFO / PROPOSE TO APPROVE

App# IS-88337
County/Basin Wasco / Hood (4)
Applicant Name OREGON DEPARTMENT OF FISH AND WILDLIFE
4034 FAIRVIEW INDUSTRIAL DR SE
SALEM, OR 97302-1142
Sources/TRSQ40Q160 FIFTEENMILE CREEK > COLUMBIA RIVER / 2.00S 11.00E 28 NWSW
Use/Quantity INSTREAM USES / 26.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	10	10	15	26	26	26	9	4	4	7	10	10

Stream Reach River Mile 49.4 to 30.6
Priority Date 12/31/2016
Stage/Status PFO / PROPOSE TO APPROVE

App# IS-88334
County/Basin Hood River / Hood (4)
Applicant Name OREGON DEPARTMENT OF FISH AND WILDLIFE
4034 FAIRVIEW INDUSTRIAL DR SE
SALEM, OR 97302-1142
Sources/TRSQ40Q160 EAST FORK HOOD RIVER > HOOD RIVER / 2.00S 10.00E 5 SESE
Use/Quantity INSTREAM USES / 175.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	175	175	175	175	175	175	110	110	145	145	175	175

Stream Reach River Mile 16.8 to 6.2
Priority Date 12/31/2016
Stage/Status PFO / PROPOSE TO APPROVE

App# IS-88335
County/Basin Hood River / Hood (4)
Applicant Name OREGON DEPARTMENT OF FISH AND WILDLIFE
4034 FAIRVIEW INDUSTRIAL DR SE
SALEM, OR 97302-1142
Sources/TRSQ40Q160 EAST FORK HOOD RIVER > HOOD RIVER / 2.00S 10.00E 8 SWSE
Use/Quantity INSTREAM USES / 127.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	75	75	75	127	127	127	127	75	75	50	50	75

Stream Reach River Mile 17.8 to 16.8
Priority Date 12/31/2016
Stage/Status PFO / PROPOSE TO APPROVE

App# IS-88355
County/Basin Clackamas / Sandy (3)
Applicant Name OREGON DEPARTMENT OF FISH AND WILDLIFE
4034 FAIRVIEW INDUSTRIAL DR SE
SALEM, OR 97302-1142
Sources/TRSQ40Q160 CLEAR CREEK > SANDY RIVER / 2.00S 7.00E 13 SENW
Use/Quantity INSTREAM USES / 45.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	45	45	45	45	45	45	27	8/6	6	6/35	45	45

Stream Reach River Mile 4.3 to Mouth
Priority Date 01/16/2017
Stage/Status PFO / PROPOSE TO APPROVE

App#	IS-88332
County/Basin	Hood River / Hood (4)
Applicant Name	OREGON DEPARTMENT OF FISH AND WILDLIFE 4034 FAIRVIEW INDUSTRIAL DR SE SALEM, OR 97302-1142
Sources/TRSQ40Q160	CLEAR BRANCH > MIDDLE FORK HOOD RIVER / 1.00S 9.00E 27 NWNE
Use/Quantity	INSTREAM USES / 45.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	44	39	42	50	50	50	30	21	18	21	34	35

Stream Reach	River Mile 1.2 to Mouth
Priority Date	05/01/2017
Stage/Status	PFO / PROPOSE TO APPROVE

App#	IS-88333
County/Basin	Hood River / Hood (4)
Applicant Name	OREGON DEPARTMENT OF FISH AND WILDLIFE 4034 FAIRVIEW INDUSTRIAL DR SE SALEM, OR 97302-1142
Sources/TRSQ40Q160	COE BRANCH > CLEAR BRANCH / 2.00S 9.00E 4 NWSE
Use/Quantity	INSTREAM USES / 20.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	14	14	20	20	20	14	14	20	20	20	14	14

Stream Reach	River Mile 3.5 to Mouth
Priority Date	05/01/2017
Stage/Status	PFO / PROPOSE TO APPROVE

App#	IS-88336
County/Basin	Hood River / Hood (4)
Applicant Name	OREGON DEPARTMENT OF FISH AND WILDLIFE 4034 FAIRVIEW INDUSTRIAL DR SE SALEM, OR 97302-1142
Sources/TRSQ40Q160	ELIOT BRANCH > CLEAR BRANCH / 2.00S 9.00E 10 NESW
Use/Quantity	INSTREAM USES / 11.000 CFS

Quantity by month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
In CFS	11	11	11	11	11	11	11	11	11	11	11	11

Stream Reach	River Mile 4.5 to Mouth
Priority Date	05/01/2017
Stage/Status	PFO / PROPOSE TO APPROVE

Mailing List for IS PFO
Scheduled Mailing Date:

Application: IS-88322

Applicant:

Oregon Department of Fish & Wildlife
4034 Fairview Industrial Drive SE
Salem, OR 97302

Copies Mailed

by: SP
(STAFF)

on: 10-17-17
(DATE)

Copies of Order to be sent to:

WRD - Watermaster: Bob Wood, District 3
WRD – Regional Manager: Mike Ladd
WRD - Data Center
WRD - Water Availability
WRD - File

Caseworker: Craig Kohanek

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem OR 97301-1266
503-986-0900
www.oregon.gov/owrd

Application for Instream Water Right Certificate

SECTION 1: ORGANIZATION INFORMATION AND SIGNATURE

Organization Information

NAME			PHONE	FAX
OREGON DEPT. OF FISH AND WILDLIFE			503-947-6000	503-947-6202
ADDRESS				CELL
4034 FAIRVIEW INDUSTRIAL DR. SE				
CITY	STATE	ZIP	E-MAIL *	
SALEM	OR	97302-1142		

Agent Information – The agent is authorized to represent the applicant in all matters relating to this application.

AGENT / BUSINESS NAME			PHONE	FAX
ANNA PAKENHAM STEVENSON / OREGON DEPT. OF FISH AND WILDLIFE			503-947-6084	503-947-6202
ADDRESS				CELL
4034 FAIRVIEW INDUSTRIAL DR. SE				
CITY	STATE	ZIP	E-MAIL *	
SALEM	OR	97302-1142	ANNA.P.STEVENSON@STATE.OR.US	

* By providing an e-mail address, consent is given to receive all correspondence from the Department electronically. (Note that paper copies of the Final Order documents will also be mailed.)

Applicant Signature	Print Name and Title	Date
	Anna Pakenham Stevenson Water Program Manager	12/1/16
Applicant Signature	Print Name and Title	Date

SECTION 2: NOTIFICATION TO DEQ, ODFW, AND PARKS

Please indicate the date you notified other state agencies of your intent to file an instream water right application.

Oregon Department of Environmental Quality was notified on: October 17 2016

Oregon Department of Fish and Wildlife was notified on: N/A

Oregon Parks and Recreation Department was notified on: October 17 2016

SECTION 3: NOTIFICATION TO AFFECTED LOCAL GOVERNMENTS

☒ Please provide copies of letters of your intent to file an instream water right application to each affected local government within whose jurisdiction the instream use is proposed. Affected local government means any city, county or metropolitan service district formed under ORS Chapter 268 or an association of local governments performing land-use planning functions under ORS 197.190.

SECTION 4: SOURCE AND REACH

Stream or lake name: East Fork Hood River Tributary to: Hood River

If the source is a stream, indicate the reach delineated by river mile (the upstream point to the downstream point) of the proposed instream water right:

The East Fork Hood River, tributary to Hood River, beginning at river mile 0.0 in the NWNE quarter of Section 1, Township 1 N, Range 9 E W.M. in Hood River County (45.6053, -121.6333) and continuing upstream to river mile 6.2 in the SENW quarter of Section 28, Township 1 N, Range 10 E W.M. in Hood River County (45.5451, -121.5814).

If the source is stored water that is authorized under a water right permit, certificate, or decree, attach a copy of the document or list the document number (for decrees, list the volume and page, or decree name). _____

☐ If the source is stored water and you do not, or will not, own the reservoir(s), please enclose a copy of your written agreement with the owner of the reservoir to release flows identified in this application.

SECTION 5: PUBLIC USES AND AMOUNTS

The public uses to be served by the requested instream water right are: For the conservation, maintenance and enhancement of aquatic and fish life, wildlife, and fish and wildlife habitat. Applied flows include water for fish and wildlife migration, spawning, nesting, brooding, egg incubation, larval or juvenile development, juvenile and adult rearing and aquatic life. Flow levels will vary based on life cycle and life stage development needs.

The monthly (or half-monthly) flows in cubic feet-per-second (CFS) or acre-feet (AF) or by lake elevation (LE) necessary to support the public uses are:

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Unit
180	210	210	210	210	210	150	150	175	175	180	180	CFS

If this is a multi-agency request, please indicate the monthly (or half-monthly) flows in cubic feet-per-second (cfs) or acre-feet (af) or by lake elevation (le) that are necessary to support the public uses for each category of public use.

USE	J	F	M	A	M	J	J	A	S	O	N	D	
													☐ CFS ☐ AF ☐ LE
													☐ CFS ☐ AF ☐ LE

SECTION 6: DATA, METHODS, AND COMPLIANCE

Please describe the technical data and methods used to determine the requested amounts.

ODFW relied on an IFIM/PHABSIM study to determine the requested amounts (Hood River Tributaries Instream Flow Study, Normandeau Associates 2014. See attached). This method quantifies physical habitat at different streamflow rates for all life stages of fish, based on stream hydraulics (Bovee et al 1998; Bovee 1997; Bovee 1982). It typically requires measurements at one to three flows, and uses hydraulic simulation to predict habitat over a wide range of flows. Results are tabulated for spawning and incubation, fry, juvenile and adult rearing, and passage flows. Criteria for spawning, rearing, and incubation include depth, velocity, substrate and cover. Fish passage is based on depth and velocity only.

ODFW used the habitat vs. flow relationships produced by this study to derive recommended flows in the East Fork Hood River. ODFW used the habitat vs. flow relationships for appropriate species and life stages to recommend flow levels specifically designed to meet the seasonal biological requirements of important fish species in the East Fork Hood River. These recommended flows were used in this instream water right application. The desired flow levels are determined by examining habitat vs. flow over the range of flows simulated, for each species and life stage according to the appropriate time periods.

Please provide written documentation of how your agency complied with the requirements contained in your own administrative rules for instream water rights, including application of the required methods to determine requested flows.

The methodology used in the study was IFIM/PHABSIM (Hood River Tributaries Instream Flow Study, Normandeau Associates 2014. See attached). As such, it conformed to the procedures laid out in the agency's rules- Determination of Instream Flow Measurement Methodologies, Oregon Administrative Rules Division 400, 635-400-0015. Specifically, the studies on the East Fork Hood used IFIM/PHABSIM to produce a relationship between physical habitat and flow. ODFW is satisfied that correct field and computer procedures were followed to produce the results (Bovee et al 1998; Bovee 1997; Bovee 1982). ODFW examined and interpreted the results of the study to determine the requested flows.

ODFW will also coordinate with OWRD instream water rights monitoring (635-400-0025). Specifically, ODFW will coordinate with OWRD to develop monitoring plans for instream water rights and to revise the existing Memorandum of Understanding between the Department and WRD to include issues related to instream water rights, such as measuring, monitoring and enforcement of instream water rights.

References:

Bovee, K.D., B.L. Lamb, J.M. Bartholow, C.B. Stalnaker, J. Taylor, and J. Henriksen. 1998. Stream habitat analysis using the Instream Flow Incremental Methodology. U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD-1998- 0004. viii+131 pp. https://www.fort.usgs.gov/publication/3910

Bovee, K.D. 1997. Dave collection procedures for the Physical Habitat Simulation System. . U.S. Geological Survey, Biological Resources Division Information and Technology Draft Report USGS/BRD-1997- 146pp. https://www.fort.usgs.gov/sites/default/files/products/publications/20002/20002.pdf

Bovee, K.D. 1982. A guide to stream habitat analysis using the instream flow incremental methodology. Instream Flow Information Paper 12. U.S. Fish and Wildlife Service FWS/OBS-82/26. 248 pp. http://www.arlis.org/docs/vol1/Susitna/1/APA193.pdf

SECTION 7: WITHIN A DISTRICT

If the reach is located within an irrigation district or other water district, please provide their contact information.

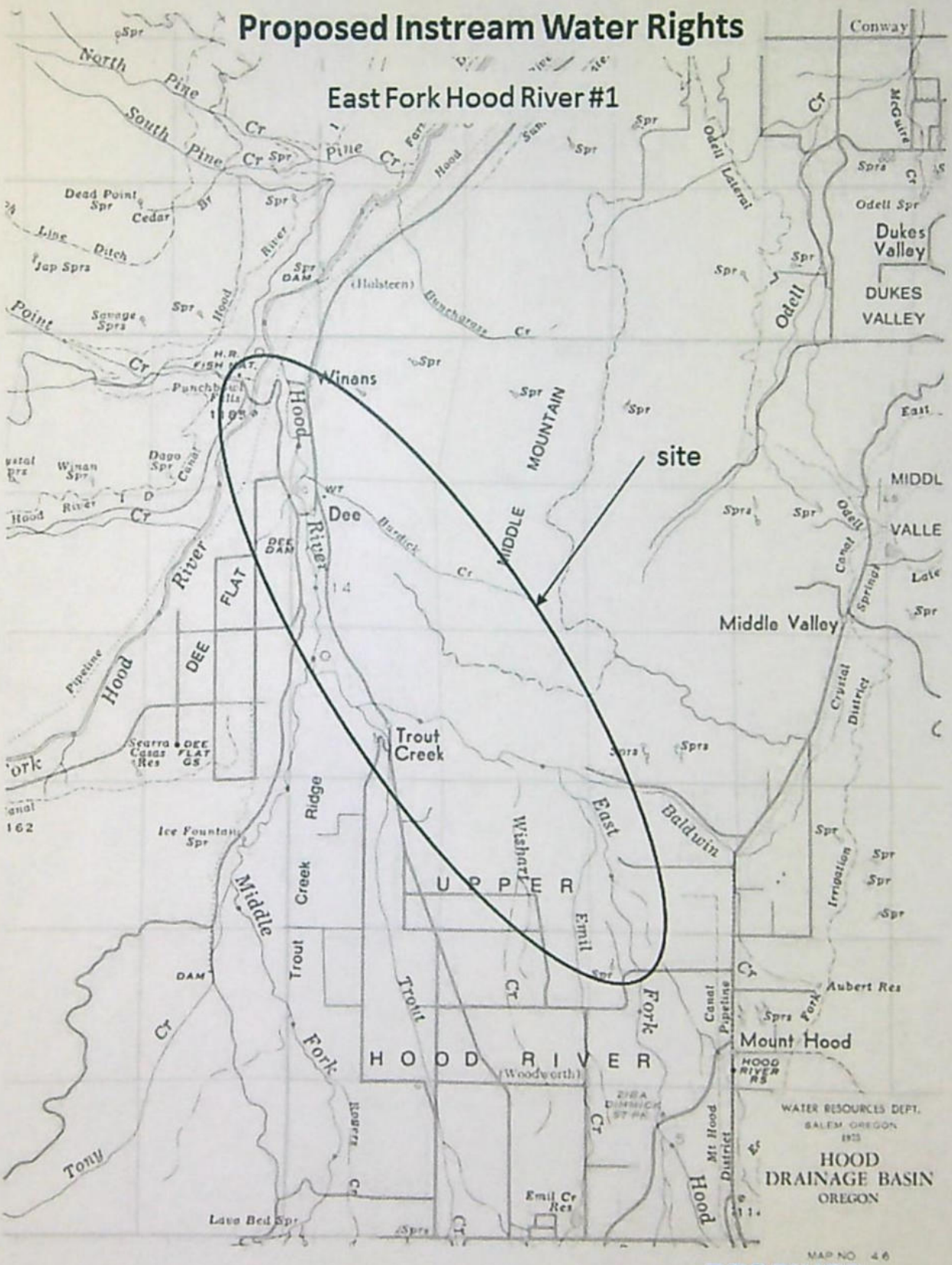
Irrigation District Name Middle Fork Irrigation District	Address 8235 Clear Creek Rd. PO Box 291	
City Parkdale	State OR	Zip 97041

Irrigation District Name Mt. Hood Irrigation District	Address PO Box 426	
City Parkdale	State OR	Zip 97041

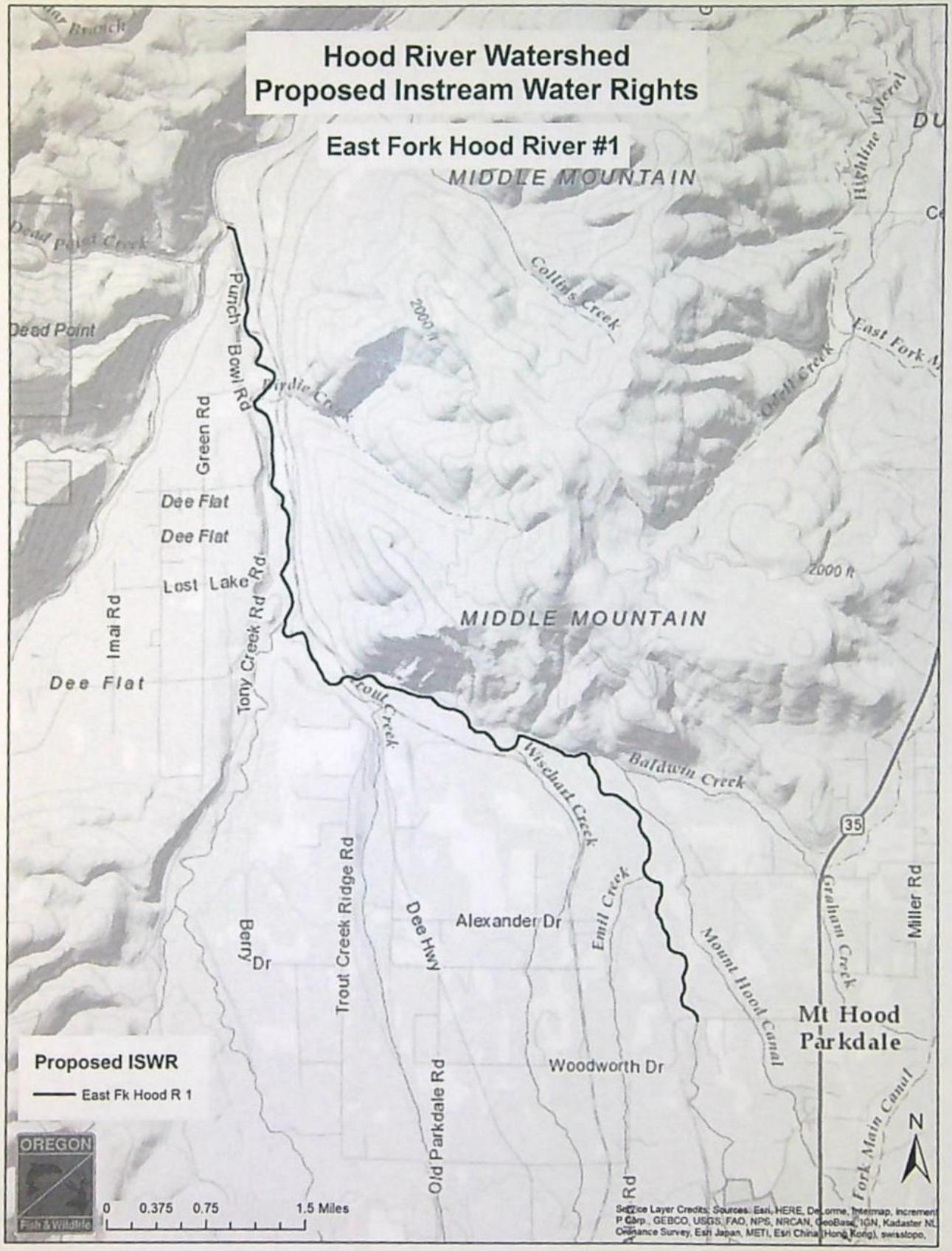
SECTION 8: REMARKS

Use this space to clarify any information you have provided in the application. ____

SECTION 9: MAP



RECEIVED
DEC 01 2016
OWRD



RECEIVED
DEC 01 2016
OWRD

PFO Checklist

Application #: IS 88322 **Applicant:** Oregon Department of Fish & Wildlife

___ Was the application **filed after 10/23/99**? Y / N (If not, add A date requirement)

___ POD characteristics identifies as **DEQ 303d**? Y / N / NA If Y, confirm DEQ cc:'d at IR, and if not, copy them on PFO

___ **Noticed on** _____ **Comment Deadline** _____ **Comments**? Y / N _____ **Comment eval?** Y / N

___ IR requested **add'l info** Y / N _____

___ Is **second gw review** necessary? Y / N / NA Complete? Y / N Add'l fees ☐ necessary ☐ collected ☐ needed

___ Has **Water Availability** changed from IR? Y / N _____ If source is Col R, use special w/a lang in RC

___ Have **conflicts** been addressed? Y / N / NA _____

___ POD/POU are correct per the map

___ **Needed prior to permit:** ☐ NA ☐ fees ☐ easement ☐ LU approval ☐ evidence of well repair ☐ storage contract ☐ plans/specs

___ **Changes** from IR determinations _____

_____

_____

___ Allowed **Use/Rate/Season** _____ **Limit** _____ **Duty** _____

___ **Conditions** _____

☐ **Small** ≤ 0.1 CFS, ≤ 9.2 AF ☐ **Medium** > 0.1 CFS but < 0.5 CFS, > 9.2 AF but < 100 AF ☐ **Large** ≥ 0.5 CFS, ≥ 100 AF

___ **SWW** If GW and interference, copy form for Stahr.

___ **Copy** to Reg Manager _____ WM _____ CWRE _____ Agent _____

_____

___ **Fees**

Base Fee	Water Amount (Q)	
$300 / $500 $700 / $1000	1st CFS/AF	_____
	_____ Addl @ _____	_____
	Add'l ☐ POD/POA ☐ use +	_____

_____

_____ + _____ = _____

(base) (Q) (total exam fee)

EXAM FEE REQUIRED	_____	RECORDING FEE REQUIRED	$300 / $400 / $900
EXAM FEE PAID	-_____	RECORDING FEE PAID	-_____
STILL OWED	_____	STILL OWED	_____

Name: Craig Kohanek **Date:** June 5, 2017 **Peer Reviewer:** _____

The purpose of this checklist is to be used as a working document by Department staff to aid in the production of the related Initial Review, Proposed Final Order, or Final Order. It is not intended to be a complete record of all factors which were considered to produce the document, nor is it intended to serve any purpose other than that stated above. The related Initial Review, Proposed Final Order, or Final Order is intended to stand alone as the record of factors considered in its production.

Mailing List for IR Copies

Application: IS 88321 through IS 88331 and IS 88334, IS 88335, IS 88337

Date: March 17, 2017

Original mailed to:

Applicant:

Director
In Care of Anna Pakenham-Stevenson
Oregon Department of Fish and Wildlife
4034 Fairview Industrial Drive SE
Salem, OR 97302-1142

Copies Mailed
by: SP (STAFF)
on: 3-20-17 (DATE)

Copies sent to:

1. WRD - File
2. WRD - Water Availability: Carlos Ortiz-Turner
3. WRD - Laura Wilke

IR, Map, and Fact Sheet Copies sent to:
(NOTE: please send only one copy per office, even if there is more than one name on the list)

1. Watermaster: Bob Wood, District 3
2. ODFW District Biologists: Rod French
3. ODFW: Anna Pakenham Stevenson
4. Columbia River Intertribal Fish Commission:
5. US Fish & Wildlife: Nancy Gilbert, 63095 Deschutes Market Rd, Bend OR 97701-9794
6. NW Power & Conservation Council, 851 SW Sixth Ave., Suite 1020, Portland, OR 97204-1347
7. DEQ: Eric Nigg & Bonnie Lamb, Eastern Region
8. DOA: Salem: Jim Johnson & Paul Measeles
9. DSL: Shawn Zumwalt
10. Confederated Tribes of the Warm Springs Indian Reservation: Robert Brunhoe – Natural Resources Mgr.

Copies sent to Other Interested Persons *(CWRE, Agent, Well Driller, Commenter, etc.):*

Caseworker: Ronald C. Kohanek

Instream Water Right Application Completeness Checklist

Minimum Requirements OAR 690-077-0020

Application 88322 County Hood Priority Date _____

POD Township 1N Range 10E Section 28

Amount 150-~~150~~ 210 CFS Use Fish Life, Wildlife WM Dist. # 3

Depending on the month

Agency (ies) Applying ODFW

Caseworker Assigned: ☐ Barbe ☐ Craig ☐ Kim ☐ Lisa ☐ Scott

☑ Contact info: Name(s) and address(es) of the agency(ies) applying (OAR 690-077-0020(4)(a));

☑ Public uses that will be served by the requested instream water right and the flows necessary to support the public uses (OAR 690-077-0020(4)(b));

☑ River, stream, or lake name (OAR 690-077-0020(4)(c));

☑ If a stream, the reach delineated by river mile and stream to which it is tributary (OAR 690-077-0020(4)(d));

☑ The appropriate section of a Department basin map with the applicable lake or stream identified (OAR 690-077-0020(4)(e));

☑ The instream flow requested by month and year in cubic feet per second or acre-feet or lake elevation (OAR 690-077-0020(4)(f));

☑ A description of the technical data and methods used to determine the requested amounts (OAR 690-077-0020(4)(g));

☑ Evidence of notification of other qualified applicant agencies (OAR 690-077-0020(4)(h));

N/A ☐ If a multi-agency request, the amounts and times requested for each category of public use (OAR 690-077-0020(4)(i));

☑ Identification of affected local governments (pursuant to OAR 690-077-0010) and copies of letters notifying each affected local government of the intent to file the instream water right application (OAR 690-077-0020(4)(j));

☐ Written documentation of how the agency applying for an instream water right has complied with the requirements contained in its own administrative rules for instream water rights including application of the required methods to determine the requested flows (OAR 690-077-0020(4)(k));

☑ Any other information required in the application form that is necessary to evaluate the application in accordance with applicable statutory requirements (OAR 690-077-0020(4)(l))

Does the applicant:

☐ propose a means and location for measuring the instream water right; (OAR 690-077-0020(5)(a)) NO - will work w/OWRD

☐ propose a strategy and responsibility for monitoring flows for the instream right; (OAR 690-077-0020(5)(b)) Local watermaster

☐ Identify any provisions needed for managing the water right to protect the public uses; (OAR 690-077-0020(5)(c)) Not Provided

Instream Water Right Application Completeness Checklist

Minimum Requirements OAR 690-077-0020

If this is a request for an instream water right to be supplied from stored water, does it identify the reservoir and have documentary evidence that an agreement has been entered into with the owners of the reservoir for a sufficient interest in the reservoir to impound enough water for the purposes set forth in the request. (OAR 690-077-0020(6));

- ☐ Yes
- ☐ No

Reviewed by: Ronald C. Koh Date: _____

S:\groups\wr\instream - state agency\Application checklist

Middle Fork Hood River IFIM Study

Prepared for

Middle Fork Irrigation District
P.O. Box 291, Parkdale, OR 97041

Prepared by

Watershed Professionals Network LLC
PO Box 8, Parkdale, Oregon 97041
www.watershednet.com

Principal Authors

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Caldwell & Associates
920 Rogers Street SW, Olympia, WA 98502
360-943-4859; jeanecaldwell@msn.com

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Meridian Environmental, Inc.
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Acknowledgements

The Middle Fork Irrigation District wishes to acknowledge the generous support of the Confederated Tribes of Warm Springs Reservation of Oregon, the USDA Forest Service, and the Oregon Watershed Enhancement Board in helping to fund this study.

Introduction

The Middle Fork Irrigation District (MFID) delivers water for irrigation, stock, spray, fire protection, temperature control, frost protection and general agricultural use to 6,400 acres[1] in the upper Hood River Valley (Figure 1). Approximately 90 to 95 percent of the water supplied by MFID is diverted from the Clear, Coe and Eliot Branches of the Middle Fork Hood River, and from Laurance Lake Reservoir on the Clear Branch. Lands served by the MFID lie between the Middle and East Forks of the Hood River, and are bounded to the south by federal lands administered by the Mount Hood National Forest on the northern slope of Mt. Hood. Both the Coe and Eliot Branches are fed by glacial runoff, are turbid during the summer months, carry high sediment loads and are subject to periodic debris flow events (3 since 1996). The MFID operates three powerhouses as an integral part of the irrigation system, utilizing existing irrigation infrastructure (Figure 1). Hydropower generation flows are returned to the Middle Fork Hood River at Rogers Creek, near Parkdale. A complete description of MFID operations is included in Appendix A.

The MFID developed a Fisheries Management Plan (FMP) in 2010 to identify and implement operational procedures and improvements to MFID facilities that minimize either risk or impact to aquatic species, while maintaining MFID's operational objectives. The FMP was developed in cooperation with several stakeholders including the United States Forest Service (USFS), the United States Fish and Wildlife Service (USFWS), Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Environmental Quality (ODEQ), National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries), and the Confederated Tribes of Warm Springs Reservation of Oregon (CTWS).

The MFID Instream Flow Incremental Methodology (IFIM) study described in this report was implemented as part of the MFID FMP. This IFIM study, in combination with fish passage and water temperature assessments, will be used by MFID and the FMP stakeholders in the selection and design of future upgrades (both system operation and infrastructure). The FMP stakeholders have been involved with all aspects of the IFIM study, from project scoping through review of study sites and methods and interim products. A summary of FMP stakeholder participation is provided in Appendix B.

[1] 43% of the irrigated land in Hood River County

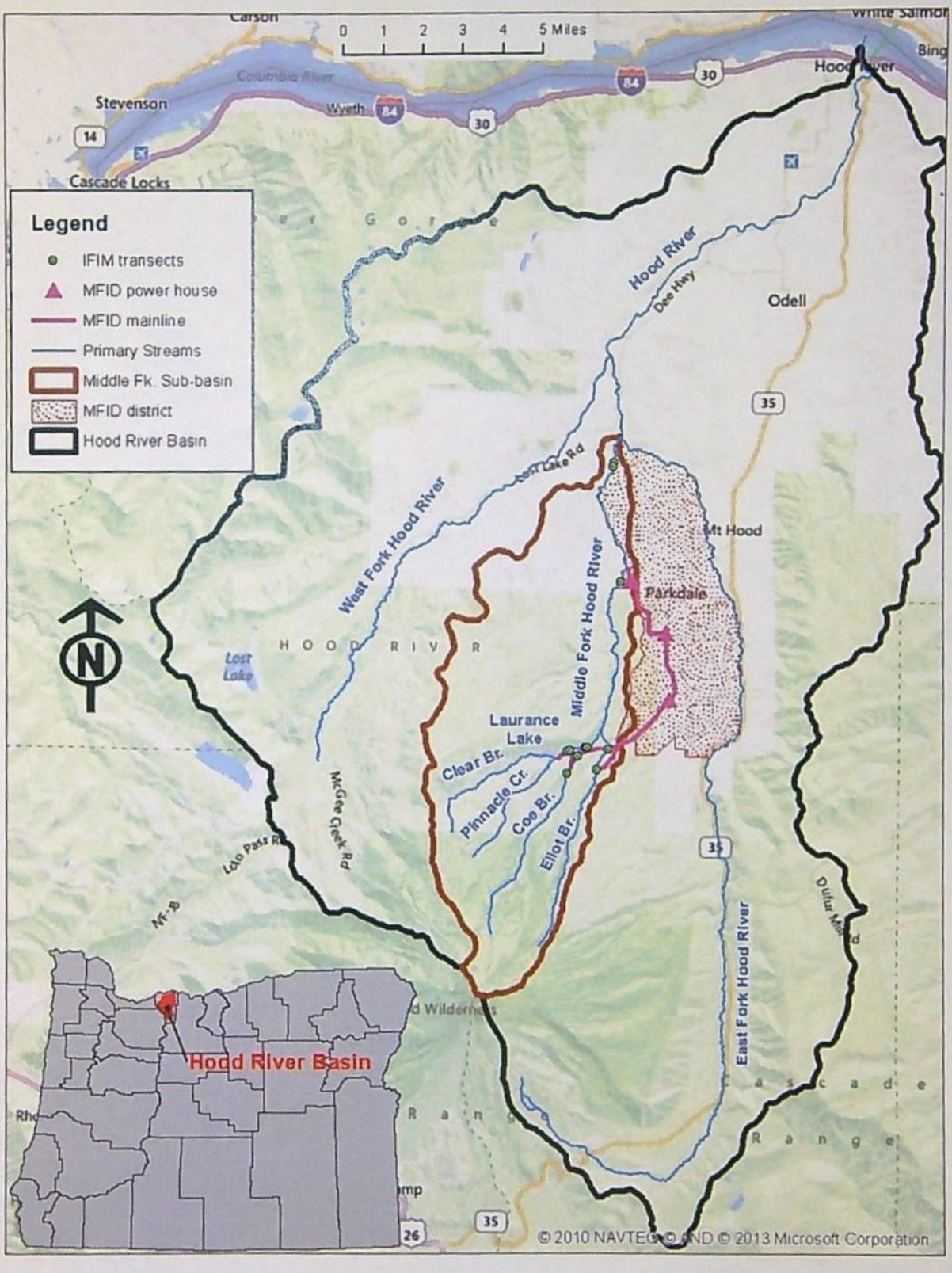

Figure 1. Location map.

The following three section of the report summarize the approach and findings of the IFIM study:

- The IFIM Study Summary section provides an overview of study streams, aquatic habitat, and study site and transect locations. Fish species and life stages of concern are identified, and habitat availability is summarized. A brief summary of the IFIM modeling results is provided by reach.

- The Hydrology Summary includes three sections: 1) a description of the development of a distributed hydrologic model of the Hood River Basin that was used as a tool to develop (in conjunction with MFID stream flow and diversion records) mean daily flow estimates at all study site locations over a ten year period (water year (WY) 2002 - 2011), 2) a discussion of how daily flow values were estimated at each study site, and 3) an analysis of effects of MFID's operations down to the mouth of the Hood River.

- In the Habitat Time Series Summary we combine the results from the IFIM Study Summary, which provided predictions of the flow/habitat relationship, irrespective of how often a given flow is present; with the stream flow distribution provided in the Hydrology Summary section; to provide a more detailed understanding of the habitat predicted to be available in the Clear and Coe Branches.

All technical analyses conducted as part of the IFIM are included as appendices at the end of this report.

IFIM Study Summary

The IFIM Study Plan called for the establishment of IFIM study reaches in six locations in the Middle Fork watershed: Clear Branch below Laurance Lake, Coe Branch, Eliot Branch, Middle Fork Hood River between Coe and Eliot Branches, Middle Fork Hood River in the vicinity of Rogers Creek, and the lower mile of the Middle Fork Hood River.

Habitat surveys were conducted in these reaches in August 2011, following the ODFW Aquatic Inventory method (Moore et al. 2011). A summary of the habitat survey results are provided in Appendix C. Results from a Fisheries Management Committee (FMP Committee) meeting and field trip in August 2011 helped refine study objectives, and finalized transect location selection within each study reach (Figure 2, Table 1).

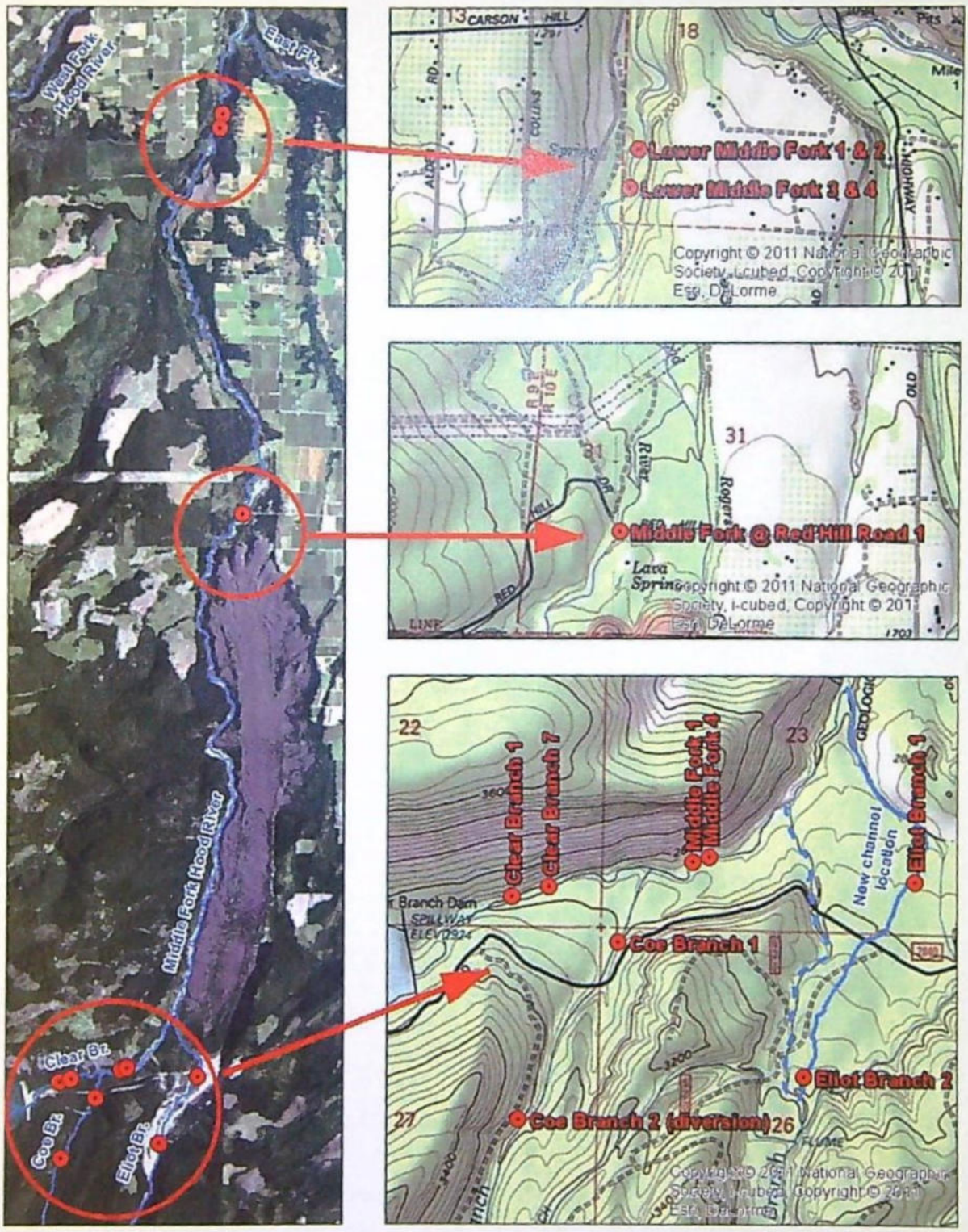

Figure 2. Lower Middle Fork transects (top right), located at ~ river mile (RM) 1. Red Hill Road transect (middle right), located at ~RM 7 upstream of the bridge. The location of the Eliot Branch channel (lower right) has changed from that shown on this USGS topographic map, due to the 2006 debris torrent.

Table 1. Transect summaries by study reach.

Lower Middle Fork (RM 1)			
Transect	**Habitat Type**	**Habitat importance**	**Comment**
1	Riffle w/pockets	Rearing, migration	
2	Riffle w/pockets		Screw trap location
3	Rapid w/boulders		
4	Rapid w/boulders		
Middle Fork (near Rogers Creek) (RM 6.1)			
1	Moderate-gradient braided channel	Upstream passage	Wetted perimeters, channel connectivity
Middle Fork (between Coe & Eliot Branches)			
1	Rapid w/boulders	Rearing, migration	
2	Riffle w/backwater	Rearing, migration	
3			
4	Plunge pool	Rearing, migration, possible spawning	Over spawning gravel if present
Clear Branch			
1	Pool tailout	Rearing	
2	Shallow pool	Rearing	Complex habitat unit
3	Pool tailout w/gravel bar	Spawning, rearing	Complex habitat unit
4	Pool w/gravel bar	Spawning, rearing	
5	Riffle w/pockets	Rearing	Common habitat type
6			
7			
Coe Branch			
1	Cascade	Cutthroat trout habitat, bull trout rearing	
2	Low-gradient cascade	Migration into Compass Creek	In diversion bypass reach
Eliot Branch			
1	Cascade	Cutthroat trout habitat, bull trout rearing, migration	Potential spawning gravel present
2	Cascade, micro-pool tailout		In diversion bypass reach, potential cutthroat spawning gravel

Field data collected in 2011 and 2012 at each transect was processed through the hydraulic simulation models that are used with the IFIM method. The models for each study site were calibrated to the observed conditions, using generally accepted methods (Bovee et al. 1998). After agency review, these predicted hydraulic conditions were compared to habitat requirements (Habitat Suitability Criteria) to produce a flow/habitat relationship for selected fish species and lifestages. Habitat Suitability Criteria used in this study are presented in Appendix K, and a summary of agency consultation is in Appendix B.

Middle Fork Irrigation District (MFID) flow records were used along with a distributed hydrologic model to generate estimates of streamflows at each study site under existing conditions and under a range of potential future operating conditions (see below, and Appendix D for a detailed description). These streamflow estimates were ranked by frequency of occurrence (flow-exceedance analysis). This hydrologic analysis was then used along with the flow-habitat relationships to rank habitat conditions by frequency of occurrence (habitat-exceedance analysis in the Habitat Time Series Summary below).

Transect Characteristics

Transect characteristics are summarized in Table 1 above, and locations shown in Figure 2.

Species and Concern and Life-stage Timing

Species of concern for each study site are summarized in Table 2. Species of concern were reviewed and approved by the FMP Committee at meetings in 2011 and 2012. See Appendix B for further details of decisions made during these meetings.

Table 2. Species of concern by study site.

Study Site	Species of Concern
Clear Branch	bull trout, winter steelhead, Chinook, coho
Coe & Eliot Branches	bull trout (all life stages), cutthroat trout (spawning, migration)
Middle Fork between Coe & Eliot	bull trout, steelhead, Chinook, coho
Middle Fork near Rogers Creek (Red Hill Road)	hydraulic conditions only of concern
Lower Middle Fork	bull trout, steelhead, Chinook, coho

Life Stage Periodicity

Table 3 summarizes life history timing for the species of concern. This was reviewed by the FMP Committee in August 2011, and again in June, 2012 (see Appendix B).

Table 3. Middle Fork IFIM study species life-stage timing (approved by FMP).

Life Stage	Winter Steelhead	Spring Chinook	Bull Trout	Coho
Adult migration pre-spawning	February - May	May - September	May-August	September – October
Spawning	February - June	August - September	September-October	October – November
Adult migration post-spawning	February - June	N/A	September - November?	N/A
Emergence	April - July	November - January	Late Spring-Early Summer?	February – March
Rearing	All Year	1 – 2 years	All Year	All Year
Juvenile outmigration	March - June	March – May & September – October (As 1+ or 2+ smolts)	All Year?	March - May

? = Not precisely known.
Source: Hood River Production Program, 2010 Projects Biological Assessment (Meridian Environmental, 2010)

Reach Summaries

Data collection goals were to measure three flow levels (low, moderate and high flow) at all transect locations sufficient to allow hydraulic modeling over the range of current, and

potential future, flows. It was recognized that the timing of data collection (fall and winter 2011/2012) might limit the range of flows that could be collected, and that access to study sites might be limited due to snow. Furthermore, it was recognized that the high-energy nature of the transect locations might make high-flow sampling dangerous. The following is a reach-by-reach summary of data collection and habitat modeling results.

Clear Branch

The Clear Branch is 0.6 miles long, from Clear Branch Dam to the confluence with the Coe Branch. The most-downstream transects are 0.27 miles upstream of this confluence, and the most-upstream transects are 0.22 miles downstream of Clear Branch Dam (Figure 2). Data collection at the seven transects occurred during September and October 2011, at three flow levels. Calibration of the hydraulic models was good.

The Clear Branch provides potential spawning and rearing habitat for bull trout, steelhead, Chinook, and coho. Analysis using these habitat predictions, and hydrologic information from MFID streamflow records, was developed into a habitat-time series for this study site. The time series was then developed into a predictive spreadsheet tool to allow analysis of differing flow regimes on available habitat. See Appendix E for habitat/flow relationships and model calibration summaries.

Coe Branch

Two transects were set in Coe Branch (Figure 2), one at the diversion in the bypass reach (approximately RM 1.07), and one downstream of the bridge crossing (approximately RM 0.3). Data collection occurred between September 2011 and March 2012. Data from a total of four flows was collected, and hydraulic model calibrations were fair to good.

The Coe Branch provides little or no spawning habitat, most likely due to a lack of suitable gravel substrates. Conditions at both transects (i.e., in the downstream reach and at the diversion) provide a small amount of rearing habitat for bull trout and cutthroat trout. Predicted habitat using criteria which incorporate the ODFW fish passage guidelines suggest that adequate habitat for migration is present over the fairly wide range of modeled flows, in both reaches. Analysis using these habitat predictions for the downstream reach, and hydrologic information from MFID streamflow records, was developed into a habitat-time series for the downstream reach. See Appendix F for habitat/flow relationships and model calibration summaries.

Eliot Branch

Two transects were set in Eliot Branch (Figure 2), one in the diversion bypass reach (approximately RM 1.07) and one near the pipeline crossing (approximately RM 0.8). Data collection took place between September and December 2011. Two flows were measured. Flows at this site were checked during subsequent field visits, but higher flow conditions were never observed. The resulting hydraulic models were fair to good.

The Eliot Branch provides a small amount of spawning habitat in the downstream reach, limited by small amounts of suitable gravel substrate. Slightly more spawning habitat is predicted for the upper reach at the diversion, due to deliberate placement of the transect at a small gravel patch. Rearing habitat for bull trout and cutthroat trout is present in small amounts in both reaches studied. Predicted habitat using criteria which incorporate the ODFW fish passage guidelines suggest that adequate habitat for migration is present in the diversion over the range of modeled flows, for both the downstream reach and at the diversion. See Appendix G for habitat/flow relationships and model calibration summaries.

Middle Fork Hood River Between Coe & Eliot Branches

This study site is approximately 0.4 miles downstream of the Coe Branch/Clear Branch confluence (Figure 2). Data collection at two flows took place between September 2011 and December 2011. On a February 2012 visit, the team found that channel avulsion and scour occurred at all four transects. The hydraulic model was built using the two available flow measurements and is constrained to a narrower range of flows than if another flow measurement had been possible, before the channel avulsion occurred.

Over the measurement period (fall/winter 2011 – 2012) extensive scour and fill was observed at all cross-sections at this study site. This channel instability limited data collection, narrowing the range of flows that could be modeled. A very small amount of spawning habitat was predicted at this site for Chinook, steelhead and bull trout. More rearing habitat for steelhead and Chinook was predicted than that for bull trout or coho, although habitat availability did not change significantly over the range of modeled flows.

Analysis of flood records at the USGS gage at Tucker Bridge in the lower Hood River Valley indicate that high flows of the magnitude that caused the channel change are fairly common (estimated 2.1-year return interval) . High sediment loads, turbid water conditions, and frequent channel avulsion are the strongest influences on fish habitat in this reach. See Appendix H for habitat/flow relationships and model calibration summaries.

Middle Fork Hood River at Red Hill Road

This single transect is at RM 7, near Parkdale and the confluence of the Middle Fork and Rogers Creek (Figure 2). The first data collection visit to this site was in September 2011. A subsequent site visit in December 2011 noted channel shift and avulsion, and a flow measurement was taken. Subsequent site visits, and a final cross-section survey in March 2012, noted further channel shift and avulsion.

Habitat/flow relationships were not developed for this study site. The purpose of this site was to investigate channel conditions and wetted perimeters in the main and side channels as flows changed. See Appendix I for habitat/flow relationships and model calibration summaries, as well as documentation of channel shifts and avulsion.

Lower Middle Fork Hood River

This study site is near Dee, between Parkdale and Hood River, approximately one mile upstream of the confluence with the East Fork Hood River (Figure 2). Data collection at the four transects took place between September 2011 and March 2012. Access to this site was limited during the winter months due to snow. Data at three flows was collected, although the range of flows measured is fairly narrow. Measurement of a higher flow was not possible, for crew safety concerns (water depths and high water velocities). The resulting hydraulic model was fair to good.

This study site is located approximately 12.5 river miles downstream of the Clear Branch/Eliot Branch confluence (Figure 2). The range of modeled flows was limited by the range of flows available to measure. This reach is primarily a rearing and migration area, and little spawning gravel is present. A small amount of spawning habitat was predicted for Chinook, steelhead and coho, and less for bull trout. Predicted rearing habitat for bull trout and coho juveniles is relatively constant over the range of modeled flows. Rearing habitat for Chinook and steelhead juveniles declines somewhat as flows increase, most likely due to increased water velocity with increased flow.

See Appendix J for habitat/flow relationships and model calibration summaries.

Hydrology Summary

The following summarizes the principle findings from the hydrologic analyses conducted for the MFID IFIM study. For a complete description of these analyses please refer to Appendix D.

Distributed Hydrologic Model of the Hood River Basin

We developed a Distributed Hydrology Soils Vegetation Model (DHSVM; Wigmosta and Lettenmaier, 1994) for the Hood River Basin. This model was needed to estimate mean daily streamflow (MDF) at ungaged locations within the Hood River Basin. Results from the DHSVM were combined with measured stream flow and diversions to estimated continuous hydrographs for transect locations (summarized in the following section below). In addition, although the MFID IFIM study is focused on the Middle Fork Hood River subbasin, it was also necessary to evaluate impacts downstream to the mouth of the Hood River. Results from the DHSVM, combined with MFID and OWRD gage data, were needed to extend the analysis to the mouth of the Hood River (summarized in the following section below).

The DHSVM requires spatial data that describes watershed conditions (i.e., soils, vegetation, topography), and meteorological data (precipitation, air temperature, wind speed, relative humidity, and solar radiation) that drives the hydrologic output. The DHSVM calculates a water budget for each model pixel (90-meter resolution was used) and time step (3-hour time step was used). Output can be derived for any point along a stream. The longest period with the most complete set of meteorological data was for water years 2001 to 2011 (10/1/2000 to 10/1/2011). The DHSVM requires that initial conditions for soil moisture, snow, and stream channel depth of flow be specified. Consequently, we used water year 2001 as a spinup period (i.e., a period after which the effects from initial conditions has been removed), and only used model results for water years 2002-2011.

The DHSVM was calibrated by comparing modeled results with observed gage records at several locations within the basin. Three metrics were used to evaluate the goodness of fit; the Nash-Sutcliffe Efficiency (NSE) statistic, the coefficient of correlation (r^2), and the ratio of modeled: observed streamflow. The first two metrics evaluate the amount of residual variability between the observed and modeled values, and the third is a measure of absolute magnitude of modeled and observed flow. Model parameter values (primarily soil parameters) were modified between model runs until the optimum model condition (i.e., the "best" values for the three evaluation metrics) was arrived at. The DHSVM performed very well for the Hood River Basin overall.

Daily discharge estimates

Mean daily flow (MDF) values were developed for all transect locations for a ten-year period; water years 2002-2011 (10/1/2001 - 9/30/2011). We supplemented gaged flow

data with modeled data from the DHSVM. We gave precedence to actual gaged data, using the modeled output primarily to estimate accretion flow between known sites. The most significant data gaps were for the Coe and Eliot Branches; almost no continuous data were available for these locations, and modeled MDF values needed to be used.

A schematic of the Hood River Basin and MFID infrastructure is given in Figure 3. The criteria used to estimate mean daily flows at the IFIM transect locations is given in Table 4. A single set of MDF values were calculated for groups of transects that were located close together, and that had no appreciable change in contributing area among the transects (e.g., Clear Branch transects 1-7). MDF values were calculated for two conditions; current and unregulated. Note that the only true "return flows" in the MFID system are the hydropower return flows that reenter the Middle Fork at Rogers Creek. The MFID has eliminated all irrigation-related tailwater return flows.

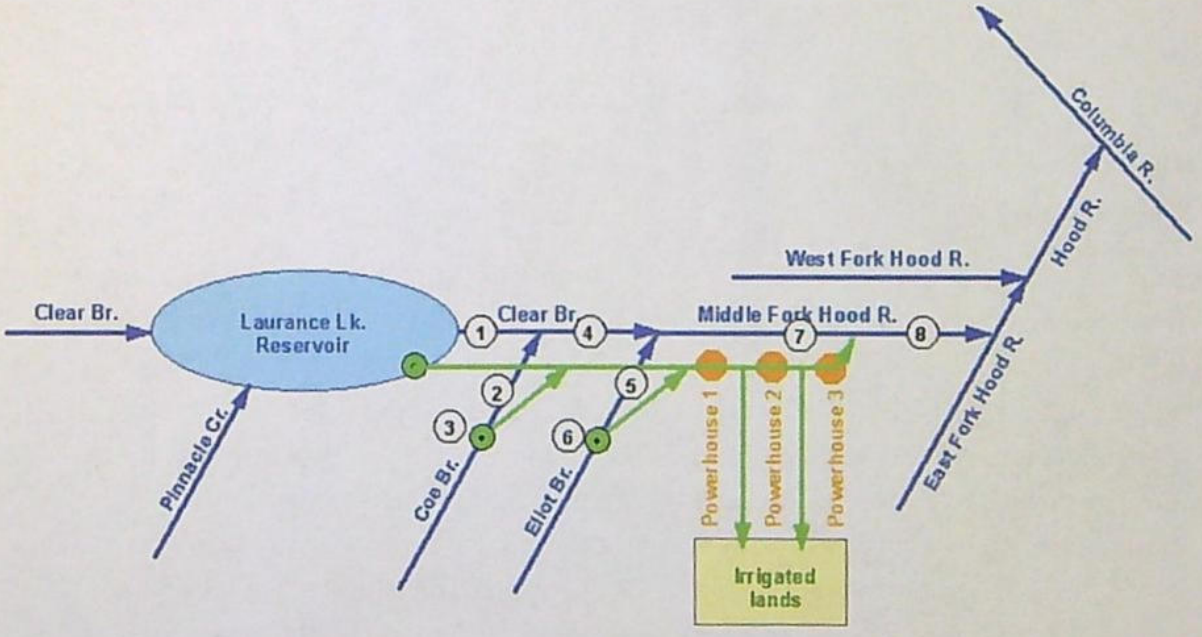

Figure 3. Schematic of Hood River Basin and MFID infrastructure. Numbered locations refer to flow calculation points described in Table 5.

Table 4. Criteria used to estimate mean daily flow at IFIM transect locations within the Middle Fork Hood River sub-basin.

Flow calc. pt.	Transect(s)	Current conditions	Unregulated conditions
1	Clear Branch 1-7 (combined)	MFID measured flow in Clear Branch DS of Laurance Lake	MFID calculated inflow to Laurance Lake
2	Coe Branch 1 (downstream)	Modeled flow at transect minus upstream diversion	Modeled flow at transect
3	Coe Branch 2 (in diversion reach)	Modeled flow at transect minus diversion minus return flow	Modeled flow at transect
4	Middle Fork 1-4 (between Coe & Eliot)	Sum of flow calculation 1 and 2 (current conditions)	Sum of flow calculation 1 and 2 (unregulated conditions)
5	Eliot Branch 1 (downstream)	Modeled flow at transect minus modified/apportioned monthly diversion	Modeled flow at transect
6	Eliot Branch 2 (in diversion reach)	Modeled flow at transect minus modified/apportioned monthly diversion minus estimated return flow	Modeled flow at transect
7	Middle Fork @ Red Hill Road	Sum of flow calculation 4 and 5 (current conditions) plus modeled accretion flows from Eliot/Middle Fork confluence to Red Hill Road	Sum of flow calculation 4 and 5 (unregulated conditions) plus modeled accretion flows from Eliot/Middle Fork confluence to Red Hill Road
8	Lower Middle Fork transects 1-4	Sum of flow calculation 4 and 5 (current conditions) plus modeled accretion flows from Eliot/Middle Fork confluence to Screw Trap plus Power House #3 (Rogers Creek) return flows	Sum of flow calculation 4 and 5 (unregulated conditions)plus modeled accretion flows from Eliot/Middle Fork confluence to Screw Trap

Downstream Effects

During the scoping process for the MFID IFIM study NMFS recommended that unimpaired flows be estimated and compared to current flows to examine consumptive use and storage in the Middle Fork, and downstream to the mouth of the Hood River. NMFS suggested using an approach developed by Tennant (1976) to analyze the impacts to aquatic habitat associated with these flows. The Tennant Method assumes that a percentage of the annual average flow (Q_{AA}) is needed to maintain a healthy stream environment (Jowett 1997). Tennant concluded that 10 percent of the average annual flow, as a minimum flow, would sustain short-term survival for most aquatic life forms. Thirty percent of the average annual flow, as a minimum flow, would sustain good survival habitat for most aquatic life forms (Table 5). Tennant suggests setting flows at two time periods: April through September and October to March. Use of this method requires an assumption that this proportion of the average annual flow will result in suitable depths and velocities for coldwater fish species, and that this relationship will apply to streams and rivers of similar size and gradient to Tennant's study rivers (Jowett 1997).

Table 5. Instream flow regimens for fish, wildlife, recreation, and related environmental resources (from Tennant, 1976).

	Recommended base flow regimens of flows	
Narrative description	Oct.-Mar.	Apr.-Sept.
Flushing or maximum	200% of the average flow	
Optimum range	60%-100% of the average flow	
Outstanding	40%	60%
Excellent	30%	50%
Good	20%	40%
Fair or degrading	10%	30%
Poor or minimum	10%	10%
Severe degradation	10% of average flow to zero flow	

We applied the Tennant Method to the Hood River downstream of the Middle Fork using estimated monthly stream flows, combined with monthly estimates of consumptive use and storage, available from the Oregon Water Resources Department (OWRD) Water Availability Reporting System (WARS). The OWRD has estimated unregulated monthly stream flows at the mouths of several water availability basins (WABs) within the Hood River Basin. Three locations within the Hood River Basin were selected for analysis: Middle Fork at the mouth, East Fork above the confluence with the West Fork, and the Hood River at the mouth. For the purposes of this analysis we used median monthly (i.e. 50% exceedance) flow values.

Annual average streamflow (Q_{AA}) values for all three locations are given in Table 6. Based on the criteria given by Tennant (1976; Table 5) we would conclude that current flow conditions downstream of the MFID project are in the optimum range (i.e., >60% of Q_{AA}), despite the cumulative impacts of all consumptive uses. Note that current stream flows in the Middle Fork are estimated to be greater than unregulated flows for the winter months, supplementing downstream flows in the lower Hood River.

Table 6. Flow characteristics for the three flow evaluation locations used in this analysis.

Map ID	Evaluation location	Annual average streamflow (Q_{AA}) under unregulated conditions (cfs)	Average April - September streamflow ($Q_{apr-sep}$; cfs)		$Q_{apr-sep}$ as percentage of Q_{AA}		Average October - March streamflow ($Q_{oct-mar}$; cfs)		$Q_{oct-mar}$ as percentage of Q_{AA}	
			Unregulated	Current	Unregulated	Current	Unregulated	Current	Unregulated	Current
1	Middle Fork @ mouth	163	175	150	107%	92%	151	153	93%	94%
2	East Fork above confluence with West Fork	384	447	306	116%	80%	322	305	84%	79%
3	Hood River @ mouth	935	877	689	94%	74%	993	934	106%	100%

Habitat Time Series Summary

Weighted Usable Area (WUA) is a weighted index of the amount of habitat, for a particular species and life stage (i.e., spawning, juvenile rearing), and is the final result of the hydraulic and habitat modeling done in an IFIM study. Weighted Usable Area (WUA) model results are always evaluated with respect to actual or predicted hydrologic conditions, to put them in perspective (Bovee et al, 1998). A habitat-time series, one of the methods to do this comparison, combines the predicted habitat/flow relationships that are the results of the hydraulic and habitat models, with daily estimates of hydrologic conditions at each study site. We performed this analysis for two of our study sites: the Clear and Coe Branches[2].

Estimates of existing streamflows were generated at each study site (See Hydrology Summary and Appendix D), and were ranked by frequency of occurrence (flow-exceedance analysis). This ranking was then used with the flow-habitat relationships (WUA vs. flow) to rank habitat conditions by frequency of occurrence (habitat-exceedance analysis). The analysis presented in this section uses streamflow estimates based on MFID project operating rules that have been in place since Water Year 2008, which are termed the "current condition" for the purposes of this analysis.

Both hydrologic time-series and habitat time-series can be calculated for any time period. The following analysis focuses on streamflows between July 1 and October 31 because summer and early fall are important periods in the Clear Branch for juvenile fish rearing, and for bull trout, chinook and coho spawning. In the Coe Branch, this time period is important for bull trout and cutthroat trout rearing and migration.

A spreadsheet tool was developed for the two study sites, to analyze any time period, and species and lifestage of concern. This tool will be available to the MFID for evaluating possible alternative future operating scenarios.

Clear Branch Study Site: Results

Table 7 presents flow-exceedance statistics for the Clear Branch, considering only mean daily flows between July 1 and October 31. These data show that at least 3 cfs is present in the stream under most conditions, while flows greater than 10 – 12 cfs are not common during the summer period. Figure 4 shows WUA results for the three salmonid species that

[2] The remaining sites had a limited range of flow observations (discussed in conclusion section and appendices), therefore the analysis could not be performed over the entire hydrologic time series.

currently (or potentially) spawn during this period, and for species rearing during this period. Table 7, Figure 5, and Figure 6 combine the hydrologic and habitat data to produce habitat-exceedance values.

Table 7. Flow-exceedance values for the Clear Branch (current condition), for summer and early fall conditions (July 1 – October 31). Weighted Usable Area (expressed as square feet of habitat per 1,000-foot long stream reach) is shown by species/life stage.

Flow Exceedance (% of time exceeded)	Mean Daily Flow (cfs)	Weighted Usable Area Provided at Given Exceedance Flow					
		Bull trout spawning	Chinook spawning	Bull trout juvenile rearing	Chinook juvenile rearing	Steelhead juvenile rearing	Coho spawning
90%	3.0	3,368	1,593	2,135	3,359	1,464	785
80%	4.0	4,117	2,032	2,381	3,965	1,760	962
70%	5.0	4,791	2,436	2,581	4,508	2,042	1,144
60%	5.6	5,127	2,648	2,643	4,765	2,190	1,255
50%	6.2	5,449	2,855	2,696	5,010	2,334	1,366
40%	8.0	6,308	3,421	2,775	5,627	2,715	1,710
30%	12.8	7,792	4,583	2,857	6,682	3,460	2,579
20%	15.0	8,161	5,017	2,899	7,011	3,719	2,938
10%	20.2	8,581	5,939	2,973	7,557	4,204	3,630

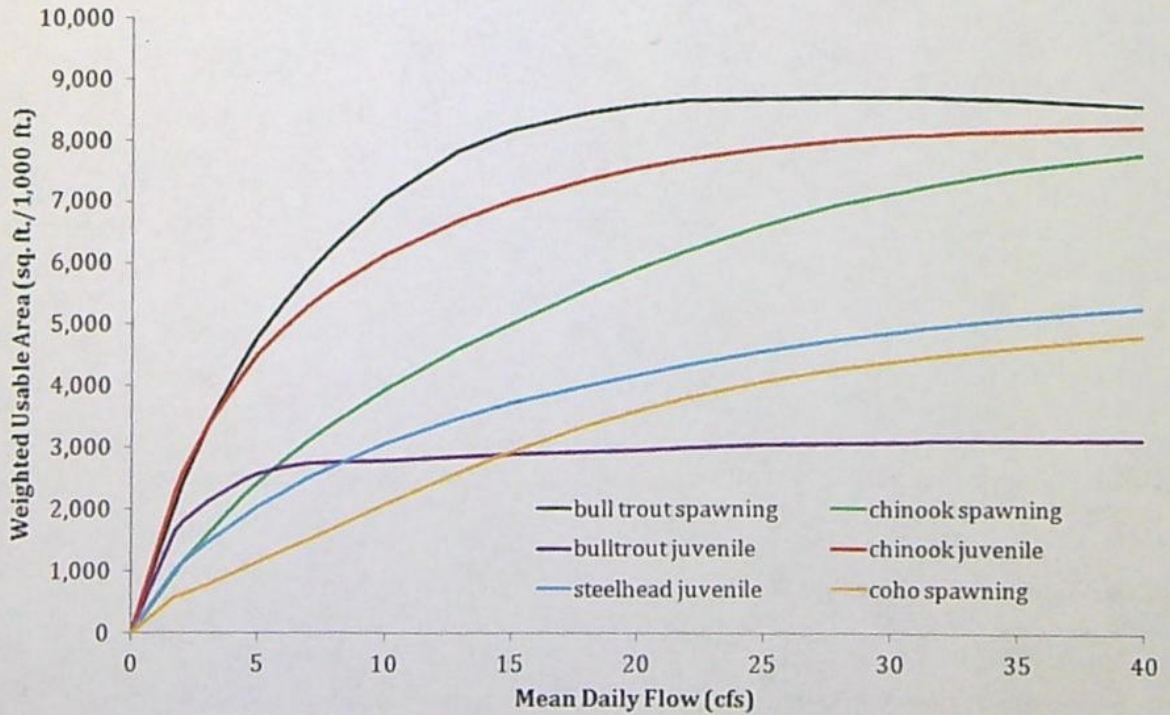

Figure 4. Weighted Usable Area results for the Clear Branch, species and life stages present during summer and early fall.

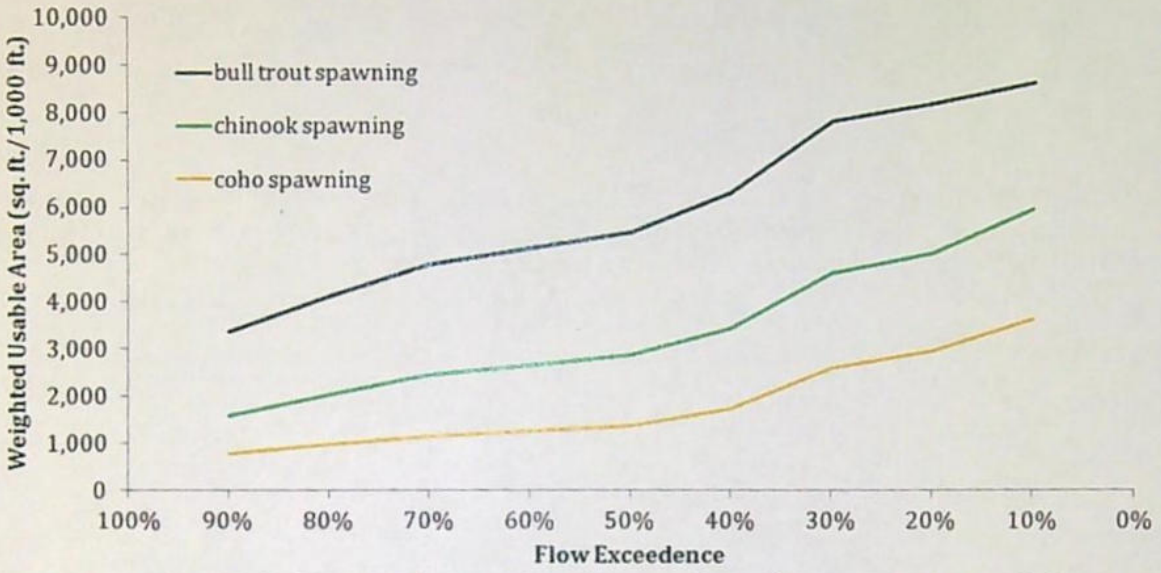

Figure 5. Example of Habitat-exceedance values for current conditions, summer- and fall-spawning life stages.

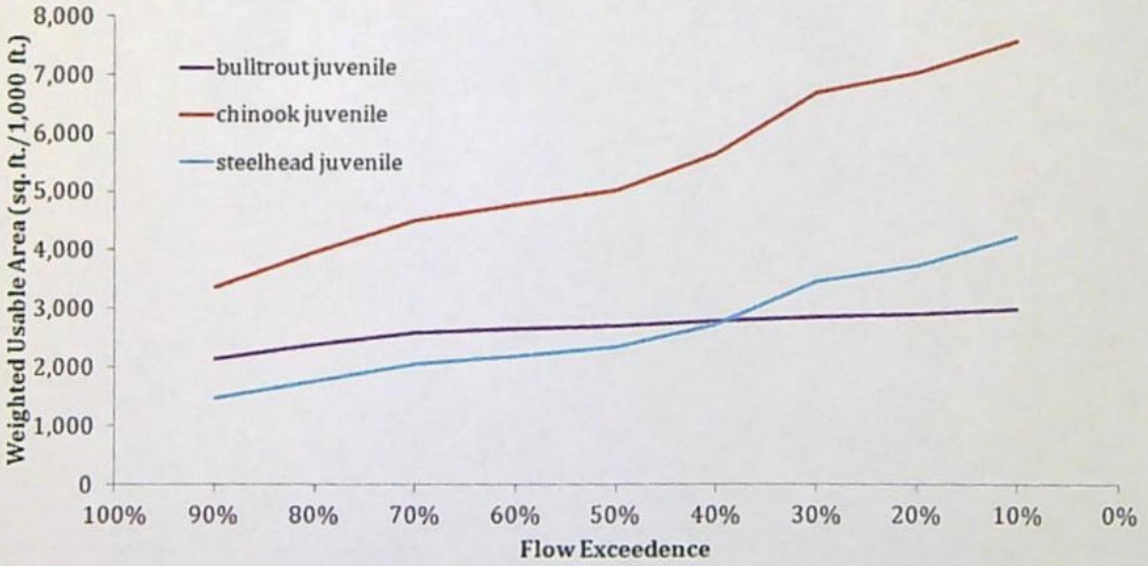

Figure 6. Example of Habitat-exceedance values for current conditions, summer- and fall-rearing life stages.

Coe Branch Study Site: Results

Table 8 presents flow-exceedance statistics for the Coe Branch Transect 1 (in the reach downstream of the diversion), considering only mean daily flows between July 1 and October 31. These data show that at least 5 cfs is present in this reach under most conditions, while flows greater than 40 cfs are not common during the summer period. Figure 7 summarizes Weighted Usable Area results for the three salmonid species that rear

during this period. (There was no spawning habitat in this reach.) Table 8, Figure 7, and Figure 8 combine the hydrologic and habitat data to produce habitat-exceedance values.

Table 8. Flow- and habitat-exceedance values for the Coe Branch Transect 1 (downstream) summer and early fall conditions (July 1 – October 31). Weighted Usable Area is expressed as square feet of habitat per 1,000-foot long stream reach.

Flow Exceedance (% of time exceeded)	Mean Daily Flow (cfs)	Weighted Usable Area Provided at Given Exceedance Flow		
		Cutthroat Juvenile/Adult Rearing/Migration	Bull Trout Juvenile	Bull Trout Juvenile/Adult
90%	5.0	4,647	1,697	2,831
80%	5.1	4,668	1,705	2,848
70%	12.7	5,725	2,277	3,981
60%	19.2	5,890	2,363	4,471
50%	25.2	5,561	2,258	4,568
40%	32.4	5,233	2,161	4,447
30%	45.4	5,189	2,116	4,130
20%	63.2	5,520	1,961	4,541
10%	89.7	5,680	1,840	5,050

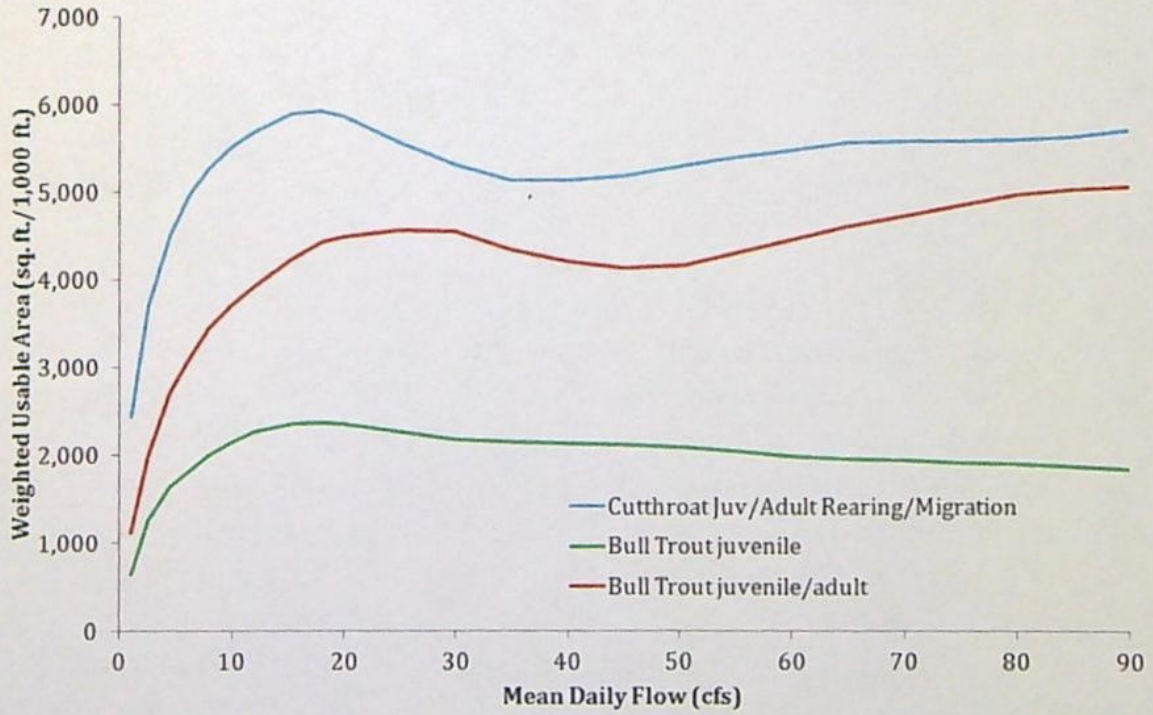

Figure 7. Weighted Usable Area results for the Coe Branch Transect 1 (downstream), species and life stages present during summer and early fall..

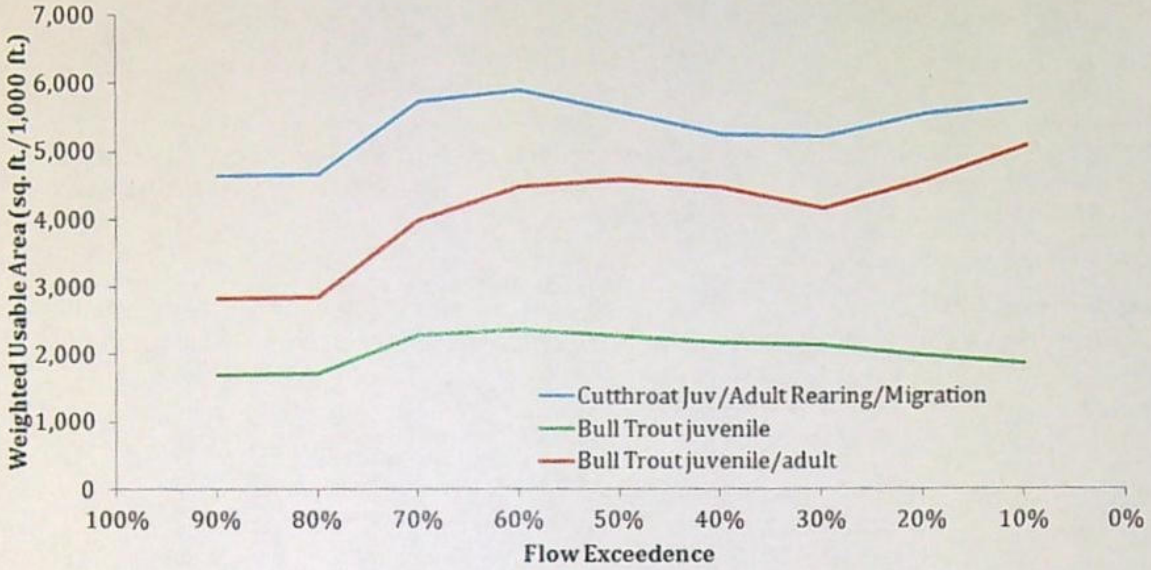

Figure 8. Habitat-exceedance values for Coe Branch Transect 1, for current conditions, summer- and fall-rearing life stages.

Model Use and Limitations

The results presented for the Clear and Coe Branch study sites illustrate estimated weighted usable area (WUA) of habitat by species and live stage under the current hydrologic regime for the summer and early fall (July 1 – October 31) period. The spreadsheet model used to generate these results can be used to estimate WUA under potential future project operating condition scenarios.

It was only possible to develop habitat–exceedance spreadsheet models for the Clear and Coe Branch sites only. Generating habitat-exceedance values requires a hydraulic model that spans the full range of streamflows predicted for the time period and operating rules under consideration. Hydraulic models developed for the other three study sites did not have a wide enough range in observed flows to develop habitat-time series over the entire hydrologic time series (See Appendices G, H, and J). However, the hydrologic data and the Weighted Usable Area results that were generated for the Eliot Branch, the Middle Fork between Coe and Eliot, and the lower Middle Fork can be used, along with the time-series for the Clear and Coe Branches, to assess available habitat under current and future operating conditions.

Conclusions

The highest quality fish habitat we observed during the extensive habitat surveys was in the Clear Branch, between the dam and the Coe Branch confluence. Habitat in the Coe and

Eliot Branches was limited, due to high channel gradient, high sediment loads carried by both streams, and the history of debris flows in both watersheds. Analysis using habitat suitability criteria that incorporated the ODFW fish passage guidelines suggest that fish migration is supported in both Coe and Eliot Branches, both at the diversions and in the downstream reaches, over most of the range of flow conditions currently estimated to occur.

Highly unstable channel conditions were measured in the Middle Fork between the Coe and Eliot Branches, and at the Red Hill Road study site. Given this instability, we believe that the largest factor influencing fish habitat in the Middle Fork downstream of the Coe and Eliot Branch confluences is the high sediment load, resulting in frequent and significant channel scour and aggradation, which limits fish habitat quality.

While we did not observe channel scour at the most-downstream study site (lower Middle Fork), high sediment loads likely result in significant impacts to fish habitat in this reach. Our results suggest that rearing and juvenile migration habitat is present in this reach, over the entire range of flows that it was possible to model.

Given the above conditions we recommend that the FMP Committee focus their future efforts on evaluating strategies that benefit habitat in the Clear Branch above the confluence with the Coe Branch and downstream of Laurance Lake Dam. This is the fish habitat most sensitive to changes in flow regime in the portion of the Middle Fork watershed that is influenced by MFID operations.

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Appendices

Appendix A - MFID Project Description

The Middle Fork Irrigation District (MFID) is located thirteen miles south of Hood River, Oregon and lies between the Middle and East Forks of the Hood River, with the northern slope of Mt. Hood to the south (Figure 1).

Water is diverted from the Clear, Coe and Eliot Branches of the Middle Fork Hood River. Laurance Lake Reservoir is on the Clear Branch, formed by Clear Branch Dam, approximately one mile upstream of the confluence of the Clear and Eliot Branches (Figure 1). The Eliot Branch diversion is approximately 1.5 mile upstream of the confluence between the Middle Fork and Eliot Branch. Downstream of this point, the river is called the Middle Fork Hood. The diversion on the Coe Branch is approximately 0.8 miles upstream of the confluence of the Middle Fork Hood and the Coe Branch.

Approximately 90 to 95 percent of the water supplied by MFID is diverted from Laurance Lake, Coe Branch and Eliot Branch. Whenever possible, water is drawn from Coe Branch and Eliot Branch first, and from Laurance Lake second. Both the Coe and Eliot Branches are fed by glacial runoff, are turbid during the summer months, carry high sediment loads and are subject to periodic debris flow events. Three major debris torrents have occurred on the Eliot Branch since 1996. The most recent, in 2006, relocated the Eliot Branch approximately 1,000 feet eastward (Figure 1).

Water from the Eliot Branch is collected in a sediment basin, and then water from all three sources flows into the Irrigation District (Figure 1). Water from the Coe and Clear Branches typically does not flow into a sediment basin. The MFID operates three powerhouses as an integral part of the irrigation system, utilizing existing irrigation infrastructure. Hydropower flows are returned to the Middle Fork Hood River at Rogers Creek, near Parkdale.

A list of all consumptive and non-consumptive MFID diversions in the Hood River Basin are provided in Table 1. A list of hydropower diversions in the Hood River Basin are provided in Table 2.

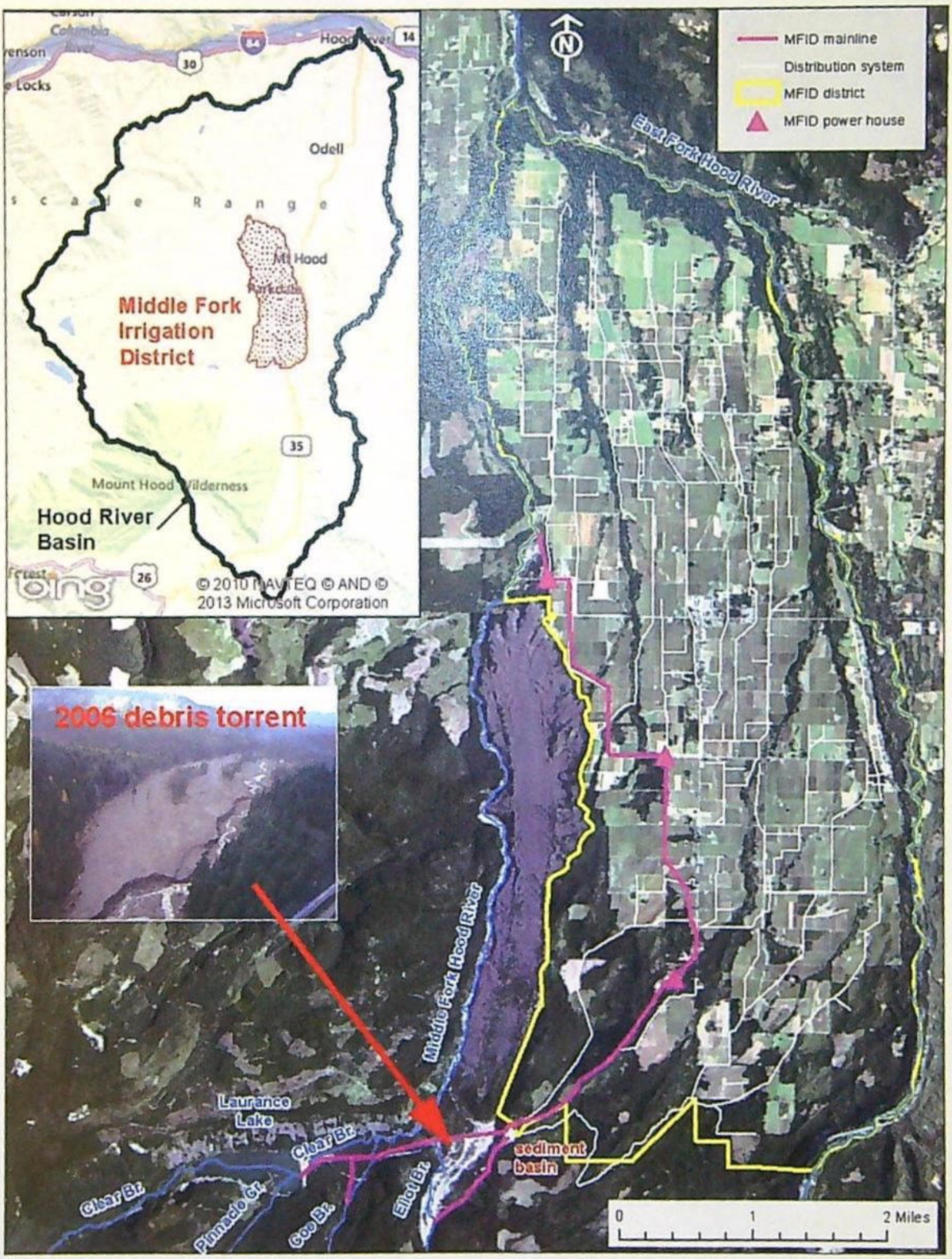

Figure 1. Middle Fork Irrigation District Map.

Table 1. Middle Fork Irrigation District Water Rights

Use	Acres	CFS	Source	Priority	Permit/ Certificate	Notes
Irrigation	17.90	0.22	Trout Cr	12/31/1892	----/ 74253	
Irrigation	85.00	1.06	Evans Cr	12/31/1894	----/ 74254	
Irrigation	75.90	0.95	Evans Cr	12/31/1896	----/ 74255	
Irrigation	3.10	0.04	Evans Cr	12/31/1896	----/ 74256	
Irrigation	837.60	6.25	EF of MF Hood R	12/31/1897	----/ 74258	
Irrigation	12.50	0.16	Trout Cr	12/31/1897	----/ 74257	
Irrigation	15.00	0.19	Trout Cr	12/31/1898	----/ 74259	
Irrigation	30.00	0.38	Evans Cr	12/31/1900	----/ 74260	
Irrigation	28.40	0.36	Evans Cr	12/31/1901	----/ 46966	Name on cert is "Routson"
Irrigation	123.00	1.54	Rogers Cr	1/19/1910	E-29/ 74261	
Irrigation	80.00	1.00	Wishart Cr	8/9/1915	S-2625/ 74262	
Irrigation	69.80	0.87	Griswell Cr	6/16/1924	S-15018/ 80478	
Irrigation	429.30	4.163	Eliot Cr	6/9/1955	S-23660/ 74264	
Irrigation/ Supplemental IR	5232.00 880.00	75.00	Clear Cr	1/2/1962	S-27788/	
Storage	10.7 ac-ft		Emil Cr	4/2/1965	R-4576/ 46266	
Supplemental IR	44.00	0.55	Emil Cr	4/2/1965	S-30434/ 46267	
Storage	3550 ac-ft		Clear Branch	4/6/1967	R-4862/	
Supplemental IR	6012.00		Clear Br Reservoir	6/6/1967	S-31956/	
Irrigation	8.20	0.10	Eliot & Clear Crs	1/22/1969	S-34104/ 46268	Eliot Cr Rate = 0.02 cfs Clear Cr Rate = 0.08 cfs
Supplemental IR	6012.00	25.00	Eliot Cr	3/9/1970	S-51366/	
Irrigation	4.40	0.06	Eliot & Clear Crs	4/9/1971	S-36065/	
Irrigation	290.40	3.63	Roger Cr	3/30/1972	S-43520/	
Supplemental IR	123.00	1.54	Eliot, Clear & Res			
Spray, Fire, Stock		1.00	Roger, Eliot, Clear			
Irrigation	311.50	3.89	Trout Cr	3/30/1972	S-43519/	
Supplemental IR	27.50	0.34	Eliot & Clear Crs			
Spray, Fire, Stock		1.35	Trout, Eliot, Clear			
Irrigation	6.00	0.08	Evans, Eliot, Clear	9/19/1977	S-42645/	
Irrigation	500.00	6.25	Eliot, Clear	5/1/1980	S-51367/	Maximum Rate = 6.25 cfs
Frost Protection	38.30	5.75				
Fire Protection		1.00				
Hydropower		20.00	Clear Br Reservoir	1/26/1981	S-49344/	Maximum Rate = 40 cfs
		10.00	Eliot Branch	1/26/1981		
		10.00	Coe Branch	1/26/1981		
		20.00	Clear Br Reservoir	1/26/1982		
		15.00	Eliot Branch	1/26/1982		
		15.00	Coe Branch	1/26/1982		
Temp Control	73.30	4.375	Clear, Eliot	2/20/1981	S-51368/	Maximum Rate = 9.843 cfs
		5.468	Evans Cr			
Stock		1.00	Clear, Evans, Eliot			
Supplemental IR	6012.00	29.50	Coe Cr	8/19/1985	S-51369/	Maximum Rate = 30.0 cfs
Fire Protection		0.25				Temp Control for
Stock		0.25				outside irrigation season
Temp Control		10.00				
Frost Protection	365.21	20.84	Clear Cr	6/1/1987	S-51370/	
		15.00	Coe Cr			
Irrigation	160.00	480 ac-ft	Laurence Lake	1/2/1996	S-51370/	
Totals	8160.00	106.193	*(Totals for irrigation only.)*			

Table 2. Hydropower diversions in the Hood River Basin.

Permit holder	permit/cert.	Priority Date	Stream Name	Max. diversion rate (cfs)
MIDDLE FORK IRRIGATION DISTRICT	S49344 / -----	1/26/1981	CLEAR BR > M FK HOOD R	10
MIDDLE FORK IRRIGATION DISTRICT	S49344 / -----	7/14/1982	CLEAR BR > M FK HOOD R	10
MIDDLE FORK IRRIGATION DISTRICT	S49344 / -----	1/26/1981	ELIOT BR > M FK HOOD R	25
MIDDLE FORK IRRIGATION DISTRICT	S49344 / -----	7/14/1982	ELIOT BR > M FK HOOD R	25
MIDDLE FORK IRRIGATION DISTRICT	S49344 / -----	1/26/1981	COE BR > M FK HOOD R	25
MIDDLE FORK IRRIGATION DISTRICT	S49344 / -----	7/14/1982	COE BR > M FK HOOD R	25
MEARS, S M	S300 / 1081	5/24/1910	WHISKEY CR > HOOD R	2.69
FRIDAY, F P	----- / 3837	12/31/1905	LENZ CR > NEAL CR	1.8
MASIKER, CARSON C	----- / 3839	12/31/1910	NEAL CR > HOOD R	0.05
H L/LOTTIE HASBROUCK,	S7480 / 6812	11/21/1925	INDIAN CR > HOOD R	5
WALLACE, GEORGE P	S12178 / 13479	5/12/1936	HOOD R > COLUMBIA R	0.044
ALLOWAY, C F	----- / 14936	12/31/1906	ODELL CR > HOOD R	1.35
ALLOWAY, C F	----- / 14936	12/31/1906	ODELL CR > HOOD R	1.35
BENSON, E N	----- / 14940	12/31/1905	CEDAR CR > HOOD R	0.3
CITY OF THE DALLES	----- / 14954	8/1/1870	DOG R > E FK HOOD R	
FLETCHER, MARY J	----- / 14963	12/31/1906	WHISKEY CR > HOOD R	0.1
NEALEIGH, J T	----- / 15003	12/31/1905	CEDAR CR > HOOD R	7.3
FRAZIER, RICHARD C	S30722 / 38340	1/5/1966	E FK HOOD R > HOOD R	0.05
PACIFIC POWER & LIGHT CO.	----- / 46965	12/31/1901	HOOD R > COLUMBIA R	500
PACIFIC POWER & LIGHT CO.	----- / 46965	12/31/1911	HOOD R > COLUMBIA R	500
ATWATER, PHILLIP D	----- / 51449	12/31/1903	NEAL CR > HOOD R	3.36
FARMERS IRRIGATION DISTRICT	S48576 / 67266	2/11/1981	DEAD POINT CR > W FK HOOD R	20
FARMERS IRRIGATION DISTRICT	S48576 / 67266	2/11/1981	S PINE CR > PINE CR	5
FARMERS IRRIGATION DISTRICT	S48576 / 67266	2/11/1981	N PINE CR > PINE CR	5
FARMERS IRRIGATION DISTRICT	S48576 / 67266	2/11/1981	DITCH CR > HOOD R	20
FARMERS IRRIGATION DISTRICT	S48576 / 67266	2/11/1981	HOOD R > COLUMBIA R	73
FARMERS IRRIGATION DISTRICT	S49871 / 67267	2/11/1981	DEAD POINT CR > W FK HOOD R	20
FARMERS IRRIGATION DISTRICT	S49871 / 67267	2/11/1981	S PINE CR > PINE CR	5
FARMERS IRRIGATION DISTRICT	S49871 / 67267	2/11/1981	N PINE CR > PINE CR	5
FARMERS IRRIGATION DISTRICT	S49871 / 67267	2/11/1981	DITCH CR > HOOD R	20
FARMERS IRRIGATION DISTRICT	S51421 / 75809	2/11/1981	GATE CR > N FK GREEN POINT CR	5
FARMERS IRRIGATION DISTRICT	S51421 / 75809	2/11/1981	N FK GREEN POINT CR > GREEN POINT CR	5
FARMERS IRRIGATION DISTRICT	S51421 / 75809	2/11/1981	N FK GREEN POINT CR > GREEN POINT CR	20
SHORT, STEVEN	----- / 84252	12/21/2007	E FK HOOD R > HOOD R	0.09
MIDDLE FORK IRRIGATION DISTRICT	S49344/-----	1/26/1981	CLEAR BR > M FK HOOD R	10
MIDDLE FORK IRRIGATION DISTRICT	S49344/-----	7/14/1982	CLEAR BR > M FK HOOD R	10

References

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Middle Fork Irrigation District, undated. Middle Fork Irrigation District, power-point presentation.

Appendix B - Summary of Agency Participation

The Middle Fork Irrigation District finalized a Fisheries Management Plan (FMP) in 2010. The purpose of the FMP is to address the requirements of the US Forest Service (USFS) Special Use Permit (SUP), and to provide operational guidance for MFID facilities.

The Fisheries Management Plan Committee (FMP Committee) completed project scoping for the instream flow study (IFIM study) in 2010 and 2011. Several meetings were held, and agency comments incorporated into the final study plan. Six potential study reaches were identified: the Clear, Coe and Eliot Branches, the Middle Fork between the Coe and Eliot Branches, the Middle Fork in the vicinity of Rogers Creek, and the lower 1-mile of the Middle Fork Hood River (Figures 1 through 3, Section 1 of this report).

Habitat surveys using ODFW Aquatic Inventory method were conducted during August 2011 (Moore et al. 2011). Summaries of the habitat survey results are in Appendix C. An FMP Committee meeting and field trip on August 17 2011 refined study objectives and selected transect locations at each study site. Fish species and life stages of concern were identified and agreed to (See Section 1, IFIM Study Summary). The Committee also discussed the development of a Distributed Hydrologic, Soil and Vegetation Model (DHSVM hydrologic model), which will be used along with existing flow records to estimate streamflows in the basin, and at each study site. Appendix D describes the DHSVM hydrologic model and the resulting hydrologic analysis.

Transect field data collection took place between August, 2011 and March, 2012. At two sites (Red Hill Road and the Middle Fork between the Coe and Eliot Branches) substantial channel avulsion, scour and aggradation occurred during this period.

On June 26, 2012, an FMP Committee meeting was held to review the draft hydraulic models, and determine the range of flows appropriate for each study site. The Committee also discussed and approved habitat suitability criteria (HSC criteria) for each species and lifestage of concern. Appendices E through J contain transect locations, measured flows, and hydraulic and habitat modeling results for each study site, with discussion. For the two sites where channel avulsion occurred, the extent of channel changes are documented (Appendices H and I). A habitat suitability criteria summary report describes the HSC criteria chosen by the FMP Committee (Appendix K).

Analyses using the habitat modeling results are presented in Section 1, of this report, IFIM Study Summary.

References

Moore, K., K. Jones, J. Dambacher, and C. Stein. 2011. Aquatic inventory Access 2011 habitat survey data collection and analysis package, Updated March 11, 2011, Version 21.1. Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Corvallis, OR 97333.

Appendix C - Habitat Survey Results Summary

Methods

Over five miles of stream habitat in six study reaches in the Middle Fork Hood River watershed were surveyed in August 2011. Reaches surveyed included the entire Clear Branch below Laurance Lake, Coe Branch (from its mouth to the MFID diversion headgate), Eliot Branch (from its mouth to the MFID diversion headgate), the Middle Fork Hood River between Coe and Eliot Branches, a 0.6-mile reach of the Middle Fork Hood River in the vicinity of Rogers Creek (downstream of Red Hill Road), and the lower one-mile of the Middle Fork Hood River starting from the confluence with the East Fork Hood River.

Habitat surveys were conducted following the Oregon Department of Fish and Wildlife (ODFW) Aquatic Inventory Method (Moore et al. 2011). However, the riparian vegetation belt transect portion of the protocol was not conducted as the focus of the study was on existing instream habitat quantity and quality. The ODFW method uses metric units. For the purposes of this survey, field measurements were taken in metric units, and then summarized using the ODFW habitat survey MS Access database template in metric units. The summary metric units were converted to standard units for the purposes of this study.

Results

Each study reach is briefly described below with representative photos; Table 1 summarizes habitat metrics for each of the six study reaches and Figure 1 depicts the reach longitudinal profiles.

Clear Branch

The Clear Branch is generally a relatively low gradient single channel stream, consisting of a series of pool-riffle complexes, with interspersed cascades and rapids at the upstream end of the reach near Clear Branch Dam. The reach is located in a moderate to steep V-shaped valley and is constrained by alternating high terraces and hill slopes. Relatively high quantities of large wood are present. The majority of large wood pieces appear to be human placed, and generally do not appear to contribute substantially to hydraulic complexity. The higher quality wood jams appear to be a combination of human placed large wood racked up with natural wood, and human placed wood mobilized from upstream placements. Clear Branch is not glacially influenced and was running clear during the survey, and the stream bottom was fully visible.

Photo Pair 1. Typical Clear Branch habitat.

Coe Branch

Coe Branch is a relatively steep stream consisting entirely of rapids and cascades in the study reach. The reach is located in a moderate to steep V-shaped valley and is constrained by alternating terraces and hill slopes. Some large wood jams, particularly a single jam located mid-way through the study reach, are likely currently upstream fish passage barriers (The single large jam, backfilled with bedload, has all surface flow appearing to pass over-top, with greater than 4-foot drop to the downstream reach). Coe Branch is glacially influenced and was turbid during the habitat survey, obscuring the stream bottom.

Photo Pair 2. Typical Coe Branch habitat.

Eliot Branch

Eliot Branch is a relatively steep stream consisting entirely of rapids and cascades in the study reach. Stream banks along the entirely reach are actively eroding in many areas and riparian vegetation is sparse due to the massive 2006 debris torrent. The lower half of the study reach is constrained by alternating hill slopes and high terraces. The upper half of the study reach is relatively unconstrained in a broad alluvial and sparsely vegetated valley. Eliot Branch is glacially influenced and was turbid during the survey, obscuring the stream bottom.

Photo Pair 3. Typical Eliot Branch habitat.

Middle Fork Hood River between Coe and Eliot Branches

The Middle Fork Hood River study reach between the Coe and Eliot Branches was heavily scoured during the 2006 debris torrent, and stream banks are actively eroding throughout the majority of the study reach. The reach is relatively steep and comprised of a single channel constrained by alternating high terraces and steep hill slopes. Stream habitat is dominated by rapids and cascades with some riffles and few pools. This reach is glacially influenced and was turbid during the survey, obscuring the stream bottom.

Photo Pair 4. Typical Middle Fork Hood River habitat between Coe and Eliot Branches.

Middle Fork Hood River near Rogers Creek (Red Hill Road)

The Middle Fork Hood River study reach in the vicinity of Rogers Creek (immediately downstream of Red Hill Road) is unconstrained and consists of two main channels, one on either side of the valley, with several interconnecting channels between these two channels. Only the channel on the west side of the valley was surveyed for the purposes of this study. The west-side channel is relatively steep consisting almost entirely of rapids. Eroding banks are common and the valley appears to be highly unstable, with apparent regular channel avulsion during peak flows. Although the east-side channel was not surveyed, reconnaissance indicated a relatively high number of large wood jams, with relatively high habitat and hydraulic complexity. This reach is glacially influenced and was turbid during the survey, obscuring the stream bottom.

Photo Pair 5. Typical Middle Fork Hood River habitat – west side channel near Rogers Creek.

Lower Middle Fork Hood River

About half of the lower Middle Fork Hood River study reach was composed of multiple unconstrained Channels in a relatively broad floodplain, and the upper half was a single channel constrained by alternating high terraces and hill slopes. The majority of stream habitat is dominated by riffles and rapids, with few pools and some steep cascades. Large wood is relatively common in the lower unconstrained portion of the reach and less common in the upper constrained portion. This reach is glacially influenced and was turbid during the survey, obscuring the stream bottom.

Photo Pair 6. Typical Lower Middle Fork Hood River habitat.

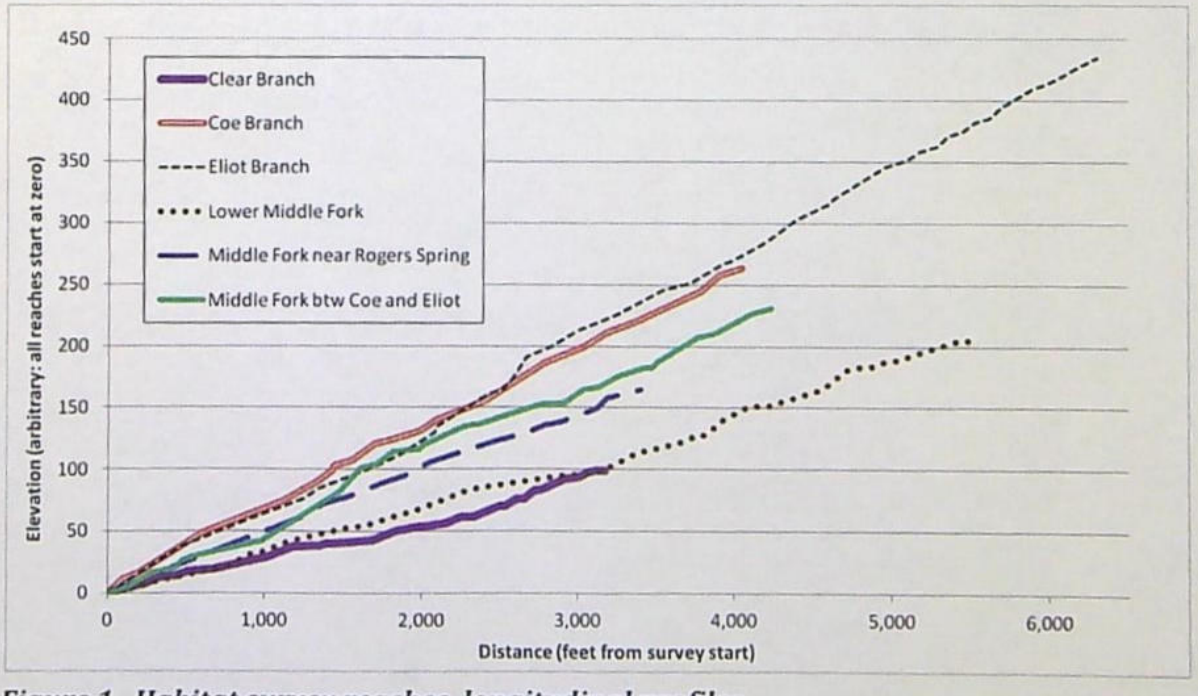

Figure 1. Habitat survey reaches, longitudinal profiles.

Table 1. Habitat survey summary by reach.

Survey Reach	Lower Middle Fork	Middle Fork (Rogers Creek)[a]	Middle Fork (btw Coe & Eliot)	Eliot Branch	Coe Branch	Clear Branch
Survey Date	8/5/2011	8/4/2011	8/2/2011	8/3/2011	8/3/2011	8/2/2011
Survey Start						
Description	at mouth	start of braids	Eliot confluence	at mouth	at mouth	at mouth
Latitude	45.57427	45.53244	45.46993	45.46991	45.46315	45.46315
Longitude	121.62819	121.62377	121.63513	121.63479	121.64548	121.64548
Survey End						
Description	750 ft above screw trap	Red Hill Road Bridge	Coe/Clear Branch confluence	diversion headgate	diversion headgate	Clear Branch Dam
Latitude	45.56498	45.52388	45.46311	45.45552	45.45366	45.46127
Longitude	121.63036	121.62598	121.64539	121.63699	121.65214	121.65488
Channel Metrics (ft)						
Primary Channel Length	5,492	3,406	4,236	6,302	4,052	3,179
Secondary Channel	361	164	1,247	0	85	197
Total Wetted Area (ft^2)	177,217	87,726	156,443	88,006	96,542	71,763
Wetted Width (ft)	27.6	22.6	26.2	14.1	23.3	21.7
Wetted Depth (ft)	2.20	1.57	1.38	0.98	1.31	1.51
Active Channel Width (ft)	49.2	29.5	42.7	23.0	36.1	33.8
Active Channel Depth (ft)	2.62	3.28	15.42	3.61	3.28	3.28
Valley Width Index	5.0	10.0	1.8	7.0	1.0	1.5
W:D Ratio	18.8	9.0	2.8	6.5	11.0	10.3
Average Unit Slope	3.7%	4.8%	5.5%	6.9%	6.5%	3.1%
Actively Eroding Banks	8.0%	33.0%	62.0%	37.0%	10.0%	0.0%
Undercut Banks	4.0%	5.0%	0.0%	0.0%	2.0%	2.0%
Reach Average Shade	50%	47%	46%	24%	63%	87%
Wood Metrics (total/100 yards primary channel)						
Wood Pieces ≥10' x 0.5'	11.1	7.4	7.0	5.9	6.5	14.0
Volume ($yards^3$)	13.0	5.9	4.3	4.4	11.1	17.5
Key pieces (≥40' x 2')	0.18	0.09	0.00	0.09	0.09	0.09
Habitat Group (% wetted area)						
Dammed & BW Pools	0.4	none	0.1	none	none	3.4
Scour Pools	4.9	none	1.0	none	none	13.4
Glides	none	none	none	none	none	none
Riffles	25.2	2.6	14.1	none		46.1
Rapids	55.9	90.2	40.2	41.2	43.7	22.6
Cascades	13.4	7.2	35.2	57.9	56.2	14.3
Step/Falls	0.2	none	1.1	0.1	0.1	none
Dry	none	none	8.3	none	none	none
Culverts	none	none	none	0.7	none	none
Pool Metrics						
All Pools	6	0	2	0	0	10
Pools ≥3' deep	3	0	1	0	0	3
Complex pools w/ LWD pieces ≥3	2	0	0	0	0	5
Pool frequency (channel w:pool)	19.8	0	64.3	0	0	10.0
Residual pool depth (mean)	2.4	0	1.6	0	0	2.1
Substrate (% wetted area)						
Silt/Organic	5	2	8	0	1	18
Sand	0	4	5	10	11	0
Gravel	0	1	0	9	1	2
Cobble	80	83	73	67	73	66
Boulder	15	10	14	14	14	14
Bedrock	0	0	0	0	0	0

[a]Partial Reach Survey – The data only reflects survey of the primary channel on the west side of the river valley. Another large secondary channel system of near equal length exists on the east side of the River Valley and many smaller channels cross between the west and east side channels.

References

Moore, K., K. Jones, J. Dambacher, and C. Stein. 2011. Aquatic inventory Access 2011 habitat survey data collection and analysis package, Updated March 11, 2011, Version 21.1. Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Corvallis, OR 97333.

The Hydrologic analysis conducted to support the MFID IFIM project consisted of three primary tasks which are described in detail below. The first task was the development of a distributed hydrologic model of the Hood River Basin. The hydrologic model was needed to develop daily discharge estimates at ungaged locations. Products from the distributed model task were used directly in the second primary task, which was to estimate mean daily discharge at several locations within the project area. The final task was to evaluate the impacts from the MFID project on downstream reaches of the Hood River.

Distributed Hydrologic Model of the Hood River Basin

Purpose and Scope

The purpose of this report is to document the development of a Distributed Hydrology Soils Vegetation Model[3] (DHSVM; Wigmosta et al. 1994) for the Hood River Basin. This model was needed to estimate mean daily streamflow (MDF) at ungaged locations within the Hood River Basin. These estimated MDFs were needed as part of the Instream Flow Incremental Methodology (IFIM) study WPN is conducting for the Middle Fork Irrigation District (MFID). Although the MFID IFIM study is focused primarily on the Middle Fork Hood River subbasin, it is also necessary to evaluate impacts downstream to the mouth of the Hood River, hence the need for the basin-scale model.

Approach

We used the DHSVM to model watershed hydrology within the Hood River Basin. The DHSVM provides a dynamic representation of the spatial distribution of soil moisture, evapotranspiration, and runoff production, at the scale of digital elevation model (DEM) pixel. Spatially distributed models such as DHSVM provide a dynamic representation of the spatial distribution of soil moisture, snow cover, evapotranspiration, and runoff production, at the scale of a DEM pixel (Figure 1). DHSVM has been used to assess changes in flood peaks due to enhanced rain-on-snow and spring radiation melt response (e.g., Thyer et al. 2004), effects of forest roads and road drainage (e.g., Lamarche and Lettenmaier 2001), and the prediction of sediment erosion and transport (Doten and Lettenmaier 2004). The most recent version of the model (3.0) was used.

[3] http://www.hydro.washington.edu/Lettenmaier/Models/DHSVM/index.shtml

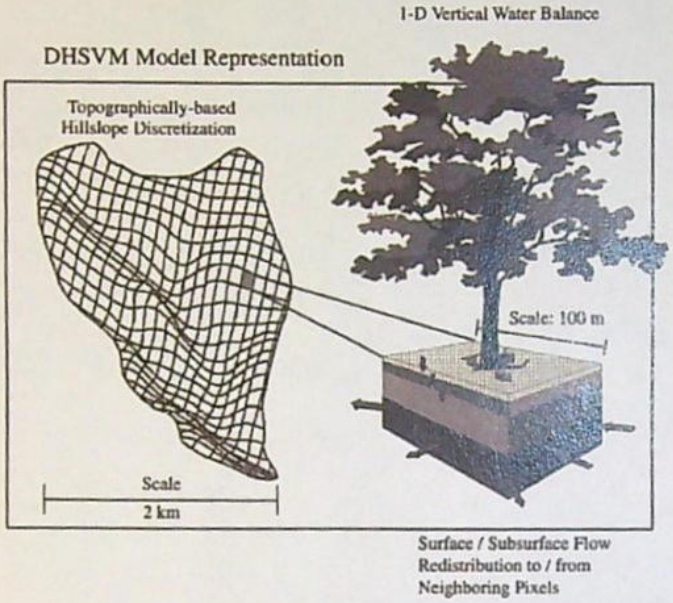

Figure 1. Schematic of the DHSVM model. Model representation of watershed soil, vegetation and topography as discrete pixels (from Vanshaar and Lettenmaier 2001).

The DHSVM model requires several types of spatial and temporal data inputs. All spatial data were processed using ArcGIS 10.0 software, with the Spatial Analyst extension. The DHSVM model itself was run on a Linux workstation.

Spatial input data

Spatial data inputs needed to run the DHSVM included digital representations of topography, vegetation, soils, and streams. The following describes the processing of spatial input data.

Digital Elevation Model Data

30-meter resolution digital elevation model (DEM) data[4] were acquired for the project area. These data were resampled to a 90-meter resolution. The resultant DEM was then filled to eliminate "sinks"; locations where the model would not "drain" in a downstream direction. A mask file was also created from the DEMs that is used by DHSVM to identify which pixels are inside (1) and outside (0) of the study watersheds. These DEM files (and all subsequent raster files) were then exported from the GIS in a binary format for input to the DHSVM.

[4] http://seamless.usgs.gov/

Vegetation

Land cover data obtained from the 2006 National Land Cover Database[5] were used for the initial classification on all lands. Forested land cover types were further reclassified based on percent canopy coverage data from the 2001 National Land Cover Database. The NLCD " Perennial Ice/Snow" type was initially used to represent glacier areas. However, Phillippe (2008) found that the USGS quad maps (the basis of the NLCD mapping) missed more than 60% of the debris-covered glacier area while overestimating glacier coverage in other areas. We used maps available in Phillippe (2008) and Ellinger (2010) to define the locations of glaciers within the Hood River Basin.

The final classification resulted in 19 overall combinations (Table 1). The reclassified data were transformed to raster format, with a pixel size that matches the other spatial data (i.e., 90 meters). Each unique vegetation classification code was assigned a suite of parameter values that the DHSVM utilizes to predict the influence of vegetation on soil moisture. Vegetation parameter values used for each classification are given at the end of this appendix. Parameter values were taken from a database of values assembled for similar forest types across the region.

Soil

The DHSVM requires spatially distributed information on both soil physical characteristics and soil depth. Model parameters associated with physical characteristics determine the rate at which moisture moves through the soil profile under saturated and non-saturated conditions, while soil depth controls the volume of soil moisture, as well as the interception of soil moisture by streams.

NRCS soil survey data[6] were used to map soil depths and physical classes on all non-federal lands, and Soil Resource Inventory[7] (SRI) data were used to describe soil characteristics on lands administered by the US Forest Service Mount Hood National Forest. Multiple soil series with similar physical types were combined, and eighteen distinct soil types were defined for the assessment area. Sixteen soil parameters needed to be defined for each of the soil types (e.g., lateral and vertical hydraulic conductivity, porosity, bulk density, etc).

[5] http://www.mrlc.gov/nlcd.php

[6] http://soildatamart.nrcs.usda.gov/Metadata.aspx?Survey=OR629&UseState=OR

[7] http://www.fs.fed.us/r6/data-library/gis/mthood/metadata/sri_metadata.htm

Table 1. Crosswalk between National Land Cover Dataset (NLCD) vegetation attributes and DHSVM vegetation codes.

NLCD ID	NLCD attribute value	DHSVM code used
11	Open Water	1
12	Glacier	2
21	Developed, Open Space	3
22	Developed, Low Intensity	
23	Developed, Medium Intensity	
24	Developed, High Intensity	4
31	Barren Land (Rock/Sand/Clay)	5
41	Deciduous Forest (<30% cover)	6
	Deciduous Forest (30-50% cover)	7
	Deciduous Forest (>50% cover)	8
42	Evergreen Forest (<30% cover)	9
	Evergreen Forest (30-50% cover)	10
	Evergreen Forest (>50% cover)	11
43	Mixed Forest (<30% cover)	12
	Mixed Forest (30-50% cover)	13
	Mixed Forest (>50% cover)	14
52	Shrub/Scrub	15
71	Grassland/Herbaceous	16
81	Pasture/Hay	17
82	Cultivated Crops	18
90	Woody Wetlands	19
95	Emergent Herbaceous Wetlands	3

Values for each soil type were estimated based on several sources including the USDA Soil Water Characteristics Hydraulic Properties Calculator , Meyer et al. (1997), Bowling and Lettenmaier (1997), LaMarche and Lettenmaier (1998), Freeze and Cherry (1979), and Dunne and Leopold (1978). Parameter values used for each of the eighteen soil types are given in tables at the end of this appendix.

Soil depths were given for most soil series included in the NRCS soil survey area, and for some of the SRI data. Missing values were interpolated based on similar and/or adjacent soil types (if available), or topographic position. Soil depth for the entire area was calculated within GIS based on elevation and slope. Soil depth ranged from values of 1.1 to 2.0 meters. As part of the model calibration (discussed below) it was found that using a uniform soil depth of 2.0 meters (the maximum depth allowed in the model) improved model performance.

Streams

The DHSVM requires spatially distributed data on the location and characteristics of stream channel types. Stream locations and characteristics influence where, and under

what conditions, subsurface flow becomes surface flow and the rate at which streamflow is routed to downstream locations. The model uses a simple linear routing algorithm to move water through the channel system.

The Oregon Department of Forestry (ODF) stream coverage[8] for the Hood River basin was assumed to be the most complete representation of the extent of the channel network. It is critical to the model's operation that the vector stream coverage used in the model matches exactly the topographical low points (i.e., the valleys) in the DEM. Consequently, it was necessary to construct a vector stream coverage from the DEM that closely matched the ODF stream coverage. This was done by tracing a flow path along the DEM from the upstream end of all channels shown on the ODF layer. Parameter values that needed to be estimated for each stream segment included 1) active channel width, 2) active channel depth, 3) channel slope, and 4) channel roughness.

The Oregon Department of Fish and Wildlife (ODFW) has Aquatic Inventory (AQI) data from several streams within the Hood River watershed. These data were used to estimate bankfull width and depth[9] based on mean annual stream flow:

$$H_a = 0.2755Q^{0.0816} \quad r^2 = 0.20 \qquad \textbf{Equation 1}$$

$$W_a = 2.6823Q^{0.296} \quad r^2 = 0.68 \qquad \textbf{Equation 2}$$

Where: H_a = active-channel depth (m)
W_a = active-channel width (m)
Q = modeled mean annual flows (cfs)

Mean annual flow in the preceding equation was estimated based on an equation from Lorensen and others (1994):

$$Ln(Q) = -15.712 + 1.176*ln(A) + 2.061*ln(P) \quad R^2 = 0.96; n=48 \qquad \textbf{Equation 3}$$

Where: Q = mean annual flow (cfs)
A = drainage area (acres)
P = mean annual precipitation (inches)

[8] http://www.oregon.gov/ODF/GIS/fishpresence.shtml

[9] The AQI metrics "active channel width" and "active channel height" were used to represent bankfull width and depth (respectively).

Drainage area and mean annual precipitation were calculated at the midpoint of each channel segment. Each segment was then assigned to one of ten classes, and channel width and depth were assigned by class. Channel slope was calculated within GIS. A roughness value of 0.065 was used for all stream segments.

Meteorological data

The DHSVM is driven by meteorological data run at a sub-daily time step. Inputs to each grid cell, either as precipitation or as inflow from adjacent cells, are processed for each time step, and then passed on to down-gradient cells. The following input data are needed for each time step:

- Air temperature
- Relative humidity
- Longwave radiation
- Wind speed
- Shortwave radiation
- Precipitation

Eighteen climate stations located within or adjacent to the Hood River Basin were considered (Figure 2, Table 2). Data were available for most stations for water years 2001 to 2011 (10/1/2000 to 10/1/2011), consequently this eleven year period was selected as the modeling period.

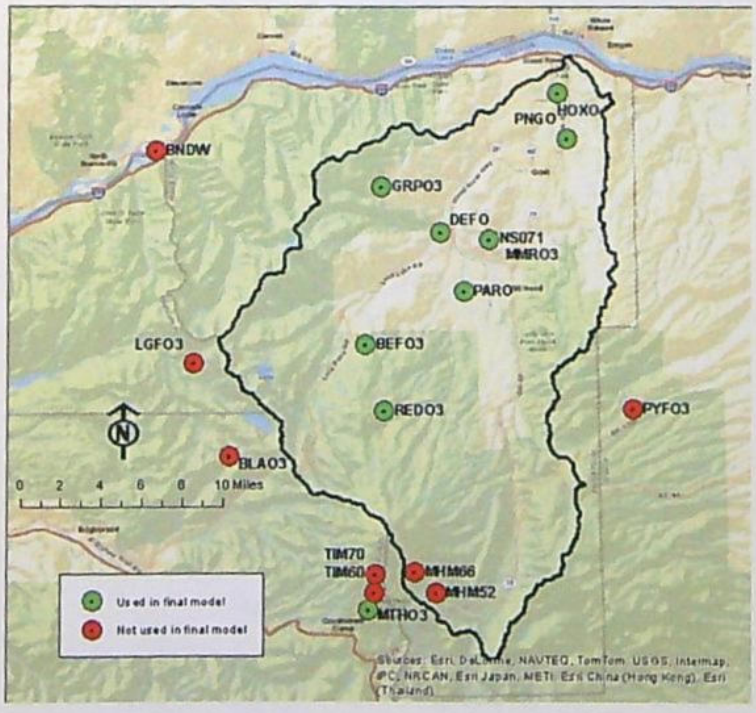

Figure 2. Climate stations used or considered for use.

Table 2. Climate data stations used in this analysis.

Station ID	Station Name	Source	Elev. (ft)	County	Status	Period of record used	
						From	To
Lower Valley							
BNDW	Bonneville Dam	AGRIMET[10]	79	Skamania	Active	4/12/2002	10/1/2011
HOXO	Hood River	AGRIMET	510	Hood River	Active	10/1/2000	10/1/2011
PNGO	Pine Grove	AGRIMET	620	Hood River	Active	10/1/2000	10/1/2011
Upper Valley							
DEFO	Dee Flat	AGRIMET	1,260	Hood River	Active	10/1/2000	10/1/2011
PARO	Parkdale	AGRIMET	1480	Hood River	Active	10/1/2000	10/1/2011
MMRO3	Middle Mtn.	RAWS[11]	2,544	Hood River	Active	11/12/2004	10/1/2011
NS071	Middle Mtn.	RAWS	2,598	Hood River	Inactive	7/11/2001	11/12/2004
Valley Rim							
LGFO3	Log Creek	RAWS	2,800	Multnomah	Active	10/1/2000	10/1/2011
GRPO3	Greenpoint	SNOTEL[12]	3,200	Hood River	Active	10/1/2000	10/1/2011
PYFO3	Pollywog	RAWS	3,320	Wasco	Active	10/1/2000	10/1/2011
BLAO3	Blazed Alder	SNOTEL	3,650	Clackamas	Active	10/1/2000	10/1/2011
BEFO3	Blue Ridge	RAWS	3,763	Hood River	Inactive	10/1/2000	9/8/2010
REDO3	Red Hill	SNOTEL	4,400	Hood River	Active	10/1/2000	10/1/2011
Mount Hood							
MHM52	Mount Hood Mdws. (Base)	NWAVAL[13]	5,249	Hood River	Active	11/16/2000	10/1/2011
MTHO3	Mt. Hood Test Site	SNOTEL	5,400	Clackamas	Active	10/1/2000	10/1/2011
TIM60	Timberline Lodge (Base)	NWAVAL	6,001	Clackamas	Active	11/17/2005	10/1/2011
MHM66	Mount Hood Mdws. (Top)	NWAVAL	6,601	Hood River	Active	11/17/2005	10/1/2011
TIM70	Timberline Lodge (Top)	NWAVAL	7,001	Clackamas	Active	11/16/2000	10/1/2011

Model runtime is directly proportional to the time step chosen. For this application we chose a 3-hour time step as a balance between capturing the effects of diurnal variation, while keeping model runtime as short as possible. Hourly data were parsed to a three hour time step.

Data were most complete for the AGRIMET stations, operated by the U.S. Bureau of Reclamation (Table 2), with all parameters measured, excepting longwave radiation, which is not measured at any of the stations in the area. Data from the U.S. Forest Service RAWS stations were mostly complete, however, the Blue Ridge RAWS station (BEFO3; Table 2) was discontinued on 9/8/2010 and values after that time were estimated from adjacent stations as described below. RAWS station NS071, located on Middle Mountain, was discontinued on 11/12/2004 and replaced by a new station (MMRO3) whose data set began on the same day. Data from these two stations were merged into a single set. The SNOTEL stations, maintained by the Natural Resources Conservation Service (NRCS) have data for precipitation and air temperature only; all other values were estimated as described below. None of the stations maintained by the Northwest Avalanche Center (NWAVAL) had shortwave radiation data, and some of the other parameters were not

[10] http://www.usbr.gov/pn/agrimet/wxdata.html or http://mesowest.utah.edu/

[11] http://www.raws.dri.edu/index.html or http://mesowest.utah.edu/

[12] http://www.wcc.nrcs.usda.gov/snow/ or http://mesowest.utah.edu/

[13] http://www.nwac.us/ or http://mesowest.utah.edu/

recorded at some stations, however data from these stations were useful in estimating missing values at other locations.

The DHSVM requires parameter values for all parameters and at each time step in the modeling period. Missing values for single time steps were estimated by either averaging values for the time steps preceding and following (this was done for air temperature, relative humidity, wind speed, and shortwave radiation), or assumed zero (for precipitation). Missing values for longer time periods were estimated as follows:

- **Air temperature, relative humidity, wind speed**: Linear regression equations were developed with adjacent stations, and the station best correlated to the station of interest was used to fill in the missing values.

- **Longwave radiation**: Incoming longwave radiation values were estimated from shortwave values and daily weather data using relationships described from Bowling and Lettenmaier (1997; pages 105-107).

- **Shortwave radiation**: Missing shortwave radiation values were estimated at each station using an approach described by Bowling and Lettenmaier (1997; pages 107-108). This involves first estimating the instantaneous amount of solar radiation incident on a horizontal surface at the top of the atmosphere (a function of position on the earth), and the daily total atmospheric transmittance (the fraction of solar radiation that reaches the earth; estimated from daily weather data).

- **Precipitation**: For most of the time periods when hourly precipitation was missing there was a sum of precipitation that occurred during the period available. In these cases the total cumulative precipitation was distributed using a rainfall pattern observed at adjacent stations. If a cumulative amount of precipitation was not available then values for the missing time steps were estimated using linear regression with adjacent stations.

The DHSVM may be run with a constant air temperature lapse rate, or with a lapse rate specified for each time step. Initial model runs used a constant air temperature lapse rate of -0.005 degrees C/meter. Air temperature lapse rates, calculated for each time step using values from all stations having data for a given time step, improved the overall performance of the model and were used in subsequent model runs.

Station precipitation values are adjusted to each grid cell within the DHSVM either by using a constant elevational lapse rate, or using the monthly precipitation raster maps prepared

as part of the PRISM project[14]. We used the PRISM map approach in our model runs. Climate station data were interpolated to pixel locations using the inverse distance weighting approach.

Model Calibration

Modeled discharge measurements at each time step were averaged to arrive at mean daily flow (MDF). Modeled MDF values were compared to observed values from several stream gages in the Hood River Basin (Table 3, Figure 3). Three metrics describing the goodness of fit of the modeled: observed data were considered during the calibration period:

- **Nash-Sutcliffe efficiency (NSE)**: The NSE is a normalized statistic that determines the relative magnitude of the residual variance ("noise") compared to the measured data variance ("information"; Nash and Sutcliffe, 1970). NSE ranges between $-\infty$ and 1.0, with NSE = 1 being the optimal value. Values between 0.0 and 1.0 are generally viewed as acceptable levels of performance (Moriasi et al. 2007).

- **Coefficient of determination (r^2)**: The coefficient of determination represents the goodness of fit of a regression; the higher the r^2 value, the more of the variance of the independent variable is explained by the dependent variable. For example, an r^2 value of 0.95 indicates that 95% of the variation is explained by the independent variable, while an r^2 value of 0.50 indicates that only 50% of the variation is explained.

- **Flow ratio (modeled: observed)**: We compared the total flow modeled flow over the period of record with the total observed flow for the same period. The closer this ratio is to 1.0 the better the model was at representing total water yield.

Table 3. Stream gages within the Hood River Basin considered for use in model calibration.

Map	Station #	Name	Status	Owner	Period of Record used in analysis	% complete
A	14120000	Hood River @ Tucker Bridge	Active	USGS	10/1/2001 - 9/30/2011	100%
B	14118500	West Fork Hood R. near Dee	Active	OWRD	10/1/2001 - 9/30/2011	100%
C	-	Middle Fork Hood R. near mouth	Unk.	ODFW	10/1/2001 - 9/30/2011	47%
D	-	Tony Creek near mouth	Unk.	ODFW	10/1/2001 - 11/26/2007	25%
E	-	Clear Branch below Laurance Lk.	Active	MFID	10/1/2001 - 9/30/2011	95%
F	-	Eliot Branch @ diversion	Discon.	PSU	7/25/2007 - 10/14/2007	2%
G	-	Coe Branch @ diversion	Discon.	PSU	6/2/2007 - 9/12/2007	3%
H	-	Mitchell Creek	Unk.	MHM	10/1/2001 - 3/27/2006	36%
I	-	East Fork Hood R. above Hwy. 35	Unk.	MHM	10/1/2001 - 12/31/2008	71%
J	-	East Fork Hood R. @ Dee Hwy.	Unk.	MHM	n/a (11/1/2010 - 1/12/2011)	-
K	14118000	Green Point Cr blw. NF near Dee	Discon.	OWRD	n/a (08/01/1949 - 09/30/1954)	-
L	14115815	Clear Branch blw. Laurance Lk.	Discon.	OWRD	n/a (05/07/1986 - 09/30/1995)	-
M	14113350	Cold Springs Cr near Parkdale	Discon.	OWRD	n/a (07/21/1928 - 09/05/1933)	-
N	14113400	Dog River near Parkdale	Discon.	OWRD	n/a (10/01/1960 - 10/31/1971)	-

[14] http://www.prism.oregonstate.edu/docs/meta/ppt_30s_meta.htm

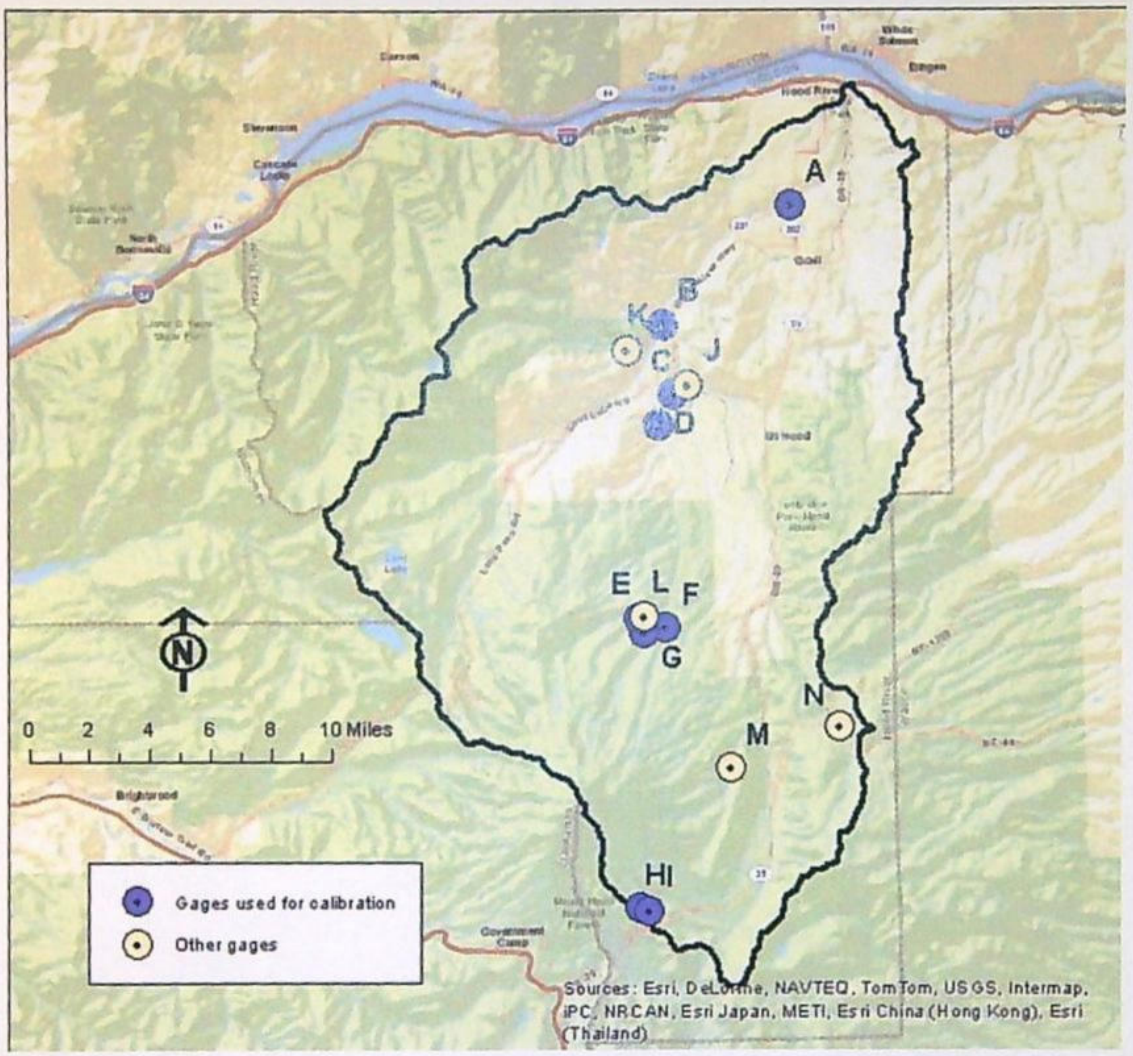

Figure 3. Location of stream gages within the Hood River Basin.

Initial model parameter values were set as described on preceding pages. Subsequent model runs were varied by adjusting the most obvious and sensitive variable to model performance. A total of 20 model runs were performed. Each model run required ~3 hours of processing time. The parameter values that were varied included the following:

- **Air temperature lapse rates**: Static vs. variable lapse rates were evaluated (variable performed better)
- **Hydraulic conductivity**: Varied the lateral and vertical hydraulic conductivity over three orders of magnitude from initial conditions (the lower rates, i.e., more rapid hydraulic conductivity, yielded better results)

- **Distribution of station meteorological data**: The technique of how station data was distributed across the landscape (nearest station (i.e., Thiessen polygons) vs. inverse distance weighting of multiple stations (inverse distance weighting yielded better results)

- **Soil depth**: Used different representations of soil depth, either variable by soil type or uniform depth set to maximum depth of 2.0 meters (uniform maximum depth yielded better results)

- **Meteorological stations**: Varied which stations were included in the model run, either all stations, or some subset of same (subset that excluded most stations not in basin yielded best results)

- **Infiltration rates**: Varied maximum soil infiltration rates (initial rates yielded best results)

Performance metrics for the final calibrated DHSVM for the Hood River Basin are given Table 4. The model performed best at the West Fork Hood River gage site (Figure 3, top), with a NSE value of 0.74, and an r^2 value of 0.797. The flow ratio was over 3 to 1 for the month of September, however, we did not account for upstream water withdrawals (most significantly Farmers Irrigation District, and the City of Hood River domestic water), consequently, these numbers seem very good. Similarly the Hood River at Tucker Bridge gage showed very good results (Figure 3, bottom). The Clear Branch below Laurance Lake was also well-modeled. Other locations showed poorer performance with respect to the NSE metric, however, the correlation between modeled and observed flows was generally very good. Eliot Branch showed a poor performance, however, it must be noted that results for both Eliot and Coe are based on a very short period of record (see Table 3).

Table 4. Performance metrics for the final calibrated DHSVM.

Site	NSE	r^2	Flow ratio (modeled: observed):		
			January	September	All months
Hood River @ Tucker Bridge	0.57	0.813	0.79	1.71	0.87
West Fork Hood R. near Dee	0.74	0.797	1.14	3.20	1.28
Middle Fork Hood R. near mouth	-1.73	0.618	-	1.27	0.76
Tony Creek near mouth	0.00	0.509	-	2.73	1.29
Clear Branch below Laurance Lk.	0.61	0.684	1.06	3.73	1.01
Eliot Branch @ diversion	-25.15	0.016	-	0.67	0.52
Coe Branch @ diversion	-0.74	0.705	-	1.67	1.10
Mitchell Creek	0.20	0.459	1.97	3.17	1.93
East Fork Hood R. above Hwy. 35	-4.77	0.717	0.71	0.78	0.45

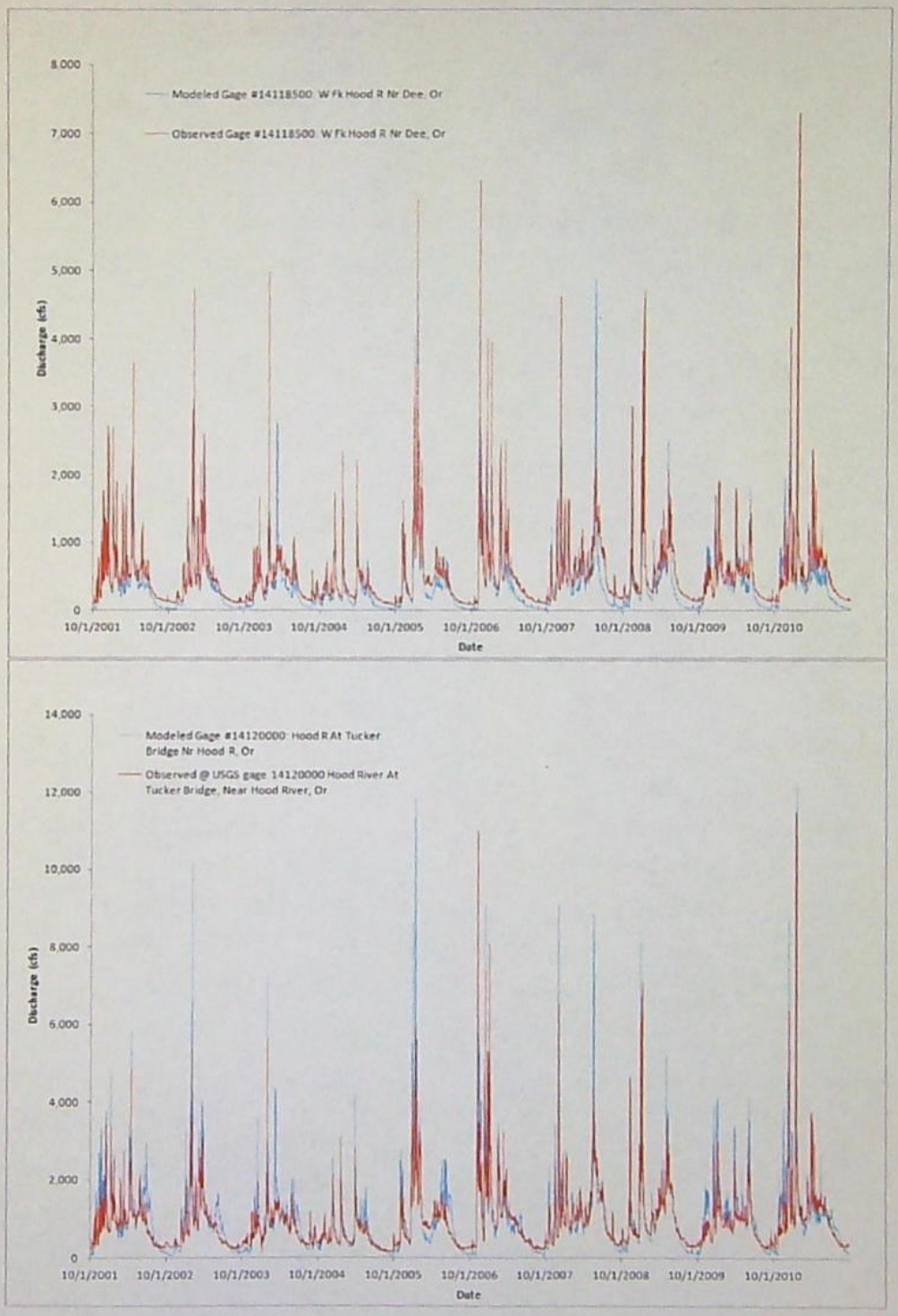

Figure 3. Observed and modeled mean daily streamflow (MDF) at the West Fork Hood River gage (top) and at the Hood River at Tucker Bridge (bottom).

Results

The calibrated DHSVM should be adequate for the purposes intended in the MFID project, which are to translate observed streamflow values at gage locations to ungaged sites. Results were used to develop MDF values for the period 10/1/2001 to 9/30/2011 at IFIM locations, and at selected mainstem locations to the mouth of the Hood River. Model files are available at the discretion of the MFID.

Vegetation Parameter Values

ID	Vegetation Description	Overstory Present	Understory Present	Fractional Coverage	Trunk Space	Aerodynamic Attenuation	Radiation Attenuation	Max Snow Int Capacity	Mass Release Drip Ratio	Snow Interception Eff	Impervious Fraction	Number of Root Zones
1	Open Water	FALSE	FALSE								0	3
2	Glacier	FALSE	FALSE								0	3
3	Developed (Open Space; Low & Medium Intensity); Emergent Herbaceous Wetlands	TRUE	TRUE	0.05	0.5	3.5	0.5	0.04	0.4	0.6	0	3
4	Developed, High Intensity	TRUE	TRUE	0.001	0.5	3.5	0.5	0.04	0.4	0.6	0	3
5	Barren Land (Rock/Sand/Clay)	FALSE	FALSE								0	3
6	Deciduous Forest (<30% cover)	TRUE	TRUE	0.2	0.3	3.5	0.5	0.04	0.4	0.6	0	3
7	Deciduous Forest (30-50% cover)	TRUE	TRUE	0.4	0.3	3.5	0.5	0.04	0.4	0.6	0	3
8	Deciduous Forest (>50% cover)	TRUE	TRUE	0.9	0.3	3.5	0.5	0.04	0.4	0.6	0	3
9	Evergreen Forest (<30% cover)	TRUE	TRUE	0.2	0.3	3.5	0.5	0.04	0.4	0.6	0	3
10	Evergreen Forest (30-50% cover)	TRUE	TRUE	0.4	0.3	3.5	0.5	0.04	0.4	0.6	0	3
11	Evergreen Forest (>50% cover)	TRUE	TRUE	0.9	0.3	3.5	0.5	0.04	0.4	0.6	0	3
12	Mixed Forest (<30% cover)	TRUE	TRUE	0.2	0.3	3.5	0.5	0.04	0.4	0.6	0	3
13	Mixed Forest (30-50% cover)	TRUE	TRUE	0.4	0.3	3.5	0.5	0.04	0.4	0.6	0	3
14	Mixed Forest (>50% cover)	TRUE	TRUE	0.9	0.3	3.5	0.5	0.04	0.4	0.6	0	3
15	Shrub/Scrub; older clearcuts	FALSE	TRUE								0	3
16	Grassland/Herbaceous; younger clearcuts	FALSE	TRUE								0	3
17	Pasture/Hay	FALSE	TRUE								0	3
18	Orchard	TRUE	TRUE	0.35	0.3	3.5	0.5	0.04	0.4	0.6	0	3
19	Woody Wetlands	TRUE	TRUE	0.15	0.3	3.5	0.5	0.04	0.4	0.6	0	3

ID	Vegetation Description	Overstory Monthly LAI											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Open Water												
2	Glacier												
3	Developed (Open Space; Low & Medium Intensity); Emergent Herbaceous Wetlands	5.52	6.13	6.73	7.45	11.3	21.3	27.6	25.1	13.8	8.54	6.84	6.08
4	Developed, High Intensity	0.45	0.5	0.55	0.61	0.92	1.75	2.26	2.06	1.13	0.7	0.56	0.5
5	Barren Land (Rock/Sand/Clay)												
6	Deciduous Forest (<30% cover)	2.49	2.49	4.15	10.1	21.6	32.4	34.3	31.1	24.1	10.4	4.15	2.49
7	Deciduous Forest (30-50% cover)	2.49	2.49	4.15	10.1	21.6	32.4	34.3	31.1	24.1	10.4	4.15	2.49
8	Deciduous Forest (>50% cover)	2.49	2.49	4.15	10.1	21.6	32.4	34.3	31.1	24.1	10.4	4.15	2.49
9	Evergreen Forest (<30% cover)	13.4	14	15	15.4	15.9	16.5	16.1	15.7	15.4	15	14	13.4
10	Evergreen Forest (30-50% cover)	13.4	14	15	15.4	15.9	16.5	16.1	15.7	15.4	15	14	13.4
11	Evergreen Forest (>50% cover)	13.4	14	15	15.4	15.9	16.5	16.1	15.7	15.4	15	14	13.4
12	Mixed Forest (<30% cover)	11.2	11.7	12.8	14.1	16.5	19.3	19.6	18.6	16.7	13.9	12	11.2
13	Mixed Forest (30-50% cover)	11.2	11.7	12.8	14.1	16.5	19.3	19.6	18.6	16.7	13.9	12	11.2
14	Mixed Forest (>50% cover)	11.2	11.7	12.8	14.1	16.5	19.3	19.6	18.6	16.7	13.9	12	11.2
15	Shrub/Scrub; older clearcuts												
16	Grassland/Herbaceous; younger clearcuts												
17	Pasture/Hay												
18	Orchard	0.46	0.46	0.76	1.85	3.95	5.94	6.29	5.71	4.42	1.91	0.76	0.46
19	Woody Wetlands	2.05	2.14	2.34	2.59	3.03	3.54	3.59	3.41	3.06	2.55	2.2	2.05

Vegetation Parameter Values (Continued)

ID	Vegetation Description	Understory Monthly LAI											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Open Water												
2	Glacier												
3	Developed (Open Space; Low & Medium Intensity); Emergent Herbaceous Wetlands	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
4	Developed, High Intensity	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
5	Barren Land (Rock/Sand/Clay)												
6	Deciduous Forest (<30% cover)	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
7	Deciduous Forest (30-50% cover)	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
8	Deciduous Forest (>50% cover)	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
9	Evergreen Forest (<30% cover)	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
10	Evergreen Forest (30-50% cover)	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
11	Evergreen Forest (>50% cover)	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
12	Mixed Forest (<30% cover)	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
13	Mixed Forest (30-50% cover)	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
14	Mixed Forest (>50% cover)	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
15	Shrub/Scrub; older clearcuts	10	10	10	10	10	10	10	10	10	10	10	10
16	Grassland/Herbaceous; younger clearcuts	3	3	3	3	3	3	3	3	3	3	3	3
17	Pasture/Hay	3	3	3	3	3	3	3	3	3	3	3	3
18	Orchard	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36
19	Woody Wetlands	0.36	0.46	0.6	0.6	0.6	0.6	1.13	1.08	0.64	0.36	0.36	0.36

ID	Vegetation Description	Overstory Monthly Albedo											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Open Water												
2	Glacier												
3	Developed (Open Space; Low & Medium Intensity); Emergent Herbaceous Wetlands	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
4	Developed, High Intensity	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
5	Barren Land (Rock/Sand/Clay)												
6	Deciduous Forest (<30% cover)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
7	Deciduous Forest (30-50% cover)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
8	Deciduous Forest (>50% cover)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
9	Evergreen Forest (<30% cover)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
10	Evergreen Forest (30-50% cover)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
11	Evergreen Forest (>50% cover)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
12	Mixed Forest (<30% cover)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
13	Mixed Forest (30-50% cover)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
14	Mixed Forest (>50% cover)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
15	Shrub/Scrub; older clearcuts												
16	Grassland/Herbaceous; younger clearcuts												
17	Pasture/Hay												
18	Orchard	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
19	Woody Wetlands	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21

Understory Monthly Albedo = 0.2 in all months for all vegetation types

Vegetation Parameter Values (Continued)

ID	Vegetation Description	Root Zone Depths (m)			Overstory Root Fraction			Understory Root Fraction		
		L1	L2	L3	L1	L2	L3	L1	L2	L3
1	Open Water	0.007	0.017	0.026				0	0	0
2	Glacier	0.007	0.017	0.026				0	0	0
3	Developed (Open Space; Low & Medium Intensity); Emergent Herbaceous Wetlands	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
4	Developed, High Intensity	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
5	Barren Land (Rock/Sand/Clay)	0.007	0.017	0.026				0	0	0
6	Deciduous Forest (<30% cover)	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
7	Deciduous Forest (30-50% cover)	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
8	Deciduous Forest (>50% cover)	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
9	Evergreen Forest (<30% cover)	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
10	Evergreen Forest (30-50% cover)	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
11	Evergreen Forest (>50% cover)	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
12	Mixed Forest (<30% cover)	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
13	Mixed Forest (30-50% cover)	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
14	Mixed Forest (>50% cover)	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
15	Shrub/Scrub; older clearcuts	0.06	0.13	0.21				0.4	0.6	0
16	Grassland/Herbaceous; younger clearcuts	0.015	0.035	0.05				0.4	0.6	0
17	Pasture/Hay	0.06	0.13	0.21				0.4	0.6	0
18	Orchard	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0
19	Woody Wetlands	0.1	0.3	0.7	0.31	0.36	0.23	0.6	0.4	0

Vegetation Parameter Values (Continued)

ID	Vegetation Description		Height (m)	Maximum Resistance	Minimum Resistance	Moisture Threshold	Vapor Pressure Deficit	Rpc
3	Developed; Emergent Herbaceous Wetlands	overstory	24.5	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
4	Developed, High Intensity	overstory	10	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
6	Deciduous Forest (<30% cover)	overstory	30.3	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
7	Deciduous Forest (30-50% cover)	overstory	30.3	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
8	Deciduous Forest (>50% cover)	overstory	30.3	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
9	Evergreen Forest (<30% cover)	overstory	30.3	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
10	Evergreen Forest (30-50% cover)	overstory	30.3	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
11	Evergreen Forest (>50% cover)	overstory	30.3	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
12	Mixed Forest (<30% cover)	overstory	30.3	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
13	Mixed Forest (30-50% cover)	overstory	30.3	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
14	Mixed Forest (>50% cover)	overstory	30.3	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
15	Shrub/Scrub; older clearcuts	overstory						
		understory	1.5	600	200	0.33	4000	10
16	Grassland/Herbaceous; younger clearcuts	overstory						
		understory	0.5	600	200	0.33	4000	10
17	Pasture/Hay	overstory						
		understory	1	600	120	0.33	4000	10
18	Orchard	overstory	4.8	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108
19	Woody Wetlands	overstory	4.8	1000	333.3	0.33	4000	0.108
		understory	0.5	5000	250	0.13	4000	0.108

Soil Parameter Values

Soil ID	Soil Description	Lateral Conductivity (m/s)	Exponential Decrease	Maximum Infiltration (m/s)	Capillary Drive	Surface Albedo	Number of Soil Layers	Porosity
1	cobbly loam	0.00313818	2	2.93E-05	0.62	0.23	3	0.387
2	clay	0.0014	2	1.31E-05	2.32	0.23	3	0.4
3	sandy loam	0.004	2	2.93E-05	0.62	0.09	3	0.387
4	sandy loam	0.0115	2	2.93E-05	0.62	0.16	3	0.387
5	gravelly loam	0.004	2	2.93E-05	0.62	0.23	3	0.387
6	silt loam	0.004	2	1.52E-05	1.56	0.23	3	0.439
7	silt loam	0.004	2	1.52E-05	1.56	0.16	3	0.439
8	gravelly loam	0.00733333	2	2.93E-05	0.62	0.20	3	0.387
9	silt loam	0.00042	2	1.52E-05	1.56	0.23	3	0.439
10	cobbly sand	0.002	2	8.95E-05	0.4	0.16	3	0.375
11	bedrock	0.01411	2	1.31E-08	0.39	0.09	3	0.4
12	fine sandy loam	0.014	2	2.93E-05	0.62	0.30	3	0.387
13	wetland	0.02121	2	1.31E-05	2.09	0.02	3	0.489
14	ice	0.01411	2	1.31E-08	0.39	0.30	3	0.4
15	clay loam	0.0014	2	1.40E-05	1.29	0.16	3	0.442
16	clay loam	0.004	2	1.40E-05	1.29	0.23	3	0.442
17	clay loam	0.0014	2	1.40E-05	1.29	0.23	3	0.442
18	Water (as clay)	0.0014	2	1.31E-05	2.32	0.23	3	0.4

Soil ID	Soil Description	Pore Size Distribution	Bubbling Pressure	Field Capacity	Wilting Point	Bulk Density (kg/m3)	Vertical Conductivity (m/s)	Thermal Conductivity	Thermal Capacity	Mannings n
1	cobbly loam	0.21	1.87	0.18	0.08	1214	3.1E-04	0.25	1.40E+06	0.01
2	clay	0.08	3.53	0.38	0.32	1200	1.4E-04	0.25	1.40E+06	0.01
3	sandy loam	0.21	1.87	0.18	0.08	1175	4.0E-04	0.25	1.40E+06	0.01
4	sandy loam	0.21	1.87	0.18	0.08	1175	1.2E-03	0.25	1.40E+06	0.01
5	gravelly loam	0.21	1.87	0.18	0.08	700	4.0E-04	0.25	1.40E+06	0.01
6	silt loam	0.25	7.15	0.33	0.19	1300	4.0E-04	0.3	1.40E+06	0.01
7	silt loam	0.25	7.15	0.33	0.19	750	4.0E-04	0.3	1.40E+06	0.01
8	gravelly loam	0.21	1.87	0.18	0.08	708	7.3E-04	0.25	1.40E+06	0.01
9	silt loam	0.21	7.15	0.33	0.19	1400	4.2E-05	0.3	1.40E+06	0.01
10	cobbly sand	0.23	0.56	0.1	0.04	1675	2.0E-04	0.6	1.40E+06	0.01
11	bedrock	0.23	0.6	0.1	0.04	950	1.4E-06	0.3	1.40E+06	0.01
12	fine sandy loam	0.21	1.87	0.18	0.08	475	1.4E-03	0.25	1.40E+06	0.01
13	wetland	0.36	12.6	0.32	0.08	1300	2.1E-06	0.25	1.40E+06	0.01
14	ice	0.36	12.6	0.32	0.08	910	1.4E-03	0.25	1.40E+06	0.01
15	clay loam	0.14	4.83	0.38	0.2	750	1.4E-04	0.35	1.40E+06	0.01
16	clay loam	0.14	4.83	0.38	0.2	1225	4.0E-04	0.35	1.40E+06	0.01
17	clay loam	0.14	4.83	0.38	0.2	1200	1.4E-04	0.35	1.40E+06	0.01
18	Water (as clay)	0.08	3.53	0.38	0.32	1200	1.4E-04	0.25	1.40E+06	0.01

Daily discharge estimates

This section of the report describes the development of mean daily flow (MDF) values at all transect locations. The MFID measures stream flow and diversion flow at several locations throughout the project area. Records for some locations go back to the 1980's, however, the most comprehensive and complete data set is for the past ten years. Values were developed for a ten-year period; water years 2002-2011 (10/1/2001 - 9/30/2011). Many key locations near IFIM cross-sections are gaged, however, some are not. We supplemented gaged flow data with modeled data from the distributed hydrology model to develop MDF records at all IFIM transect locations. We gave precedence to actual gaged data, using the modeled output primarily to estimate accretion flow between known sites. The most significant data gaps were for the Coe and Eliot Branches; almost no continuous data were available for these locations, and modeled MDF values needed to be used.

A schematic of the Hood River Basin and MFID infrastructure is given in Figure 4. The criteria used to estimate mean daily flows at the IFIM transect locations is given in Table 5. A single set of MDF values were calculated for groups of transects that were located close together, and that had no appreciable change in contributing area among the transects (e.g., Clear Branch transects 1-7). MDF values were calculated for two conditions; the current condition, and for the unregulated condition. Note that the only true "return flows" in the MFID system are the hydropower return flows that reenter the Middle Fork at Rogers Creek. The MFID has eliminated all irrigation-related tailwater return flows.

No daily diversion records were available for the Eliot Branch diversion, consequently monthly totals were distributed equally among days in a given month.

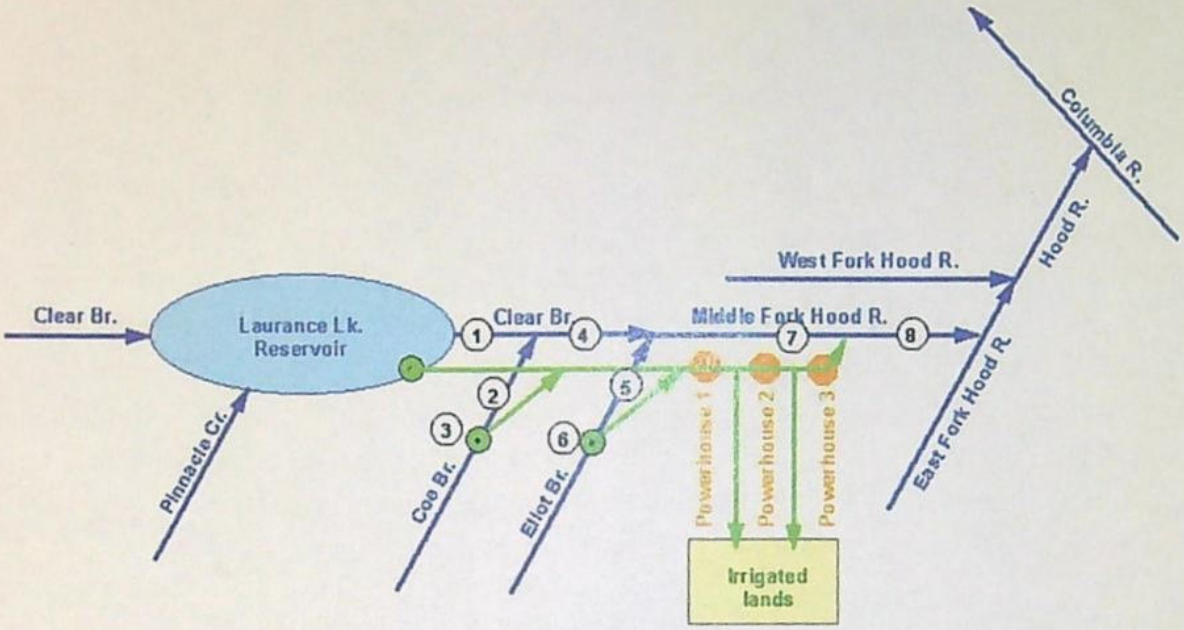

Figure 4. Schematic of Hood River Basin and MFID infrastructure. Numbered locations refer to flow calculation points described in Table 5.

Table 5. Criteria used to estimate mean daily flow at IFIM transect locations within the Middle Fork Hood River sub-basin.

Flow calc. pt.	Transect(s)	Current conditions	Unregulated conditions
1	Clear Branch 1-7 (combined)	MFID measured flow in Clear Branch DS of Laurance Lk	MFID measured inflow to Laurance Lake
2	Coe Branch 1 (downstream)	Modeled flow at transect minus upstream diversion	Modeled flow at transect
3	Coe Branch 2 (in diversion reach)	Modeled flow at transect minus diversion minus return flow	Modeled flow at transect
4	Middle Fork 1-4 (between Coe & Eliot)	Sum of flow calculation 1 and 2 (current conditions)	Sum of flow calculation 1 and 2 (unregulated conditions)
5	Eliot Branch 1 (downstream)	Modeled flow at transect minus modified/apportioned monthly diversion	Modeled flow at transect
6	Eliot Branch 2 (in diversion reach)	Modeled flow at transect minus modified/apportioned monthly diversion minus estimated return flow	Modeled flow at transect
7	Middle Fork @ Red Hill Road	Sum of flow calculation 4 and 5 (current conditions) plus modeled accretion flows from Eliot/Middle Fork confluence to Red Hill Road	Sum of flow calculation 4 and 5 (unregulated conditions) plus modeled accretion flows from Eliot/Middle Fork confluence to Red Hill Road
8	Lower Middle Fork transects 1-4	Sum of flow calculation 4 and 5 (current conditions) plus modeled accretion flows from Eliot/Middle Fork confluence to Screw Trap plus Power House #3 (Rogers Creek) return flows	Sum of flow calculation 4 and 5 (unregulated conditions)plus modeled accretion flows from Eliot/Middle Fork confluence to Screw Trap

Downstream Effects

During the scoping process for the MFID IFIM study NMFS recommended that unimpaired flows be estimated and compared to current flows to examine consumptive use and storage in the Middle Fork, and downstream to the mouth of the Hood River. NMFS suggested using an approach developed by Tennant (1976) to analyze the impacts to aquatic habitat associated with these flows. This section of the report provides an assessment using the Tennant Method.

Tennant Method

Methods to investigate and determine instream flow requirements can be divided into three categories: 1) historic flow regime methods, 2) hydraulic methods and 3) habitat methods. The Tennant Method is an example of a historic flow regime method that relies on the recorded or estimated annual average streamflow (Q_{AA}, as defined by USGS). It assumes that a percentage of the annual average flow is needed to maintain a healthy stream environment (Jowett 1997). In contrast, the IFIM Method has both a hydraulic and a habitat component.

Field observations that were developed into the Tennant Method were taken between 1964 and 1974 on eleven streams in Nebraska, Montana and Wyoming. Measurements were taken at between two and nine flow levels per river, at a total of 58 cross-sections for all rivers and all sites. Based on analysis of depth and velocity data collected and on professional judgment, Tennant concluded that 10 percent of the average annual flow, as a minimum flow, would sustain short-term survival for most aquatic life forms. Thirty percent of the average annual flow, as a minimum flow, would sustain good survival habitat for most aquatic life forms (Table 6). Tennant suggests setting flows at two time periods: April through September and October to March, although these time periods could be adjusted to better reflect local fish species and life histories.

Use of this method requires an assumption that this proportion of the average annual flow will result in suitable depths and velocities for coldwater fish species, and that this relationship will apply to streams and rivers of similar size and gradient to Tennant's study rivers (Jowett 1997). This assumption has not been validated in Oregon or other parts of the Pacific Northwest.

Table 6. Instream flow regimens for fish, wildlife, recreation, and related environmental resources (from Tennant, 1976).

	Recommended base flow regimens of flows	
Narrative description	Oct.-Mar.	Apr.-Sept.
Flushing or maximum	200% of the average flow	
Optimum range	60%-100% of the average flow	
Outstanding	40%	60%
Excellent	30%	50%
Good	20%	40%
Fair or degrading	10%	30%
Poor or minimum	10%	10%
Severe degradation	10% of average flow to zero flow	

We applied the Tennant Method to the Hood River downstream of the Middle Fork using estimated monthly stream flows, combined with monthly estimates of consumptive use and storage, available from the Oregon Water Resources Department (OWRD) Water Availability Reporting System (WARS)[15]. The OWRD has estimated unregulated monthly stream flows at the mouths of several water availability basins (WABs) within the Hood River Basin. Three locations within the Hood River Basin were selected for analysis: Middle Fork at the mouth, East Fork above the confluence with the West Fork, and the Hood River at the mouth (Figure 5). For the purposes of this analysis we used median monthly (i.e.50% exceedance) flow values.

Consumptive use estimates available from the OWRD at the outlets of the Water Availability Basins were used in this analysis. A consumptive use is defined as any water use that causes a net reduction in stream flow. These uses are usually associated with an evaporative or transpirative loss. The OWRD recognizes four major categories of consumptive use: irrigation, municipal, storage, and all others (e.g., domestic, livestock). Cooper (2002) estimates the consumptive use for irrigation using estimates made by the USGS; including estimates from the 1987 Census of Agriculture, estimates from the OSU Cooperative Extension Office, 1989-90 Oregon Agriculture and Fisheries Statistics, and an OSU Study of Crop Water Requirements (Cuenca, 1992). Irrigation uses are not estimated to be 100 percent consumptive. Consumptive use from other categories of use is obtained by multiplying a consumptive use coefficient (e.g., for domestic use, the coefficient is 0.20) by the maximum diversion rate allowed for the water right. The OWRD assumes that all of the non-consumed part of a diversion is returned to the stream from which it was diverted. The exception is when diversions are from one watershed to another, in which case the use is considered to be 100 % (i.e., the consumptive use equals the diversion rate).

[15] http://apps.wrd.state.or.us/apps/wars/wars_display_wa_tables/search_for_WAB.aspx

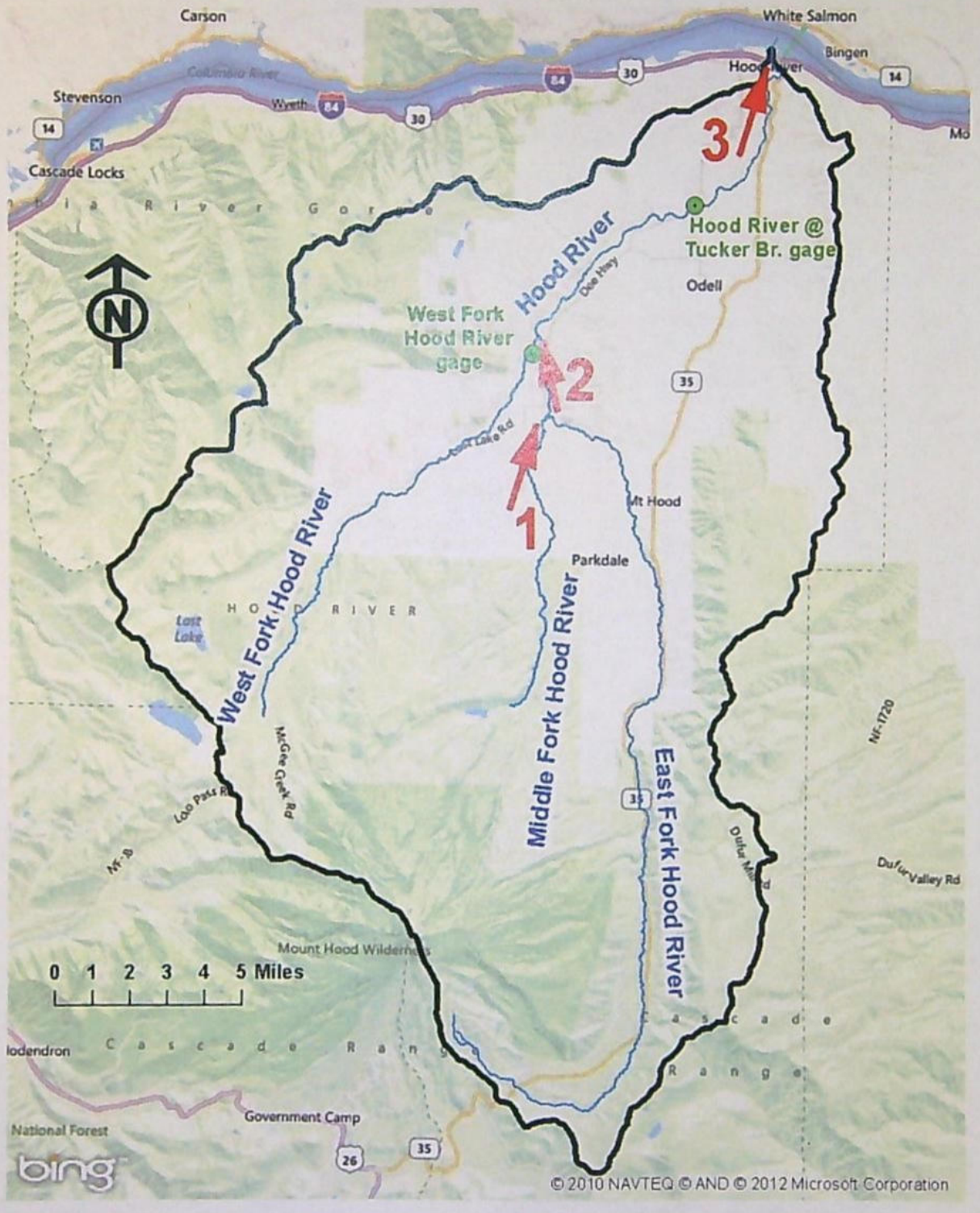

Figure 5. Hood River Basin, showing the five flow evaluation locations used in this analysis. Each location corresponds to a Oregon Water Resources Department Water Availability Basin outlet.

Monthly unregulated and current stream flows for the Middle Fork Hood River at the mouth are shown in Figure 6 (top graph). The difference between the unregulated and current flow is due to the estimated consumptive uses. OWRD estimates of consumptive use for irrigation and other agricultural uses were replaced by the calculated values at the Lower Middle Fork transects site (Table 5). Use of these values assumes that irrigation and agricultural use is 100% consumptive, which is a reasonable assumption for the Middle Fork Basin, given that most of the irrigated lands in the MFID are located within the East Fork Hood River sub-basin (see Figure 1 in the main report for an illustration). The current stream flows in Figure 6 (top graph) incorporate OWRD estimates of other consumptive uses: Municipal (3 cfs; all months), Industrial (0.25 cfs; all months) and Domestic (0.38 cfs; all months).

Consumptive use for the months of May and June appears anomalously large, given that very little irrigation is occurring during these months. The reason for the high consumptive use estimates during these months is reservoir filling at Laurance Lake.

Median current stream flows are estimated to be greater than unregulated flows for several months of the year (February +14 cfs, March +5 cfs, October and December +3 cfs each). This provides an important supplement to downstream flows, as portions of the lower Hood River are considered to be flow-limited during all months of the year.

Annual average streamflow (Q_{AA}) under unregulated conditions is 163 cfs at the mouth of the Middle Fork (Table 7). The average April - September streamflow ($Q_{apr\text{-}sep}$)Under the Unregulated flow regime was 175 cfs, and under current conditions 150 cfs (Table 7). These values represent 107% and 92% respectively of the annual average streamflow (Q_{AA}), which places the outlet of the Middle Fork in the optimum range of conditions for both scenarios using the Tennant (1976) criteria (Table 6). The average October - March streamflow ($Q_{oct\text{-}mar}$) under the Unregulated flow regime was estimated at 151 cfs, and under current conditions 153 cfs (Table 7). These values represent 93% and 94% respectively of the annual average streamflow (Q_{AA}), which places the outlet of the Middle Fork in the optimum range of conditions for both scenarios using the Tennant (1976) criteria (Table 6).

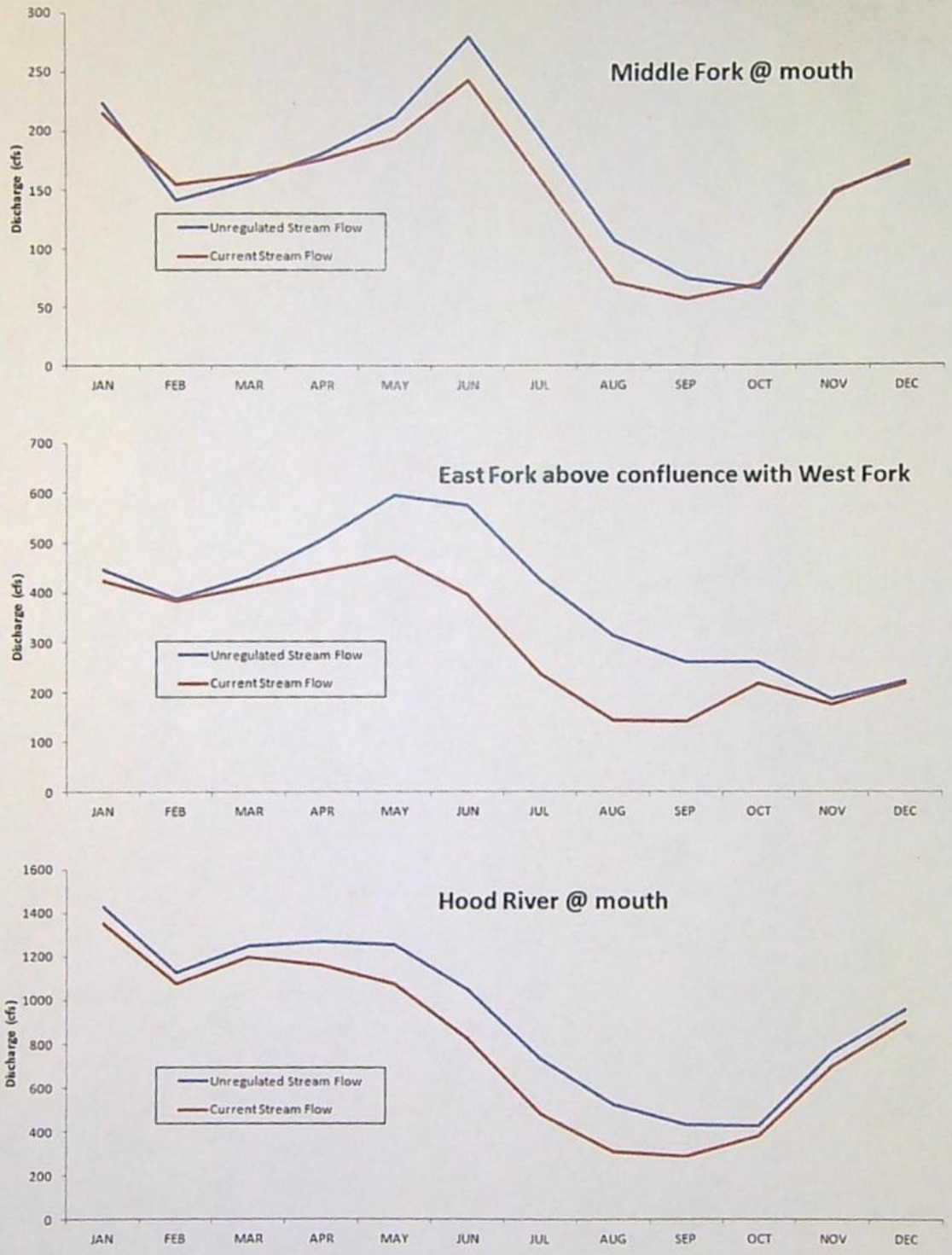

Figure 6. Median monthly flow estimates for the Middle Fork Hood River at the mouth (top), the East Fork Hood River above the West Fork confluence (middle), and at the mouth of the Hood River (bottom).

Table 7. Flow characteristics for the three flow evaluation locations used in this analysis.

Map ID	Evaluation location	Annual average streamflow (Q_{AA}) under unregulated conditions (cfs)	Average April - September streamflow ($Q_{apr-sep}$; cfs)		$Q_{apr-sep}$ as percentage of Q_{AA}		Average October - March streamflow ($Q_{oct-mar}$; cfs)		$Q_{oct-mar}$ as percentage of Q_{AA}	
			Unregulated	Current	Unregulated	Current	Unregulated	Current	Unregulated	Current
1	Middle Fork @ mouth	163	175	150	107%	92%	151	153	93%	94%
2	East Fork above confluence with West Fork	384	447	306	116%	80%	322	305	84%	79%
3	Hood River @ mouth	935	877	689	94%	74%	993	934	106%	100%

Monthly unregulated and current stream flows for the East Fork Hood River above the confluence with the West Fork are shown in Figure 6 (middle graph). This location includes the combined flows of the Middle Fork, and the East Fork above the Middle Fork, as well as accretion flows for the drainage area between the Middle Fork and West Fork confluences. Monthly current stream flow values were estimated by summing median monthly values for the Hood River @ Tucker Bridge gage, the West Fork Hood River gage, and modeled accretion flows upstream of the Tucker bridge gage to the mouth of the West Fork, and between the Middle and West Forks. Only gage records for WY 2002 - 2011 were used in order to match the records developed for the Middle Fork (described in previous sections above). The current stream flows in Figure 6 (middle graph) incorporate OWRD estimates of other consumptive uses: Storage (monthly values range from 0.04 to 0.19 cfs), Municipal (9.48 - 23.10 cfs), Industrial (2.67 cfs; all months), Commercial (0.05 - 0.22 cfs), and Domestic (1.46 cfs; all months). Monthly estimates for consumptive use from irrigation and agriculture (modified for the Middle Fork as described above) range from 0 to 170 cfs.

Both April - September and October - March streamflow for the East Fork Hood River above the confluence with the West Fork (Table 7) are well within the optimum range of conditions under both the Unregulated and Current flow regimes using the Tennant (1976) criteria (Table 6). The larger proportional difference between estimated unregulated and current stream flows for the East Fork Hood River above the confluence with the West Fork (Figure 6, middle) as compared to the Middle Fork @ mouth (Figure 6, top), is due to the proportionally greater consumptive uses that the OWRD estimates in the East Fork above the Middle Fork confluence.

Monthly unregulated and current stream flows for the Hood River at the mouth are shown in Figure 6 (bottom graph). Monthly current stream flow values were estimated by summing median monthly values for the Hood River @ Tucker Bridge gage and modeled

accretion flows from the Tucker bridge gage downstream to the mouth of the Hood River. The current stream flows in Figure 6 (bottom graph) incorporate OWRD estimates of other consumptive uses: Storage (monthly values range from 0.04 to 0.31 cfs), Municipal (34.5 - 48.1 cfs), Industrial (2.96 cfs; all months), Commercial (0.06 - 0.23 cfs), and Domestic (2.16 cfs; all months). Monthly estimates for consumptive use from irrigation and agriculture (modified for the Middle Fork as described above) range from 7.6 to 207.2 cfs.

Both April - September and October - March streamflow (Table 7) are within the optimum range of conditions under both the Unregulated and Current flow regimes using the Tennant (1976) criteria (Table 6).

Application of the Tennant Method to the Hood River downstream of the Middle Fork suggests that, based on the Tennant (1976) criteria given in Table 6, the current flow regime is within the "optimum" habitat range, despite the cumulative impacts of all consumptive uses.

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Introduction

The Clear Branch study site is located in the 0.6-mile-long reach between Clear Branch Dam and the Coe Branch confluence.

Habitat Mapping Results

A total of 3,376 feet of stream channel were surveyed, from the Coe Branch confluence to the Clear Branch Dam at Laurance Lake, on August 2-3, 2011. The stream is not glacially influenced and was clear at the time of the survey. Table 1 summarizes habitat types found in the Clear Branch.

Table 1. Clear Branch habitat types.

Habitat Type	Percent of Wetted Area
Dammed & Backwater Pools	3.4%
Scour Pools	13.4%
Riffles	46.1%
Rapids	22.8%
Cascades	14.3%

Transects

A total of seven cross-sections (transects) were chosen during an interagency site visit on August 17, 2011. Transect locations are shown in Figure 1 (Section 1). They are summarized below in Table 2, and shown in Figures 5 - 11. The most-downstream transect is located 0.27 miles upstream from the Coe Branch confluence, and the most-upstream transect is located 0.22 miles downstream of Clear Branch Dam.

Table 2. Clear Branch transect selection summary.

Transect	Habitat Type	Habitat importance	Comment
1	Pool tailout	Rearing	
2	Shallow pool	Rearing	Complex habitat unit
3	Pool tailout w/gravel bar	Spawning, rearing	Complex habitat unit
4	Pool w/gravel bar	Spawning, rearing	
5	Riffle w/boulder pockets	Rearing	Common habitat type
6			
7			

Flow Measurements

Flow measurements were collected in September and October, 2011, and are summarized in Table 3. Calibration flows of 4.4 cfs, 12.9 cfs and 30.8 cfs were calculated by averaging the measured flows at Transects 1, and 3 through 7. (Transect 2 gave a poorer estimate of flows due to water flowing laterally across the transect.)

Table 3. Clear Branch study site flow measurements.

Transect	Measured Discharge (cfs)		
	9/20/2011	10/18/2011	10/19/2011
Clear Branch 1	3.7	12.9	30.0
Clear Branch 2	8.4*	15.1	34.9
Clear Branch 3	4.4	13.1	33.6
Clear Branch 4	3.9	13.2	31.7
Clear Branch 5	4.2	12.6	27.6
Clear Branch 6	4.3	14.6	31.5
Clear Branch 7	5.3	11.1	30.3

*poor estimate due to lateral flow across transect.

Hydraulic Model Calibration

Channel and water surface elevations at Transects 1 through 4 were surveyed to a benchmark, and elevations at Transects 5 through 7 were surveyed to a second benchmark[16]. Using the Middle Fork Irrigation District rating curve for the staff gage at the study site (E. Lavelle, MFID, pers. comm. 2011), an additional water surface elevation at 40 cfs was estimated at each transect. This extended the range of flows predicted by the hydraulic model to cover the range of current flow conditions as well as most of the range of historic flow conditions. Using standard methods, the range of flows from the resulting hydraulic model should be from 1.6 cfs to 100 cfs.

Revisions to Measured Data

Transect 3 Side Channel

An adjustment to the measured channel profile was necessary at Transect 3. Transect 3 has a main channel and a side channel, which had standing water or very low velocities at the 4.4 cfs and 12.9 cfs measurements (Figure 3, Appendix B). At these flow levels, the side channel flow is regulated primarily by an upstream hydraulic control. Because the side

[16] Note that all elevations are relative to a benchmark, where each benchmark was ascribed an arbitrary elevation of 100 feet.

channel thalweg has a lower elevation than the main channel thalweg, the hydraulic model routed water through the side channel instead of the main channel during model calibration.

To address this, the side channel profile was moved upward, so that the side channel thalweg elevation was equal to the main channel thalweg elevation (Figure 1). This allowed the predicted water surface elevations and predicted velocities to match the observed conditions between 4.4 and 30.8 cfs.

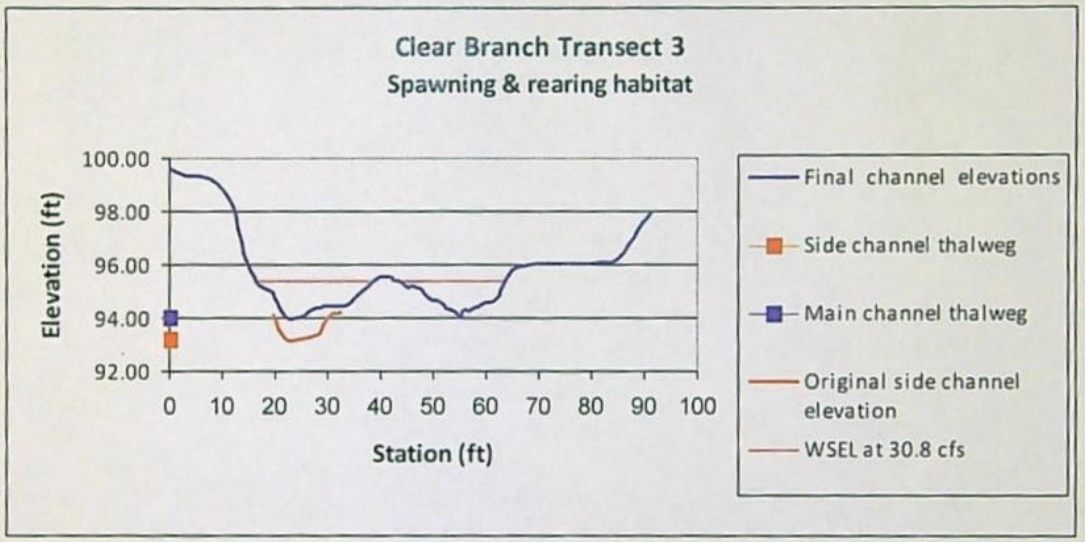


Figure 1. Clear Branch transect 3, adjustments to cross-section elevation. The main channel is between stations 44 and 63.

Water Surface Elevation Model

A three-flow regression using the measured flows was used to calibrate the water surface elevation model. Calibration parameters are in Table 4. All transect's stage-discharge relationship and the relationship of modeled and predicted flows at the calibration flows was good. U.S. Fish & Wildlife Service (2010a) consider that this method works well if: the beta-value (B-value) calculated by the model is between 2.0 and 4.5; the mean error of the stage discharge relationship is less than 10 percent; there is less than a 0.1 difference between the measured and calculated water surface elevations, there is no more than a 25% difference between measured flows and flows calculated by the model.

Measured and estimated water surface elevations in the Clear Branch are in Figure 2. "SZF" refers to the stage of zero flow (hydraulic control), which was estimated during field data collection.

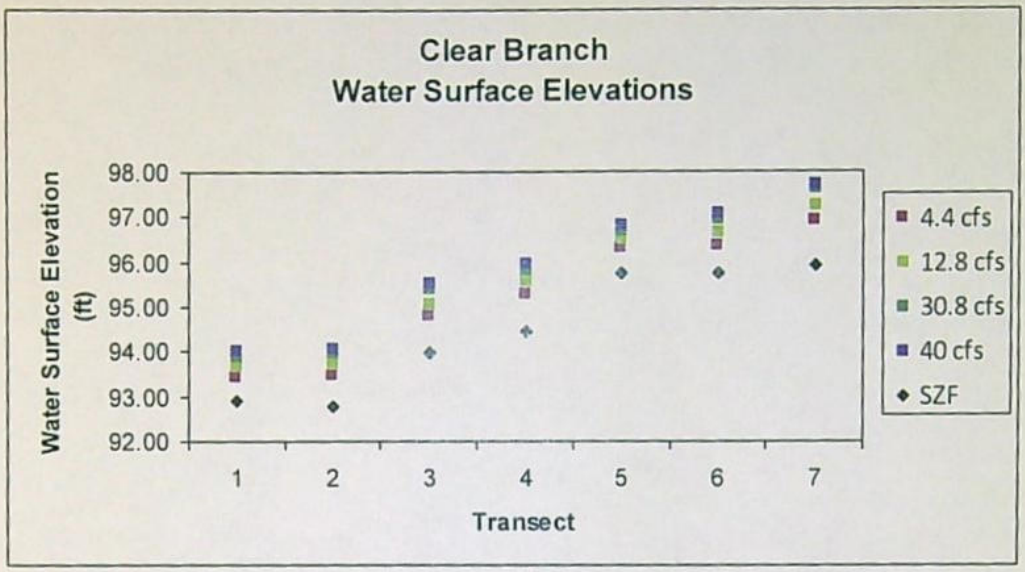


Figure 2. Water surface elevations and hydraulic control elevations ("SZF", stage of zero flow) for the Clear Branch transects. Transects 1 -4 are referenced to Benchmark 1, transects 5 – 7 to Benchmark 2.

Table 4. Summary of Clear Branch hydraulic model calibration details.

Transect						
1	2	3	4	5	6	7
Discharge (cfs) Best Estimate from Measured Data & Staff Gage Rating Curve (for 40 cfs)						
4.4	4.4	4.4	4.4	4.4	4.4	4.4
12.9	12.9	12.9	12.9	12.9	12.9	12.9
30.8	30.8	30.8	30.8	30.8	30.8	30.8
40	40	40	40	40	40	40
Stage (given) (ft)						
93.43	93.44	94.80	95.27	96.30	96.35	96.90
93.65	93.70	95.05	95.55	96.48	96.62	97.23
93.89	93.95	95.40	95.81	96.69	96.92	97.60
94.01	94.07	95.52	95.93	96.81	97.04	97.72
Ratio of Measured to Predicted Discharge						
0.989	0.907	0.947	1.012	0.954	0.997	0.998
1.008	0.990	1.102	0.966	1.061	1.002	1.018
1.046	1.039	0.988	1.042	1.076	1.012	0.989
0.959	0.973	0.970	0.983	0.918	0.989	1.001
Mean Error of Stage-Discharge Relationship (%)						
2.64	1.91	4.81	2.61	6.65	<1	1.00
B-Coefficient of Stage-Discharge Relationship						
3.06	3.41	3.43	3.75	3.58	2.96	3.61

Velocity Predictions

Because the locations of high-velocity cells changed between calibration flows, a "three-velocity" regression model was not appropriate to use in this case. Instead, a "one-velocity" regression model using velocities measured at either the middle flow or the high flow

measurement. The low-flow measurement was used to judge the quality of the velocity model for the lower range of flows.

A summary of the predictive models performance compared to measured values is below in Table 5. Velocity predictions were considered to be good if they were within 15% of measured velocities or within 0.2 fps for low velocities. Italics below indicate cases where these criteria were not met. In general, predicted velocities matched fairly well with measured velocities. In the case of the maximum flow at Transect 1, poor prediction was generally limited to a few cells.

Table 5. Summary of measured and predicted velocities, Clear Branch hydraulic model.

Transect	1		Calibration Velocity Set: 12.9 cfs			
Velocity	Measured Low	Predicted Low	Measured Mid	Predicted Mid	Measured High	Predicted High
Mean	0.19	0.20	0.51	0.43	0.94	0.70
Minimum	0.09	0.01	0.00	0.03	0.00	0.05
Maximum	*0.80*	*0.55*	*1.54*	*1.26*	*2.65*	*2.22*
Transect	2		Calibration Velocity Set: 30.8 cfs			
Velocity	Measured Low	Predicted Low	Measured Mid	Predicted Mid	Measured High	Predicted High
Mean	*0.42*	*0.16*	0.52	0.35	0.67	0.62
Minimum	0.00	0.01	-0.04	0.00	0.00	0.01
Maximum	*1.10*	*0.47*	*2.23*	*1.04*	2.20	1.87
Transect	3		Calibration Velocity Set: 30.8 cfs			
Velocity	Measured Low	Predicted Low	Measured Mid	Predicted Mid	Measured High	Predicted High
Mean	0.35	0.33	0.74	0.54	1.11	0.85
Minimum	0.06	0.01	-0.35	0.00	-0.10	0.04
Maximum	*1.72*	*0.97*	*2.42*	*1.72*	*3.65*	*2.74*
Transect	4		Calibration Velocity Set: 12.9 cfs			
Velocity	Measured Low	Predicted Low	Measured Mid	Predicted Mid	Measured High	Predicted High
Mean	0.33	0.47	0.71	0.95	1.29	1.26
Minimum	0.00	0.03	0.00	0.04	0.02	0.09
Maximum	0.99	1.13	1.96	2.05	*2.86*	*3.82*
Transect	5		Calibration Velocity Set: 12.9 cfs			
Velocity	Measured Low	Predicted Low	Measured Mid	Predicted Mid	Measured High	Predicted High
Mean	0.35	0.36	0.70	0.71	1.12	1.20
Minimum	0.02	0.01	-0.11	0.01	0.01	0.02
Maximum	*1.55*	*0.90*	1.54	1.54	*2.85*	*3.67*
Transect	6		Calibration Velocity Set: 12.9 cfs			
Velocity	Measured Low	Predicted Low	Measured Mid	Predicted Mid	Measured High	Predicted High
Mean	0.29	0.28	0.66	0.62	1.06	0.93
Minimum	0.03	0.02	-0.06	0.01	0.01	0.01
Maximum	*1.05*	*0.73*	1.92	1.76	*2.46*	*2.89*
Transect	7		Calibration Velocity Set: 12.9 cfs			
Velocity	Measured Low	Predicted Low	Measured Mid	Predicted Mid	Measured High	Predicted High
Mean	0.59	0.72	*0.60*	*0.88*	*1.01*	*1.49*
Minimum	0.14	0.16	0.01	0.11	0.01	0.06
Maximum	*1.22*	*1.52*	2.19	1.89	*3.12*	*4.15*

Proposed Transect Weighting

The PHABSIM model calculates the flow-habitat relationship (Weighted Usable Area (WUA) vs. Flow) in square feet of habitat normalized to a hypothetical 1,000 linear feet of stream. This is an index, not an actual map of habitat. The modeler specifies the "transect weighing", which is the relative importance of each transect. One common approach to transect weighting is to assign a percentage value. Transects 1 - 4 are in pool habitats and contain gravel (16% of the total habitats in the reach) and Transects 5 – 7 are in riffle habitats (46 % of the total) (Table 1). This is roughly a 1 : 3 ratio. Using that idea, we propose that transects 1 – 4 have a 40% weighting, and Transect 5 – 7 have a 60% weighting. This gives additional weight to the importance of pools and spawning gravel in this reach of the Clear Branch, but acknowledges that riffle habitats are very common. Final transect weightings, as agreed to by the FMP Committee, are in Table 6.

Table 6. Transect weighting for the Clear Branch study site PHABSIM model.

Transect	Proposed Weighting (%)
1	10
2	10
3	10
4	10
5	20
6	20
7	20

Clear Branch Weighted Usable Area

Results & Discussion

The range of flows over which habitat is modeled depends on what flows were actually measured. This range is presented in Table 7. The flow-exceedence value calculated for the minimum and maximum flows to be modeled is also given in Table 7. For the Clear Branch, measured flows will allow modeling over a fairly wide range of potential future conditions.

Table 7. Flow ranges for hydraulic modeling for the Clear Branch study site.

	Allowable range of modeled flows (cfs):		Associated flow exceedence (%):	
Study Site	Minimum	Maximum	Minimum	Maximum
Clear Branch	1.6	100	100%	3%

Spawning Life Stages

Table 8 and Figure 2 present results for spawning life stages for this study site. Weighted Usable Area is expressed as square feet of habitat scaled to a 1,000-foot stream reach. WUA predictions are most correctly seen as an index of change in available habitat as flows change, and should always be analyzed in the context of basin hydrology. This appendix presents WUA results, while further analysis is presented in Section 3 of this report.

Table 8. Weighted Usable Area results for the Clear Branch study site, spawning lifestages. WUA is expressed as square feet of habitat for a 1,000-foot stream reach.

Flow (cfs)	Clear Branch			
	Bull Trout Spawning WUA	Chinook Spawning WUA	Steelhead Spawning WUA	Coho Spawning WUA
1.71	2097	986	278	586
2	2404	1124	324	624
3	3368	1593	482	785
4.28	4417	2207	703	1033
4.4	4791	2436	795	1144
5	5350	2790	949	1329
6	5843	3118	1102	1515
8	6300	3415	1255	1706
12.9	7067	3940	1560	2084
15	7815	4604	2005	2595
18	8161	5017	2325	2938
20	8446	5571	2768	3368
25	8572	5904	3041	3606
30.8	8649	6206	3312	3813
31.56	8683	6614	3701	4077
35	8710	6948	4065	4292
40	8703	7195	4391	4443
45	8698	7256	4475	4479
60	8682	7365	4630	4546
75	8651	7505	4837	4634
80	8554	7770	5293	4824
100	8395	7935	5649	4949

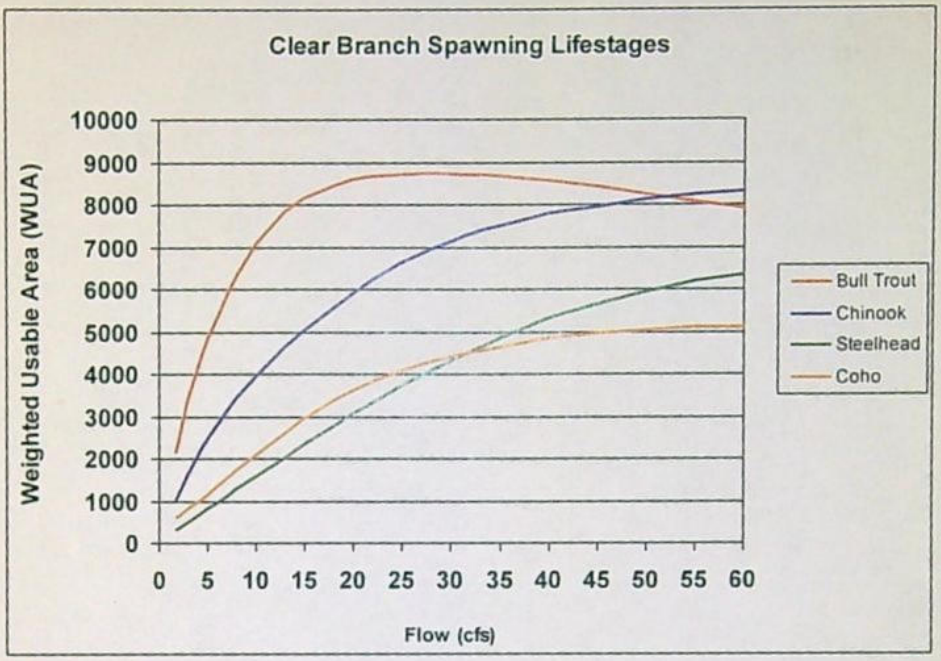


Figure 3. Weighted Usable Area results for the Clear Branch study site, spawning lifestages. WUA is expressed as square feet of habitat for a 1,000-foot stream reach.

Rearing Life Stages

Table 9 and Figure 4 present Weighted Usable Area predictions for the Clear Branch rearing life stages.

Table 9. Clear Branch Weighted Usable Area results, rearing life stages. WUA is expressed as square feet of habitat for a 1,000-foot stream reach.

Flow (cfs)	Clear Branch				
	Bull Trout Juvenile WUA	Chinook Juvenile WUA	Steelhead Juvenile WUA	Bull Trout Juvenile/Adult WUA	Coho Juvenile WUA
1.71	1660	2297	1023	1852	1660
2	1782	2568	1128	2046	1782
3	2135	3359	1464	2658	2135
4.28	2479	4206	1879	3371	2479
4.4	2581	4508	2042	3636	2581
5	2684	4937	2289	4037	2684
6	2743	5302	2512	4390	2743
8	2775	5622	2712	4702	2775
12.9	2799	6140	3060	5205	2799
15	2859	6700	3473	5722	2859
18	2899	7011	3719	6008	2899
20	2941	7357	4017	6337	2941
25	2969	7539	4185	6501	2969
30.8	3004	7691	4346	6636	3004
31.56	3038	7871	4557	6811	3038
35	3066	7998	4748	6954	3066
40	3094	8075	4906	7073	3094
45	3101	8090	4946	7105	3101
60	3113	8116	5018	7158	3113
75	3120	8145	5101	7218	3120
80	3133	8201	5269	7354	3133
100	3145	8223	5419	7454	3145

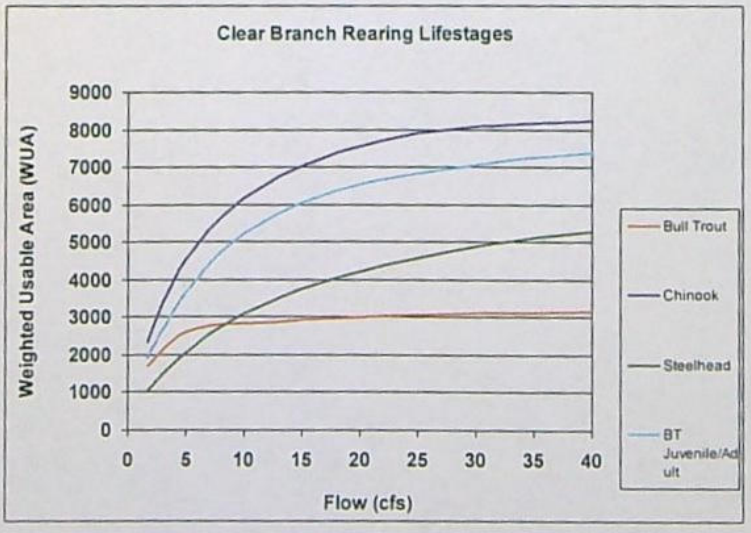


Figure 4. Clear Branch Weighted Usable Area results, rearing life stages. WUA is expressed as square feet of habitat for a 1,000-foot stream reach.

Habitat-Time Series

These results are produced without reference to whether if, or how often, a given flow is present in the stream channel. Therefore, Weighted Usable Area predictions are always be analyzed with respect to basin hydrology. An analysis using these habitat predictions and the synthesized hydrologic time-series developed a habitat-time series analysis. These results are presented in Section 3 and Appendix L. In turn, the habitat-time series was developed into a spreadsheet tool that could compare existing and potential future operations of the MFID project.

Clear Branch Study Site Transect Photographs

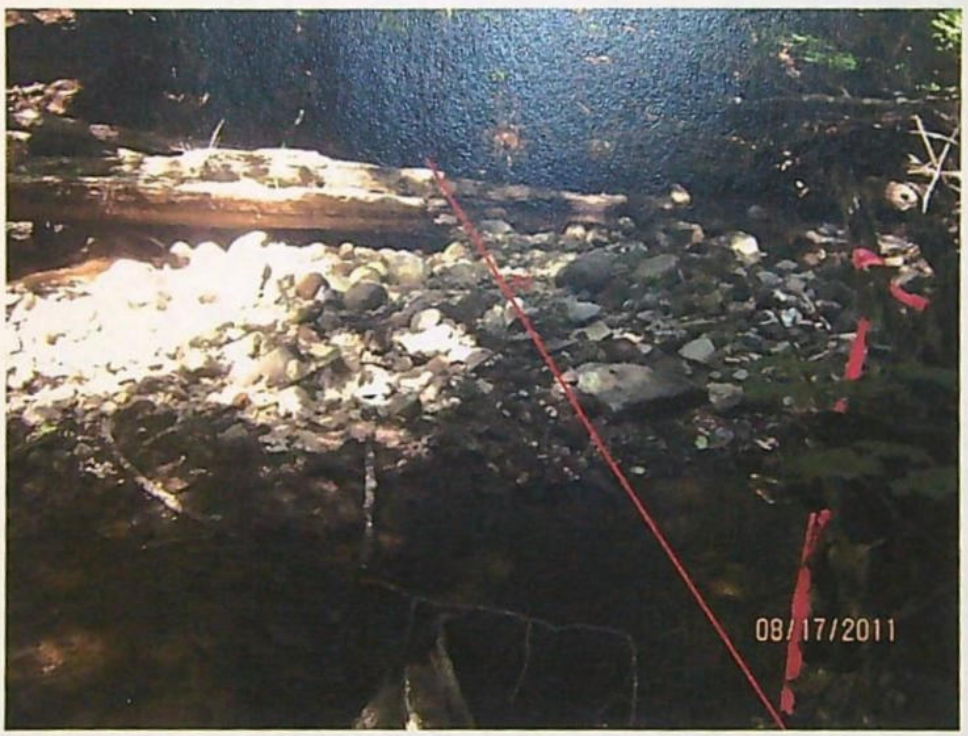


Figure 5. Clear Branch Transect 1, looking across the channel.

Figure 6. Clear Branch transect 2, looking across the channel.

Figure 7. Clear Branch transect 3, composite looking upstream. Main channel is on left, side channel on right, gravel bar in photo center.

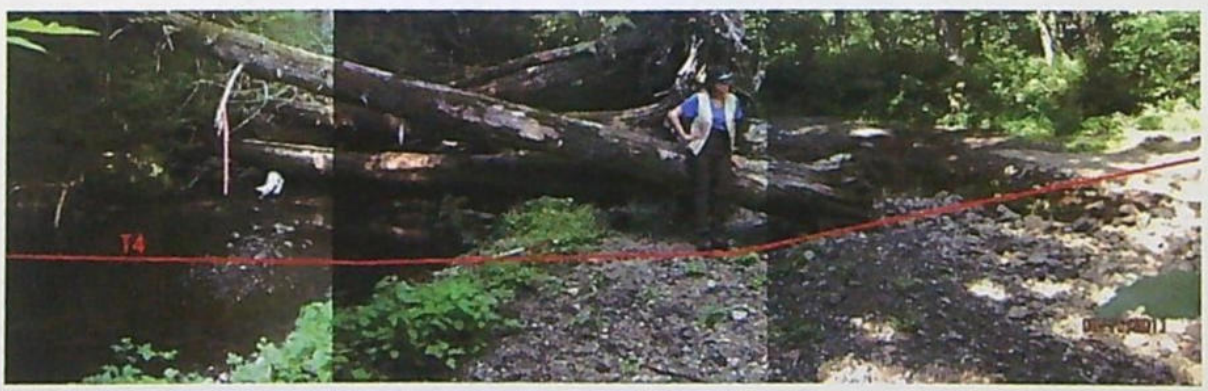


Figure 8. Clear Branch transect 4. This photo is looking upstream at the main channel.

Figure 9. Clear Branch transect 5, looking across the channel.

Figure 10. Clear Branch transect 6, looking across the channel.

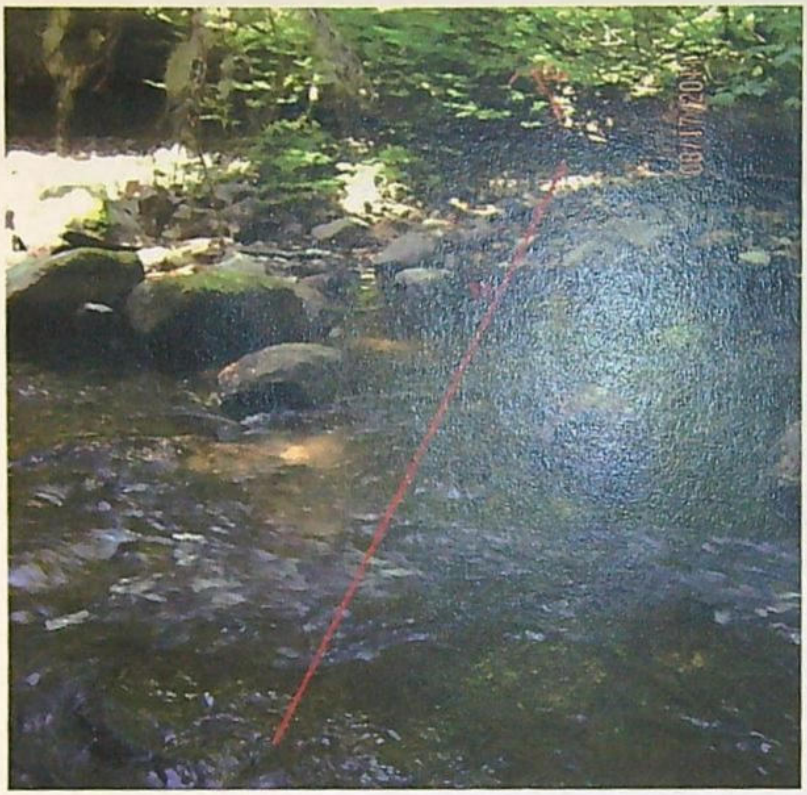


Figure 11. Clear Branch transect 7, looking across the channel.

References

Oregon Dept. of Fish & Wildlife. 2006. Standard review checklist for PHABSIM modeling. Memo from E.G. Robison, ODFW. July 7, 2006. Obtained via T. Hardin, ODFW, pers. comm. 2011.

U.S. Fish & Wildlife Service (USFWS). 2010a. Flow-habitat relationships for spring and fall-run chinook salmon and steelhead trout spawning in the Yuba River. Sacramento Fish & Wildlife Office, Sacramento, CA. August, 2010.

Introduction

The Coe Branch study reach is located in the Coe Branch, between the confluence with the Clear Branch and the MFID diversion, approximately 1.07 miles upstream (Figure 1, Section 1).

Habitat Mapping Results

A total of 4,137 feet of stream channel, from the Clear Branch confluence to the diversion headgate, were surveyed on August 3, 2011. Rapids comprised 43.7 % of the habitat, with 56.2% cascades habitats. This reach is glacially influenced and was turbid at the time of the survey.

Transects

Two cross-sections (transects) were set at this study site. Transect 1 is located approximately 0.3 miles upstream of the confluence with the Clear Branch, in a cascade habitat unit downstream of the access road. Transect 2 is located approximately 1.07 miles upstream of the Clear Branch confluence, in the diversion reach. Rationale for the placement of Transect 1 was to represent typical cutthroat trout habitat in the Coe Branch. Rationale for the placement of Transect 2 was to represent conditions in the bypass reach, especially for trout potentially migrating further upstream into Compass Creek. Transect photos are Figures 4 - 6.

Table 1. Coe Branch transect selection summary.

Transect	Habitat Type	Habitat importance	Comment
1	Cascade	Cutthroat trout habitat, migration	
2	Low-gradient cascade	Migration into Compass Creek	In diversion bypass reach

Flow Measurements

Flow measurements were collected between September 2011 and March 2012, and are summarized in Table 2. These were used as calibration flows. While results for both

transects are presented together, they are not in physical proximity, and relative elevations[17] relate to different benchmarks.

Table 2. Coe Branch study reach measured flows.

Transect	Flow Measured (cfs)	Measurement Date
One	50.5	9/19/2011
	15.4	10/18/2011
	6.2	12/8/2011
Two	18.2	9/19/2011
	10.8	3/28/12
	2.53	10/18/2011
	1.39*	12/8/2011

*This lowest measured flow was not used in the hydraulic model.

Using standard methods, this should allow a range of modeled flows at Transect 1 from 2.5 cfs to 125 cfs, and from approximately 2 cfs to 45.5 cfs in the diversion reach at Transect 2.

Hydraulic Model Calibration

Water Surface Elevation Model

A three-flow regression using the measured flows was used to calibration the water surface elevation model. Calibration parameters are presented below, in Table 3. Both transect's stage-discharge relationship and the relationship of modeled and predicted flows at the calibration flows was good. U.S. Fish & Wildlife Service (2010a) consider that this method works well if: the beta-value (B-value) calculated by the model is between 2.0 and 4.5; the mean error of the stage discharge relationship is less than 10 percent; there is less than a 0.1 difference between the measured and calculated water surface elevations, there is no more than a 25% difference between measured flows and flows calculated by the model.

[17] Note that all elevations are relative to a benchmark, where each benchmark was ascribed an arbitrary elevation of 100 feet

Table 3. Summary of Coe Branch hydraulic model statistics.

	Transect 1	Transect 2
Discharge (cfs) Best Estimate from Measured Data		1.4*
	6.2	2.5
	15.4	10.8
	50.5	18.2
Stage (given) (ft)	94.82	92.01
	95.16	92.18
	95.63	92.36
Ratio of Measured to Predicted Discharge	1.036	1.971
	0.935	1.030
	1.033	0.940
Mean Error of Stage-Discharge Relationship (%)	4.53	5.87
B-Coefficient of Stage-Discharge Relationship	3.51	0.81

* (not used in hydraulic model)

Based on the USF&WS guidelines, the hydraulic models for both transects would be considered good, except for the anomalously low B-coefficient value for Transect 2. No good explanation can be found for this. Attempts to adjust the hydraulic model in order to generate a B-coefficient value in the desired range resulted in high mean errors and poor measured/predicted discharge ratios. As is, the mean error value and the ratio of measured to predicted flows are both good. Because of this, and because predicted velocities were reasonable (see below), the model was not adjusted further.

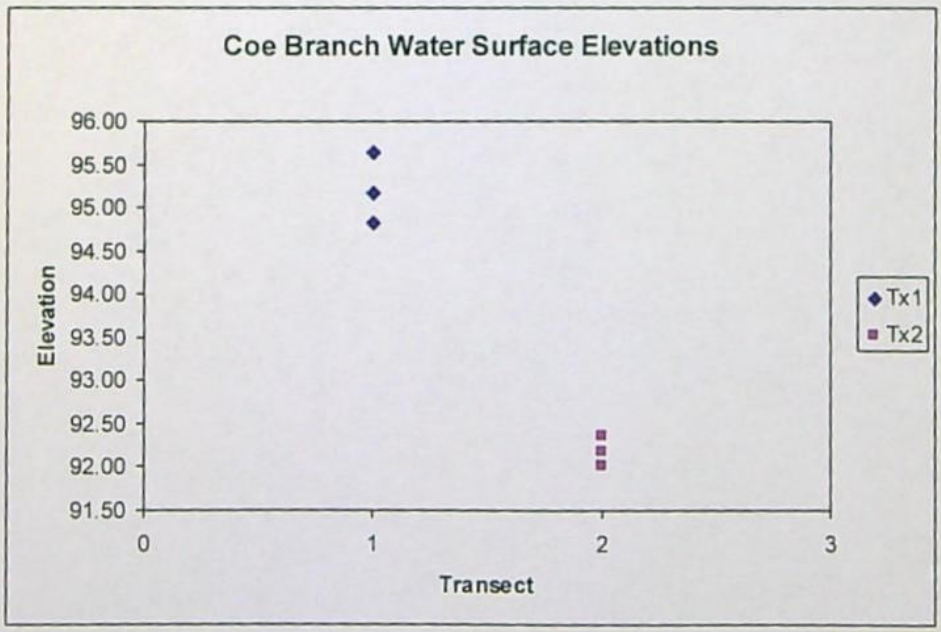


Figure 1. Coe Branch measured relative water surface elevations. Elevations at each transect refer to a different benchmark.

Velocity Predictions

Because the locations of high-velocity cells across the transect changed between calibration flows, a "three-velocity" regression model was not appropriate to use in this case. Instead, a "one-velocity" regression model using the middle flow measurement was used. The low-flow and high-flow measurement were used to judge the quality of the mid-flow velocity model.

A summary of the mid-flow velocity model, compared to measured values is in Table 4. Velocity predictions were considered to be good if they were either within 15% of measured velocities, or within 0.2 fps for low velocities. Italics below indicate cases where these criteria were not met.

Table 4. Coe Branch velocity prediction summary.

Transect 1		Calibration Velocity Set: 15.4 cfs			Downstream Reach	
Velocity	Measured Low Q (fps)	Predicted Low Q (fps)	Measured Mid Q (fps)	Predicted Mid (fps)	Measured High Q (fps)	Predicted High Q (fps)
Mean	0.53	0.50	0.89	0.82	1.70	1.57
Minimum	0.02	0.01	0.02	0.02	0.02	0.04
Maximum	2.16	1.68	2.83	2.69	5.38	5.10
Transect 2		Calibration Velocity Set: 10.8 cfs			Diversion Reach	
Velocity	Measured Low Q (fps)	Predicted Low Q (fps)	Measured Mid Q (fps)	Predicted Mid (fps)	Measured High Q (fps)	Predicted High Q (fps)
Mean	0.52	0.48	1.49	1.49	1.61	1.67
Minimum	0.03	0.09	0.05	0.29	0.20	0.04
Maximum	1.25	0.87	2.91	2.49	3.89	4.14

Overall, predicted velocities matched fairly well with measured velocities. In the case of the maximum flow at Transect 1, poor prediction was mostly limited to a single cell (See Appendix A).

Transect Weighting

Each of these transects was selected to represent habitat in two reaches with different flow regimes. Therefore, we propose that the habitat-flow relationship for each transect be calculated separately.

Coe Branch Habitat Model Results & Discussion

Coe Branch Transect 1

Coe Branch Transect 1 is located approximately 0.3 miles upstream from the confluence with the Clear Branch. The flow-exceedance table (Table 5) shows that we did capture the flow range for the unregulated condition, and most of the flow range flow range for the current conditions. (The current condition flows were estimated by subtracting actual diversion records from modeled streamflow estimates, and some uncertainty does occur with these data. See Appendix D.)

Table 5. Flow ranges for hydraulic modeling for each IFIM study site.

	Allowable range of modeled flows (cfs):		Associated flow exceedence (%):	
Study Site	Minimum	Maximum	Minimum	Maximum
Coe Branch 1 (downstream)	2.5	125	100%	7%
Coe Branch 2 (at diversion, in bypass)	2	45.5	77%	28%

Spawning Life Stages

HSC criteria curves were run for resident cutthroat trout and bull trout spawning at Transect 1, but Weighted Usable Area values were zero for these life stages. This is most likely due to the fact that no suitable substrates were present at the transect. For photo of the transect location see Figure 4.

Rearing Life Stages

Table 6 and Figure 2 present results for rearing habitat at Transect 1. WUA values for the entire range of modeled flows are presented in the table, while the figure presents a truncated flow range, in order to present results at lower flows in a better scale. Table 7 presents the same results, expressed as a percentage of the total stream area. These results indicate that there is a small amount of bull trout habitat in stream reaches represented by Transect 1. Because the curve titled "Juvenile/adult rearing/migration" incorporates the ODFW salmonid passage criteria, these results also suggest that between 20% and 30% of the stream channel is passable at most of the modeled flows, and that low flows do not restrict migration in this reach.

Table 6. Weighted Usable Area for rearing and migration lifestages in the Coe Branch downstream of the diversion. WUA is expressed as square feet of habitat for a 1,000 foot stream reach.

Flow (cfs)	Cutthroat Juvenile/Adult Rearing/Migration WUA	Bull Trout Juvenile WUA	Bull Trout Juvenile/ Adult WUA
1	2431	639	1114
2.49	3683	1252	1983
4.5	4512	1647	2715
6.22	4969	1816	3104
8	5273	1992	3446
10	5525	2148	3710
12	5685	2260	3919
15.4	5893	2349	4241
18	5931	2376	4429
20	5864	2355	4498
25	5573	2262	4569
30	5319	2171	4544
35	5136	2149	4338
40	5131	2126	4212
45	5180	2118	4127
50.5	5296	2092	4169
55	5385	2040	4300
60	5470	1987	4450
65	5548	1948	4590
70	5562	1932	4717
75	5573	1914	4837
80	5579	1890	4959
85	5606	1865	5018
90	5685	1838	5052
95	5726	1814	5075
100	5715	1790	5126
105	5692	1763	5183
110	5644	1733	5204
115	5628	1706	5192
126.25	5568	1662	5075

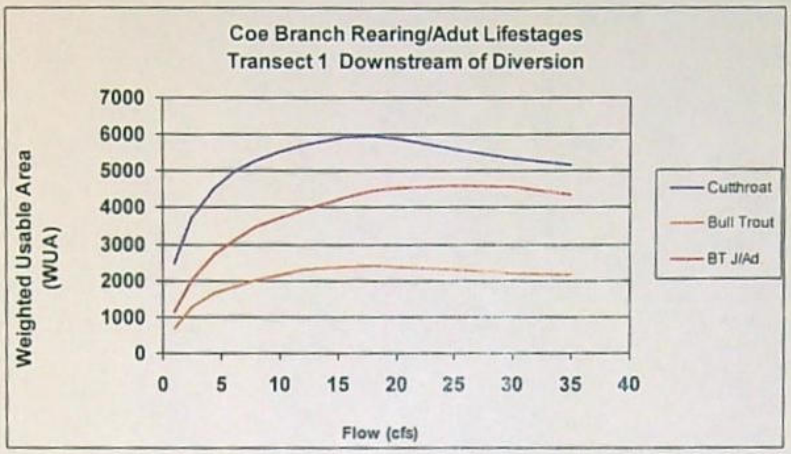


Figure 2. Weighted Usable Area for rearing and migration lifestages in the Coe Branch downstream of the diversion. WUA is expressed as square feet of habitat for a 1,000 foot stream reach. The range of flows shown is truncated to better display conditions at lower flows.

Table 7. Coe Branch Transect 1, rearing habitat expressed as a percent of the total stream area.

Flow (cfs)	WUA - Percentage of Total Area		
	Cutthroat Juvenile/Adult Rearing/Migration WUA	Bull Trout Juvenile WUA	Bull Trout Juvenile/Adult WUA
1	19	5	9
2.49	25	8	13
4.5	27	10	16
6.22	28	10	18
8	29	11	19
10	30	12	20
12	30	12	21
15.4	30	12	21
18	29	12	22
20	29	12	22
25	27	11	22
30	26	10	22
35	24	10	21
40	24	10	20
45	23	10	19
50.5	23	9	18
55	22	8	18
60	22	8	18
65	22	8	19
70	22	8	19
75	22	8	19
80	22	7	20
85	22	7	20
90	22	7	20
95	22	7	20
100	22	7	20
105	22	7	20
110	22	7	20
115	22	7	20
126	21	6	19

Habitat-Time Series

These results are produced without reference to whether if, or how often, a given flow is present in the stream channel. Therefore, Weighted Usable Area predictions are always be analyzed with respect to basin hydrology. An analysis using these habitat predictions and the synthesized hydrologic time-series developed a habitat-time series analysis. These results are presented in Section 3 and Appendix L. In turn, the habitat-time series was developed into a spreadsheet tool that could compare existing and potential future operations of the MFID project.

Coe Branch Transect 2

Coe Branch Transect 2 is located approximately 1.07 miles upstream of the confluence with the Clear Branch, within the diversion bypass reach (see Figure.

Spawning Life Stages

HSC criteria curves were run for resident cutthroat trout and bull trout spawning, but Weighted Usable Area values were zero for these life stages. This is most likely due to the fact that no suitable substrates were present at the transect. For photos of the transect location, see Figures 5 and 6.

Rearing Life Stages

Table 8 presents Weighted Usable Area results for rearing life stages. Because the cutthroat juvenile-adult Because the curve titled "Juvenile/adult rearing/migration" incorporates the ODFW salmonid passage criteria, these results also suggest that at least 30% of the stream channel is passable at most of the modeled flows, and that low flows do not restrict migration into Compass Creek.

Table 8. Weighted Usable Area for rearing and migration lifestages in the Coe Branch at the diversion. WUA is expressed as square feet of habitat for a 1,000 foot stream reach.

Flow (cfs)	Cutthroat Juvenile/Adult Rearing/Migration WUA	Bull Trout Juvenile WUA	Bull Trout Juvenile/Adult WUA
1	3884	1895	1700
1.39	3922	1823	2048
2.53	4050	1374	2860
5	4382	858	3770
8	4859	733	4337
10.8	5153	759	4796
15	5114	826	5064
18.2	5156	916	5308
25	5627	1187	5502
30	6128	1446	5791
40	6788	1923	6194
45.5	6945	2091	6304

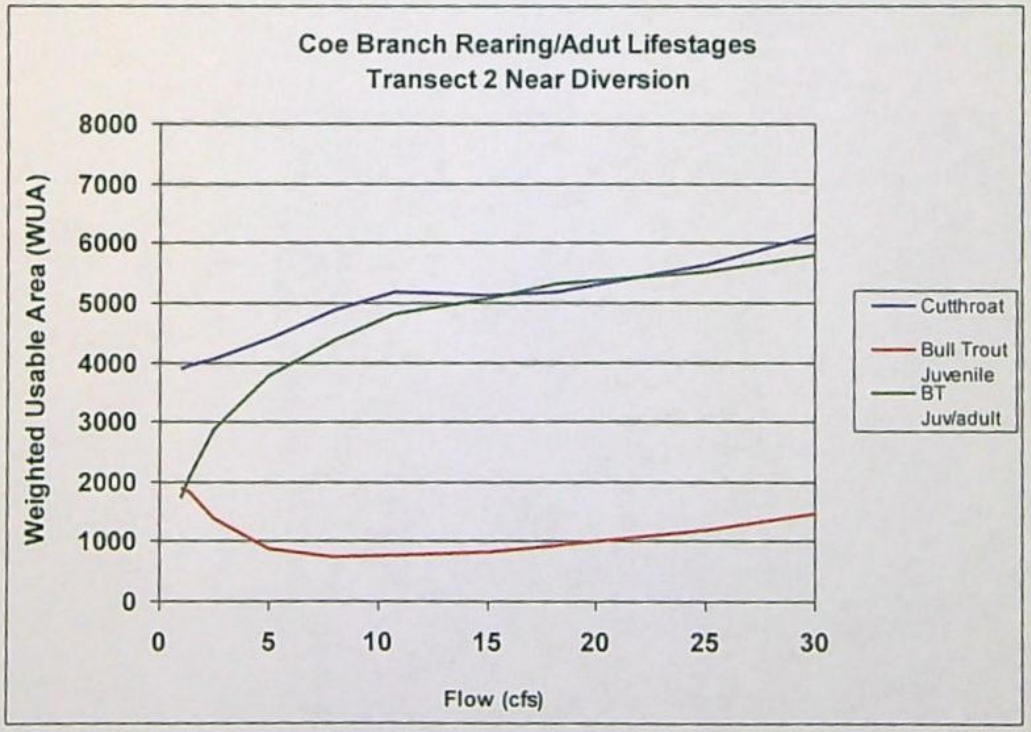


Figure 3. Weighted Usable Area for rearing and migration lifestages in the Coe Branch at the diversion. WUA is expressed as square feet of habitat for a 1,000 foot stream reach.

Table 9. Coe Branch Transect 2, rearing habitat expressed as a percent of the total stream area.

Flow (cfs)	Percentage of Total Area		
	Cutthroat Juvenile/Adult Rearing/Migration WUA	Bull Trout Juvenile WUA	Bull Trout Juvenile/Adult WUA
1	32	16	14
1.39	32	15	17
2.53	33	11	23
5	35	7	30
8	37	6	33
10.8	37	5	34
15	34	6	34
18.2	33	6	34
25	35	7	34
30	37	9	35
40	40	11	36
45.5	40	12	36

Coe Branch Study Site - Transect Photos.

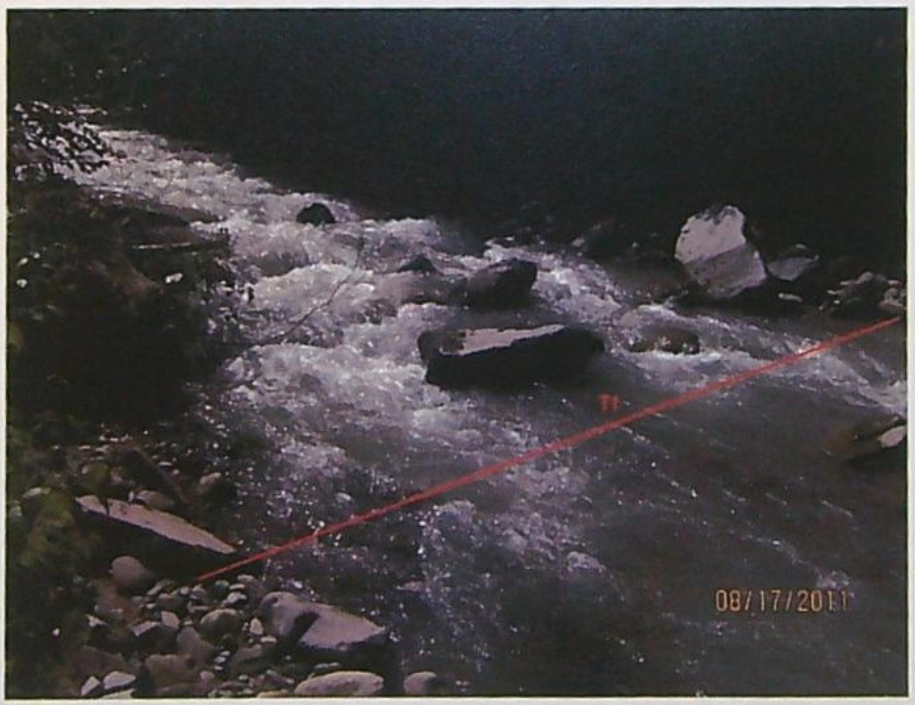


Figure 4. Coe Branch transect 1, downstream of the diversion and 0.3 miles upstream from the Clear Branch confluence, looking upstream.

Figure 5. Coe Branch transect 2, at diversion, approximate 1.07 miles upstream from the Clear Branch confluence, looking upstream.

Figure 6. Coe Branch Transect 2 (at diversion), collection of 10.8 cfs calibration flow, 3/28/12.

References

Oregon Dept. of Fish & Wildlife. 2006. Standard review checklist for PHABSIM modeling. Memo from E.G. Robison, ODFW. July 7, 2006. Obtained via T. Hardin, ODFW, pers. comm. 2011.

U.S. Fish & Wildlife Service (USFWS). 2010a. Flow-habitat relationships for spring and fall-run chinook salmon and steelhead trout spawning in the Yuba River. Sacramento Fish & Wildlife Office, Sacramento, CA. August, 2010.

Introduction

The Eliot Branch study reach extends from the confluence with the Middle Fork Hood River upstream approximately 1.5 miles upstream to the MFID diversion (Figure 1, Section 1).

Habitat Mapping Results

A total of 6,302 feet of stream channel were surveyed on August 3, 2011, from the Middle Fork confluence to the diversion headgate. This reach is glacially influenced and was turbid at the time of the survey. Rapids and cascades were the most common habitat types (Table 1).

Table 1. Relative habitat frequency, Eliot Branch.

Habitat Type	Percent wetted area (%)
Rapids	41.21%
Cascades	57.94%
Step/Falls	0.11%
Culverts	0.73%

Cross Sections

A total of two transects were set. Transect 1 is located in a cascade habitat 0.81 mile upstream of the confluence with the Middle Fork, downstream of the diversion. Transect 2 is located approximately 1.5 miles upstream of the confluence, at the diversion (Figure 1, Section 1). (The current channel of Eliot Branch has changed from that shown on the USGS map.) Rationale for the placement of Transect 1 was to represent typical cutthroat trout habitat in the Eliot Branch. Rationale for the placement of Transect 2 was to represent migration habitat conditions in the bypass reach. Transect photos are Figures 6-9.

Table 2. Eliot Branch transect selection summary.

Transect	Habitat Type	Habitat importance	Comment
1	Cascade	Cutthroat trout habitat, migration	
2	Cascade tailout		In diversion bypass reach, potential spawning gravel present

Flow Measurements

Flow measurements were collected between September and December 2011 (Table 3). While results for both transects are presented together, they are not in physical proximity, and the relative elevations relate to different benchmarks. Flow measurement goals originally included collection of a higher flow measurement, but during our field measurement period (September 2011 – March 2012) no higher flows were observed in the Eliot Branch.

Table 3. Eliot Branch study reach measured flows.

Transect	Flow Measured (cfs)	Measurement Date
Transect 1	11.6	9/19/2011
	5.7	12/8/2011
Transect 2	9.7	9/19/2011
	2.5	12/8/11

Using standard methods for situations where only two flows were measured, this should allow a range of modeled flows at Transect 1 from 4 cfs to 14 cfs, and from 2 cfs to 12 cfs in the diversion reach at Transect 2.

Water Surface Elevation Model

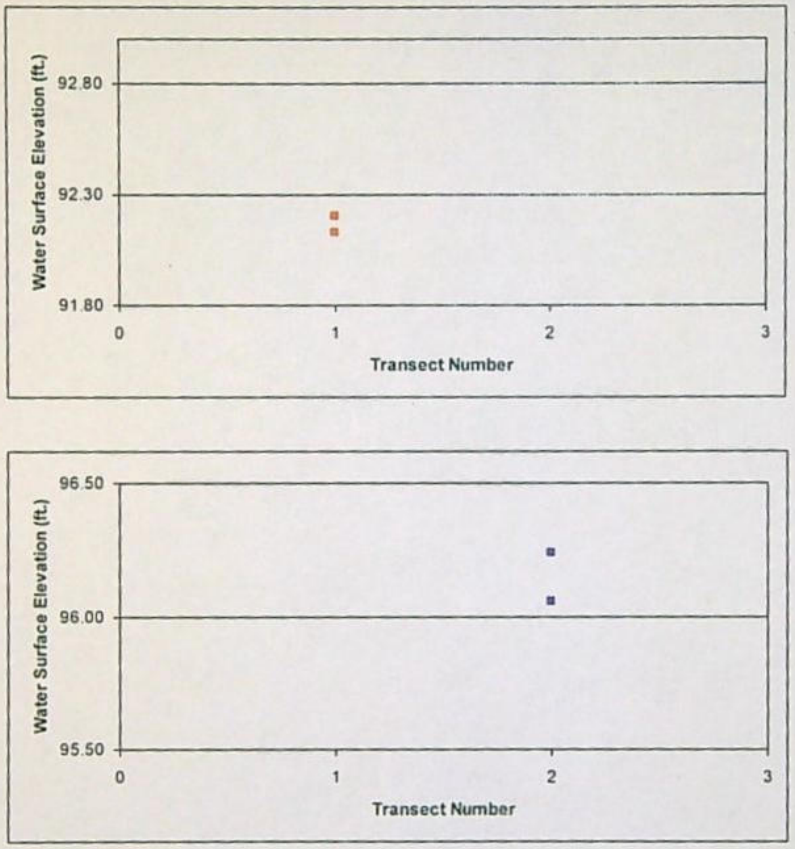
Water surface elevations were predicted from the higher flow measurement using the channel conveyance (Manning's equation) methods in the hydraulic model. Model performance is in Table 4. At Transect 1, for the 5.7 cfs flow measurement, the observed water surface elevation was adjusted to allow the hydraulic model to route 5.7 cfs through the measured cross-section (Figure 4).

Table 4. Summary of Eliot Branch hydraulic model statistics.

	Transect 1	Transect 2
Discharge	5.7	2.5
Best Estimate from Measured Data	11.6	9.7
Stage (given) (ft)	92.13*	96.05
	92.20	96.23
Ratio of Measured to Predicted Discharge	1.108	1.5
	1.011	1.091
Mean Error of Given & Calculated Stage	< 1%	< 1%
Beta value estimated using Manning's Equation for Channel-Conveyance Method	0.6963	0.5226

*Measured stage was 91.83 at 5.7 cfs. Stage adjusted as described in text.

For Transect 2, the given flow was 2.5 cfs, and the predicted flow was 1.65 cfs, which created the high ratio of measured/predicted flow, which is partly caused by the fact that these flows are so low (Figure 9). This hydraulic model should be considered only fair for flows under 2 cfs, although the velocity predictions are good for flows 2 cfs and above (Table 5).



Figures 1a, 1b. Eliot Branch measured relative water surface elevations. Elevations at each transect refer to a different benchmark.

Velocity Model

A one-velocity regression model using the higher of the two flow measurements was used. A summary of the predictive model performance, compared to measured values, is in Table 5. A comparison table of all measured and predicted velocities is in Appendix A – Eliot Branch. Velocity predictions were considered to be good if they were either within 15% of measured velocities, or within 0.2 fps for low velocities. Italics below indicate cases where these criteria were not met.

Table 5. Eliot Branch velocity prediction summary. Individual cell velocities are presented in Appendix A.

Transect 1 - Downstream Reach		Calibration Velocity Set: 11.6 cfs		
Velocity	Measured Low Q (fps)	Predicted Low Q (fps)	Measured Mid Q (fps)	Predicted Mid (fps)
Mean	1.42	0.75	1.18	1.27
Minimum	0.1	0.01	0.01	0.01
Maximum	*2.91*	*1.99*	3.71	3.51
Transect 2 - Diversion Reach		Calibration Velocity Set: 9.7 cfs		
Velocity	Measured Low Q (fps)	Predicted Low Q (fps)	Measured Mid Q (fps)	Predicted Mid (fps)
Mean	0.34	0.39	1.04	1.15
Minimum	0.03	0.18	0.47	0.52
Maximum	0.88	1.06	2.22	2.46

In general, predicted velocities matched fairly well with measured velocities. In the case of the low flow maximum velocity at Transect 1, poor prediction was limited to three cells with high observed velocities at the higher calibration flow (photo in Appendix B, Figure 3). Modeling that would have calibrated these cells caused under-prediction of low-flow velocities (as well as under-prediction of the overall flow value). For Transect 1, the hydraulic model is fair to good. For Transect 2, the hydraulic model is fair to good for flows greater than 2 cfs.

Transect Weighting

Each of these transects was selected to represent habitat in two reaches with different flow regimes. Therefore, we propose that the habitat-flow relationship for each transect be calculated separately.

Eliot Branch Habitat Model Results & Discussion

Eliot Branch Transect 1

This transect was located in the reach downstream of the diversion, approximately 0.8 mile upstream of the current location of the confluence with the Middle Fork. The range of modeled flows was constrained to 4 – 14 cfs because only two flows were measured, although flows higher than measured flows were not observed in the Eliot Branch over the measuring period (Sept 2011 – March 2012). The flow-exceedence table (Table 6) shows that we were able to successfully capture the lower-flow end of the spectrum, which will allow an assessment of this predominantly rearing and migration habitat. (The current condition flows were estimated by subtracting actual diversion records from modeled streamflows, and some uncertainty does occur with these data. See Appendix D.)

Table 6 Flow ranges for hydraulic modeling for each IFIM study site.

Study Site	Allowable range of modeled flows (cfs):		Associated flow exceedance (%):	
	Minimum	Maximum	Minimum	Maximum
Eliot Branch 1 (downstream)	4	14	91%	63%
Eliot Branch 2 (at diversion, in bypass)	2	12	92%	65%

* This range is using guidelines for measurements with only two flows.

Rearing Life Stages

Rearing habitat is presented over the range of flows in Table 7 and Figure 2, and does not vary greatly over the range of modeled flows. Table 2 presents the same results, expressed as a percentage of the total area. Since the cutthroat juvenile/adult rearing/migration HSC criteria incorporates the ODFW salmonid passage criteria, these results suggest that there is some suitable rearing habitat in this reach, and that conditions at these streamflows will allow fish migration. Bull trout juvenile habitat appears limited in this reach, although the results from the HSC criteria that contain both adult and juvenile observations suggest that migration and rearing of larger individuals is possible in this reach over the range of modeled flows.

Table 7. Weighted Usable Area for rearing and migration lifestages in the Eliot Branch downstream of the diversion. WUA is expressed as square feet of habitat for a 1,000 foot stream reach.

Flow (cfs)	Cutthroat Juvenile/Adult Rearing/Migration WUA	Bull Trout Juvenile WUA	Bull Trout Juvenile/Adult WUA
4	2737	1043	6061
5.7	2929	1138	6738
6	2954	1142	6839
7	2965	1121	7104
8	2901	1114	7233
9	2699	1140	7157
10	2536	1172	6879
11.5	2327	1196	5954
12	2316	1209	5764
13	2275	1215	5432
14	2191	1217	5392

Figure 2. Weighted Usable Area for rearing and migration lifestages in the Eliot Branch downstream of the diversion.

Table 8. Weighted Usable Area for rearing and migration lifestages in the Eliot Branch downstream of the diversion. WUA is expressed as a percentage of total area for a theoretical 1,000-foot stream reach.

	Percentage of Total Area		
Flow (cfs)	Cutthroat Juvenile/Adult Rearing/Migration	Bull Trout Juvenile	Bull Trout Juvenile/Adult
4	21	8	47
5.7	22	9	51
6	22	9	52
7	22	8	53
8	21	8	53
9	20	8	52
10	18	9	50
11.5	17	9	43
12	17	9	42
13	16	9	39
14	16	9	39

Spawning Life Stages

The habitat model predicted small amounts of spawning habitat in the Eliot Branch downstream of the diversion. Because the model scales habitat predictions to a theoretical 1,000-foot long stream reach, these predictions of the amount of spawning habitat are most likely an overestimate.

Table 9. Weighted Usable Area for the Eliot Branch Transect 1. WUA is expressed as square feet of habitat for a 1,000-foot stream reach.

Q (cfs)	Cutthroat Spawning WUA	Bull Trout Spawning WUA
4	1251	1438
5.7	903	1509
6	852	1505
7	671	1456
8	579	1397
9	497	1304
10	474	1223
11.5	446	1115
12	443	1093
13	439	1045
14	431	999

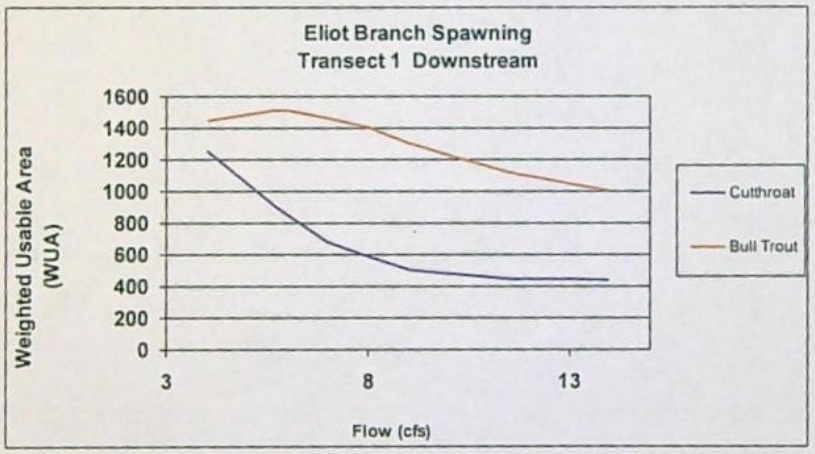


Figure 3. Weighted Usable Area for the Eliot Branch Transect 1. WUA is expressed as square feet of habitat for a 1,000-foot stream reach.

Table 10. Weighted Usable Area for the Eliot Branch Transect 1. WUA is expressed as a percentage of total area for a 1,000-foot stream reach.

Q (cfs)	Percent of Total Area	
	Cutthroat Spawning	Bull Trout Spawning
4	9.8	11.2
5.7	6.8	11.4
6	6.4	11.4
7	5.0	10.9
8	4.3	10.3
9	3.6	9.5
10	3.5	8.9
11.5	3.2	8.1
12	3.2	7.9
13	3.2	7.6
14	3.1	7.2

Eliot Branch Transect 2

Rearing Life Stages

This transect was located in the diversion reach, approximately 1.7 miles upstream of the current confluence of the Eliot Branch and the Clear Branch. The range of modeled flows was constrained to 2 to 12 cfs because only two flows were measured, although flows higher than measured flows were not observed in the Eliot Branch over the measuring period (Sept 2011 – March 2012). Table 6 shows that we were able to successfully capture the lower-flow end of the spectrum, which will allow an assessment of this predominantly rearing and migration habitat.

Rearing habitat does not vary greatly over the range of modeled flows (Table 11, Figure 4). Table 12 presents the results as a percentage of the total area. Since the cutthroat juvenile/adult rearing/migration HSC criteria incorporates the ODFW salmonid passage criteria, these results suggest that between 20% and 30% of the total area meets criteria and would allow migration through this reach, over this flow range. These results also suggest that the diversion reach does not contain much bull trout rearing habitat, although the results from the HSC criteria that contain both adult and juvenile observations suggest that migration and rearing of larger individuals would be possible in this reach over the range of modeled flows.

Table 11. Weighted Usable Area for rearing and migration lifestages in the Eliot Branch near the diversion. WUA is expressed as square feet of habitat for a 1,000 foot stream reach.

Flow (cfs)	Cutthroat Juvenile/Adult Rearing/ Migration WUA	Bull Trout Juvenile WUA	Bull Trout Juvenile/Adult WUA
2	2951	924	2173
2.5	3147	935	2488
4	3577	930	3272
6	3942	986	4047
8	4200	942	4619
9.8	4257	870	4952
14	4107	712	5291

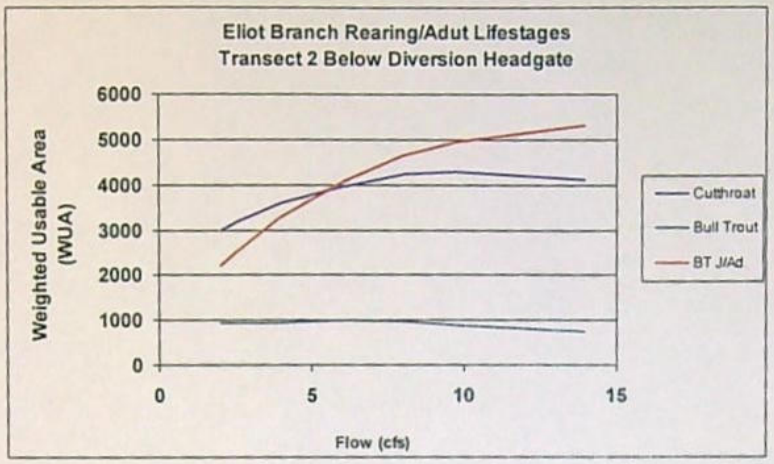


Figure 4. Weighted Usable Area for rearing and migration lifestages in the Eliot Branch near the diversion.

Table 12. Weighted Usable Area for rearing and migration lifestages in the Eliot Branch near the diversion. WUA is expressed as a percentage of total area for a theoretical 1,000-foot stream reach.

	Percentage of Total Area		
Flow (cfs)	Cutthroat Juvenile/Adult Rearing/Migration	Bull Trout Juvenile	Bull Trout Juvenile/ Adult
2	18	6	13
2.5	19	6	15
4	22	6	20
6	24	6	25
8	26	6	28
9.8	26	5	30
14	25	4	32

Spawning Lifestages

The model predictions for spawning habitat may be misleading. There is a relatively small amount of spawning habitat in the rapids and cascades habitat types that make up this reach. However, Transect 2 was deliberately placed at the location of a small amount of potential spawning gravel. Because the hydraulic model scales the WUA estimate to a 1,000 foot stream reach, the calculated WUA for spawning is likely to be an overestimate.

Table 13. Weighted Usable Area for spawning lifestages in the Eliot Branch transect 2 near the diversion. WUA is expressed as square feet of habitat for a 1,000 foot stream reach.

Q (cfs)	Cutthroat Spawning WUA	Bull Trout Spawning WUA
2	1,720	3,207
2.5	2,142	3,653
4	3,041	4,814
6	3,678	5,526
8	4,206	5,808
9.8	4,442	6,018
14	3,563	6,030

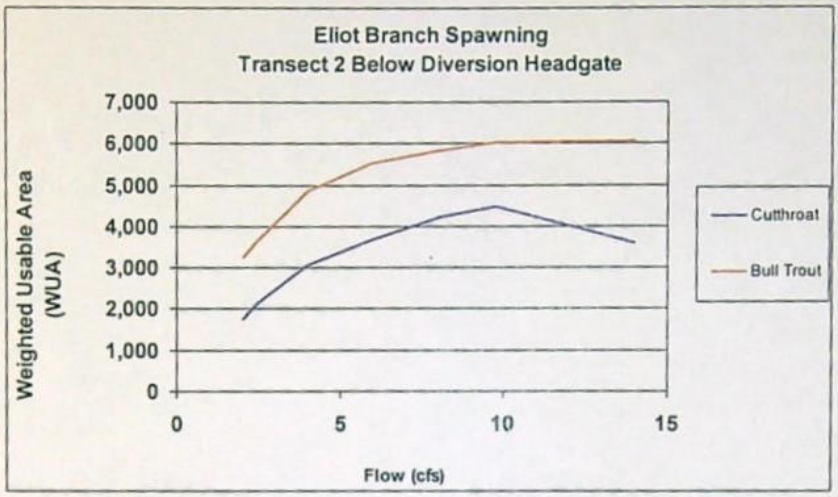


Figure 5. Weighted Usable Area for spawning lifestages in the Eliot Branch near the diversion.

Eliot Branch Study Site - Transect Photographs

Figure 6. Eliot Transect 1, 11.6 cfs measurement (picture blurred). High-velocity cells are in the center of the channel.

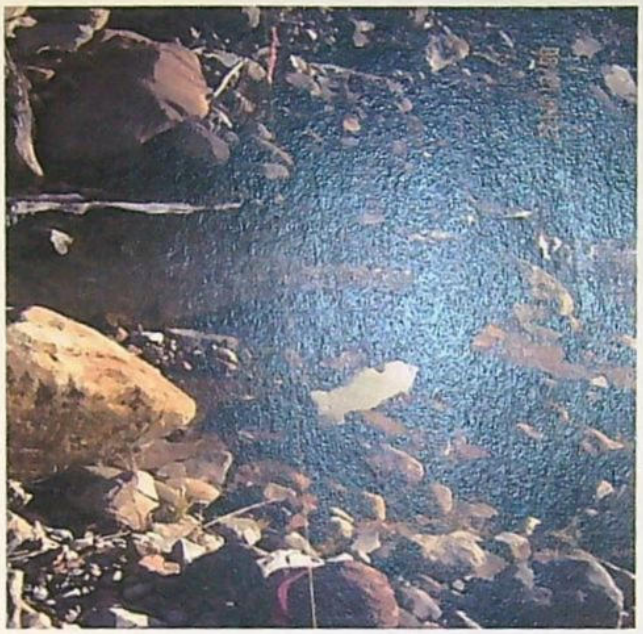


Figure 7. Eliot Transect 1, 5.7 cfs measurement, looking across channel.

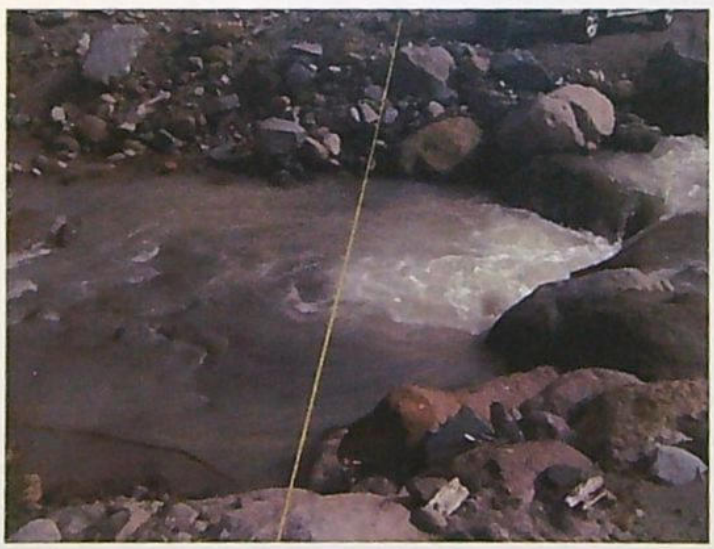


Figure 8. Eliot Branch Transect 2, 9.7 cfs measurement, looking across channel.

Figure 9. Eliot Transect 2, 2.5 cfs measurement, looking across channel.

References

Oregon Dept. of Fish & Wildlife. 2006. Standard review checklist for PHABSIM modeling. Memo from E.G. Robison, ODFW. July 7, 2006. Obtained via T. Hardin, ODFW, pers. comm. 2011.

Introduction

This study site is located in the 0.80 mile of stream reach between the Eliot Branch confluence and the Coe/Clear Branches confluence (Figure 1). The river is titled the Middle Fork downstream of the confluence of the Coe and Clear Branches. The study site is located approximately 0.24 miles downstream of the Coe Branch confluence. This reach is primarily a rearing and migration area, although one transect was located in possible spawning habitat.

Habitat Mapping Results

A total of 4,236 feet of primary channel and 1,247 feet of secondary channel were surveyed, from the Eliot confluence to the Coe/Clear Branch confluence, on August 2, 2011. The relative frequency of habitat types is summarized from the primary stream channel observations. This reach is glacially influenced and was turbid at the time of the survey.

Table 1. Relative habitat frequency, Middle Fork between the Coe and Eliot Branches.

Habitat Type	Percent wetted area (%)
Dammed & Backwater Pools	0.14%
Scour Pools	1.03%
Riffles	14.12%
Rapids	40.21%
Cascades	35.18%
Step/Falls	1.07%
Dry	8.26%

Cross Sections

This study site is located approximately 0.24 miles downstream of the Coe Branch confluence. A total of four transects were selected, and are summarized in Table 2, below. Transect locations are shown in Figure 1 (Section 1). Photos taken during transect selection in August 2011 are in Figures 2 through 4.

Table 2. Transect selection summary.

Transect	Habitat Type	Habitat Importance
1	Rapid with boulders	Rearing, migration habitat
2	Deep Riffle/Scour Pool with backwater	
3	Deep Riffle/Scour Pool with backwater	
4	Plunge pool	Rearing, migration habitat, possibly spawning

Flow Measurements

Table 3 summarizes the flow measurement history at this site. Measurement goals were similar for all study sites: to measure a range of flows to develop a habitat/flow relationship for the range of current conditions, and potentially for historic conditions.

Table 3. Flow measurement summary, Middle Fork between Coe & Eliot Branches.

Date	Flow (cfs)	Comments
9/21/2011	26.2	Flow measurements at all transects, averaged at each flow
12/9/2011	15.3	
2/24/2012	92.6	At transect 4 only, after channel change

The IFIM method recognizes that river systems are dynamic, and will change over time. One assumption in the method, however, is that the river channel will remain reasonably stable during the measurement period (Bovee et al. 1998). This was not the case at this study site. On the February, 2012, data collection visit, Transects 1 through 3 showed extensive scour, or scour and fill. A flow measurement and water surface elevation was collected at Transect 4. Our intention was to use the higher flow measurement at transect 4 to extend the flow-habitat relationship at the other three transects. During hydraulic model calibration, we found that Transect 4 also had significant channel change, due to the stream channel scour and removal of sandy substrates. Surface sand dominated the transect wetted area in September 2011, but was largely absent in February 2012. Therefore, the range of the hydraulic modeling possible with this data is constrained to a narrower range of flows than originally planned (approximately 12 to 31 cfs, using standard methods where situations where only two flows were measured). Photos detailing the channel changes are in Figures 5 through 11. Channel cross-sections showing the channel changes are in Figures 12 through 15.

Water Surface Elevation Model

Water surface elevations were predicted from the 26.2 cfs flow measurement using the channel conveyance (Manning's equation) methods in the PHABSIM model. Model performance is in Table 4. Measured water surface elevations are in Figure 1.

Table 4. Middle Fork between Coe and Eliot Branches, summary of hydraulic model statistics.

	Transect 1	Transect 2	Transect 3	Transect 4
Discharge	26.2	26.2	26.2	26.2
Best Estimate from Measured Data (cfs)	15.3	15.3	15.3	15.3
Stage (given) (ft)	94.30	94.51	94.61	93.61
	94.10	94.41	94.46	93.51
Stage (estimated) (ft)	94.396	94.56	94.61	92.61
	94.096	94.41	94.46	93.51
Mean Error of Given & Calculated Stage (%)	<1.0	<1.0	<1.0	<1.0
Beta value estimated using Manning's equation for Channel-Conveyance Method	0.2130	0.5603	0.6064	0.7048

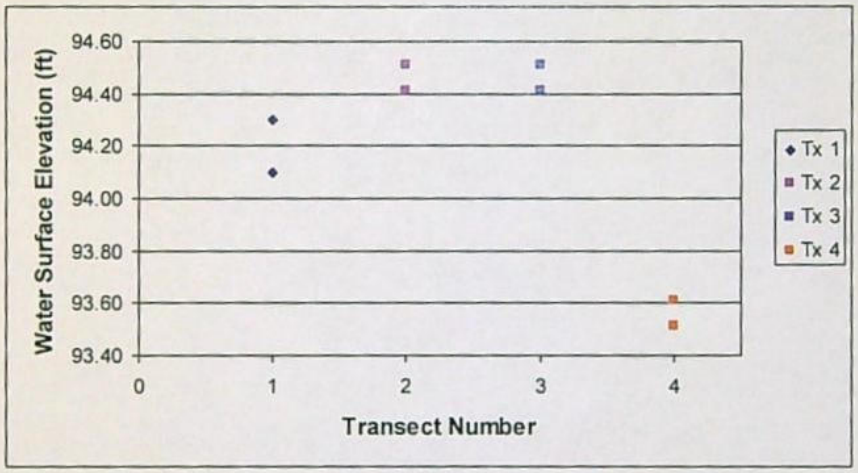


Figure 1. Middle Fork Between Coe and Eliot Branches, measured relative water surface elevations. Elevations at Transects 1 through 3 relate to the same benchmark, Transect 4 relates to a second benchmark.

Velocity Model

A one-flow regression model using the velocities measured at the 26.18 cfs flow was used. A summary of the prediction model's performance, compared to measured values, is below in Table 5. A comparison table of all measured and predicted velocities is in Appendix A – Middle Fork between Coe & Eliot. Velocity predictions were considered to be good if they were either within 15% of measured velocities, or within 0.2 fps for low velocities. Italics below indicate cases where these criteria were not met.

Table 5. Middle Fork Between Coe and Eliot Branches velocity prediction summary.

Transect 1		Calibration Velocity Set 29.1 cfs		
Velocity	Measured Low Q (fps)	Predicted Low Q (fps)	Measured Mid Q (fps)	Predicted Mid Q (fps)
Mean	1.04	1.00	1.44	1.25
Minimum	0.09	0.02	0.02	0.02
Maximum	3.28	3.28	3.98	3.93
Transect 2				
Velocity	Measured Low Q (fps)	Predicted Low Q (fps)	Measured Mid Q (fps)	Predicted Mid Q (fps)
Mean	0.62	0.72	1.18	0.99
Minimum	0.15	0.07	0.22	0.07
Maximum	*1.31*	*1.62*	2.57	2.34
Transect 3				
Velocity	Measured Low Q (fps)	Predicted Low Q (fps)	Measured Mid Q (fps)	Predicted Mid Q (fps)
Mean	0.46	0.42	*0.94*	*0.68*
Minimum	0.01	0.01	0.02	0.02
Maximum	*2.30*	*1.46*	2.50	2.16
Transect 4				
Velocity	Measured Low Q (fps)	Predicted Low Q (fps)	Measured Mid Q (fps)	Predicted Mid Q (fps)
Mean	0.73	0.63	1.07	0.88
Minimum	0.02	0.06	0.14	0.02
Maximum	1.30	1.14	1.86	1.75

Predicted velocities matched fairly well with measured velocities. This is probably due to some degree to the fact that the modeled flows are in a narrow range. Velocities by cell are presented in Appendix A – Middle Fork between Coe & Eliot Branches.

Transect Weighting

The PHABSIM model calculates the flow-habitat relationship (Weighted Usable Area (WUA) vs. Flow) in square feet of habitat normalized to a hypothetical 1,000 linear feet of stream. This is an index, not an actual map of habitat. The modeler specifies the "transect weighting", which is the relative importance of each transect. One common approach to transect weighting is to assign a percentage value. Transect 1 is in a rapid with boulders (40% of habitats surveyed). Transects 2 and 3 are in a riffle with backwater (14% of habitats) and transect 4 is in a plunge pool (2% of habitats) (Tables 1, 2). Based on this ratio, and on the relative importance of fairly rare pool habitats, the following transect weighting was determined after FMP Committee review in June, 2012.

Table 6. Transect weighting for the Middle Fork between Coe & Eliot Branches PHABSIM model.

Transect	Proposed Weighting (%)
1	40
2	20
3	20
4	20

Results & Discussion

The range of flows over which habitat is modeled depends on what flows were actually measured. This range is presented in Table 7. The flow-exceedence value calculated for the minimum and maximum flows to be modeled is also given in Table 7. For this site, modeling is possible over a narrower range than if the channel avulsion had not limited data collection.

Table 7. Flow ranges for hydraulic modeling for the Middle Fork between Coe and Eliot study site.

Study Site	Allowable range of modeled flows (cfs):		Associated flow exceedence (%):	
	Minimum	Maximum	Minimum	Maximum
Middle Fork between Coe & Eliot	12	31	98%	72%

Weighted Usable Area Results

Spawning Life Stages

Table 8 and Figure 2 present results for spawning life stages for this study site. There is very little spawning habitat in this reach.

Table 8. Weighted Usable Area for spawning life stages in the Middle Fork between the Coe and Eliot Branches. WUA is expressed as square feet of habitat for a 1,000-foot long stream reach.

Flow (cfs)	Chinook Spawning WUA	Bull Trout Spawning WUA	Steelhead Spawning WUA	Coho Spawning WUA
12	17	23	4	0
13.1	26	35	6	0
15.3	48	68	11	0
15.32	48	68	11	0
18	81	123	18	0
21.9	141	215	32	0
26.18	210	338	50	1
28	247	407	59	4
30	287	499	70	6
31	309	542	76	7

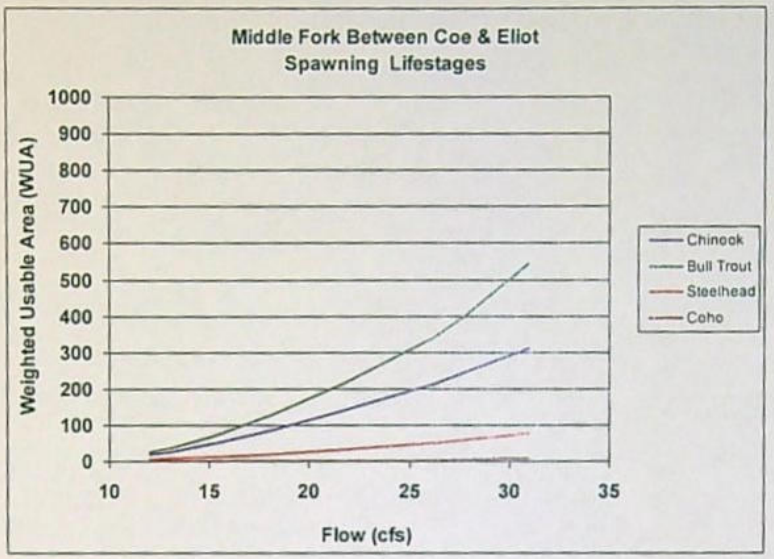


Figure 2. Weighted Usable Area for spawning life stages.

Rearing Life Stages

Table 9 and Figure 3 present habitat results for the rearing life stages, over the range of flows it was possible to model. These results suggest that, while there is less rearing habitat for bull trout than for steelhead or chinook in this reach, habitat availability is fairly stable over this range, increasing as flows increase.

Table 9. Weighted Usable Area for rearing life stages in the Middle Fork between the Coe and Eliot Branches. WUA is expressed as square feet of habitat for a 1,000-foot long stream reach.

Flow (cfs)	Chinook Rearing WUA	Bull Trout Rearing WUA	Steelhead Rearing WUA	Coho Rearing WUA
12	6095	2448	3309	1361
13.1	6243	2402	3446	1348
15.3	6495	2354	3678	1380
15.32	6495	2353	3678	1379
18	6735	2318	3901	1413
21.9	6993	2301	4159	1458
26.18	7135	2317	4412	1469
28	7170	2336	4518	1454
30	7173	2348	4617	1415
31	7179	2350	4665	1401

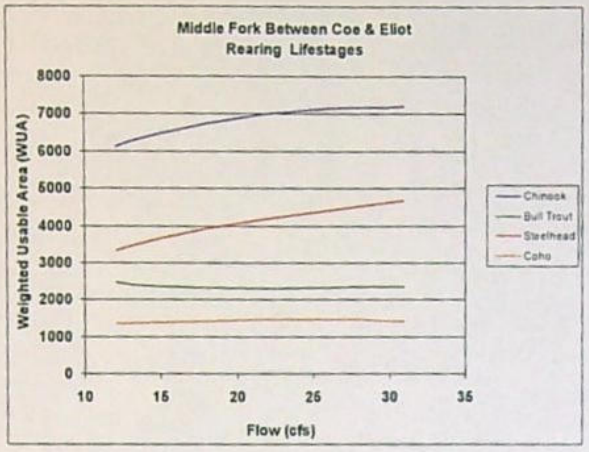


Figure 3. Weighted Usable Area for rearing life stages.

Discussion

This site is downstream of the Coe Branch and its habitat characteristics show the addition of the typically high sediment loads carried by both the Coe and Eliot Branches (Coccoli 1999).

Based on our field visit timing, the high flow event that caused the channel shift at this study site most likely occurred at the end of December, 2011. Figure 4 shows the USGS record for the Tucker Bridge USGS gage in the lower Hood River Valley, showing a flood peak of approximately 10,000 cfs. Using 52 years of annual peak flow data from the Tucker Bridge gage (water years 1959 - 2011, which does not include the water year during which we took measurements), a flow of 10,000 cfs has a return interval of 2.1 years. This suggests that flows of this magnitude are not uncommon in this watershed. This further suggests that the flow-habitat relationship that is most limiting in the Middle Fork downstream of the Coe Branch is the relatively common occurrence of flows that cause channel shift, scour and aggradation. This is also supported by channel conditions observed during the habitat survey for this reach (Figures 5 through 15) and measured downstream at the Red Hill Road study site (Appendix I).

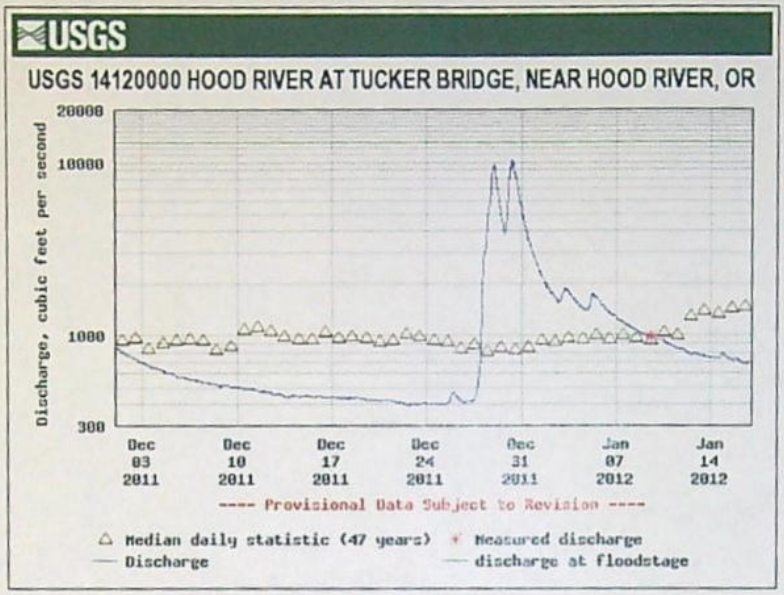


Figure 4. Streamflows in the lower Hood River between December 3, 2011 and January 14, 2012.

Middle Fork between Coe & Eliot Branches - Transect Selection Photos & Channel Change Documentation

Figure 5. Middle Fork between Coe & Eliot Branches, Transects 1 through 3. This photo is looking upstream.

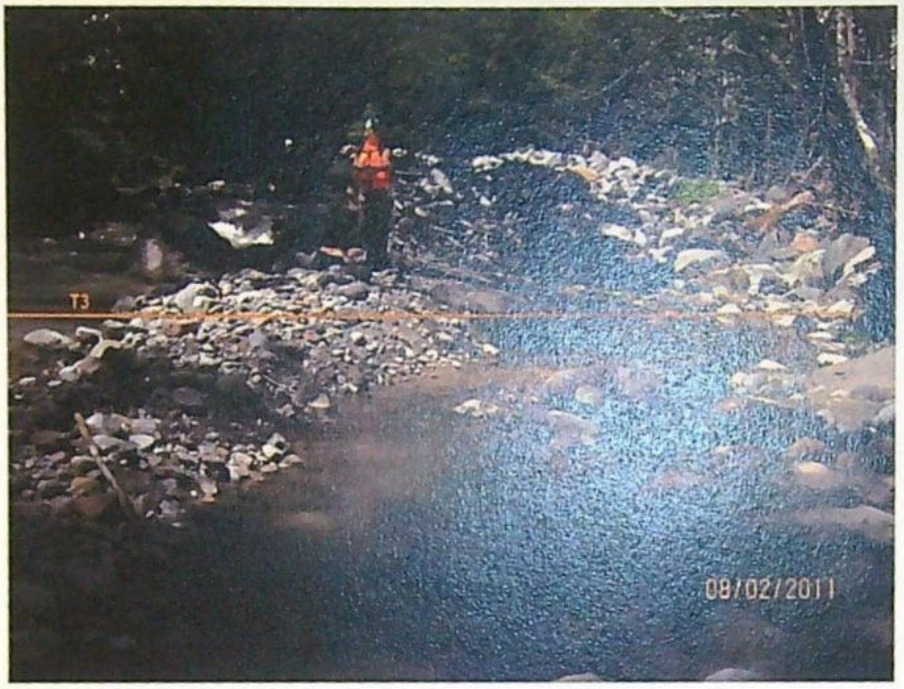


Figure 6. Middle Fork between Coe & Eliot Branches, Transect 3, looking upstream.

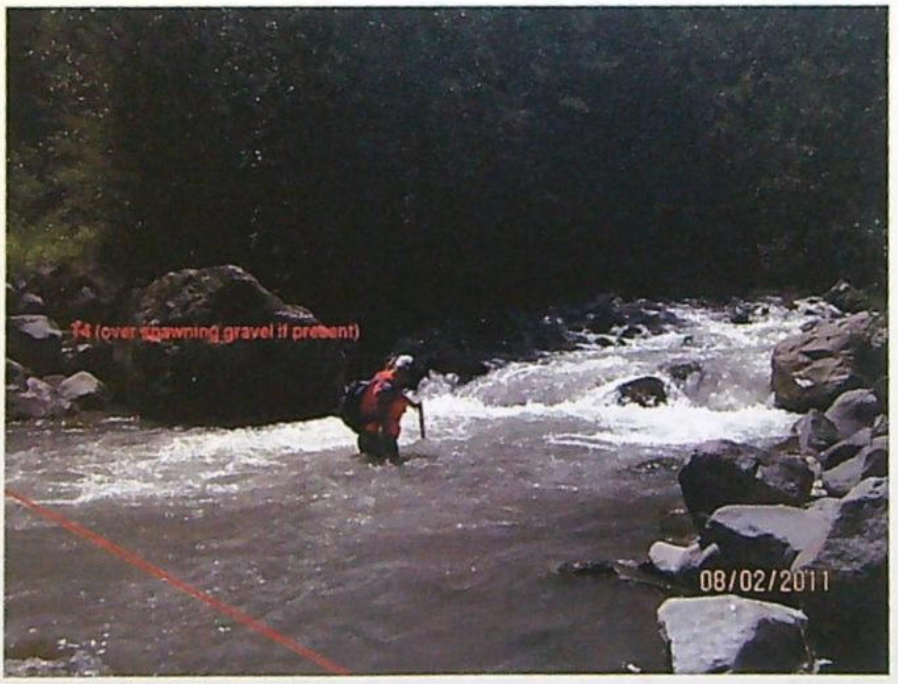


Figure 7. Middle Fork between Coe & Eliot Branches, Transect 4, looking upstream.

Figure 8. Middle Fork between Coe & Eliot, Transect 4, September 9, 2011, looking across channel. Red circles indicate areas of sand accumulation (thalweg was also dominated by surface sand).

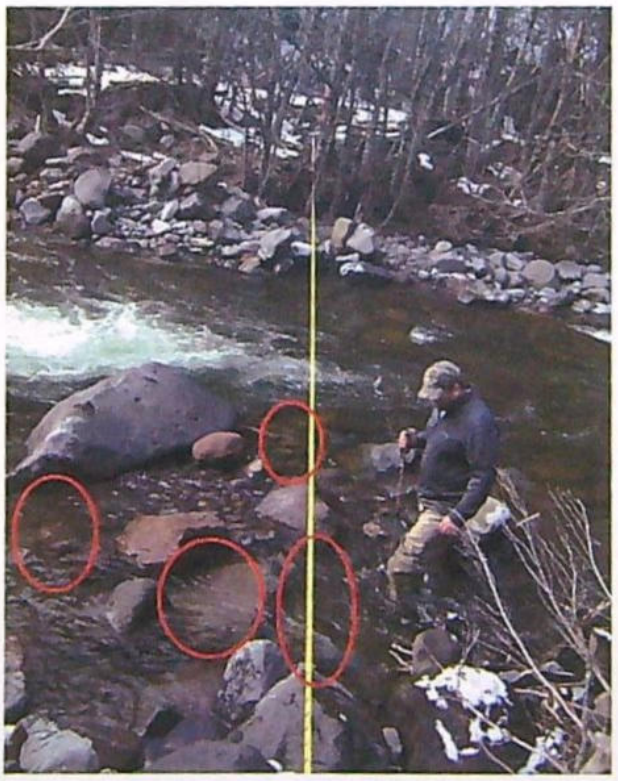


Figure 9. Middle Fork between Coe & Eliot, Transect 4, February 24, 2012, looking across channel. Red circles indicate areas where sand substrates have been removed (thalweg also lacked surface sand).

Figure 10. Channel change at Transect 1 between September, 2011 and February, 2012, looking across channel (substantial scour).

Figure 11. Channel change at Transects 1 -3 (scour at downstream end at Transect 1; aggradation at upstream end on Transect 3) between August, 2011 and February, 2012 (looking upstream).

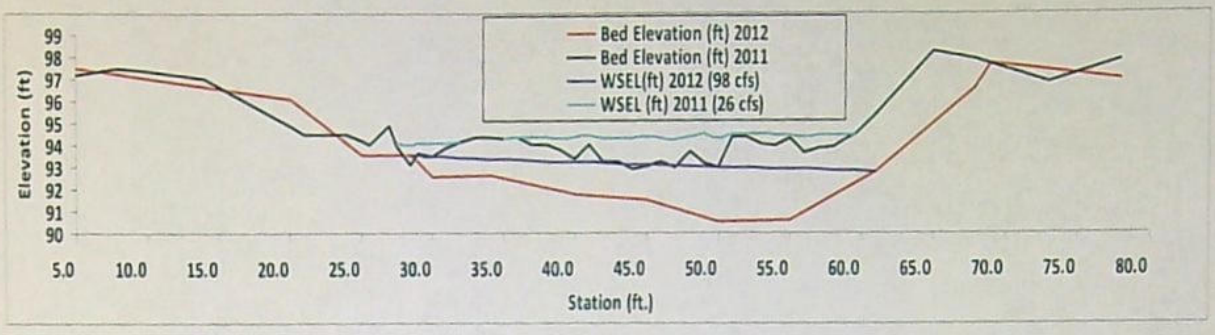


Figure 12. Transect 1, Middle Fork between Coe and Eliot Branches. Changes in water surface elevation (WSEL) and bed profile between 2011 and 2012 measurements. This transect exhibited mostly scour. Vertical axis scale is different than horizontal axis.

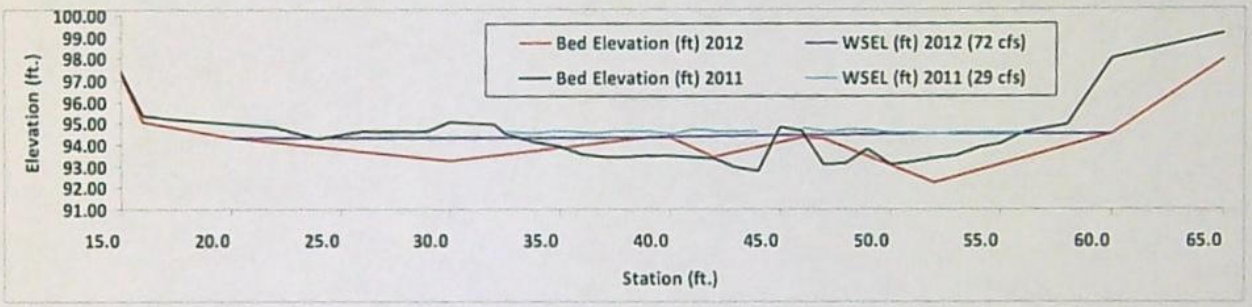


Figure 13. Transect 2, Middle Fork between Coe and Eliot Branches. Changes in water surface elevation (WSEL) and bed profile between 2011 and 2012 measurements. This transect exhibited scour and fill. Vertical axis scale is different than horizontal axis.

Figure 14. Transect 3, Middle Fork between Coe and Eliot Branches. Changes in water surface elevation (WSEL) and bed profile between 2011 and 2012 measurements. This transect exhibited mostly fill. Vertical axis scale is different than horizontal axis.

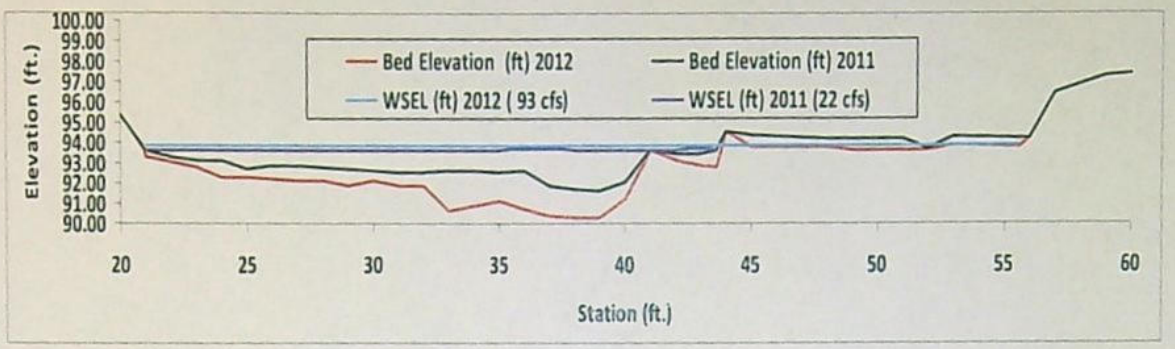


Figure 15. Transect 4, Middle Fork between Coe and Eliot Branches. Changes in water surface elevation (WSEL) and bed profile between 2011 and 2012 measurements. This transect exhibited mostly scour. Vertical axis scale is different than horizontal axis scale.

References

Bovee, K.D., B.L. Lamb, J.M. Bartholow, C.B. Stalnaker, J. Taylor and J. Henriksen. 1998. Stream habitat analysis using the Instream Flow Incremental Methodology. U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD-1998-0004. Ft. Collins, CO.

Coccoli, H. 1999. Hood River watershed assessment. Hood River Watershed Group. 141 electronic pages.

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Introduction

This study site is located near Parkdale, OR, approximately 7.2 miles downstream of the Clear and Coe Branch confluence, and approximately 7 miles upstream of the confluence of the East and Middle Forks of the Hood River (Figure 2, Section 1). This site is 7.2 miles downstream from the Clear Branch/Coe Branch confluence, and approximately 7 miles upstream of the confluence of the Middle and East Forks of the Hood River.

Habitat Mapping Results

The study plan called for mapping habitat for the Middle Fork in the vicinity of Red Hill Road and Rogers Creek. In this reach, the river channel is wide, with braided multiple channels. A total of 3,406 feet of primary channel on the west side of the river valley was surveyed, from a confluence of several side channels upstream to the Red Hill Road bridge. Almost all of the habitat found to be rapids (Table 1). A large secondary channel of nearly equal length on the east side of the river valley, and many cross-channels that were found between these two main channels, were not surveyed. Figures 1 through 3 show typical habitat features. This reach is glacially influenced as was turbid at the time of the survey.

Table 1. Habitat types in the Middle Fork Hood River in the vicinity of Rogers Creek (Rogers Spring).

Habitat Type	Percent wetted area (%)
Riffles	2.6%
Rapids	90.2%
Cascades	7.2%

Cross-Section Location

During an agency site visit in August, 2011, the FMP Committee discussed the fact that a location with unstable, multiple braided channels was not a good candidate for an IFIM study site, because the channel was likely to shift during the measurement period. However, the Committee requested that a single transect be located just upstream of the Red Hill Road bridge extending across the entire floodplain, in order to investigate channel conditions and wetted perimeters in the main and side channels at different flows.

Field Data Collection

In September, 2011, a flow and cross-section measurement was taken at 72.8 cfs (Table 2). A subsequent visit collected a flow measurement of 49.8 cfs. A site visit in January, 2012, noted that both channels had changed, with substantial aggradation in the western (primary) channel and degradation in the eastern (secondary) channel. Additional channel change was noted when a final cross-section was measured in March, 2012. Figures 4 and 5 compare photographs of channel conditions during September 2011 (transect setup) and subsequent changes observed in February 2012. Channel cross-sections and water surface elevations at those measurements are in Figures 6 and 7.

Table 2. Red Hill Road cross-section, data collection summary.

Date	Flow Measurement	Cross-section data
9/20/2011	72.8 cfs	Collected
12/8/2011	49.8 cfs	
3/28/12		Collected

Discussion

The shifting channel at this location is not suitable for PHABSIM modeling. The habitat survey and subsequent cross-section data collection document that the high bedload and shifting channel present in this reach are likely the most significant factors influencing fish habitat quantity and quality.

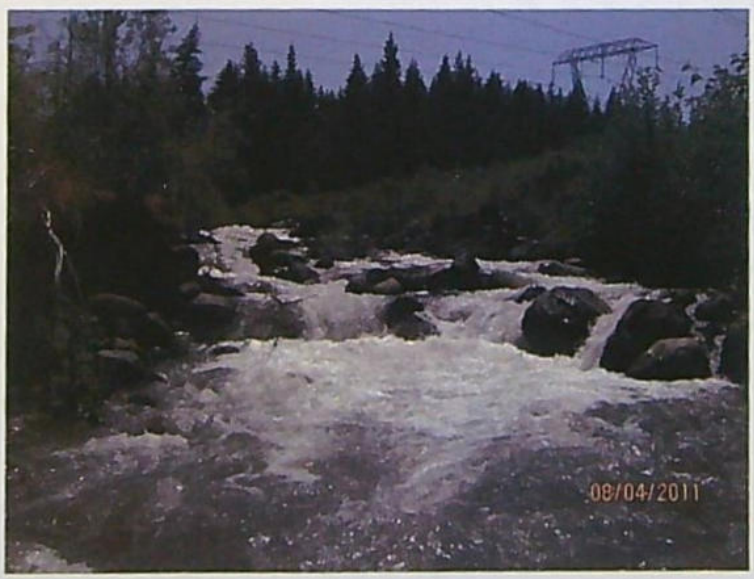

Figure 1. Middle Fork in the vicinity of Rogers Creek, typical cascade habitat, looking upstream.

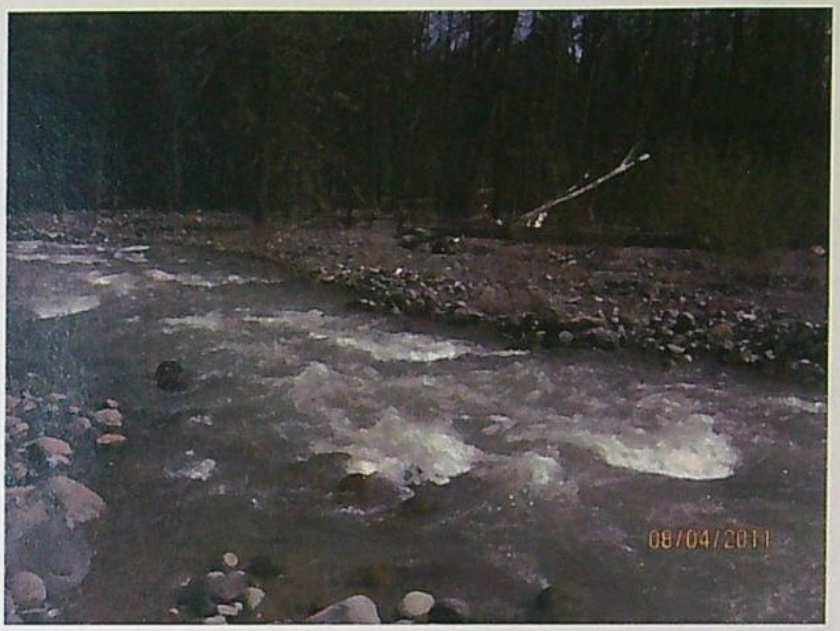

Figure 2. Middle Fork in the vicinity of Rogers Creek, typical rapid habitat, looking downstream.

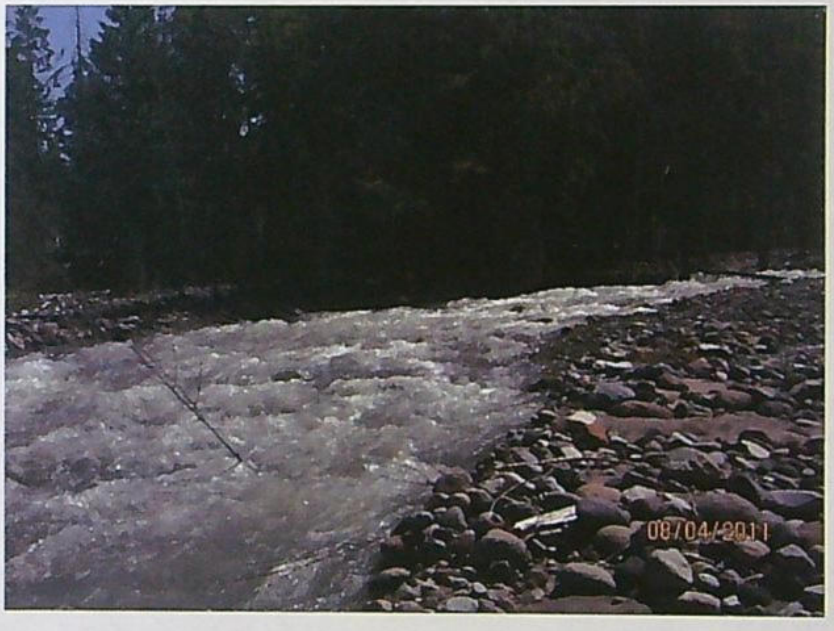

Figure 3. Middle Fork in the vicinity of Rogers Creek, typical riffle habitat, looking upstream.

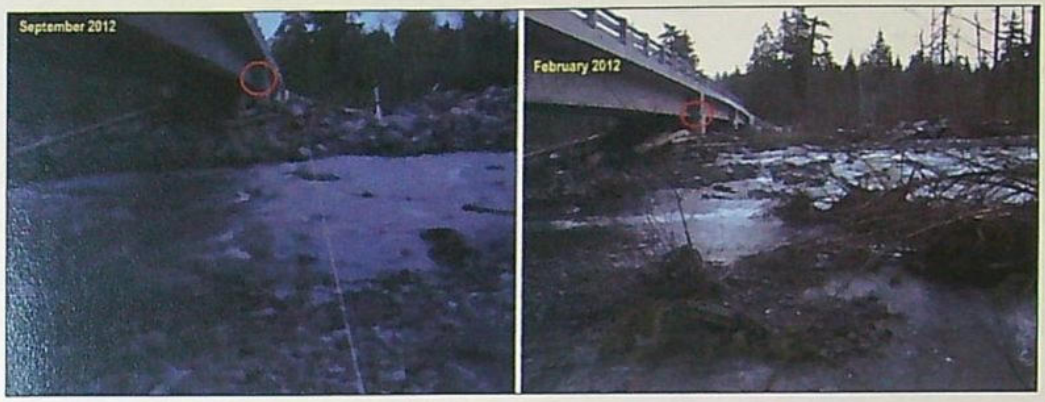

Figure 4. Primary channel at the Red Hill Road transect, looking east (upstream of bridge on transect). Channel changes between September 2011 and February 2012. Both photos are looking across the channel.

Figure 5. Flood plain between primary and secondary channels at the Red Hill Road transect, looking west. Channel change between September 2011 and February 2012. Both photos are looking across the channel.

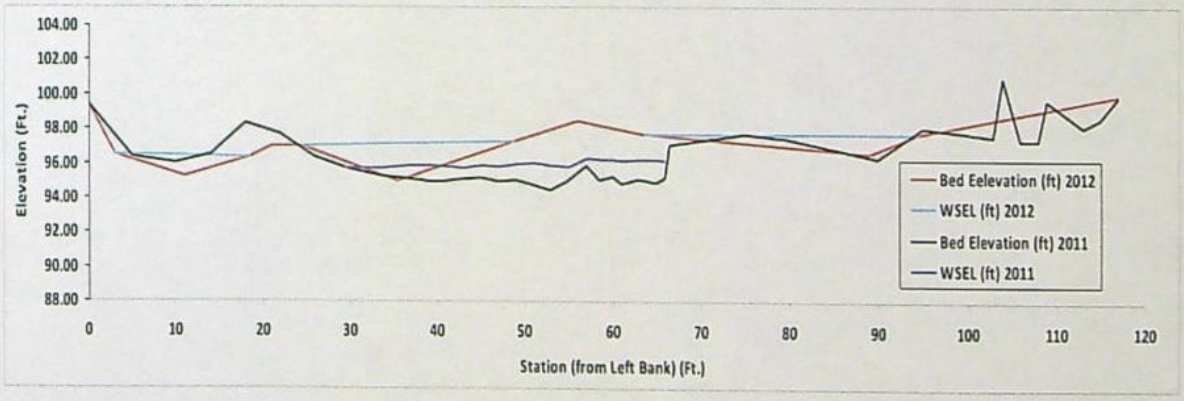

Figure 6. Red Hill Road transect – Western (primary) channel change between the 2011 and 2012 measurements. Vertical scale is different than horizontal scale.

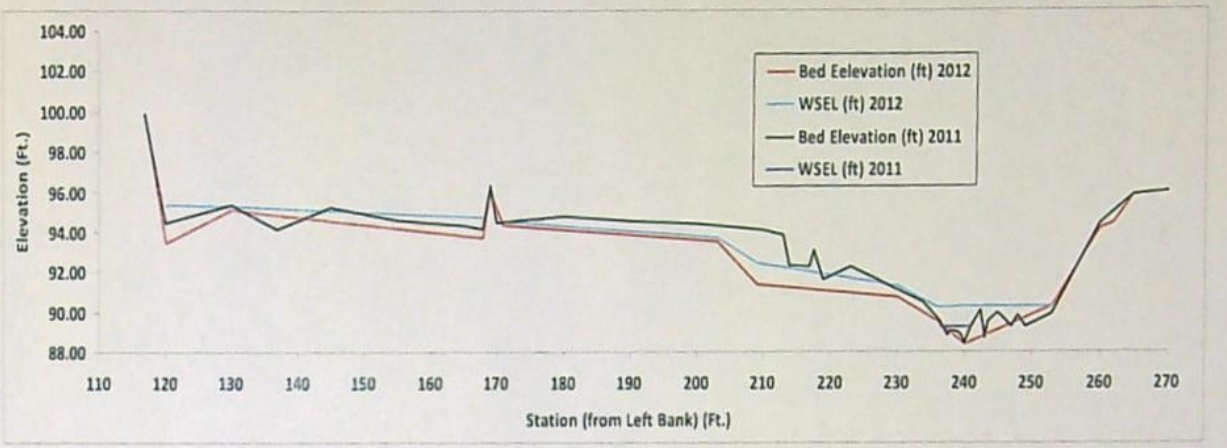

Figure 7. Red Hill Road transect – Eastern (secondary) channel change between 2011 and 2012 measurements. The water surface elevation for the 2012 measurement reflects water flowing downstream in the secondary channel (on right in figure) and water flowing in a smaller channel laterally across the floodplain (from left to right in figure); see Figure 5 – February 2012 photo. Vertical scale is different than horizontal scale.

Introduction

The study reach is located within the lower mile of the Middle Fork Hood, upstream of the confluence with the East Fork (Figure I-3, Introduction). This study site is at River Mile 1.0, approximately 12.5 river miles downstream of the Clear Branch/Eliot Branch confluence. A total of 57 percent of the total watershed area (approximately 16,633 acres) lies downstream of the Clear/Eliot confluence (Figure 3, Section 1).

Habitat Mapping Results

A total of 5,492 feet of primary channel and 361 feet of secondary channel were surveyed on August 5, 2011. The survey went from the East Fork confluence to 250 yards upstream of the ODFW screw trap location. The East Fork confluence is approximately 13.5 river miles downstream of the Clear Branch/Eliot Branch confluence. Rapids were the most common habitat types, followed by riffles and cascades (Table 1). This reach is glacially influenced and was turbid at the time of the survey.

Table 1. Relative habitat frequency, Lower Middle Fork.

Habitat Type	Percent wetted area (%)
Dammed & Backwater Pools	0.4%
Scour Pools	4.9%
Riffles	25.2%
Rapids	55.9%
Cascades	13.4%
Step/Falls	0.2%

Cross-Sections

A total of four transects were placed at this study site, and are described in Table 2. Photos are provided at the end of the section.

Table 2. Transect Descriptions, Lower Middle Fork.

Transect	Habitat Type	Habitat Importance
1	Rapid with Boulders	Rearing, migration
2*	Riffle/Scour Pool tailout	
3	Rapid with Boulders	
4	Rapid with Boulders	

*ODFW screw trap location in scour pool

Flow Measurements

Table 3 details the flow measurement history at this site. In September, 2011, flows were measured over a two-day period, with different flow levels each day. Water surface elevations were surveyed to benchmarks and to staff gage readings at the ODFW screw trap site, located at Transect 2. During the measurements of Transects 3 and 4, it was noted that the stage was rising during the flow measurement. Data from contemporaneous measurements from the ODFW data logger was used to correct the water surface elevation estimate to account for the rising stage (ODFW data provided by Phil Simpon, Hood River Research Program Leader).

In December, 2011, we found that ODFW had removed the data logger and staff gage from this site, although the metal fence post remained in place, which the staff gage plate was mounted on. Water surface elevations were measured with respect to the our benchmarks and to the top of the remaining staff gage post for both the December 2011 and March 2012 flow measurements. Interpretation of a photo taken of the intact staff gage plate mounted on the fence post was used to estimate the staff gage reading at the top of the fence post. During the December 2011 and march 2012, the distance from the top of the fence post to the water surface was measured then related to the staff gage increment.

In March 2012, water depths and high water velocities precluded collection of instream velocity data. A stage-discharge relationship was developed using our flow measurements and three flow measurements made by ODFW in 2011. This was used to estimate the flow value for the March 2012 water surface elevation measurement (204.7 cfs). This relationship also allowed another, slightly different, estimate of the flows during our earlier measurements (Table 3). These estimates were consulted during hydraulic model calibration, and flows estimated by this method were used instead of measured flows if the stage-discharge relationship developed by the model was improved. (An example of an improved stage-discharge relationship would be that the ratio of the measured and predicted flows is closer to 1.0 (Table 4)).

Table 3. Measured flows and flows estimated from stage-discharge relationship developed from WPN team/ODFW 2011 flow measurements and ODFW screw trap staff gage readings.

Transect 1	Date	9/19/2011	12/19/2011	3/28/2012
	Measured Flow (cfs)	205.8	104.4	too high to measure
	Estimated Flow (stage-discharge) (cfs)	176.4	110.3	204.7
Transect 2	Date	9/19/2011	12/19/2011	3/28/2012
	Measured Flow (cfs)	189.1	116.0	too high to measure
	Estimated Flow (stage-discharge) (cfs)	176.4	110.3	204.7
Transect 3	Date	9/18/2011	12/19/2011	3/28/2012
	Measured Flow (cfs)	145.9	102.0	too high to measure
	Estimated Flow (stage-discharge) (cfs)	133.9	110.3	204.7
Transect 4	Date	9/18/2011	12/19/2011	3/28/2012
	Measured Flow (cfs)	115.6	100.1	too high to measure
	Estimated Flow (stage-discharge) (cfs)	117.4	110.3	204.7

Water Surface Elevation Model

A three-flow regression using the measured and estimated flows was used to calibrate the water surface elevation model. Calibration parameters are presented below (Table 4), and show which of the two flow estimates were used to develop the regression for each transect. The measured flow was preferred over the estimated flow, but if using the estimated flow improved the stage-discharge relationship that flow was used instead.

All transect's stage-discharge relationships and the relationship of modeled and predicted flows at the calibration flows were good. U.S. Fish & Wildlife Service (2010a) consider that this method works well if: the beta-value (B-value) calculated by the model is between 2.0 and 4.5; the mean error of the stage discharge relationship is less than 10 percent; there is less than a 0.1 difference between the measured and calculated water surface elevations, there is no more than a 25% difference between measured flows and flows calculated by the model.

Using standard methods for situations where only two flows were measured, this should allow a range of modeled flows from 80 cfs to 240 cfs.

Table 4. Lower Middle Fork hydraulic model calibration details. Flows in italics are those estimated using from the WPN/ODFW stage-discharge relationship (Table 3), all other flows are estimated from measured depths and velocities.

	Transect 1	Transect 2	Transect 3	Transect 4
Discharge (cfs)	110.3	116	110.3	100
	176.4	189	134	115.6
	204.7	204.7	204.7	204.7
Stage (given)	90.6	91.11	84.48	85.18
	90.83	91.45	84.55	85.27
	90.94	91.53	85.02	85.96
Ratio of Measured to Predicted Discharge	0.992	0.998	0.950	0.975
	1.026	1.012	1.062	1.030
	0.982	0.990	0.991	0.996
Mean Error of Stage-Discharge Relationship	1.73	3.32	4.00	1.95
B-Coefficient of Stage-Discharge Relationship	4.08	3.32	2.39	2.64

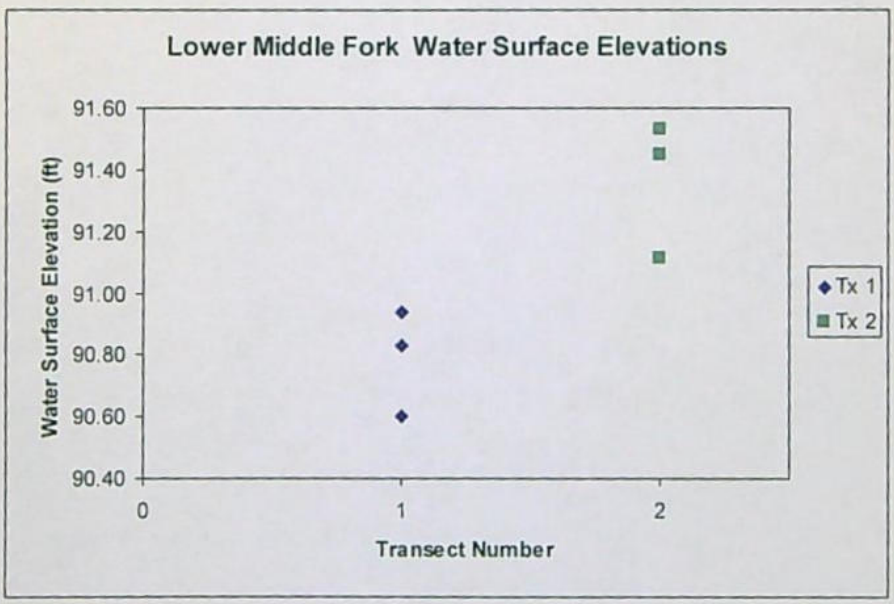

Figure 1. Water surface elevations for Transects 1 and 2. Both transects have the same benchmark.

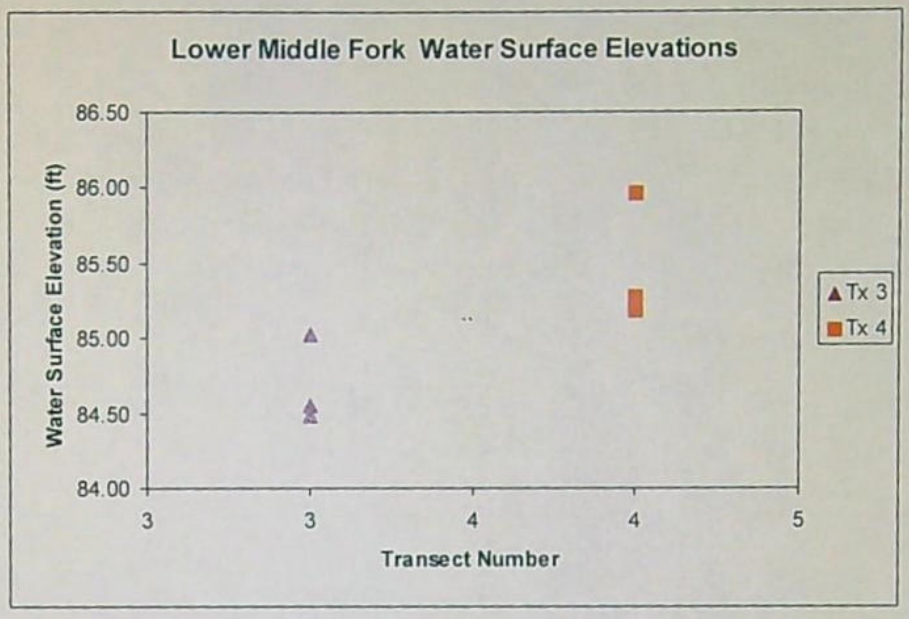

Figure 2. Water surface elevations for Transects 3 and 4. Both of these transects refer to the same benchmark.

Velocity Model

Because the flows measured (or estimated) varied between transects, the velocity model for each transect was calibrated to the higher of the two flows where velocity measurements were available. Predictions of velocities at the lower of the two measured flows are not presented because the two measured flows are close together, especially at Transects 3 and 4 (Table 4). Velocity predictions generally matched measured flows.

Table 5. Summary of velocity predictions at calibration flow for each transect.

	Measured Velocities (fps)	Predicted Velocities (fps)
Transect 1 Calibration Flow: 176 cfs		
Average	2.53	2.52
Minimum	0.08	0.06
Maximum	4.24	4.41
Transect 2 Calibration Flow: 189 cfs		
Average	2.19	2.07
Minimum	0.06	0.04
Maximum	4.18	4.41
Transect 3 Calibration Flow 146 cfs		
Average	2.85	2.86
Minimum	0.09	0.09
Maximum	4.87	4.95
Transect 4 Calibration Flow 115.6 cfs		
Average	2.40	2.08
Minimum	0.02	0.02
Maximum	4.45	4.30

Transect Weighting

Transects 1, 3 and 4 are in the same habitat type (rapid with boulders). Transect 2 is a transition between a scour pool tailout and a fast riffle. Because rapid habitats are approximately twice as common as riffle and scour pool habitats combined (Table 1), we propose the following transect weighting (Table 6). This also reflects the relatively greater importance as fish habitat of riffles and scour pools compared to rapids.

Table 6. Transect weighting for the Lower Middle Fork study site.

Transect	Proposed Weighting (%)
1	20
2	30
3	25
4	25

Weighted Usable Area Results

Table 7 shows the range of modeled flows allowable based on the field measurements collected, and shows flow/exceedence values for that range with the project ("current") and without ("unregulated"). These results show that, while we captured the mid-range of flows, we did not capture an estimate of lower flows (those with an exceedence value between 80% and 100%). These flows generally occur between August and mid-November, and our data collection period included this time period. However, flows lower than the lowest measured flows were not observed during Fall 2011.

Table 7. Flow ranges for hydraulic modeling for this study site.

	Allowable range of modeled flows (cfs):		Associated flow exceedence (%):	
Study Site	Minimum	Maximum	Minimum	Maximum
Lower Middle Fork *	80	240	80%	20%

* This range is using guidelines for measurements with only two flows.

Spawning Life Stages

Table 8 and Figure 3 present the results for spawning lifestages for this site. This reach is primarily a rearing and migration area, and little spawning gravel is present. Table 2 presents spawning area as a percent of the total area (study site normalized to a 1,000-foot reach). Very little spawning habitat is present in this reach.

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Table 8. Weighted Usable Area for spawning life stages in the lower Middle Fork. WUA is expressed at square feet of habitat per 1000-foot reach of stream.

Flow (cfs)	Chinook Spawning WUA	Bull Trout Spawning WUA	Steelhead Spawning WUA	Coho Spawning WUA
80	2895	320	2158	2134
90	2821	268	2213	2063
100	2719	221	2228	1962
102	2689	212	2227	1935
104.4	2654	202	2225	1900
115.6	2511	172	2163	1736
116	2505	171	2160	1730
120	2452	161	2129	1674
135	2212	127	2025	1466
140	2133	117	1972	1397
160	1787	77	1729	1160
176	1528	49	1563	1011
189	1294	38	1398	899
204.7	1132	45	1222	782
210	1079	46	1167	746
220	1024	49	1091	685
230	1040	57	1051	641
240	1064	56	1021	599

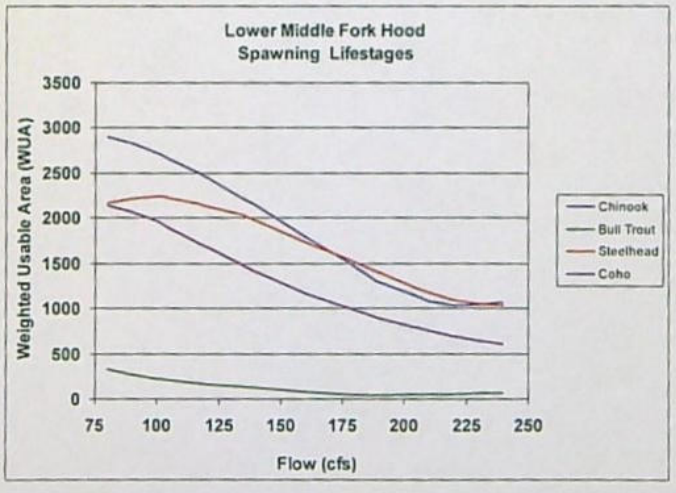


Figure 3. Weighted Usable Area for spawning lifestages at the Lower Middle Fork Hood River study site.

Table 9. Lower Middle Fork Hood RM 1, Weighted Usable Area expressed as a percentage of total habitat area for a 1000-foot reach of stream.

Flow (cfs)	Percentage of Total Area			
	Chinook Spawning	Bull Trout Spawning	Steelhead Spawning	Coho Spawning
80	9	1	6	6
90	8	1	6	6
100	8	1	6	6
102	8	1	6	5
104.4	7	1	6	5
115.6	7	<1	6	5
116	7	<1	6	5
120	7	<1	6	5
135	6	<1	6	4
140	6	<1	5	4
160	5	<1	5	3
176	4	<1	4	3
189	3	<1	4	2
204.7	3	<1	3	2
210	3	<1	3	2
220	3	<1	3	2
230	3	<1	3	2
240	3	<1	3	1

Rearing Life Stages

Table 10 and Figure 4 present results for rearing life stages for this study reach. These results suggest that while bull trout and coho rearing area is relatively constant over the range of flows we were able to model, rearing habitat for chinook and steelhead juveniles declines somewhat as flows increase, most likely due to increases in velocity as flows increase.

Table 10. Weighted Usable Area for rearing life stages in the Lower Middle Fork. WUA is expressed as square feet per 1,000 feet of stream.

Flow (cfs)	Chinook Rearing WUA	Bull Trout Rearing WUA	Steelhead Rearing WUA	Coho Rearing WUA
80	6587	1821	5822	873
90	6336	1755	5742	901
100	6154	1697	5661	960
102	6126	1697	5638	971
104.4	6090	1697	5607	983
115.6	5923	1708	5486	1023
116	5917	1708	5481	1025
120	5867	1719	5443	1038
135	5672	1775	5303	1094
140	5602	1786	5264	1107
160	5362	1828	5048	1154
176	5172	1859	4850	1181
189	5041	1897	4709	1199
204.7	4899	1943	4564	1208
210	4861	1952	4529	1217
220	4803	1964	4457	1241
230	4766	1984	4382	1264
240	4741	1998	4294	1273

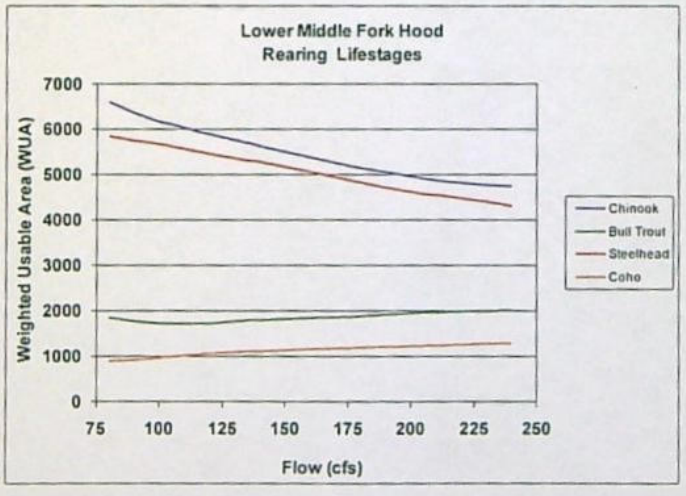


Figure 4. Weighted Usable Area for rearing life stages in the lower Middle Fork.

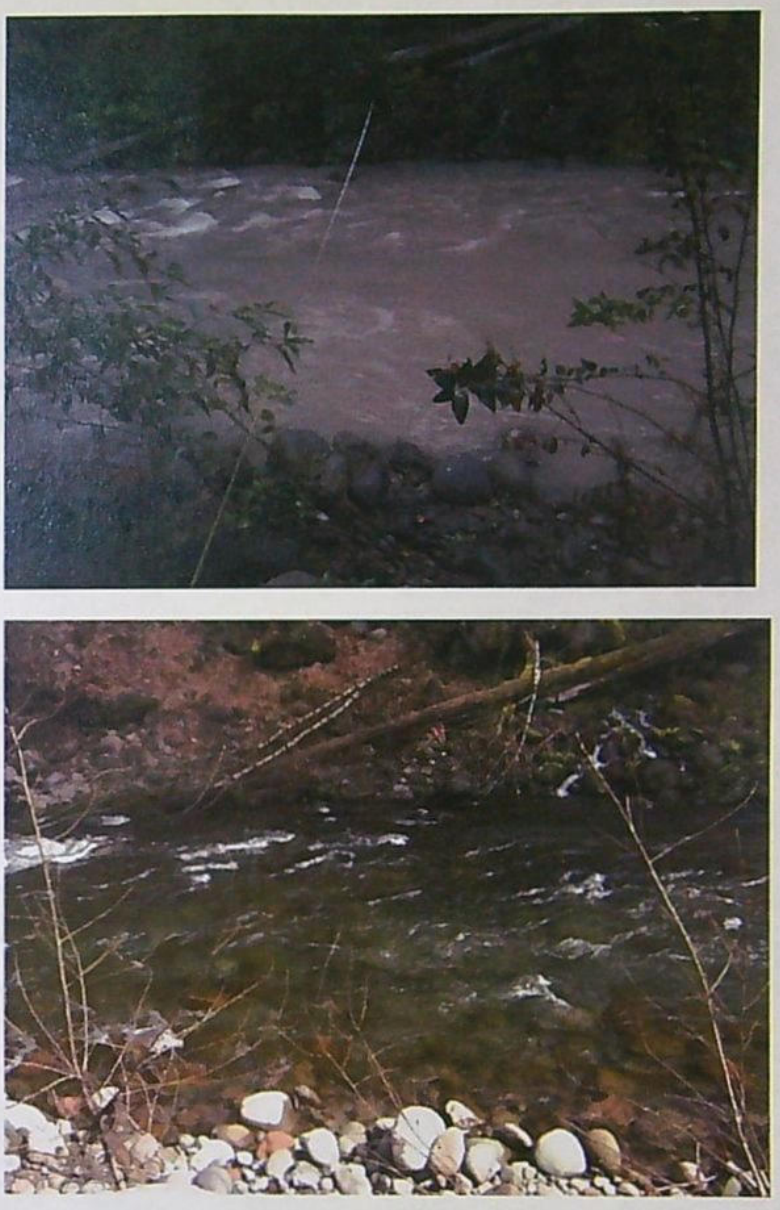
Discussion

This study site is at River Mile 1.0, approximately 12.5 river miles downstream of the Clear Branch/Eliot Branch confluence, with an additional 16,633 acres of tributary watershed area (57 percent of the whole) (Figure 3, Section 1). It is possible that any effect of the operation of the MFID project may be limited due to the additional watershed area and

tributary inflow. Over the range of flows it was possible to model, available rearing habitat for bull trout and coho remains fairly stable, while available habitat for chinook and steelhead decreases as streamflows increase. This is most likely due to increases in water velocity.

Lower Middle Fork Study Site - Transect Photos

Figures 5a, 5b. Lower Middle Fork Transect 1, September 2011 measurement (above) and March 2011 measurement (below). Photos are looking across channel.



Figures 6a, 6b. Lower Middle Fork Transect 2, September 2011 measurement (above), and March 2012 measurement (below). Photos are looking across channel.

Figure 7. Lower Middle Fork Transect 3, September 2011 measurement. Note variation in water surface elevations across transect. Photos are looking across channel.

Figure 8. Lower Middle Fork Transect 4, September 2011 measurement. Note variation in water surface elevations across transect. Photos are looking across channel.

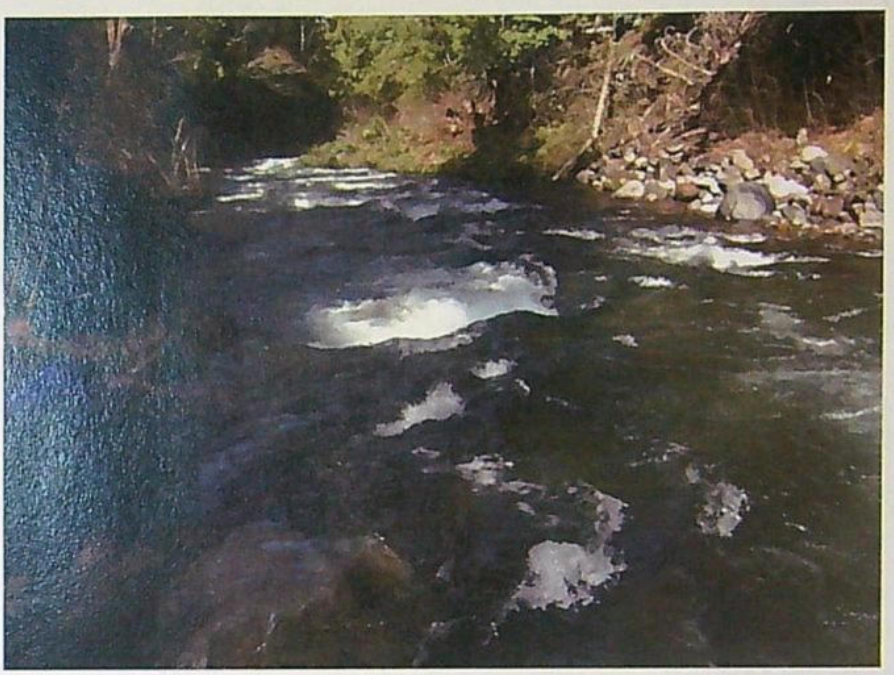


Figure 9. Lower Middle Fork, vicinity of Transect 3 and 4, March 2012 measurement. Photo is looking downstream.

References

Oregon Dept. of Fish & Wildlife. 2006. Standard review checklist for PHABSIM modeling. Memo from E.G. Robison, ODFW. July 7, 2006. Obtained via T. Hardin, ODFW, pers. comm. 2011.

U.S. Fish & Wildlife Service (USFWS). 2010a. Flow-habitat relationships for spring and fall-run chinook salmon and steelhead trout spawning in the Yuba River. Sacramento Fish & Wildlife Office, Sacramento, CA. August, 2010.

Introduction

This report documents the Habitat Suitability Criteria (HSC Criteria) that were discussed and approved by the FMP Committee in June, 2012, to be used to develop habitat/flow relationships in the Middle Fork Hood River IFIM Study. For each species and lifestage, depth and velocity criteria are presented. Substrate criteria are presented for spawning life stages. Cover type criteria for steelhead and bull trout juveniles are presented, as well as a cover type criteria for chinook juveniles that incorporates a distance-to-cover metric.

Spawning and Adult Life Stages

Bull Trout Spawning (Depth and Velocity)

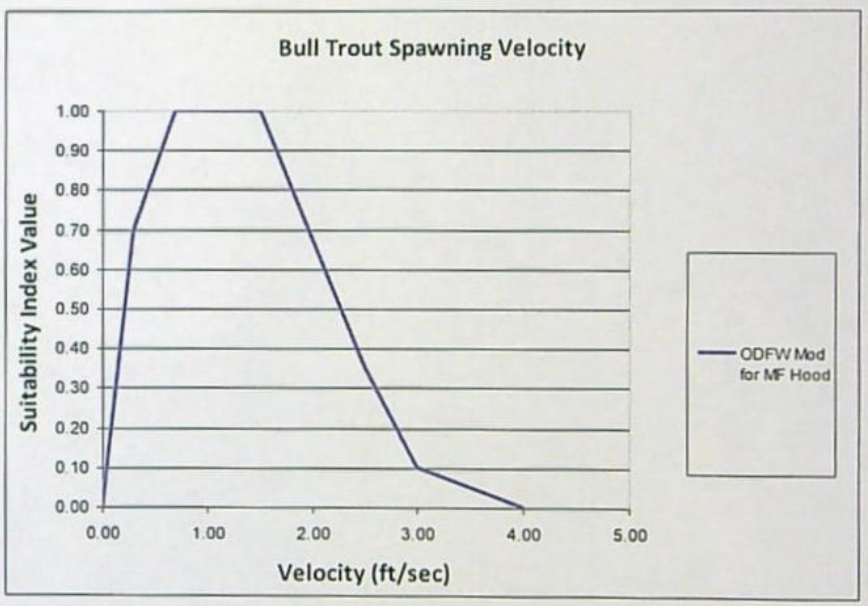


Figure 1a. Bull trout spawning final velocity criteria.

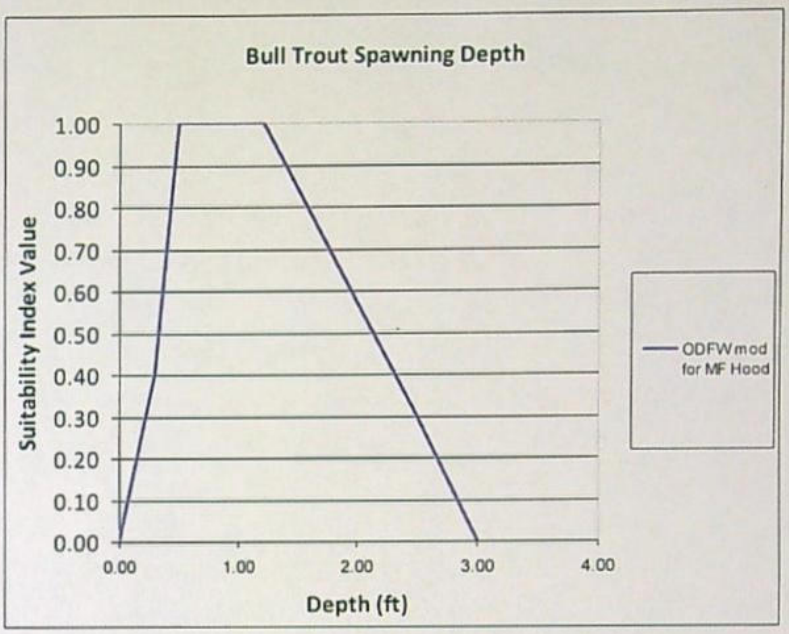


Figure 1b. Bull trout spawning final depth criteria.

Table 1. Bull trout spawning depth and velocity criteria.

Velocity (ft/sec)	Suitability
0.00	0.00
0.30	0.70
0.70	1.00
1.50	1.00
2.50	0.35
3.00	0.10
4.00	0.00

Depth (ft)	Suitability
0.00	0.00
0.30	0.40
0.50	1.00
1.20	1.00
2.50	0.30
3.00	0.00

Winter Steelhead Spawning (Depth & Velocity)

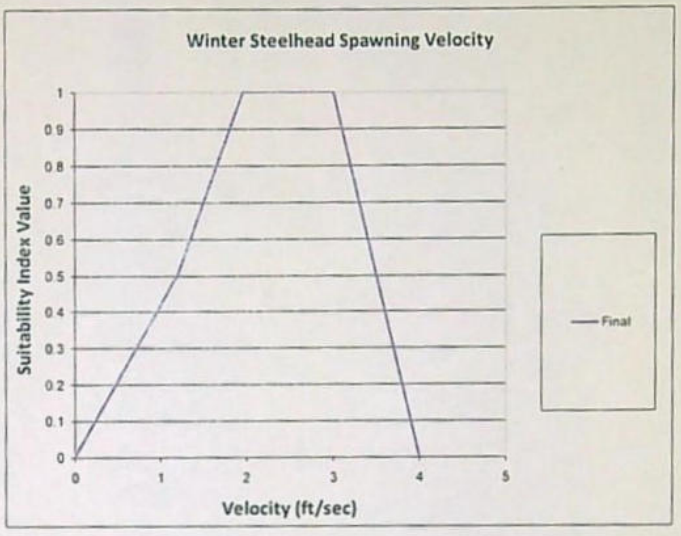


Figure 2a. Winter steelhead spawning final velocity criteria.

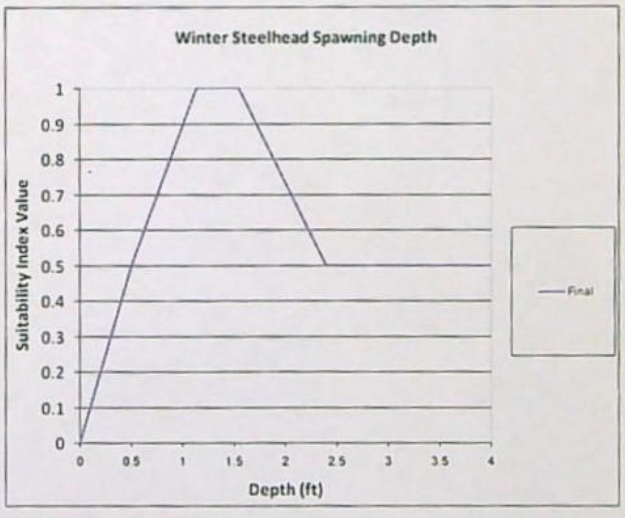


Figure 2b. Winter steelhead spawning final depth criteria.

Table 2. Winter steelhead spawning depth and velocity criteria.

Velocity (fps)	Suitability
0	0
1.2	0.5
1.96	1
2.28	1
3	1
4	0

Depth (ft)	Suitability
0	0
0.5	0.5
1.14	1
1.4	1
1.55	1.00
2.40	0.50
5.00	0.50

Spring Chinook Spawning (Depth & Velocity)

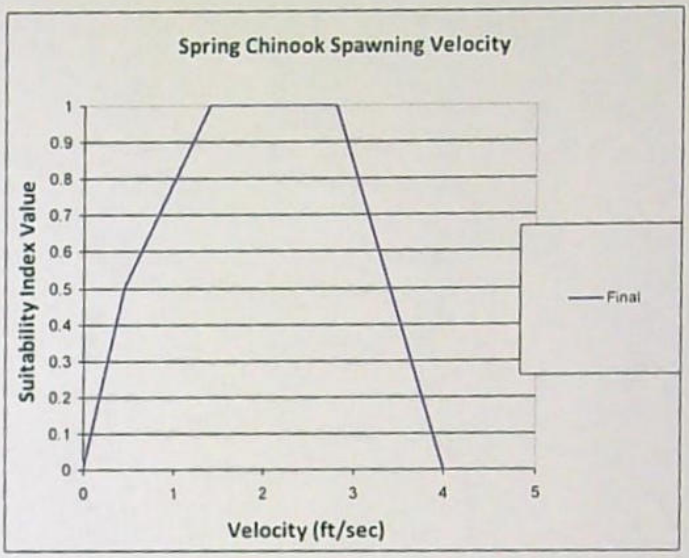


Figure 3a. Spring Chinook spawning final velocity criteria.

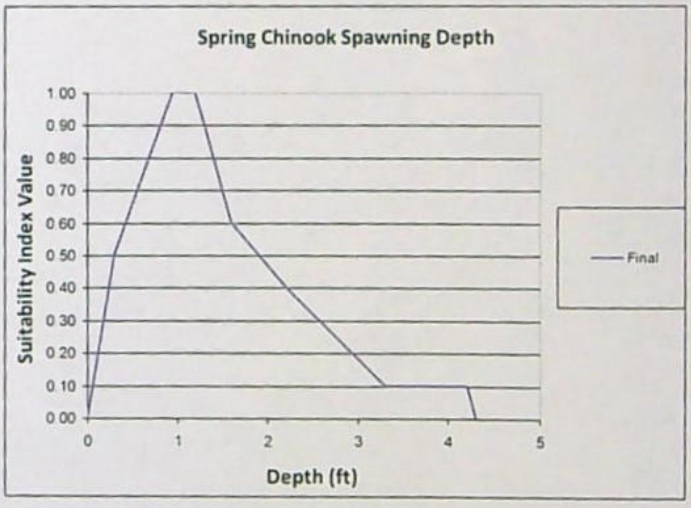


Figure 3b. Spring Chinook spawning final depth criteria.

Table 3. Spring chinook spawning final depth and velocity criteria.

Velocity (fps)	Suitability
0	0
0.45	0.5
1.4	1
1.90	1.00
2.80	1.00
4.00	0.00

Depth (ft)	Suitability
0	0.00
0.3	0.50
0.95	1.00
0.90	1.00
1.20	1.00
1.30	0.90
1.60	0.60
2.20	0.40
3.30	0.10
4.20	0.10
4.30	0.00

Cutthroat Resident Spawning (Depth & Velocity) (Coe & Eliot Branches)

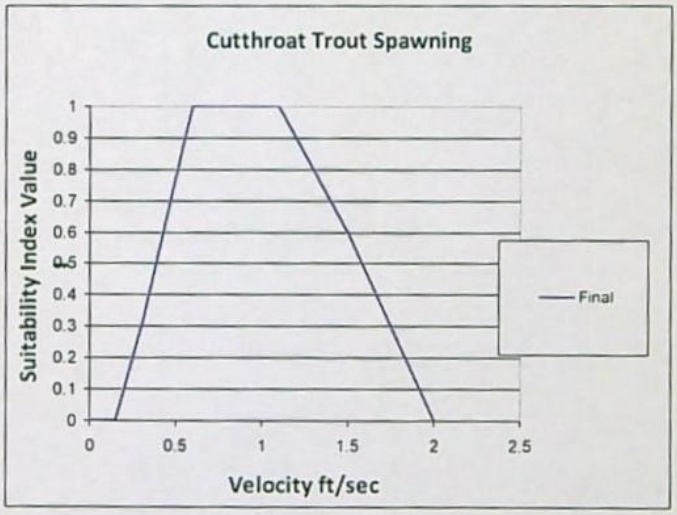


Figure 4a. Resident cutthroat trout spawning final velocity criteria.

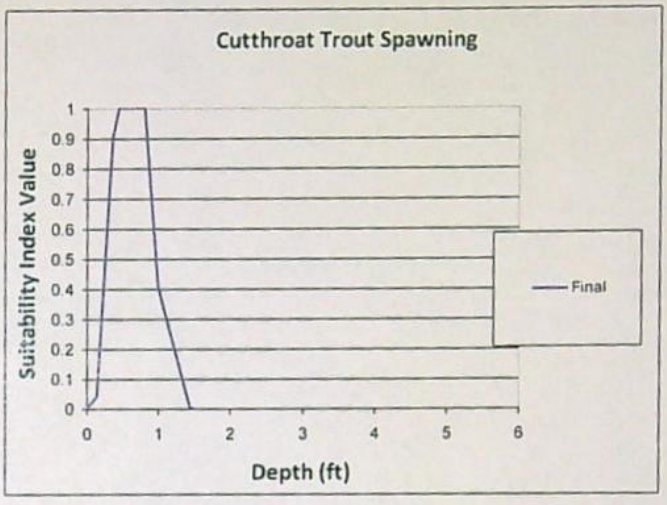


Figure 4b. Resident cutthroat trout spawning final depth criteria.

Table 4. Cutthroat trout spawning final depth and velocity criteria.

Velocity (fps)	Suitability
0	0
0.15	0
0.3	0.3
0.55	0.9
0.6	1
1.1	1
1.5	0.6
2	0

Depth (ft)	Suitability
0	0
0.15	0.04
0.35	0.9
0.45	1
0.75	1
0.80	1
1.00	0.4
1.45	0

Cutthroat Adult and Juvenile Rearing & Migration Criteria (Depth & Velocity) (Coe & Eliot Branches)

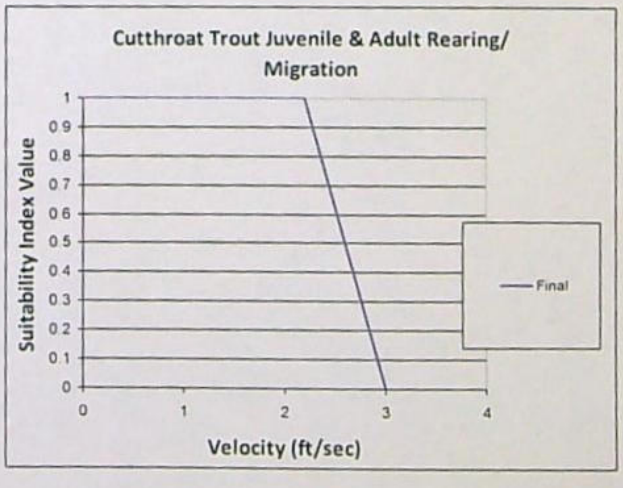


Figure 5a. Cutthroat adult and juvenile rearing final velocity criteria.

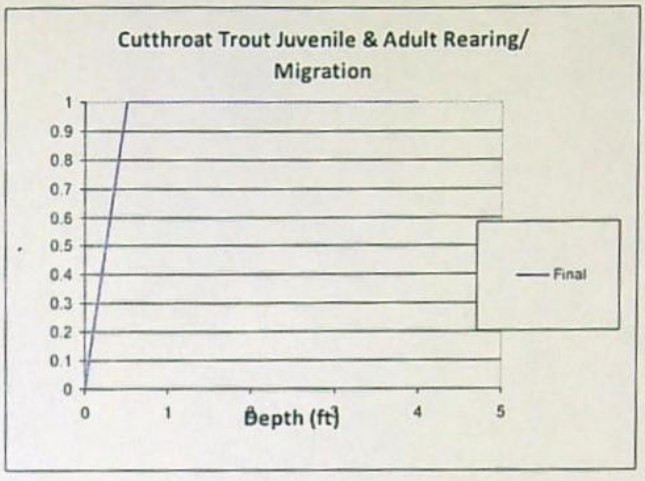


Figure 5b. Cutthroat trout juvenile and adult rearing final depth criteria.

Table 5. Cutthroat trout adult & juvenile rearing & migration final velocity and depth criteria.

Velocity	Final
0	1
2.2	1
3	0

Depth	Final
0	0
0.5	1
2	1
4	1

Coho salmon spawning (Depth & Velocity)

The FMP Committee decided to generate flow/habitat relationships for coho salmon, using the Washington Dept of Fish & Wildlife/Dept of Ecology criteria for depth, velocity and substrate.

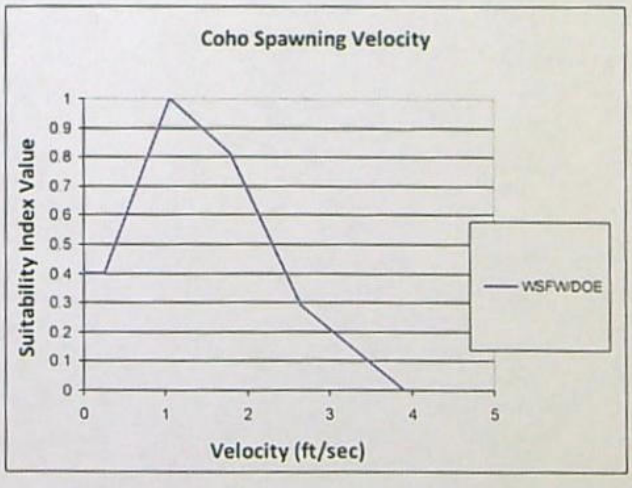


Figure 6a. Coho salmon spawning final velocity criteria.

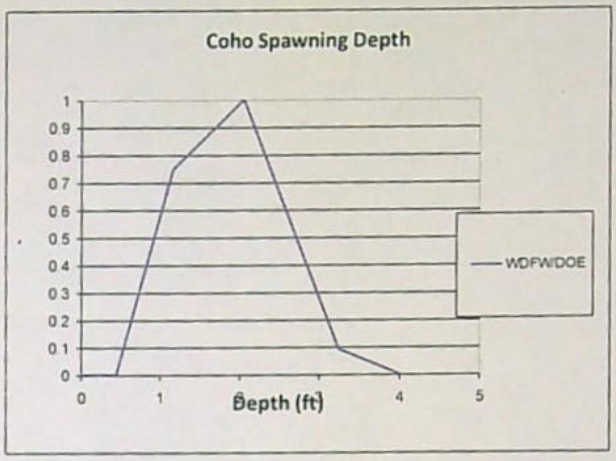


Figure 6b. Coho salmon spawning final depth criteria.

Table 6. Coho salmon spawning final depth and velocity criteria.

Velocity (fps)	Suitability
0	0.4
0.25	0.4
1.05	1
1.8	0.81
2.65	0.29
3.9	0

Depth (ft)	Suitability
0	0
0.45	0
1.15	0.75
2.05	1
3.25	0.09
4	0

Substrate Criteria- Spawning Lifestages

The FMP Committee approved the proposal to use WDFW/DOE substrate criteria, although the gravel size preferences for bull trout spawning were modified using professional judgment and experience with the Middle Fork Hook River bull trout populations.

Table 7. Final substrate preference values for spawning salmonids.

Substrate Type	Size	Code	Spawning			
			Salmon	Steelhead	Resident Trout	Bull Trout
Silt, clay, organic		1	0.0	0.0	0.0	0.0
Sand		2	0.0	0.0	0.0	0.0
Small gravel	0.1 – 0.5 "	3	0.3	0.5	0.8	1.0
Medium gravel	0.5 – 1.5 "	4	1.0	1.0	1.0	1.0
Large gravel	1.3 – 3 "	5	1.0	1.0	0.8	1.0
Small cobble	3 – 6 "	6	1.0	1.0	0.5	0.5
Large cobble	6 – 12 "	7	0.5	0.3	0.0	0.0
Boulder	> 12"	8	0.0	0.0	0.0	0.0
Bedrock		9	0.0	0.0	0.0	0.0

Source: WDFW/DOE 2008, Table 1, Page 23, modified by the FMP Committee for bull trout spawning.

Juvenile Lifestages (Depth & Velocity)

Bull Trout Juvenile Rearing (Depth & Velocity)

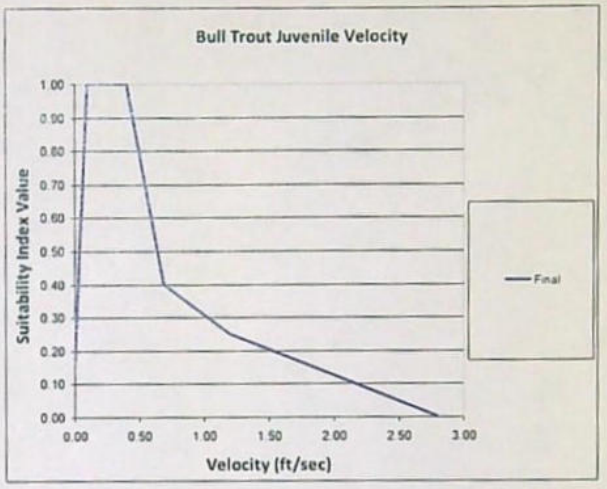


Figure 7a. Juvenile bull trout rearing final velocity criteria.

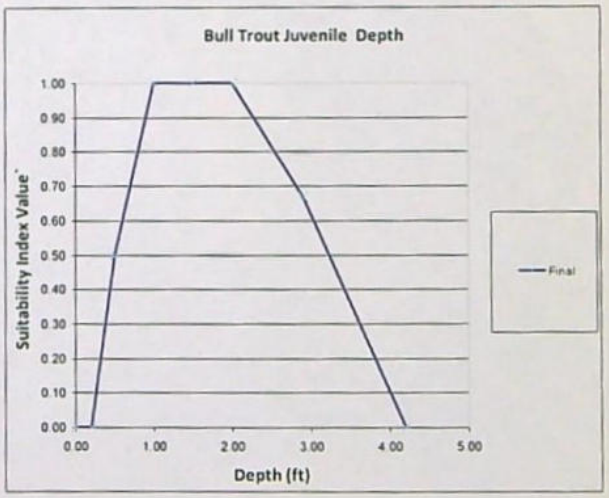


Figure 7b. Juvenile bull trout rearing final depth criteria.

Table 8. Juvenile bull trout rearing final velocity and depth criteria.

Velocity (fps)	Suitability
0.00	0.16
0.10	1.00
0.40	1.00
0.69	0.40
1.20	0.25
2.80	0.00

Depth (ft)	Suitability
0.00	0.0
0.20	0.0
0.5	0.5
1.00	1.00
1.50	1.00
2.00	1.00
2.90	0.67
4.20	0.00

Steelhead Juvenile Rearing (Depth & Velocity)

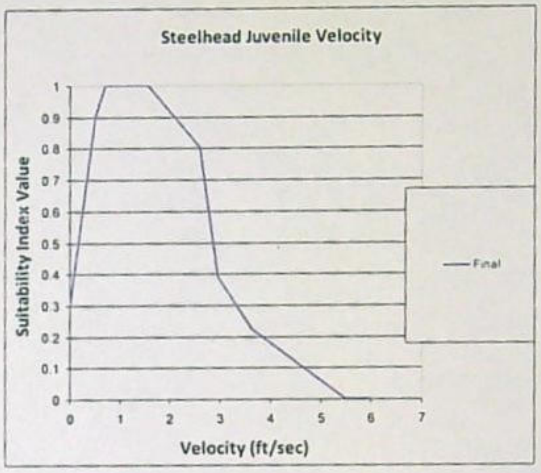


Figure 8a. Juvenile steelhead final velocity criteria.

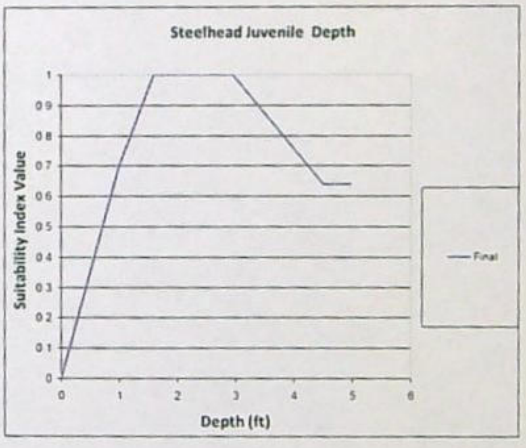


Figure 8b. Juvenile steelhead rearing final depth criteria.

Table 9. Juvenile bull trout rearing final velocity and depth criteria.

Velocity (fps)	Suitability
0	0.3
0.5	0.9
0.7	1
1.35	1
1.55	1
2.6	0.8
2.95	0.39
3.65	0.22
5.5	0
6	0

Depth (ft)	Suitability
0	0
1	0.7
1.2	0.8
1.4	0.9
1.6	1
2.65	1
2.95	1
4.5	0.64
5	0.64
10	0.64

Spring Chinook Juvenile (Depth & Velocity)

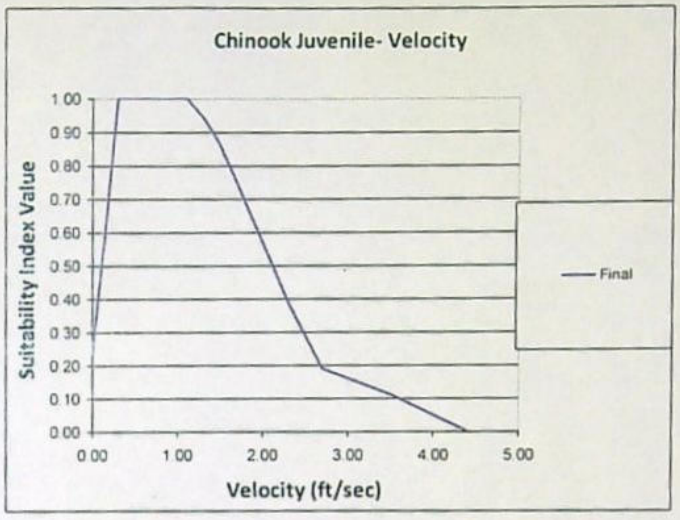


Figure 9a. Juvenile chinook final velocity criteria.

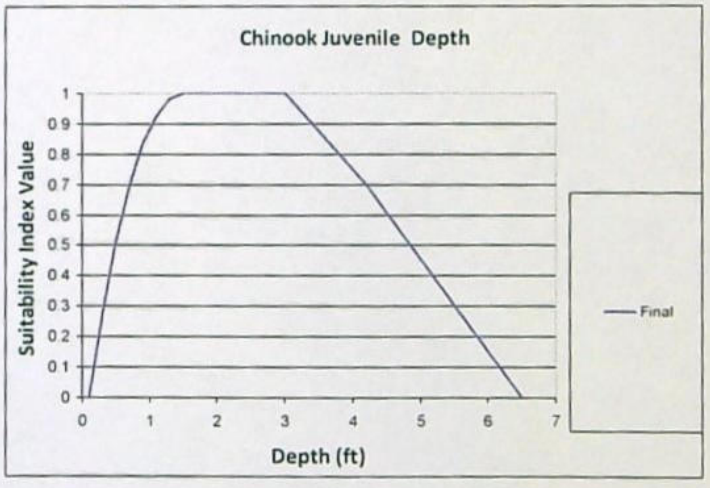


Figure 9b. Juvenile chinook final depth criteria.

Table 10. Juvenile chinook rearing final velocity and depth criteria.

Velocity (fps)	Suitability
0.00	0.23
0.15	0.61
0.30	1.00
0.90	1.00
1.10	1.00
1.30	0.94
1.50	0.86
1.70	0.75
1.90	0.63
2.10	0.51
2.30	0.39
2.50	0.29
2.70	0.19
3.50	0.11
4.40	0.00

Depth (ft)	Suitability
0.1	0
0.3	0.27
0.5	0.51
0.7	0.69
0.9	0.83
1.1	0.92
1.3	0.98
1.5	1
3	1
4.2	0.7
6.5	0

Coho juvenile rearing

The HSC criteria used for juvenile rearing used the WDFW/DOW coho juvenile rearing depth and velocity criteria, and the cover criteria developed for this flow study, using observations taken between 0 and 2 feet of the transect, as used for steelhead rearing.

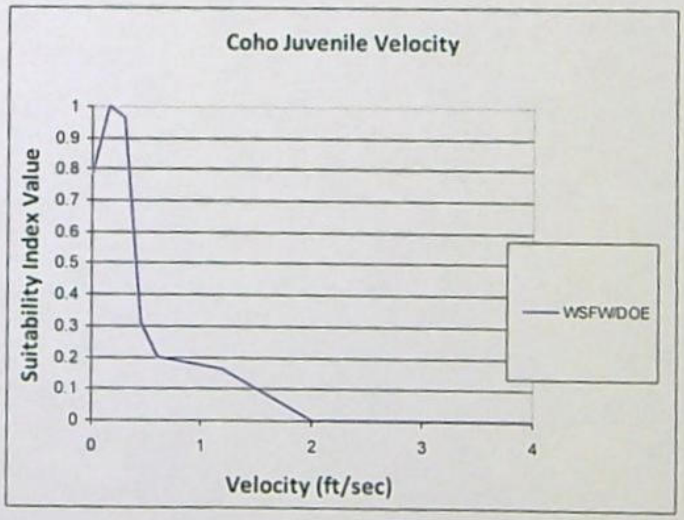


Figure 10a. Coho juvenile rearing velocity criteria.

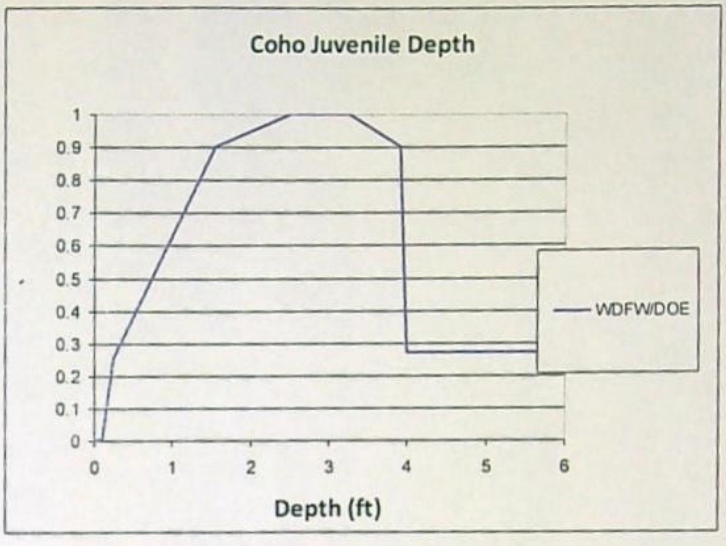


Figure 10b. Coho juvenile rearing depth criteria.

Table 11. Coho juvenile rearing depth and velocity criteria.

Velocity (fps)	Suitability
0	0.78
0.15	1
0.3	0.96
0.45	0.31
0.6	0.2
1.2	0.16
2	0
3.65	0
5.5	0
6	0
7	0

Depth (ft)	Suitability
0	0
0.1	0
0.25	0.25
1.55	0.9
2.5	1
3.25	1
3.9	0.9
4	0.27
5	0.27
10	0.27
11	0.27

Instream Cover, Rearing Lifestages

Instream cover type values in Table 12 were be used, along with depth and velocity criteria, for rearing bull trout and winter steelhead juveniles. Instream cover values incorporating a distance-to-cover metric, in Table 13, were used for rearing chinook juveniles.

Table 12. Cover conditions observed in the Middle Fork Hood River, and juvenile salmonid cover preference criteria.

Conditions Observed at the Middle Fork IFIM Study Sites	Juvenile Salmonid HSC Criteria
Boulder	0.6
Cobble	0.3
Cobble & Log	0.8
Boulder & Log	0.8
Boulder & rootwad	1.0
Log	0.5
Logs	0.8
Log & rootwad or logjam	1.0
No Cover	0.3*

*To allow some habitat value for areas with preferred depth and velocity, no cover.

Table 13. Two-distance cover suitability scores used in the juvenile chinook habitat modeling.

Juvenile Habitat Type Code*	Habitat Conditions Observed W/in 2 ft	Habitat Conditions Observed W/in 5 ft	Additive Code/Distance Scores Used in Juvenile Chinook Habitat Model (values > 1.0 adjusted)	Cover Code Value W/in 2 ft	Distance Score (1 foot value)	Cover Code Value 2-5 feet	Distance Score (2 ft value)	Summed (Code Value *Distance Value) Scores at both distances
1	Log	Log + rootwad	0.9	0.5	1.00	1	0.4	0.900
2	Log + rootwad	Log + rootwad	1.0	1.0	1.00	1	0.4	1.400
3	None	rootwad and logs	0.7	0.3	1.00	1	0.4	0.700
4	None	Small Log jam	0.7	0.3	1.00	1	0.4	0.700
5	Small Log jam	Small Log jam	1	1	1.00	1	0.4	1.400
6	Boulder	Boulder + Log	0.9	0.6	1.00	0.8	0.4	0.920
7	Boulder + Log	Log	1	0.8	1.00	0.5	0.4	1.000
8	Boulder	Boulder & rootwad	1.0	0.6	1.00	1	0.4	1.000
9	Boulder & rootwad	Boulder & rootwad	1	1	1.00	1	0.4	1.400
14	Log + boulder	None	0.9	0.8	1.00	0.3	0.4	0.920
15	Logs	Logs	1	0.8	1.00	0.8	0.4	1.120
16	None	Boulder + Log	0.6	0.3	1.00	0.8	0.4	0.620
18	Rootwad + trees	Rootwad + trees	1.0	1.0	1.00	1	0.4	1.400
19	Log & Boulder	Log & Boulder	1.0	0.8	1.00	0.8	0.4	1.120
22	Log	Log	0.7	0.5	1.00	0.5	0.4	0.700
24	None	Log	0.2	0.3		0.5	0.4	0.200
26	Overhead Log	None	0.62	0.5	1.00	0.3	0.4	0.620
27	Small woody vegetation	Boulder	0.5	0.3	1.00	0.6	0.4	0.540
30	Boulder	Boulder	0.84	0.6	1.00	0.6	0.4	0.840
31	Boulder	None	0.72	0.6	1.00	0.3	0.4	0.720
32	Cobble	Cobble	0.42	0.3	1.00	0.3	0.4	0.420
33	Cobble	Log	0.5	0.3	1.00	0.5	0.4	0.500
35	Log	None	0.62	0.5	1.00	0.3	0.4	0.620
36	None	Boulder	0.54	0.3	1.00	0.6	0.4	0.540
38	None	Cobble	0.42	0.3	1.00	0.3	0.4	0.420
40	None	None	0.42	0.3	1.00	0.3	0.4	0.420

*(for modeling purposes)

References

Washington Depts. of Ecology and Fish and Wildlife (DOE & WDFW). 2008 (update). Instream Flow Study Guidelines. Olympia, WA. Available via the internet at www.ecy.wa.gov/wr/instream-flows/isfsci.html.

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CAMPBELL-CRAVEN
ENVIRONMENTAL CONSULTANTS

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Tigard, Oregon 97223
(503) 639-7200

October 27, 1987

Mr. Dave Nichols
Oregon Department of Fish and Wildlife
P. O. Box 59
Portland, Oregon 97207

Subject: Odell Creek Hydropower Project

Dear Dave:

I have reviewed the project area severaltimes in the last few months. The first visit was primarily an overview of the area. The second visit in June primarily was to look at the area from the powerhouse downstream to the East Fork Hood River. The third visit in August was to walk the diversion reach to characterize the habitat and to take some flow measurements. The fourth visit was September 9 to vary the flows and to observe and photograph the changes. A fifth visit occurred October 13 to conduct an instream flow study. My impressions at those times under the flows present and recollections from conversations and review of various documents, and the results of the instream flow study are as follows:

1. The species of interest is steelhead. According to Jim Newton, adult summer and winter steelhead are present in the Hood River Drainage. Summer steelhead enter the river in February or March and spawn in April and/or May. Winter steelhead enter the river in November or December and spawn in April and/or May.

2. There are no records of any upstream passage of anadromous fish into Odell Creek; however, Tim Unterwegner (ODFW) said there were adult steelhead in Odell Creek the last 2 or so years, but he was not sure how they got there, either over the ladder or from East Fork; in addition, according to Jim Newton, the East Fork manager has reported adult fish in Odell.

3. The estimated stream flow (Exhibit E, 1982) varies from 17.6 to 63.1 cfs. This estimate included the augmentation (.3 to 5.5 cfs) from the East Fork Irrigation District, which has been severely curtailed. The instream flow was established (without any studies) as 10 cfs from December 1 through June 30 and 7 cfs from July 1 through November 30. The estimated natural flows, augmentation, and mininim flows are:

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
NAT.	15.4	32.9	52.1	62.8	47.4	41.0	40.5	39.1	29.2	17.8	12.4	12.1
AUG.	4.0	0.3	0.3	0.3	0.3	0.3	5.0	5.0	5.5	5.5	5.5	5.5
TOTAL	19.4	33.2	52.4	63.1	47.7	41.3	45.5	44.1	34.7	23.3	17.9	17.6
MIN. FLOW	7.0	10.0	10.0	10.0	10.0	10.0	10.0	7.0	7.0	7.0	7.0	7.0

4. Steelhead access to the stream potentially would occur from November through March; the cascades and drops, especially those from the river upstream into Odell Creek for about 500 feet, could provide partial or full blocks to upstream passage depending on water levels;

5. There is a potential block to upstream (and downstream?) fish passage about 300 feet upstream from the powerhouse. This potential block is formed from wooded debris in the stream and possibly stream boulders; it appears to have been in place a couple of years;

6. There is a STEP program (3 hatch boxes) for steelhead about RM 3.5 to 6.0 that was started in 1985. The releases from that program have been:

1985-fish released into another stream system

1986-29,000 fry released into Odell Creek

1987-fish released into another stream system

7. The diversion reach of Odell Creek Project is about 1200 feet long near the mouth of Odell Creek. The habitat is fairly consistent throughout the reach and consists of an average gradient of about 2% or so and has a heavy canopy provided by riparian vegetation.

From the dam to about 200 feet downstream, the stream is about 6 to 10 feet wide and has sand and gravel near the dam and weir which grades into more bedrock and cobble material near the lower end of the 200 feet. The stream course was altered during dam construction and the stream rerouted into a new channel (about 100+ feet of the 200 feet) that was excavated.

From this area downstream, the stream is about 8 to 15 feet wide and consists of a stairstep pattern of pools or runs that are not too obvious because of the heavy vegetation, the clarity

of the water, and the generally small cascades or drops of 6 to 12 inches or so that separate the pool areas. The pools are deeper than they appear from casual observation; most of the substrate consists of bedrock, large cobble and boulders which forms hydraulic controls with small drops at the tailend of the pools which are as deep as 3 feet. This same pattern is fairly consistent to the powerhouse although the velocity, depth, and size of substrate varies. Velocities throughout the reach vary from about 1/2 to 3 feet per second and are regulated by the size of pools, depth of water, presence of boulders, and stream width.

Spawning-sized gravel is absent except in the area immediately below the dam; however, spawning has not been observed in the stream below the dam (or above the dam?). The gravel is a result of placement during construction of the dam.

8. The use of Odell Creek by steelhead apparently is very low:

Adult migration-potential is low because of high gradient drops at mouth, and low volume of water; adults apparently could enter Odell Creek from the East Fork Irrigation system. Adults could be present from November through May.

Rearing from dam to mouth-potential is possibly moderate (if fish are present) because of pool areas, but high velocities would tend to moderate the value for fry and juveniles.

Spawning from dam to mouth-potential is low to non-existent because of gradient, large cobble/boulders, and virtual absence of gravel except in the area near the dam;

Downstream migration of fry/smolts-potential is low to non-existent for naturally produced fish; potential for fish from the STEP program will vary from year to year but could be significant, depending on survival rates. Fry or smolts possibly could enter Odell Creek from East Fork Irrigation system.

9. The project reach was photographed at several points on September 9, 1987, at flows of 10, 7, 4.7, and 1.8 cfs. The observations and photos show some loss of wetted perimeter, but it appears to be a small loss because of the nature of the stream, a lowered velocity as flow was decreased, and maintenance of pools even down to 1.8 cfs.

10. Based on these photo and personal observations, the following appears possible:

A. Spawning in the project area will not be affected by flows down to 1.8 cfs.

B. Rearing in the project are will not be affected by

flows down to 1.8 cfs.

C. Downstream movement of fry/juveniles/smolts from spawning or hatch box releases upstream will not be affected by flows down to 1.8 cfs.

D. Upstream and downstream migration by adults possibly could be affected at flows of 1.8 cfs in the project reach.

11. An instream flow study was conducted to evaluate the potential for adverse effects on habitat as a result of changes in flow. Three areas of the stream were selected to place transects to conduct the study. The transects were surveyed to obtain water surface elevations and bottom profiles. Substrate was coded for each transect. Velocities were measured at verticals at flows of about 2, 4, and 10 cfs.

An evaluation of the data suggested that the three-flow analysis technique would not be appropriate because of the change in flow structure between flows. Therefore, a one-flow analysis was conducted using the stage-discharge relationship from all three flows and the velocity distribution at 4 cfs.

Two sets of suitability curves were used for comparison. One set was for rainbow trout (USFWS, 1984) and the other was for winter steelhead for Umpqua Basin fish (obtained from M. Yoshinaka, USFWS). A comparison for the two sets of curves for fry and juveniles is shown in the accompanying figures. The greatest difference in the curves that would affect results are in the velocity curves. The steelhead suitability curve is considerably wider for both fry and juveniles. Although the depth curve is greately wider for rainbow, this would not affect the analysis significantly because of the lack of depths greater that 2 feet or so.

The HABOUT from the analysis is provided for review for each of the sets of suitability curves. As is shown in the analysis, the choice of suitability curve affects the interpretation.

At this point, I believe that we should sit-down and discuss the observations and the results of the instream flow study to determine the next course of action.

Sincerely,

Richard E. Craven

ODFW

ODELL CREEK HYDRO PROJECT, OCTOBER 13, 1987
TRANSECT NUMBER 1A, 2A, and 3A

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**************************************************
*      PHYSICAL HABITAT SIMULATION SYSTEM        *
*      INSTREAM FLOW GROUP, USFWS                *
*      VERSION OF AUGUST, 1983                   *
*      RUN DATE 10-24-87   TIME 16:59:05         *
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H     H   A     A   B     B      T      A     A      T
H     H   A     A   B     B      T      A     A      T
H     H   A     A   BBBBBB       T      A     A      T
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HABTAT PROGRAM VERSION NUMBER 4-1
LAST MODIFIED ON 31 AUGUST 1983

TRANSLATED BY THOMAS R. PAYNE & ASSOCIATES

PERMISSION TO USE GRANTED TO
CAMPBELL-CRAVEN
SERIAL NO. 02-012

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CURVE ID NUMBERS 11000 11001 11002 11010

CURVE SET DEFINITION DATA WAS OBTAINED FROM THE FILE -

SUITABILITY CURVES FROM USFWS FOR DOUGLAS COUNTY PROJECT

LAST UPDATED ON 07-09-87 14:55:58

ODELL CREEK HYDRO PROJECT, OCTOBER 13, 1987
TRANSECT NUMBER 1A, 2A, and 3A

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR

WINTER STEELHEAD

	Q	FRY	JUVENILE	ADULT	SPAWNING
1	1.00	2445.35	1241.85	.00	.00
2	3.00	3755.10	2723.10	.00	35.59
3	5.00	4237.29	3406.82	.97	97.15
4	10.00	4882.01	4588.02	19.77	150.75
5	15.00	4962.38	5299.50	78.91	204.29
6	20.00	4771.60	5619.13	163.72	318.90
7	50.00	3269.96	5035.87	272.83	768.66

Q VS. AVAILABLE HABITAT AREA AS A PERCENTAGE OF THE GROSS AREA FOR

WINTER STEELHEAD

	Q	GROSS	FRY	JUVENILE	ADULT	SPAWNING
1	1.00	8579.96	28.50	14.47	.00	.00
2	3.00	13414.32	27.99	20.30	.00	.27
3	5.00	14817.10	28.60	22.99	.01	.66
4	10.00	17250.99	28.30	26.60	.11	.87
5	15.00	19096.45	25.99	27.75	.41	1.07
6	20.00	19782.82	24.12	28.40	.83	1.61
7	50.00	23128.19	14.14	21.77	1.18	3.32

$$$ NORMAL COMPLETION OF JOB

TRPA PROGRAM-HABTAT 10-24-87 16:40:50

ODELL CREEK HYDRO PROJECT, OCTOBER 13, 1987
TRANSECT NUMBER 1A, 2A, and 3A

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*      INSTREAM FLOW GROUP, USFWS                *
*      VERSION OF AUGUST, 1983                   *
*      RUN DATE 10-24-87   TIME 16:40:50         *
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LAST MODIFIED ON 31 AUGUST 1983

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CURVE SET DEFINITION DATA WAS OBTAINED FROM THE FILE -

RAINBOW TROUT SUITABILITY CURVES FROM STANDARD CURVES-USFWS

LAST UPDATED ON 01-01-80 00:00:00

TRPA PROGRAM-HABTAT 10-24-87 16:40:50 PAGE

ODELL CREEK HYDRO PROJECT, OCTOBER 13, 1987
TRANSECT NUMBER 1A, 2A, and 3A (FILE ODHAB1.23

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR

RAINBOW TROUT

	Q	SPAWNING	FRY	JUVENILE	ADULT
1	1.00	.00	2058.22	643.23	1394.29
2	3.00	.00	2633.95	1044.35	2474.70
3	5.00	.00	2789.64	1207.84	3189.35
4	10.00	.00	2790.99	1359.16	3873.25
5	15.00	.00	2811.28	1456.74	4654.26
6	20.00	.00	2792.26	1531.61	4989.25
7	50.00	.00	2113.94	1733.67	4804.81

Q VS. AVAILABLE HABITAT AREA AS A PERCENTAGE OF THE GROSS AREA FOR

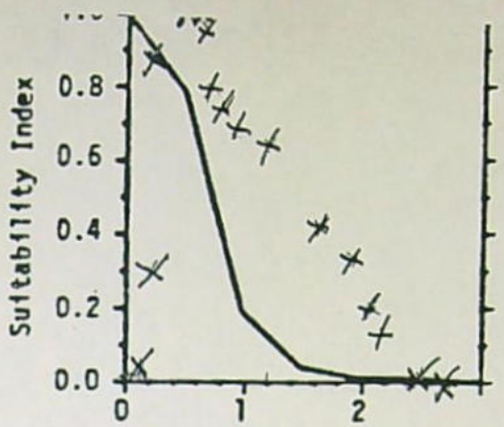
RAINBOW TROUT

	Q	GROSS	SPAWNING	FRY	JUVENILE	ADULT
1	1.00	8579.96	.00	23.99	7.50	16.25
2	3.00	13414.32	.00	19.64	7.79	18.45
3	5.00	14817.10	.00	18.83	8.15	21.52
4	10.00	17250.99	.00	16.18	7.88	22.45
5	15.00	19096.45	.00	14.72	7.63	24.37
6	20.00	19782.82	.00	14.11	7.74	25.22
7	50.00	23128.19	.00	9.14	7.50	20.77

$$$ NORMAL COMPLETION OF JOB

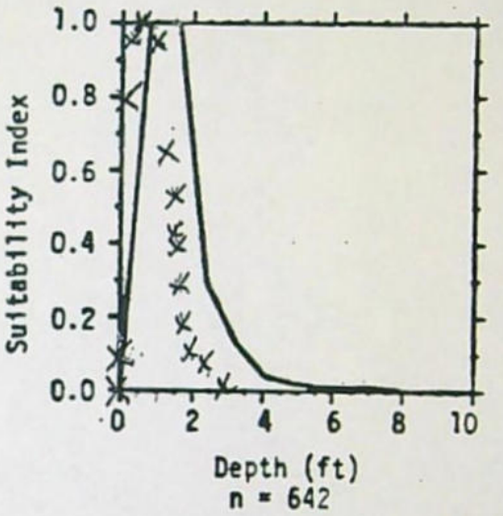
Coordinates

x	y
0.00	1.0
0.49	0.78
0.98	0.19
1.48	0.04
1.97	0.01
2.46	0.01
2.95	0.00
100.00	0.00



X = WINTER STEELHEAD

x	y
0.00	0.00
0.10	0.11
0.82	1.00
1.64	1.00
2.46	0.29
3.28	0.13
4.10	0.04
4.92	0.02
5.74	0.01
7.38	0.01
8.20	0.00
100.00	0.00



x	y
0.0	0.00
1.0	0.00
2.0	0.02
3.0	0.01
4.0	0.17
5.0	0.13
6.0	1.00
7.0	1.00
8.0	0.18
8.1	0.00
100.0	0.00

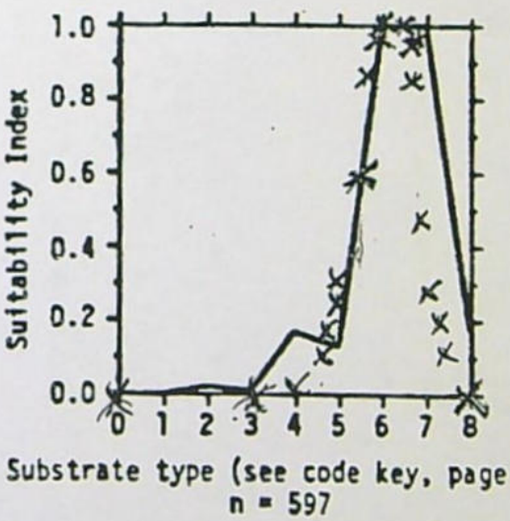
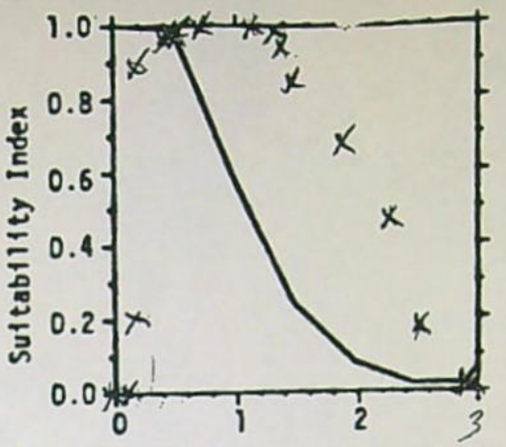


Figure 3. SI curves for rainbow trout fry velocity, depth, substrate, and temperature.

Coordinates

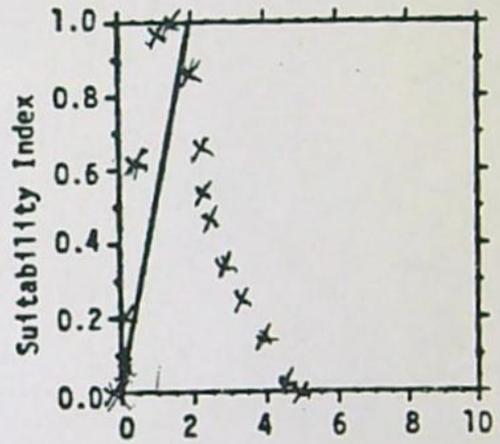
x	y
0.00	1.00
0.49	0.99
0.98	0.59
1.48	0.24
1.97	0.08
2.46	0.02
3.44	0.02
3.50	0.00
100.00	0.00



X = WINTER STEELHEAD

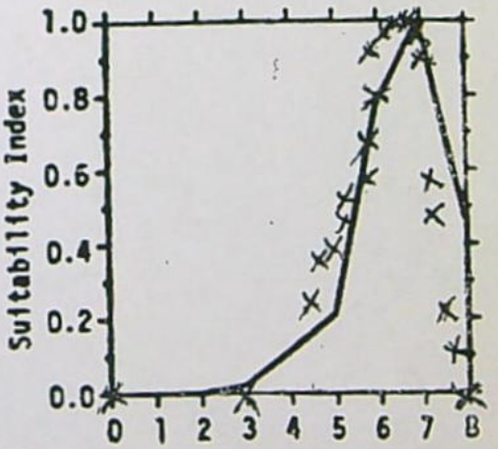
Mean water column velocity (ft/sec)
n = 546

x	y
0.0	0.0
2.0	1.0
100.0	1.0



Depth (ft)
n = 565

x	y
0.0	0.00
2.0	0.00
3.0	0.02
4.0	0.11
5.0	0.21
6.0	0.77
7.0	1.00
8.0	0.47
8.1	0.00
100.0	0.00



Substrate type (see code key, page 39)
n = 457

Figure 4. SI curves for rainbow trout juvenile velocity, depth, substrate, and temperature.

NORMANDEAU
environmental consultants

Hood River Tributaries Instream Flow Study

Presented To:
Hood River County
601 State Street
Hood River, OR 97031

Submitted On:
June 13, 2014

Submitted By:
Normandeau Associates, Inc.
890 L Street
Arcata, CA 95521

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Draft Hood River Tributaries Instream Flow Study

Prepared for
Hood River County
601 State Street
Hood River, OR 97031

Prepared by
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890 L Street
Arcata, CA 95521

Date
June 13, 2014

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Executive Summary

These instream flow studies established the relationship between an index of fish habitat suitability (Area Weighted Suitability, AWS) and stream flow. The Hood River Tributaries: Neal Creek, Green Point Creek, West Fork Hood River, and East Fork Hood River are included in this report. The AWS for the species and life-stages of interest were combined with the historical and potential future changes in flow over time creating habitat time series. The habitat time series enables stakeholders to compare future climate-modified habitat time series with the historical record and make proactive decisions on managing the resource.

The Hood River County Water Planning Group (HRWPG) engaged Normandeau to conduct the instream flow studies in conjunction with a water resource model to determine the impacts of potential future climate-modified scenarios on salmonid habitat in the Hood River Tributaries. Normandeau conducted standard PHABSIM instream flow studies on one mile reaches in each of the tributaries with two reaches in the East Fork Hood River. The studies included stakeholder involvement, habitat mapping, transect selection and placement, habitat suitability criteria (HSC) development, hydraulic field measurement, simulation, and habitat modeling. The body of this report includes the methodology, summary results, and example comparisons. The detailed results are included in the Appendices. Annexes A and A1 include additional background about the HSC. There are 390 habitat time series. These are included in Annexes B1-B5 in user interactive Excel workbooks, one file for each reach. These Excel files are intended as the primary tool to compare the habitat time series.

Normandeau collaborated with Dr. Koehler of Visual Analytics on a novel method of presenting habitat time series, using raster plots for viewing and understanding the data. In addition to the standard habitat duration graphs, the final presentation (Annex C) included raster plots of the climate modified flow scenarios, and habitat time series for the East Fork Hood River. The user can toggle between raster plots in presentation mode to visually compare the historical and future scenarios enabling a detailed depiction of the impacts. This method can be useful in identifying habitat bottlenecks.

The AWS for the East Fork Hood River indicated lower flow suitability for adult and juvenile salmonids than previous studies. Annex A1 presents additional analysis of the hydraulic character of the East Fork and Annex D is a letter from the Hood River Production Program (Oregon Department of Fish and Wildlife and Confederated Tribes of the Warm Springs) detailing their concerns with the lower AWS. Habitat mapping of the entire stream sections in addition to the one mile reaches mapped for this study will indicate if the reaches are representative or if additional transects could be added to increase the accuracy of the fish habitat model.

Acronyms and Abbreviations

ADCP Acoustic Doppler Current Profiler

AWS Area Weighted Suitability (current name for WUA)

BOR Bureau of Reclamation

CTWS Confederated Tribes of the Warm Springs

HRCWPG Hood River County Water planning Group

HSC Habitat Suitability Criteria

IFG Instream Flow Group

MFID Middle Fork Irrigation District

ODFW Oregon Department of Fish and Wildlife

PHABSIM Physical Habitat Simulation model developed by the U.S. Fish and Wildlife Service

RHABSIM Riverine Habitat Simulation software conversion and enhancement of PHABSIM by TRPA, currently Normandeau Associates

SEFA System for Environmental Flow Analysis, software enhancing the capabilities of RHABSIM, RYHABSIM, and PHABSIM developed by T. Payne, I. Jowett, and B. Milhouse.

TRPA Thomas R. Payne and Associates

WDFW Washington Department of Fish and Wildlife

WSEL Water Surface Elevation

WUA Weighted Usable Area, a Habitat Index (old name for AWS)

Introduction

The Hood River County Water planning Group (HRCWPG) is developing a water resource model as a tool to assist in the long-term management of water in the Hood River Basin. Components of the water resource model account for inflows, outflows, and changes in hydrology due to climate change. In order to provide model assessment of fish habitat, Normandeau was contracted to develop an index relationship of hydraulic fish habitat to flow in various tributaries to the Hood River.

Normandeau conducted an instream flow study in each of the Hood River Tributaries: East Fork Hood River, West Fork Hood River, Neal Creek, and Green Point Creek. The objective of the instream flow study was to determine the incremental relationship between stream flow and an index to physical habitat availability, commonly called weighted usable area (WUA) and more recently called area weighted suitability (AWS, Jowett et.al. 2014), for the species and life stages of interest.

The standard approach to instream flow analysis since 1980 has been the Instream Flow Incremental Methodology (IFIM). The IFIM is a structured habitat evaluation process initially developed by the Instream Flow Group of the U.S. Fish and Wildlife Service (USFWS) in the late 1970's to allow evaluation of alternative flow regimes for water development projects (Bovee and Milhous 1978; Bovee et al. 1998). Techniques used in the IFIM process have continued to evolve since its introduction (Bovee and Zuboy 1988; Bremm 1988; Payne 1987, 1988a, 1988b, 1992). Improvements have been made in the in the approaches to defining study reaches (Morhardt et al. 1983), in transect selection (Payne 1992), and in the techniques of PHABSIM data collection, computer modeling, and analysis (Milhous et al. 1984). The IFIM may involve multiple scientific disciplines and stakeholders, in the context of which physical habitat simulation (PHABSIM) studies are usually designed and implemented. Normandeau utilized PHABSIM for the instream flow model in each of the reaches.

Study Area

The study area was in Hood River County, Washington and included approximately one mile long reaches in the West Fork Hood River, Green Point Creek, and Neal Creek and two approximately one mile long reaches in the East Fork Hood River (Figure 1).

Figure 1. Locations of the Study Reaches on the East Fork and West Fork Hood River, Green Point Creek, and Neal Creek.

Methodology

Development of a relationship between suitable aquatic habitat and river flow for selected species and life stages within the IFIM/PHABSIM framework depends on the measurement or estimation of physical habitat parameters (depth, velocity, substrate/cover) within the study reach. Generally, the distribution of these parameters at given river flows are determined at points along transect lines across the stream channel, positioned to account for spatial and flow-related variability. A variety of hydraulic modeling techniques can be used to simulate water depth and velocity as a function of river flow; substrate and cover values are generally fixed at a given point. With physical habitat thus characterized for a range of river flows, the suitability of the habitat (for a particular species and life stage) at each point is scaled from zero to one, usually by multiplying together the corresponding suitability values for depth, velocity, and substrate from the appropriate habitat suitability criteria (HSC) curves. These point estimates of suitability are then used to weight the physical area of the study represented by each point, and the weighted areas are accumulated for the entire study reach to produce an index of useable habitat as a function of river flow for each species and life stage.

The physical area represented by each transect point depends on the design of the PHABSIM study. This study used the mesohabitat typing, or habitat mapping, approach originally described by Morhardt et al. (1983) and summarized by Bovee et al. (1998). In this design, mesohabitats (broadly defined habitat generalizations) were mapped over the entire study reach, such that each area of the waterway was characterized by a general habitat type, and the total length and proportion of the study reach assigned to each mesohabitat type was determined.

Physical habitat parameters (river flow dependent depth and velocity, substrate, and cover) representative of each mesohabitat type were measured or modeled at one or more transects placed within the mesohabitat area. The exact number and placement of transects placed in a mesohabitat type depended on the proportion of the study reach represented by each mesohabitat type, as well as practical issues such as accessibility. Generally, the total number of transects was distributed among mesohabitat types in proportion to the length of the study reach represented by each mesohabitat. The physical area represented by each transect point was then determined by both the lateral distribution of points on a transect, and the length or proportion of the study reach that each transect represented.

Stakeholder Involvement

Stakeholders, through the HRCWPG, provided input into the selection of study reaches, transect locations, species and life-stages of interest, HSC, and calibration flows, as well as reviewing the AWS curves.

Habitat Mapping

Habitat mapping consists of identifying the type (e.g. pools, runs, and riffles) and measuring the length of individual macrohabitat units over the total distance of stream courses within a project area (Morhardt et al. 1983). The method allows each transect where hydraulic data is collected to be given a weight proportional to the quantity of habitat represented by that transect. Mapping was conducted by walking the stream channel while deploying biodegradable cotton thread from a surveyor's hip chain to measure total distance. The location and length of each individual macrohabitat type was calculated by noting the distance from a downstream base reference point to upstream boundaries. Reference points were marked using surveyor's flagging every 500 feet (generally at the nearest hydraulic control) as well as GPS waypoints. These marks serve as temporary and fixed, known reference points from which to relocate specific habitat units or other features of interest during the stream studies. Other information noted during the mapping process included estimating the maximum depth for each pool habitat, and determining whether a unit could be hydraulically modeled.

Normandeau conducted habitat mapping in the five, one-mile reaches using the ODFW Aquatic Inventories Project Methods for Stream Habitat Surveys (ODFW 2010) as a guide. The basic survey included identifying habitat types, habitat unit lengths and widths, maximum depth and general substrate and riparian characteristics. Generally, for a PHABSIM study, only habitat type unit lengths and depths (pools) are used as a basis for selecting transects and weighting of the habitat model.

The mapping information was used to determine the percentages of various macrohabitats, assist with selection of study sites, and placement of transects for the hydraulic data collection. Each habitat unit was also evaluated for appropriateness for PHABSIM modeling. Such conditions that prohibit satisfactory hydraulic simulation included complex hydraulic conditions associated with strongly transverse flow conditions, plunge pools, or unique split channel configurations. Potentially dangerous and unsafe habitat units, such as those near dangerous falls or cascades, were also identified for subsequent elimination as candidates for hydraulic modeling.

The individual macrohabitat identifications and distances were entered into a database program to create a sequential map of habitat units along the entire length of stream that was surveyed. The database allowed for the computation of the percent abundance of any macrohabitat type within the entire study area or within designated reaches. The mapping data and location markers aided in the relocation of individual habitat units for subsequent inspection and transect selection.

PHABSIM: Transect Selection and Installation

Habitat mapping forms the basis for transect selection. Percent contribution of individual habitat types to total habitat is derived from the total length of a given reach. The PHABSIM habitat analysis relies upon hydraulic conditions measured along stream cross sections, or transects, placed in a variety of different macrohabitats. Habitat unit selection and transect placement was conducted by Normandeau study leads in conjunction with the HRCWPG and

ODFW. Actual habitat unit selection and transect placement was accomplished with a combination of random selection and professional judgment through the following procedure:

1. The macrohabitat type with the lowest percentage of abundance within each study segment was used as the basis for random selection (provided that the habitat type was ecologically significant and made up greater than 5% of the total study reach) and sequentially numbered. Several units were be selected by random number.

2. In the field, the first selected unit was relocated and, if it was modelable, reasonably typical, and it appeared safe to collect hydraulic data during high flows, a transect was placed that would best represent the habitat type. The second or higher randomly selected units were used only if initial units were rejected.

3. At least one example of each remaining more-abundant habitat type was then located in the immediate vicinity of the random transect (upstream or downstream) until the additional study transects were placed in other macrohabitat units. This created a study site and transect "cluster", which reduced data collection travel time.

Calibration Flows

Calibration flows are the flows at which water surface elevations and velocities are measured and from which the model simulations are built. A total of three sets of calibration flow measurements, high, middle and low were made at each transect. Generally the simulations will be valid for a range of flows from forty percent of the low calibration flow to 250 percent of the high calibration flow. Velocities at each transect station were measured at the highest safe calibration flow. In the case of unregulated rivers, such as the streams in this study, calibration flow targets were identified, but the measurements were opportunistic depending on the weather during the sampling period.

Field Data Collection

Water Surface Elevation and Velocity Measurements

One complete set of depths and velocity measurements was collected at each transect at the middle flow or the flow level that could be effectively and safely measured. Data was collected using wading/velocity measurement techniques at shallow habitats, and an acoustic Doppler current profiler (ADCP) mounted on a rigid trimaran in deep pool habitats. The TRDI Rio Grande 1200kHz ADCP sends and receives acoustic pulses in order to measure the Doppler shift and phase change of the echoes to calculate depth and velocity patterns. Additional measurements of water surface elevation for each transect and a single discharge measurement (per transect cluster) were made at the middle and low flow levels.

The amount and type of data collected is suitable for use in a hydraulic simulation with the PHABSIM computer model in the one-velocity mode for the entire range of flows (Payne 1987). The one-flow model of PHABSIM has been shown to calculate habitat values very close to those obtained with three full sets of depth and velocity data (Payne 1988b).

Field data collection and the form of data recording basically followed the guidelines established in the IFG field techniques manuals (Trihey and Wegner 1981; Milhous et al. 1984; Bovee 1997). Additional quality control checks that have been found valuable during previous applications of the simulation models were employed. The techniques for measuring discharge generally followed the guidelines outlined by Rantz (1982). A minimum of 20 wetted stations per stream transect were be established, with a goal of no less than 15 wetted stations at the lowest measured flow. The boundaries of each station along each transect were normally at consistent increments, but significant changes in velocity, substrate, depth, or other important stream habitat features sometimes required additional stationing.

Substrate and Cover Characterization

Substrate and cover attributes and codes used in this study are described in Tables 1 and 2.

Table 1. Substrate size and codes.

Substrate Type	Size	Code
Silt, clay, organic		1
Sand		2
Small gravel	0.1 – 0.5 "	3
Medium gravel	0.5 – 1.5 "	4
Large gravel	1.3 – 3 "	5
Small cobble	3 – 6 "	6
Large cobble	6 – 12 "	7
Boulder	> 12"	8
Bedrock		9

Table 2. Cover types and codes.

Cover Type	Code
Boulder	1
Cobble	2
Cobble + Log	3
Boulder + Log	4
Boulder + Rootwad	5
Log	6
Logs	7
Log + Rootwad or Logjam	8
None (Depth <6.5 ft.)	9
None (Depth ≥6.5 ft.)	9.65
Undercut bank	10
Overhanging Vegetation	11
Terrestrial Vegetation	12
Roots	13
Woody Debris	14

Quality Assurance/Quality Control

To assure quality control in the collection of field data, the following data collection procedures and protocols were utilized:

Staff gauges were established and continually monitored throughout the course of collecting data. If significant changes occurred, water surface elevations were re-measured following collection of transect water velocity data.

Independent benchmarks were established for each set of transects. The benchmark was an immovable tree, boulder, or other naturally occurring object not subject to tampering. Upon establishment of headpin and tailpin elevations, a level loop was shot to check the auto-level instrument for accuracy. Acceptable error tolerances on level loop measurements were set at 0.02 feet. This tolerance was also applicable to both headpin and tailpin measurements, unless extenuating circumstances (e.g., pins under sloped banks, shots through dense foliage) accounted for the discrepancies, and the accompanying headpin or tailpin met the tolerance criteria.

Water surface elevations were measured on both banks on each transect. If possible, on more complex and uneven transects, such as riffles, water surface elevations were also measured at multiple locations across a transect. An attempt was made to measure water surface elevations at the same location (station or distance from pin) across each transect at each calibration flow. Water surface elevation measurements were obtained by placing the bottom of the stadia rod at the water surface until a meniscus formed at the base or selecting a stable area next to the water's edge.

Pin and water surface elevations were calculated on-site during field measurement and compared to previous measurements. Changes in stage since the previous flow measurement were calculated. Patterns of stage change were compared between transects and determined if reasonable. If any discrepancies were discovered, potential sources of error were explored, corrected where possible, and noted.

The ADCP was used to collect water velocity data from stations along each transect where wading was not possible. High-quality and well-maintained current velocity meters were used to collect velocities of shallower, edge cell velocity data.

Prior to deployment, the ADCP was system checked, compass calibrated, moving bed test performed, and user configured for each individual transect with appropriate commands for the existing environmental conditions. Often several transect measurements were necessary to obtain the optimum configuration. Each transect measurement length and discharge calculation was compared to the actual values or to repetitive measurements in order to ensure accurate bottom tracking and velocity measurements. Real time graphic depictions of depth and velocity were examined during data collection for inconsistencies and obvious errors. As a precaution against data loss, all electronic data files were copied onto a separate USB drive at the end of each field day.

All calculations were completed in the field, given adequate time and daylight. Pin elevations and changes in water surface elevations were compared between flows on the same transect. Discharges were calculated on-site and were compared between transects during the same flow (high, mid, and low). If an excessive amount of discharge (greater than 10% of the stream flow) was noted for an individual transect cell, additional adjacent stations were established to more precisely define the velocity distribution patterns at that portion of the transect.

Photographs were taken of all transects, downstream, across, and upstream at the three calibration flows. Photographs were taken from the same location at each of the flows, if possible. Photographs provided a valuable record of physical conditions and water surface levels that were utilized during hydraulic model calibration.

All data (stationing, depth profiles, velocities, substrate/cover codes) were entered into the RHABSIM computer files. Internal data graphing routines were then used to review the bottom and velocity profiles for each transect separately and in context with others for quality control purposes. All data gaps (e.g., missing velocities) or discrepancies (e.g., conflicting records) were identified and corrected using available sources, such as field notes, photographs, or adjacent data points.

Transect Weighting

The number of transects selected for each habitat type was determined by the percentage of the study reach represented by each habitat type. In this way each habitat type was represented approximately in proportion to that which was mapped. Each transect was then weighted so that each habitat type was represented in the exact proportion to that existent in the study area.

Hydraulic Simulation

The purpose of hydraulic simulation under the PHABSIM framework is to simulate depths and velocities in streams under varying stream flow conditions. Simulated depth and velocity data were then used to calculate the physical habitat, either with or without substrate and/or cover information. All data was entered into the RHABSIM software used for this analysis.

Water Surface Prediction

The water surface elevations, in conjunction with the transect profiles, were used to determine water depths at each flow. Water depth is an important parameter for determining the physical habitat suitability. Either an empirical log/log regression formula of stage and flow based on measured data or a channel conveyance method (MANSQ) that relies on the Manning's N roughness equation was used to create the rating curves.

The log/log regression method uses a stage-discharge relationship to determine water surface elevations. Each cross section is treated independently of all others in the data set. A minimum of three stage-discharge measurement pairs were used to calibrate the stage-discharge relationship. The quality of the rating curves is evaluated by examination of mean error and slope output from the model. Mean errors of less than 10% is considered acceptable and less than 5% is very good. In general the slope between groups of transects should be similar.

MANSQ only requires a single stage-discharge pair and utilizes Manning's equation and channel shape to determine a rating curve; however, it is generally validated by additional

stage-discharge measurements. This modeling method involves an iterative process where a beta coefficient is adjusted until a satisfactory result is obtained. In situations where irregular channel features occur on a cross section, for instance bars or terraces, MANSQ is often better at predicting higher stages than log/log. MANSQ is most often used on riffle or run transects and is generally not considered as effective in establishing a rating curves for transects that have backwater effects from downstream controls, such as pools. It can also be useful as a test and verification of log/log relationships.

Velocity Simulation

Simulated velocities were based on measured data and a relationship between a fixed roughness coefficient (Manning's n) and depth. In some cases roughness is modified for individual cells if substantial velocity errors are noted at simulation flows. Velocity Adjustment Factors (VAF's), the degree in which measured velocity and discharge is adjusted to simulated velocity and simulated discharge are an indication of the quality of hydraulic simulations. These are examined to detect any significant deviations and determine if velocities remained consistent with stage and total discharge. VAF's in the range of 0.8 to 1.2 at the calibration (measured) flow are considered acceptable, 0.95 to 1.05 is considered excellent.

Habitat Suitability Criteria

Method of Selection

Habitat Suitability Criteria (HSC) define the habitat requirements of the species/life-stages of interest. If no site specific HSC are developed, HSC are selected from the plethora of curves developed for other studies. Not all HSC are transferable from one stream to another. For example, HSC developed for *O. mykiss* inhabiting a small mountain stream upstream of an impassable barrier do not define the habitat requirements of steelhead in a large river. Likewise, habitat requirements vary with the life-stage of each species and HSC are typically specified for each life-stage. Although there are many HSC available, care must be taken to establish transferability by examining the source metrics (e.g. river size, geographic location, number of observations, etc.).

The results of a PHABSIM instream flow study are determined by both the hydraulic data collected and the HSC selected. Since the results of this PHABSIM study will be used in the BOR water resource model along with the results of the Middle Fork Hood IFIM Study (Watershed Professionals Network), it is important to use consistent HSC.

The method for selecting HSC for this PHABSIM study was:

1. Appropriate Middle Fork HSC (Watershed Network Professionals unpublished draft data) for the species/life-stages that were modeled in that study were also used in this study. The MFID HSC were compared to other HSC for informational purposes.
2. Additional HSC were selected based on literature and professional judgment.

Annexes A and A1 discuss the development of the HSC.

Target Species

Species and life stages selected for habitat modeling are presented in Table 3.

Table 3. Target species and life stages selected for modeling in each of the five stream reaches.

Species	Life Stage	Stream Reach				
		EF-Upper	EF-Lower	West Fork	Green Point	Neal Creek
Bull trout	Juvenile rearing			x		
	Adult rearing			x		
	Spawning			x		
Coho	Fry	x	x	x	x	x
	Juvenile rearing	x	x	x	x	x
	Adult holding	x	x	x	x	x
	Spawning	x	x	x	x	x
Cutthroat trout	Juvenile rearing	x	x	x	x	x
	Adult rearing	x	x	x	x	x
	Spawning	x	x	x	x	x
Spring Chinook	Fry	x	x	x	x	x
	Juvenile rearing	x	x	x	x	x
	Adult holding	x	x	x	x	x
	Spawning	x	x	x	x	x
Steelhead	Fry	x	x	x	x	x
	Juvenile rearing	x	x	x	x	x
	Adult holding	x	x	x	x	x
	Spawning	x	x	x	x	x

Habitat Simulation

Combining the hydraulic and HSC components generates the habitat suitability (AWS/WUA) index. Unlike hydraulic modeling and calibration, there are a limited number of decisions to make prior to production runs. Transects are weighted according to the percentage of habitat types present in the reach. The range of flows to model, and specific flows within that range, are determined largely by the suitability of the hydraulic data for extrapolation and general flows of interest. Generally the range of flows of interest are those mandatory either as minimum standards or seasonal requirements, but can also be based on natural flows. The habitat index was computed based on a multiplicative procedure:

$$Ci = Vi * Di * Si$$

Where:

Ci = Cell suitability composite index value
Vi = Velocity suitability value associated with cell
Di = Depth suitability value associated with cell
Si = Substrate or other channel suitability value associated with cell

The cell composite number is then multiplied by the cell width to produce number of square feet of area in that cell. For each transect, all the cells' areas are summed to produce a total number of square feet of usable habitat available at a specified flow. This result is then multiplied by the percentage the individual transect represents as a proportion of all transects being modeled. All transect results are then summed to produce overall habitat suitability in square feet.

Time Series Analysis

Utilization and interpretation of habitat modeling output, namely habitat index curves, presents a challenge from both a technical and functional perspective. The habitat versus flow relationships derived from PHABSIM represent a conceptual association between flow and habitat. Though some basic inference can be made from this relationship, evaluation without incorporating flow regimes can lead to erroneous interpretations. This analysis is particularly valuable when considering a suite of species and life stages with varying habitat versus flow relationships, and instances when known life history needs may not be directly exhibited in the habitat versus flow relationship output from PHABSIM.

The tendency to look at the maximum or "peak" of a habitat index curve greatly oversimplifies the results. For example, maximum spawning habitat may occur at a flow that rarely exists in a given reach. Additionally, the amount of habitat can be the same at two flows, one lower and one higher than the maximum (Figure 2). Because the amount of habitat available at any given time of year is a function of hydrology, incorporating a time-series analysis provides a more realistic view of available habitat. Such an analysis is important when determining effects of different flow regimes that may result from changes in water usage. Times series involves matching the habitat index for a given species or life stage to flow, as illustrated in Figure 3.

The major basis for habitat time series analysis is that habitat is a function of stream flow and that stream flow varies over time. Habitat time series displays the temporal habitat change for a particular species and life stage during selected seasons or critical time periods under various flow scenarios. Typically results are represented by habitat duration curves indicating the quantity of habitat that is equaled or exceeded over the selected time period.

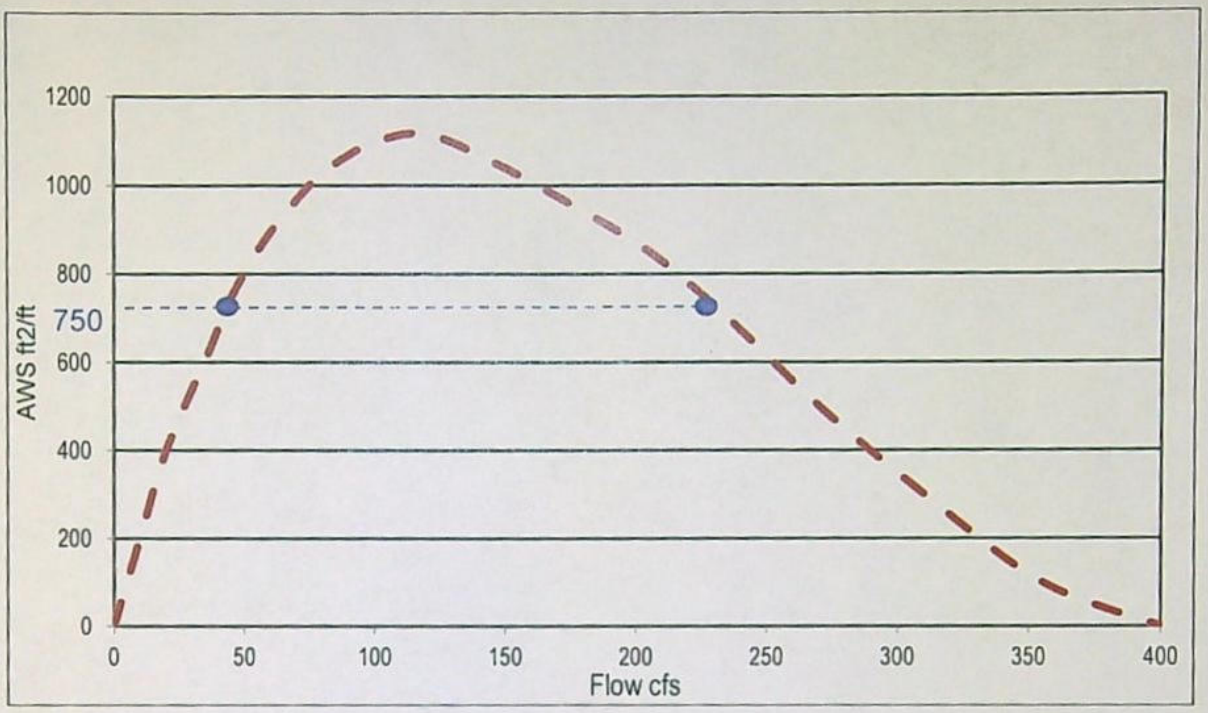


Figure 2. Generic habitat index curve illustrating equal AWS values at two different flows.

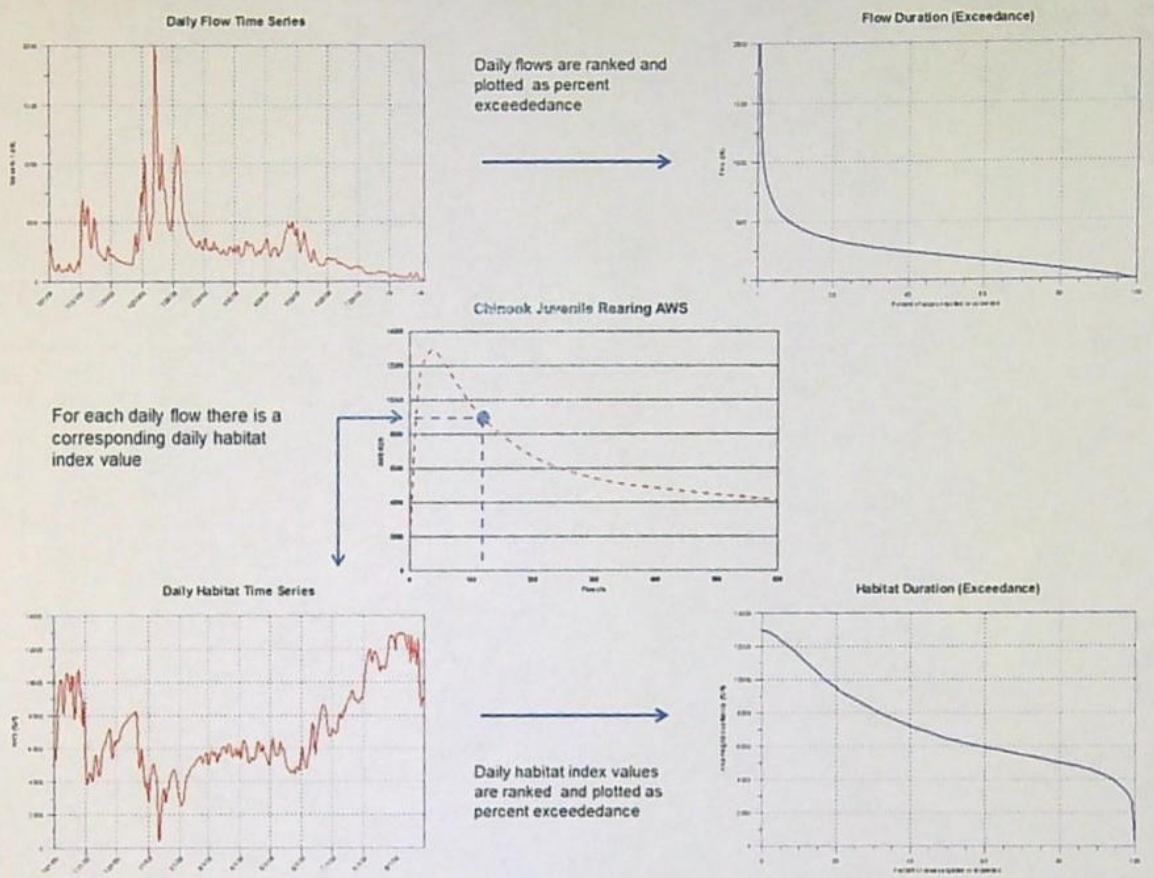


Figure 3. Time series process.

Results

Habitat Mapping

Habitat mapping was conducted on the five study reaches between September 19 and September 22, 2012. The following provides a brief overview of Habitat Mapping results by reach. Habitat unit types collected in the field were based on the ODFW Basic Level Stream Survey. These types were condensed into slow water types (pools) and fast water types which includes glide, riffle (low gradient), rapid (high gradient riffle) and cascade as per ODFW optional types. Complete Habitat Mapping summaries and database are provided in Appendix A.

Green Point Creek

Riffles and cascades were the dominant habitat type in Green Point Creek accounting for 68% of the reach followed by pools at 22% and glides at 8% (Table 4).

Table 4. Habitat mapping summary for Green Point Creek.

Habitat Type	*Number of Units*	*Length Feet*	*Length Percent*
Pool	45	1329	22.4
Glide	14	494	8.3
Low Gradient Riffle	38	2098	35.3
High Gradient Riffle	14	809	13.6
Cascade	25	1112	18.7
Other	12	103	1.7
Totals	148	5945	100.0

Neal Creek

Habitat Mapping results for Neal Creek show a dominance of low gradient riffle (66%) and an equal proportion of glide and pool accounting for 16% each (Table 5).

Table 5. Habitat mapping summary for Neal Creek

Habitat Type	*Number of Units*	*Length Feet*	*Length Percent*
Pool	40	894	16.0
Glide	33	895	16.0
Low Gradient Riffle	68	3696	66.2
High Gradient Riffle	3	74	1.3
Cascade	0	0	0.0
Other	2	23	0.4
Totals	146	5582	100.0

East Fork Hood River (lower reach)

Habitat Mapping results for this reach show a dominance of riffle types with 50% low gradient riffle and 27% high gradient. Glides only accounted for 2% of the reach (Table 6).

Table 6. Habitat mapping summary for East Fork Hood River (lower).

Habitat Type	*Number of Units*	*Length Feet*	*Length Percent*
Pool	14	702	17.0
Glide	2	89	2.2
Low Gradient Riffle	33	2080	50.4
High Gradient Riffle	15	1111	26.9
Cascade	3	148	3.6
Other	0	0	0.0
Totals	67	4130	100.0

East Fork Hood River (upper reach)

Habitat Mapping results for this reach show a dominance of riffle types with 44% high gradient riffle and 30% low gradient. Glides accounted for 17% of the reach and pools for 9% (Table 7).

Table 7. Habitat mapping summary for East Fork Hood River (upper).

Habitat Type	*Number of Units*	*Length Feet*	*Length Percent*
Pool	13	536	9.2
Glide	16	1020	17.5
Low Gradient Riffle	20	1718	29.4
High Gradient Riffle	23	2557	43.8
Cascade	0	0	0.0
Other	1	10	0.2
Totals	73	5841	100.0

West Fork Hood River

Habitat Mapping results for this reach show a dominance of riffle types with 13% high gradient riffle and 37% low gradient. Glides accounted for 16% of the reach and pools for 28% (Table 8).

Table 8. Habitat mapping summary for West Fork Hood River.

Habitat Type	Number of Units	Length Feet	Length Percent
Pool	13	1452	27.8
Glide	16	821	15.7
Low Gradient Riffle	19	1953	37.4
High Gradient Riffle	9	671	12.8
Cascade	4	327	6.3
Other	0	0	0.0
Totals	61	5224	100.0

Study Site and Transect Selection

Study sites were established by randomly selecting the least available habitat type, locating the habitat unit and placing a transect to represent the unit. Additional transects were then established in other habitat types in the immediate vicinity in general proportion to availability. A total of 7 cross sections were used to represent hydraulic and habitat conditions in each reach (Table 9).

Table 9. Number of transects by habitat type and reach with habitat selector identified (*).

	Number of Transects by Reach and Habitat Type				
Habitat Type	Green Point Creek	Neal Creek	E.F. Hood River (upper)	E.F. Hood River (lower)	West Fork Hood River
Pool	2	2	1*	2*	2
Glide	1*	2*	2	0	2
Low Gradient Riffle	3	3	2	3	2
High Gradient Riffle	1	0	2	2	1*
Cascade	0	0	0	0	0
Total	7	7	7	7	7

Hydraulic Simulation

Field data collection took place between September and December 2012. Low flow was measured in late September in all reaches except Neal Creek, which was deemed to be the approximate middle flow target. Middle flow and velocity acquisition took place in all other reaches in late October and high flow occurred in late November and early December. Transect profiles, calibration velocities, and calibration flow water surface elevation plots are depicted in Appendix B.

Stage-Discharge

Overall, stage-discharge metrics fell well within the bounds of acceptability. All but one transect had a mean error of less than 5 percent for log/log rating curve (Table 10). Measured versus predicted WSL at the three calibration flows were generally less than 0.02 feet (Table 11).

Log/log rating curves were used for all pool transects and most glide transects (Table 10.) MANSQ was used on most riffle transects and some glide transects to correct for small errors at the upper extent of the rating curve?

Velocity

Some adjustments to roughness and Manning's N were made in selected cells to account for unrealistic simulated velocities at high flows. In addition, adjustments were made to edge cells if predicted velocities at higher flows were excessively high (i.e. higher than adjacent cells in the main channel) or remained excessively low.

With few exceptions, VAF's were within 5 percent of the measured flow (Table 10). Three transects, two in Green Point Creek and one in the West Fork had VAF's within 10 percent of the measured flow.

Table 10. Measured flow, calibration flow (velocity acquisition flow), stage-discharge rating curve mean error and method and VAF for transects in five reaches of the Hood River.

Reach	Transect #	Habitat Type	Measured Flow	Calibration Flow	% Mean Error log/log Rating Curve	Final Rating Curve Method	VAF at Calibration Flow
Green Point Creek	1	Glide	73.98	74.0	1.21	Log/Log	1.013
	2	Pool	75.42	74.0	1.06	Log/Log	0.989
	3	LGR	85.51	74.0	3.53	MANSQ	0.991
	4	LGR	81.37	74.0	3.16	MANSQ	0.980
	5	HGR	74.96	74.0	1.32	MANSQ	0.983
	6	LGR	81.84	74.0	0.51	MANSQ	0.907
	7	Pool	66.73	74.0	5.28	Log/Log	1.081
E.F. Hood Upper	1	Pool	149.58	147.45	0.10	Log/Log	0.987
	2	HGR	149.25	147.45	0.47	Log/Log	1.001
	3	HGR	148.73	147.45	1.03	Log/Log	1.047
	4	Glide	146.33	147.45	0.86	Log/Log	1.008
	5	LGR	152.03	147.45	1.81	MANSQ	0.968
	6	LGR	145.63	147.45	0.39	MANSQ	0.998
	7	Glide	142.08	147.45	0.79	Log/Log	1.029
E.F. Hood Lower	1	Pool	151.79	149.26	0.02	Log/Log	1.051
	2	Pool	149.26	149.26	2.01	Log/Log	0.990
	3	LGR	138.61	149.26	3.56	MANSQ	1.032
	4	LGR	151.20	149.26	1.12	MANSQ	1.047
	5	HGR	148.41	149.26	2.53	MANSQ	0.992
	6	LGR	156.40	149.26	0.95	MANSQ	0.968
	7	HGR	158.85	149.26	1.60	MANSQ	0.963
W.F. Hood	1	HGR	113.92	117.0	0.07	MANSQ	1.025
	2	Pool	255.37	250.0	2.97	Log/Log	0.986
	3	Glide	257.40	250.0	2.13	Log/Log	0.971
	4	LGR	246.00	225.0	2.93	MANSQ	0.965
	5	Glide	224.95	225.0	2.51	MANSQ	1.002
	6	Pool	235.43	225.0	0.44	Log/Log	0.985
	7	LGR	116.54	117.0	2.54	MANSQ	1.056
Neal Creek	1	Glide	12.86	12.23	3.19	Log/Log	1.016
	2	LGR	13.21	12.23	2.45	MANSQ	0.962
	3	LGR	13.59	12.23	2.03	MANSQ	0.951
	4	LGR	12.24	12.23	0.49	MANSQ	1.043
	5	Glide	12.63	12.23	0.55	MANSQ	0.975
	6	Pool	12.23	12.23	0.89	Log/Log	1.001
	7	Pool	12.42	12.23	3.64	Log/Log	0.994

Table 11. Measured versus predicted WSL for transects on Green Point Creek

Transect #	Habitat Type	Calibration Flow #	Calibration Flows (cfs)	Calibration WSL	Calculated WSL
1	Glide	1	224.0	98.47	98.48
		2	74.0	97.57	97.56
		3	10.2	96.50	96.50
2	Pool	1	224.0	98.48	98.49
		2	74.0	97.61	97.60
		3	10.2	96.56	96.56
3	LGR	1	224.0	97.70	97.76
		2	74.0	97.02	97.02
		3	10.2	96.13	96.16
4	LGR	1	224.0	98.83	98.81
		2	74.0	98.19	98.19
		3	10.2	97.41	97.40
5	HGR	1	224.0	100.54	100.56
		2	74.0	99.61	99.61
		3	10.2	98.59	98.60
6	LGR	1	224.0	100.56	100.59
		2	74.0	99.66	99.66
		3	10.2	98.76	98.77
7	Pool	1	224	102.12	102.08
		2	74	101.32	101.36
		3	10.2	100.62	100.61

Table 12. Measured versus predicted WSL for transects on E.F. Hood Upper

Transect #	Habitat Type	Calibration Flow #	Calibration Flows (cfs)	Calibration WSL	Calculated WSL
1	Pool	1	355.0	98.37	98.37
		2	147.45	97.53	97.53
		3	92.55	97.18	97.18
2	HGR	1	355	92.38	92.38
		2	147.45	91.92	91.92
		3	92.55	91.71	91.71
3	HGR	1	355.0	93.81	93.81
		2	147.45	93.36	93.34
		3	92.55	93.14	93.14
4	Glide	1	355.0	94.37	94.37
		2	147.45	93.94	93.93
		3	92.55	93.73	93.73
5	LGR	1	355.0	96.21	96.21
		2	147.45	95.59	95.60
		3	92.55	95.35	95.35
6	LGR	1	355.0	95.50	95.50
		2	147.45	94.83	94.83
		3	92.55	94.55	94.55
7	Glide	1	355.0	96.56	96.56
		2	147.45	95.83	95.84
		3	92.55	95.54	95.54

Table 13. Measured versus predicted WSL for transects on E.F. Hood Lower.

Transect #	Habitat Type	Calibration Flow #	Calibration Flows (cfs)	Calibration WSL	Calculated WSL
1	Pool	1	259.3	95.75	95.75
		2	149.3	95.36	95.36
		3	100.5	95.11	95.11
2	Pool	1	259.3	96.87	96.86
		2	149.3	96.43	96.45
		3	100.5	96.21	96.20
3	LGR	1	259.3	94.12	94.12
		2	149.3	93.73	93.77
		3	100.5	93.56	93.56
4	LGR	1	259.3	94.20	94.20
		2	149.3	93.87	93.88
		3	100.5	93.68	93.68
5	HGR	1	259.3	95.53	95.53
		2	149.3	95.04	95.08
		3	100.5	94.80	94.8
6	LGR	1	259.3	99.80	99.80
		2	149.3	99.51	99.50
		3	100.5	99.31	99.31
7	HGR	1	259.3	100.73	100.73
		2	149.3	100.44	100.42
		3	100.5	100.22	100.22

Table 14. Measured versus predicted WSL for transects on W.F. Hood River

Transect #	Habitat Type	Calibration Flow #	Calibration Flows (cfs)	Calibration WSL	Calculated WSL
1	HGR	1	117.0	94.81	94.81
		2	250.0	95.34	95.32
		3	450.75	95.84	95.84
2	Pool	1	117.0	95.34	95.32
		2	250.0	95.97	96.02
		3	450.75	96.74	96.71
3	Glide	1	117.0	96.06	96.05
		2	250.0	96.63	96.66
		3	450.75	97.30	97.28
4	LGR	1	117.0	97.56	97.56
		2	225.0	97.93	97.95
		3	450.75	98.53	98.53
5	Glide	1	117.0	97.91	97.91
		2	225.0	98.30	98.34
		3	450.75	98.92	98.92
6	Pool	1	117.0	97.41	97.41
		2	225.0	97.83	97.91
		3	450.75	98.41	98.41
7	HGR	1	117.0	95.49	95.49
		2	225.0	95.92	95.97
		3	450.75	96.62	96.61

Table 15. Measured versus predicted WSL for transects on Neal Creek.

Transect #	Habitat Type	Calibration Flow #	Calibration Flows (cfs)	Calibration WSL	Calculated WSL
1	Glide	1	30.0	96.71	96.72
		2	12.2	96.44	96.43
		3	6.3	96.25	96.26
2	LGR	1	30.0	94.24	94.24
		2	12.2	93.97	93.96
		3	6.3	93.80	93.80
3	LGR	1	30.0	97.49	97.49
		2	12.2	97.30	97.29
		3	6.3	97.17	97.17
4	LGR	1	30.0	97.87	97.87
		2	12.2	97.64	97.63
		3	6.3	97.50	97.50
5	Glide	1	30.0	98.50	98.50
		2	12.2	98.26	98.26
		3	6.3	98.12	98.12
6	Pool	1	30.0	96.64	96.64
		2	12.2	96.38	96.38
		3	6.3	96.22	96.22
7	Pool	1	30.0	96.66	96.67
		2	12.2	96.41	96.40
		3	6.3	96.23	96.24

Calibration summaries for individual transects are presented in Appendix C and simulated water surface elevations and velocities are presented in Appendix D.

Habitat/Flow Relationship

AWS values in tabular format are presented in Appendix E.

Green Point Creek

Juvenile rearing AWS curves for all species and adult rearing for cutthroat trout show the greatest response at flows less than 100 cfs before a trending downward slightly or remaining flat as flows increase. Fry curves for Chinook, coho, and steelhead exhibit the greatest response at flows between 10 cfs and 25 cfs and maintain a slight downward trend at higher flows. The most suitable flows for Chinook and steelhead spawning occur between 150 cfs and 300 cfs and for coho spawning between 150 cfs and 400 cfs. Cutthroat spawning is most suitable at flows between 100 cfs and 200 cfs (Figures 4-5).

Neal Creek

Juvenile and adult rearing AWS curves for all species are relatively flat indicating that flow does not have an effect on habitat suitability. Fry curves for Chinook and coho exhibit a trend

upward from the lowest to highest simulated flows, a product of low velocities being maintained near the banks due to vegetation. Chinook and steelhead spawning curves reach maximum suitability between 20 and 40 cfs and remain relatively flat through the highest simulated flow (Figures 6-7).

East Fork Hood River (upper reach)

AWS curves for juvenile rearing and fry for all species, and adult rearing for cutthroat trout decline sharply between the lowest simulated flow and approximately 400 cfs. Chinook, coho and steelhead spawning AWS is highest between 100 cfs and 200 cfs, and then drops until 400 cfs before maintaining a flat response. The cutthroat spawning curve shows most suitable habitat at the lowest flows then becomes flat up to 600 cfs before declining (Figures 8-9).

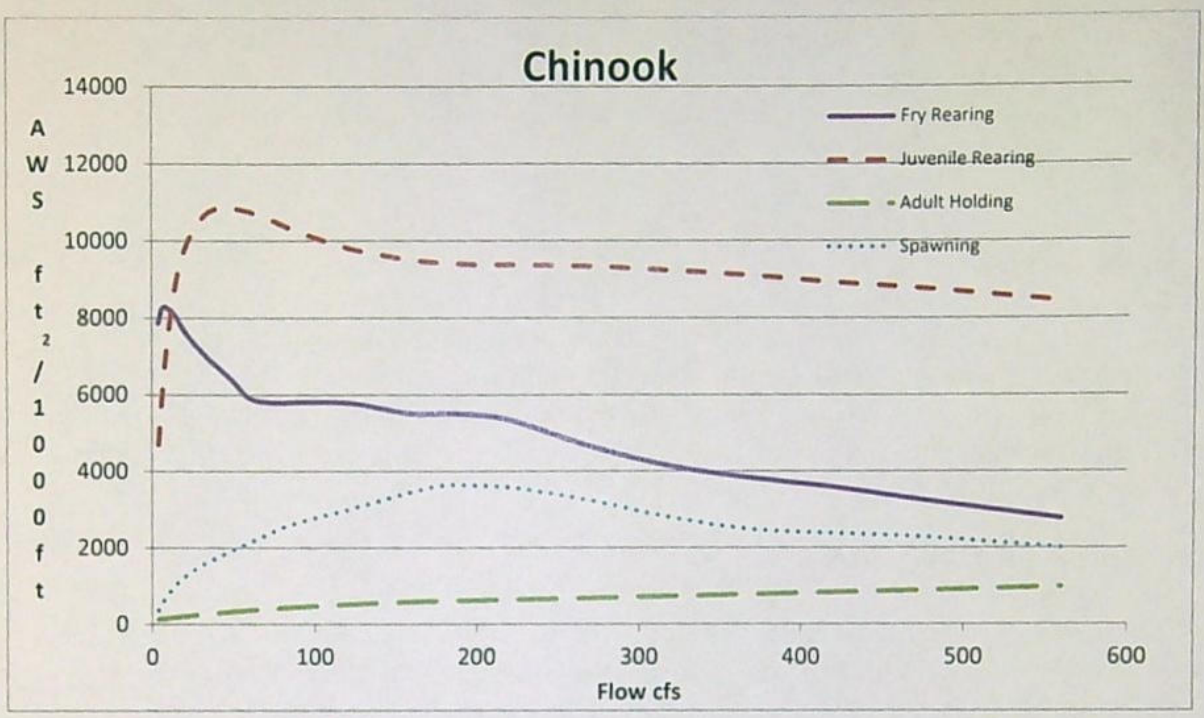
East Fork Hood River (lower reach)

Juvenile rearing, with the exception of coho, show maximum suitability between 50 and 150 cfs before declining. Fry (Chinook, coho and steelhead) decline from lowest flows to approximately 200 cfs before remaining flat. Coho juveniles show a relatively flat response, likely due to the inclination for slow velocities which are only maintained along the margins as flows increase. Chinook, coho and steelhead spawning suitability is maximized between 50 and 300 cfs. The cutthroat spawning curve shows most suitable habitat at the lowest flows then declines to 200 cfs before becoming flat (Figures 10-11).

West Fork Hood River

Juvenile rearing AWS varies between species. Chinook curves show maximum suitability for flows between 100 cfs and 350 cfs. Steelhead juvenile rearing increases from low flows, with the greatest suitability between 200 cfs and 400 cfs, then remain relatively flat. Cutthroat juvenile and adult trend slightly upward with increasing flows while bull trout juvenile rearing show a gradual decline and the adult curve is flat. Coho suitability is greatest at low flows then drops slightly as flows increase, though the curve is essentially flat past 200 cfs. Fry rearing for all species declines as flows increase.

Spawning AWS curves for Chinook, coho and steelhead are similar with abrupt increases from low flows to maximum suitability at 200-400 cfs for Chinook, 100-350 cfs for coho and 150-450 cfs for steelhead. Spawning suitability for bull trout and cutthroat is highest at flows less than 200 cfs, and declines gradually as flow increase (Figures 13-14).



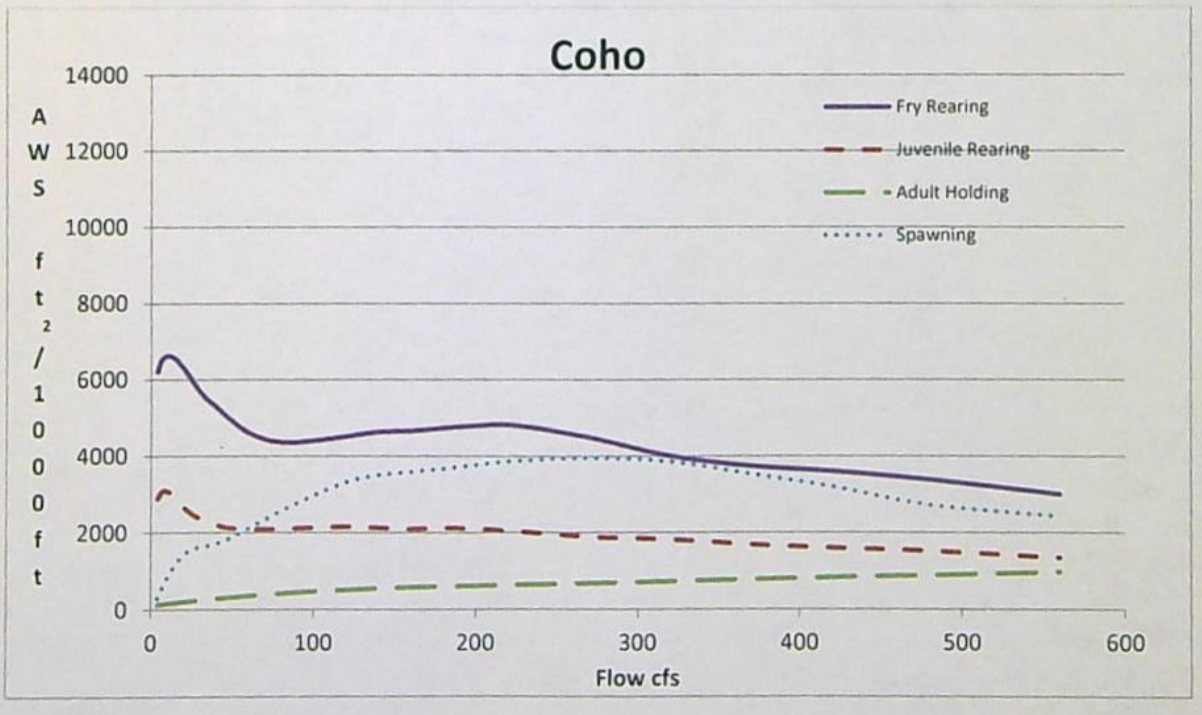
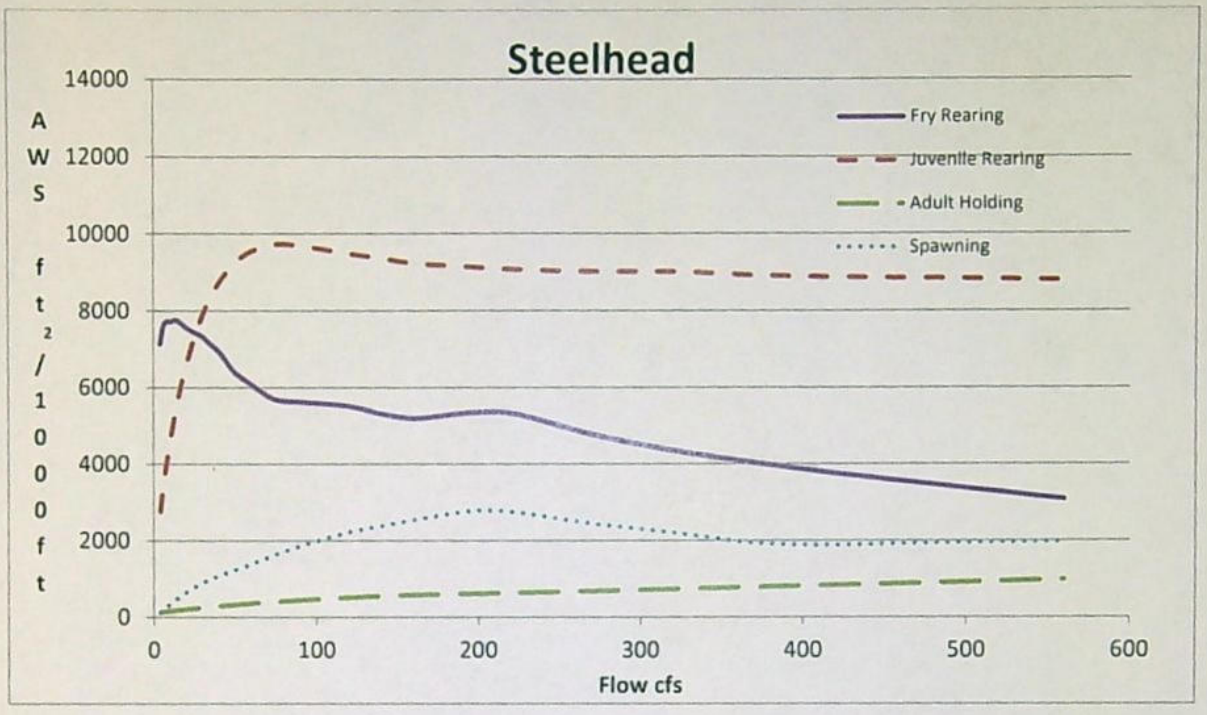


Figure 4. Chinook and coho AWS curves for Green Point Creek.



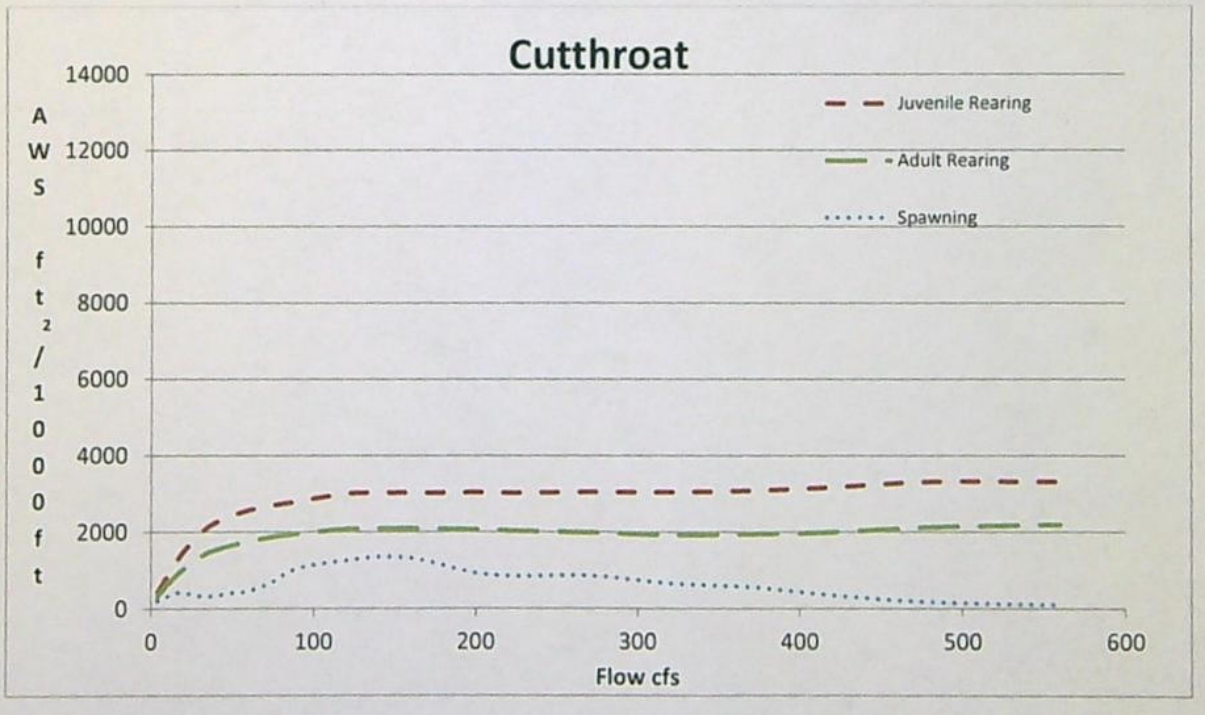
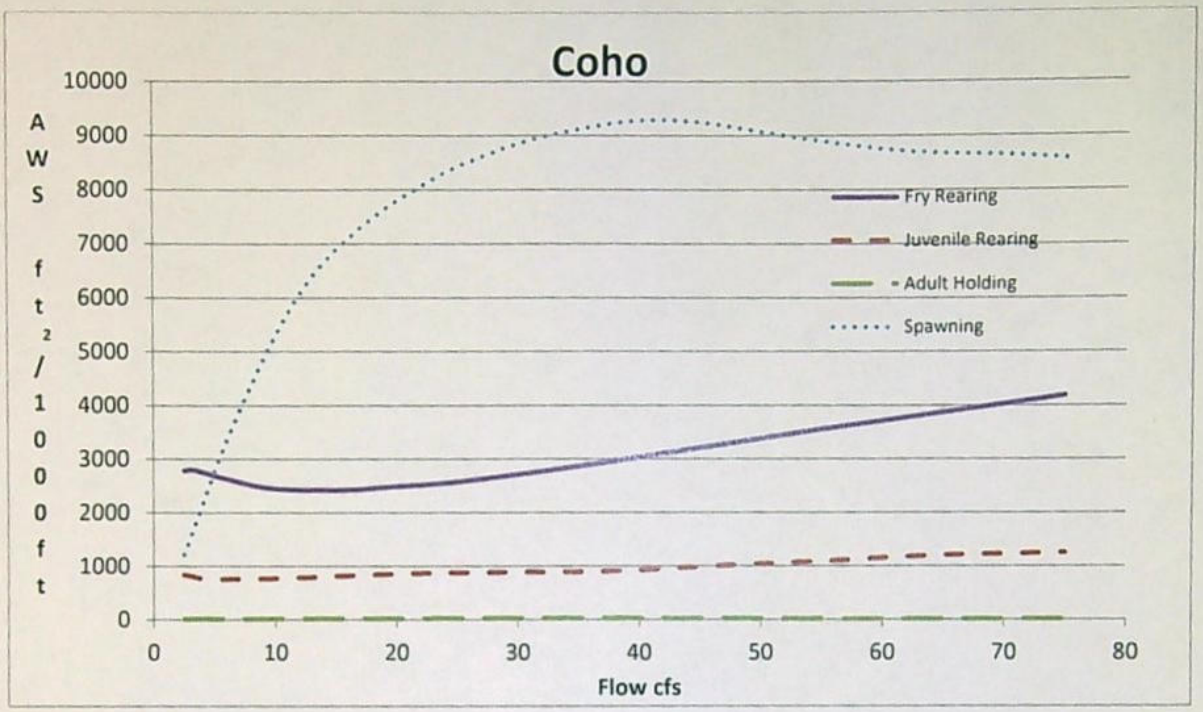


Figure 5. Steelhead and cutthroat AWS curves for Green Point Creek.



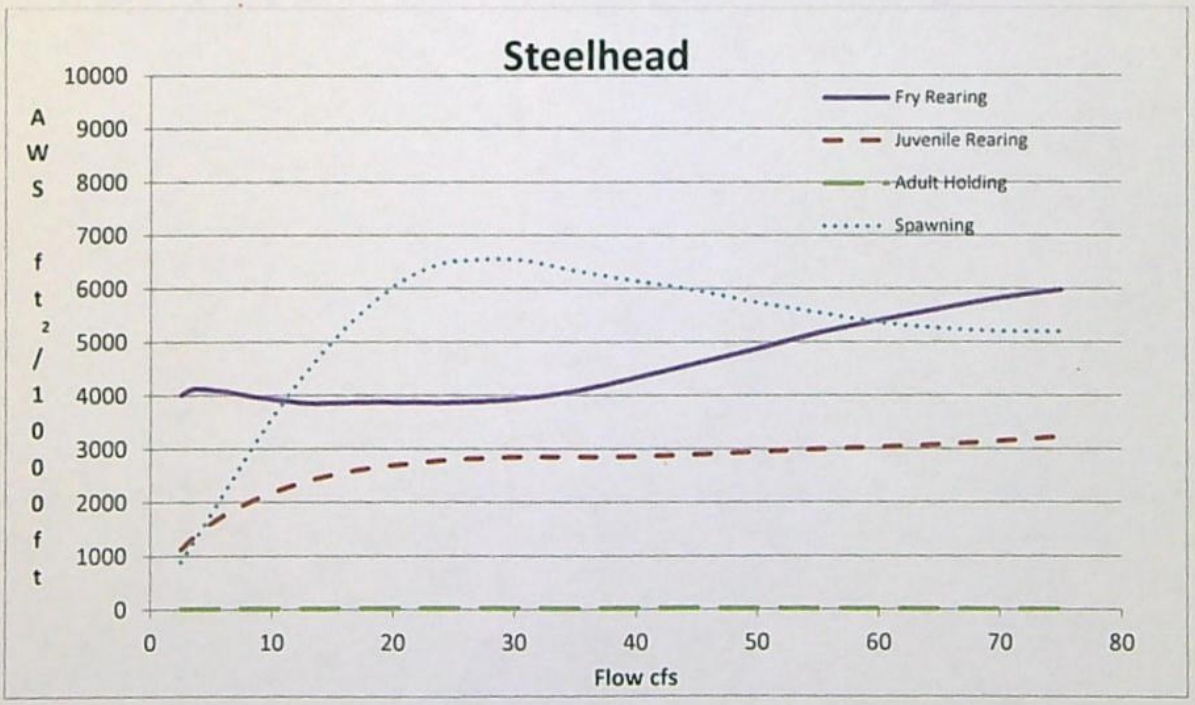


Figure 6. Steelhead and coho AWS curves for Neal Creek.

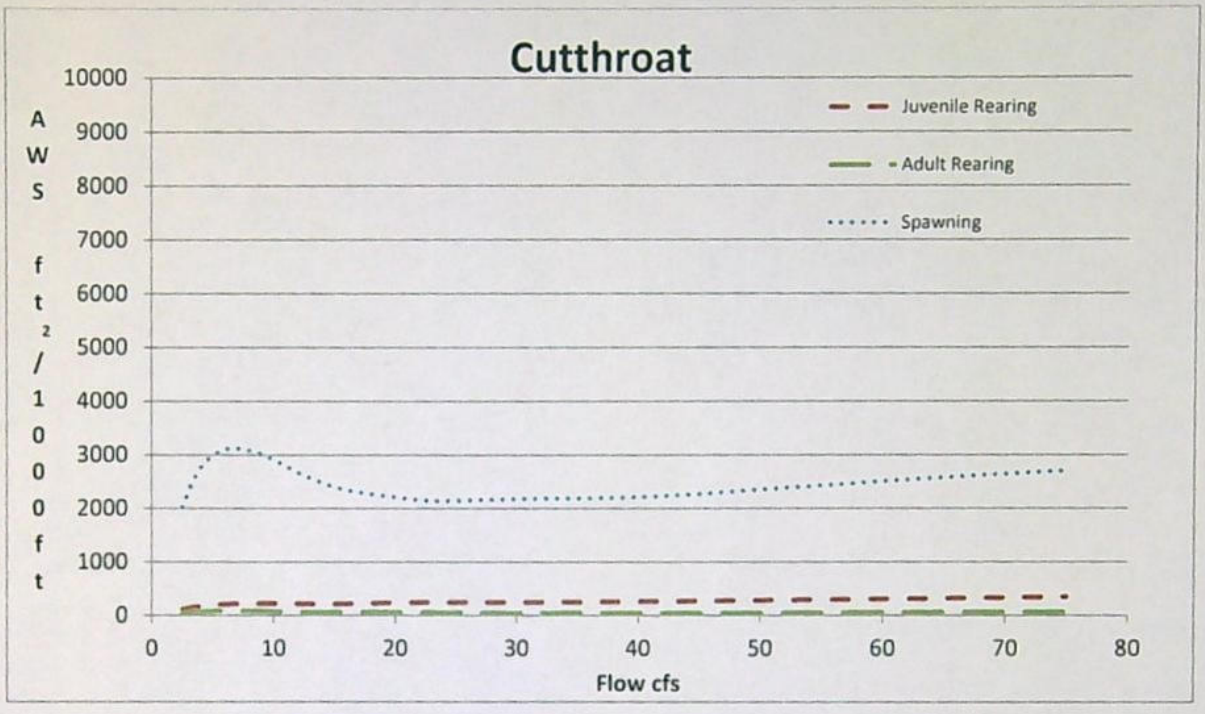
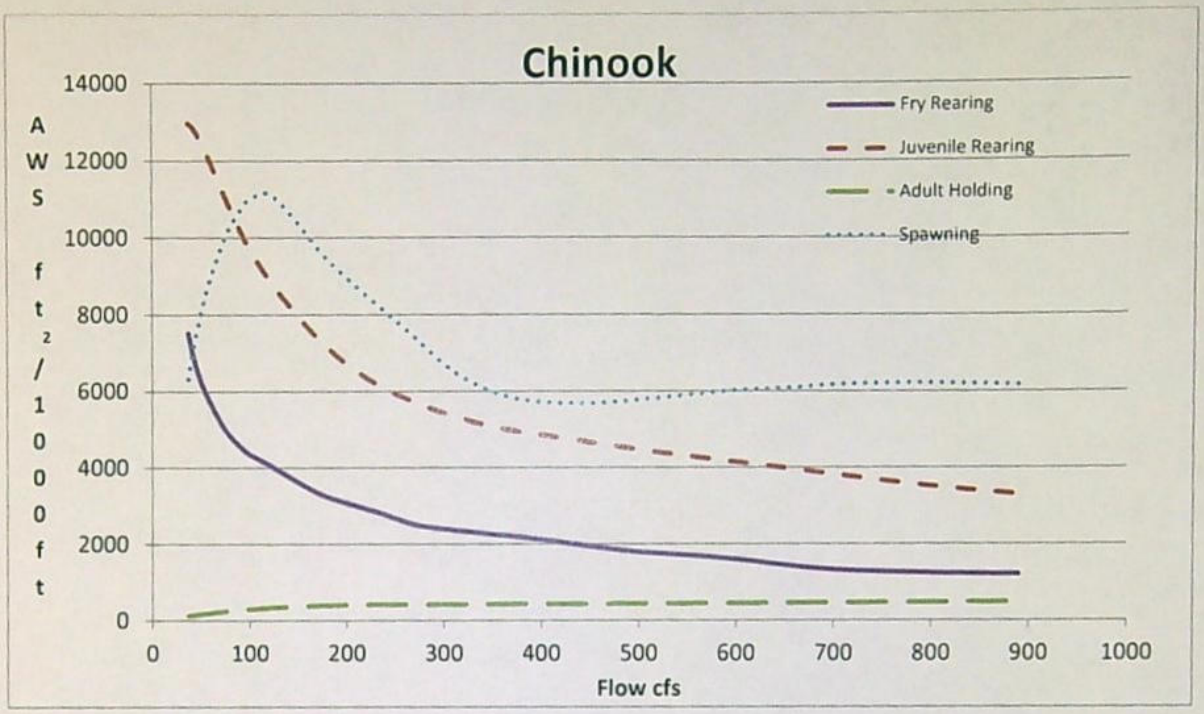


Figure 7. Cutthroat AWS curves for Neal Creek.



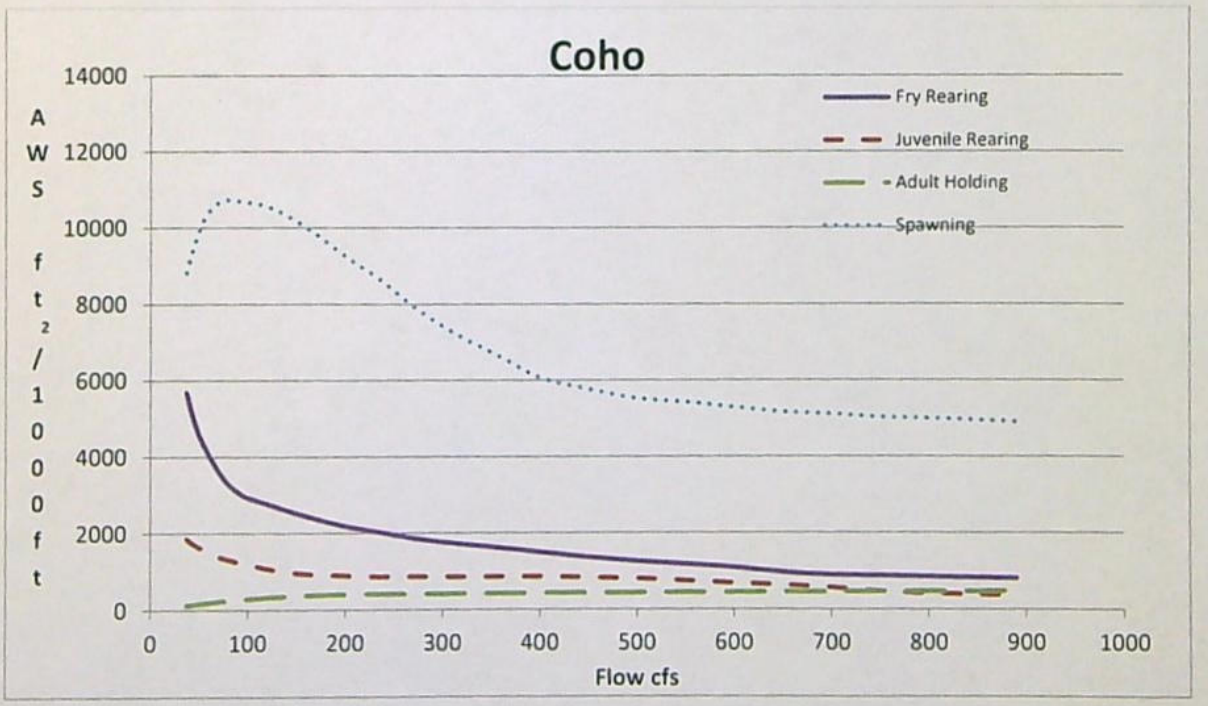
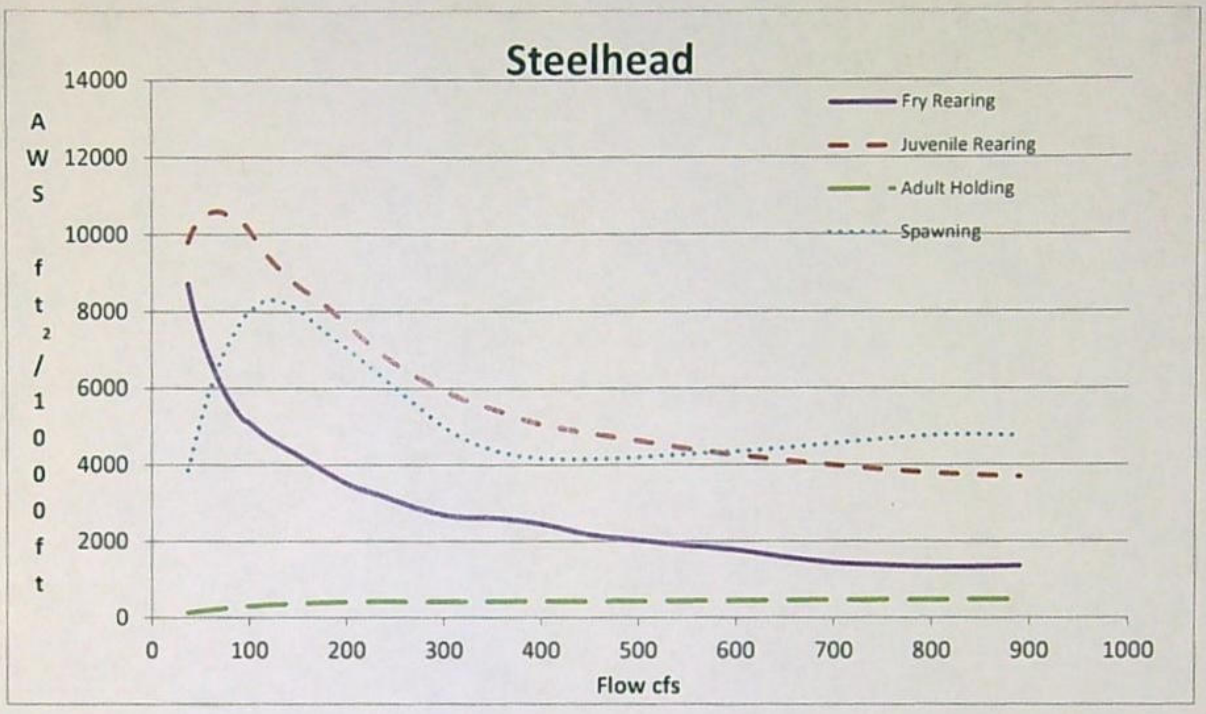


Figure 8. Chinook and coho AWS curves for E.F. Hood (upper).



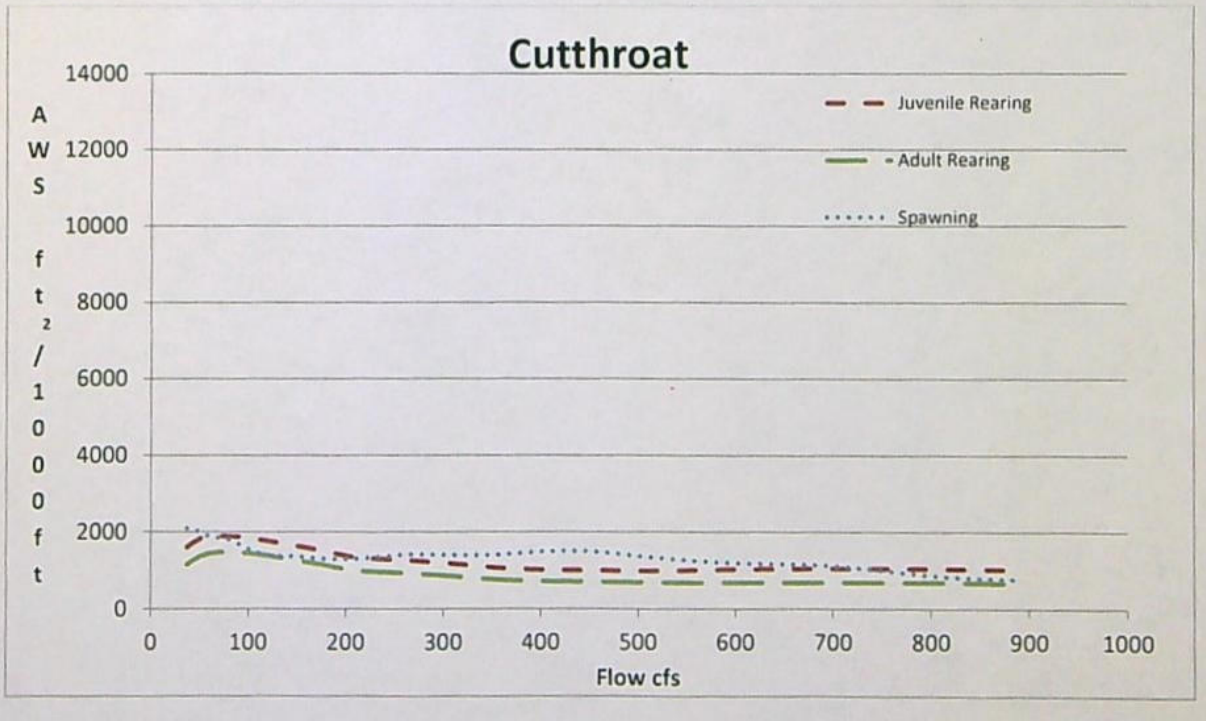
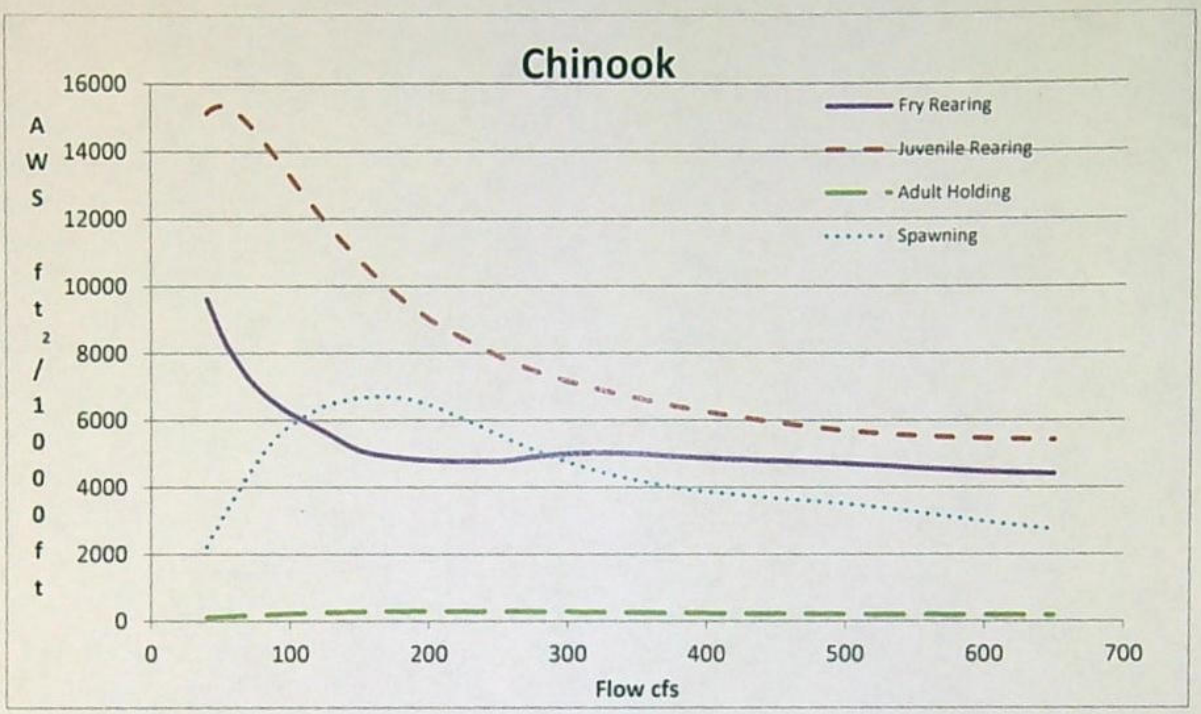


Figure 9. Steelhead and cutthroat AWS curves for E.F. Hood (upper).



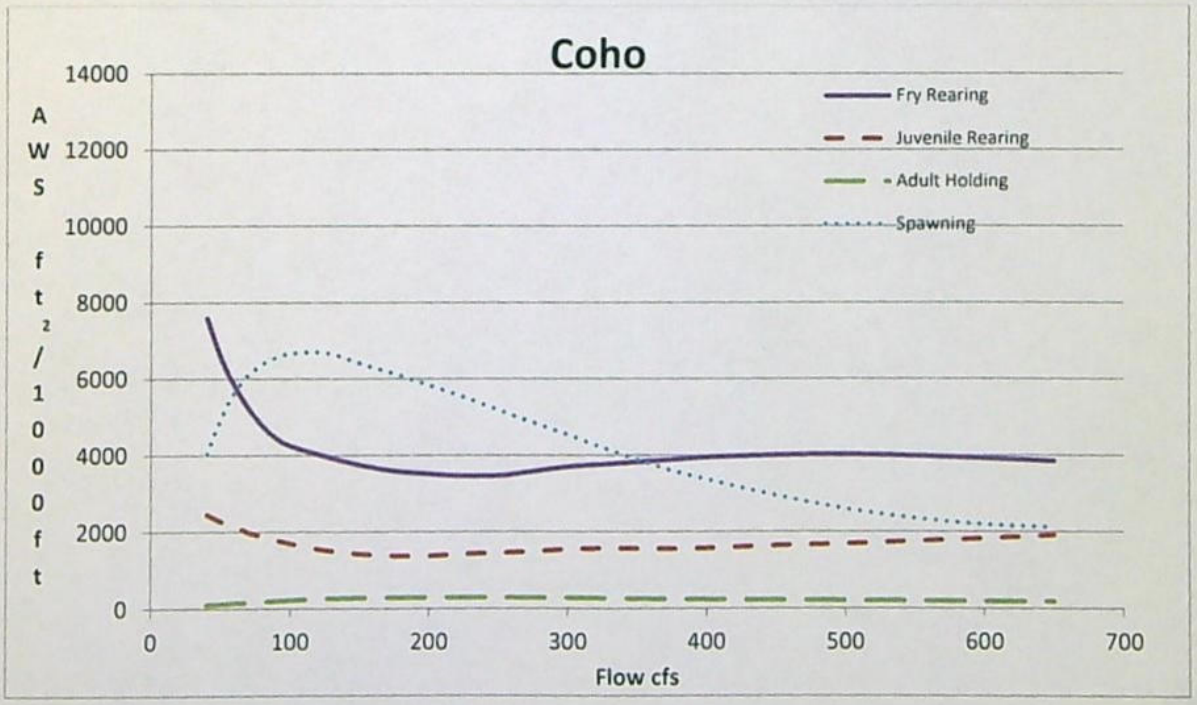


Figure 10. Chinook and coho AWS curves for E.F. Hood (lower).

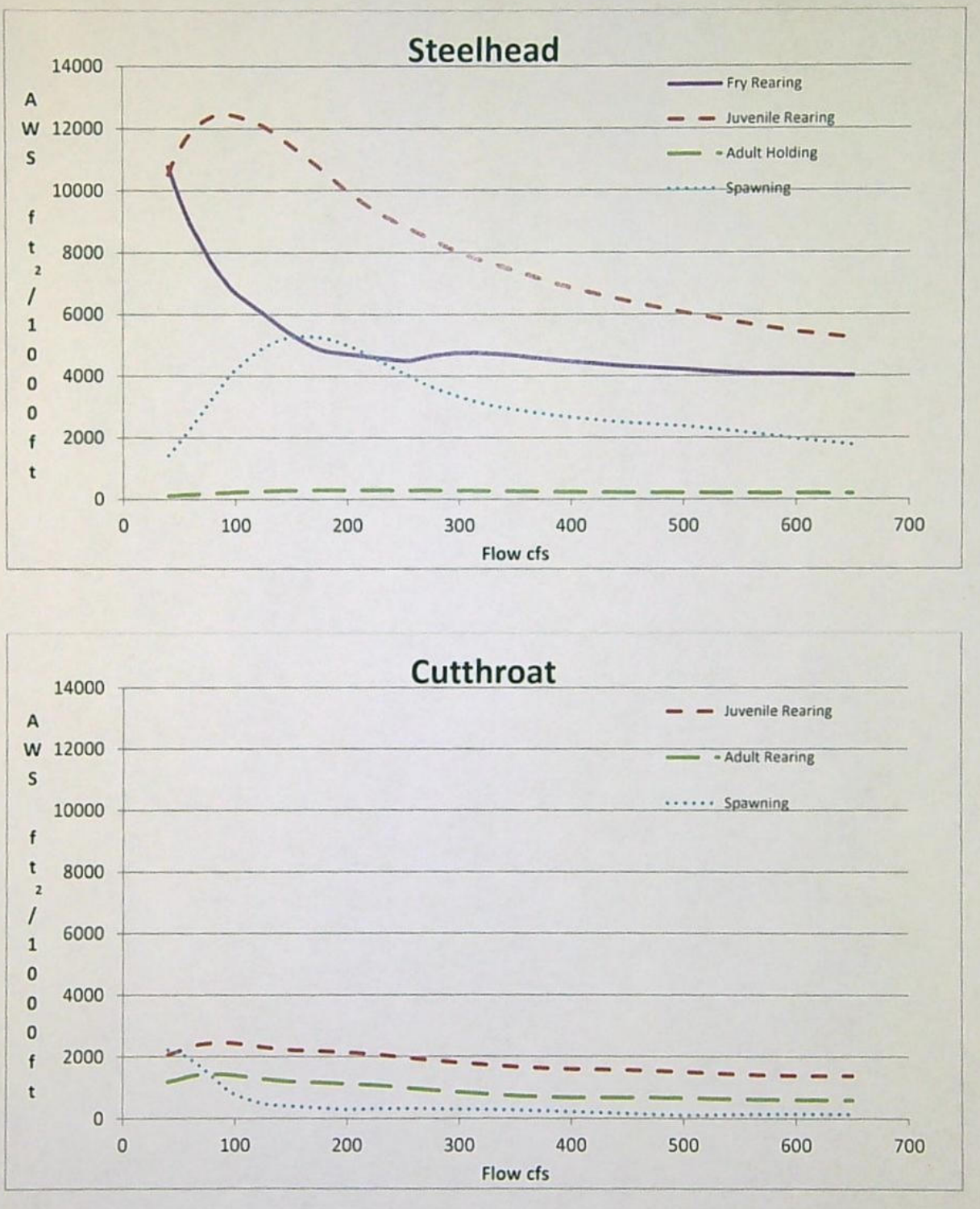
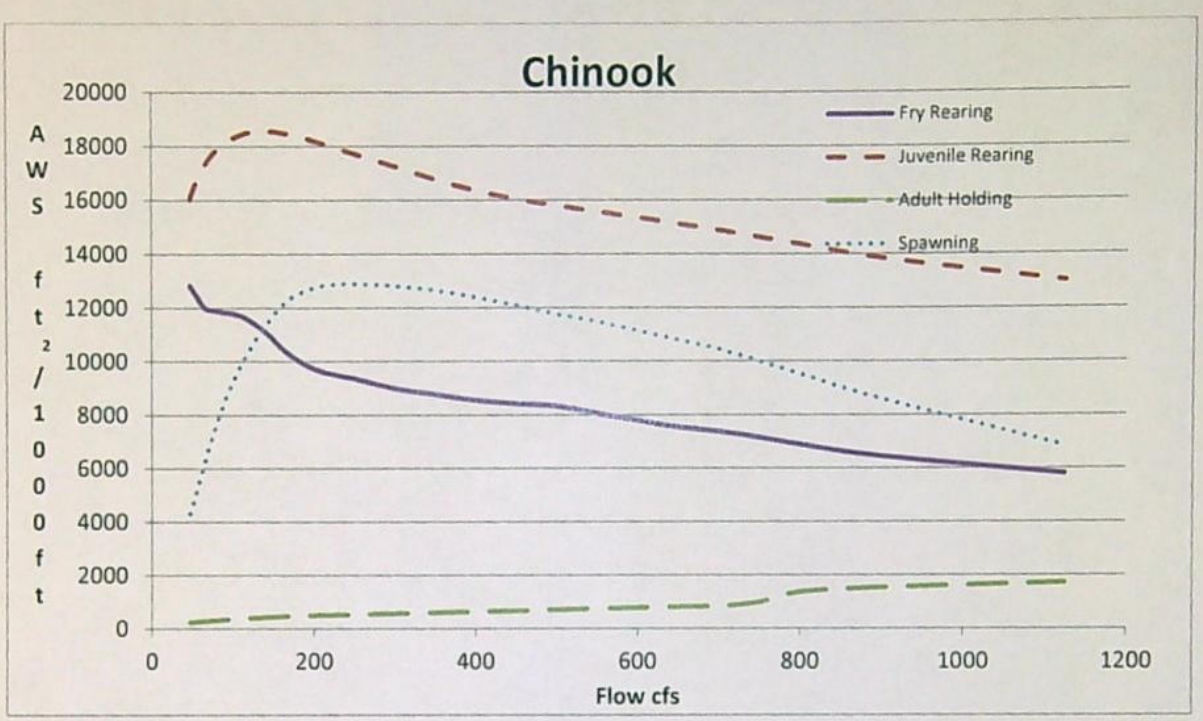


Figure 11. Steelhead and cutthroat AWS curves for E.F. Hood (lower).



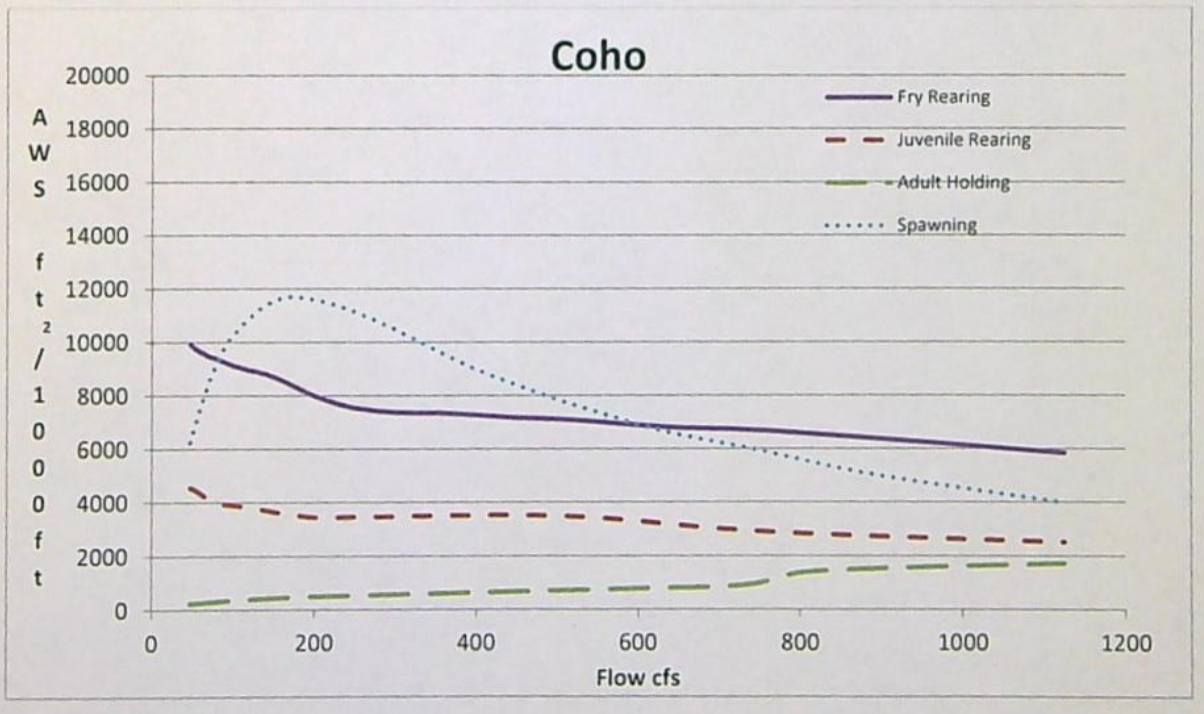
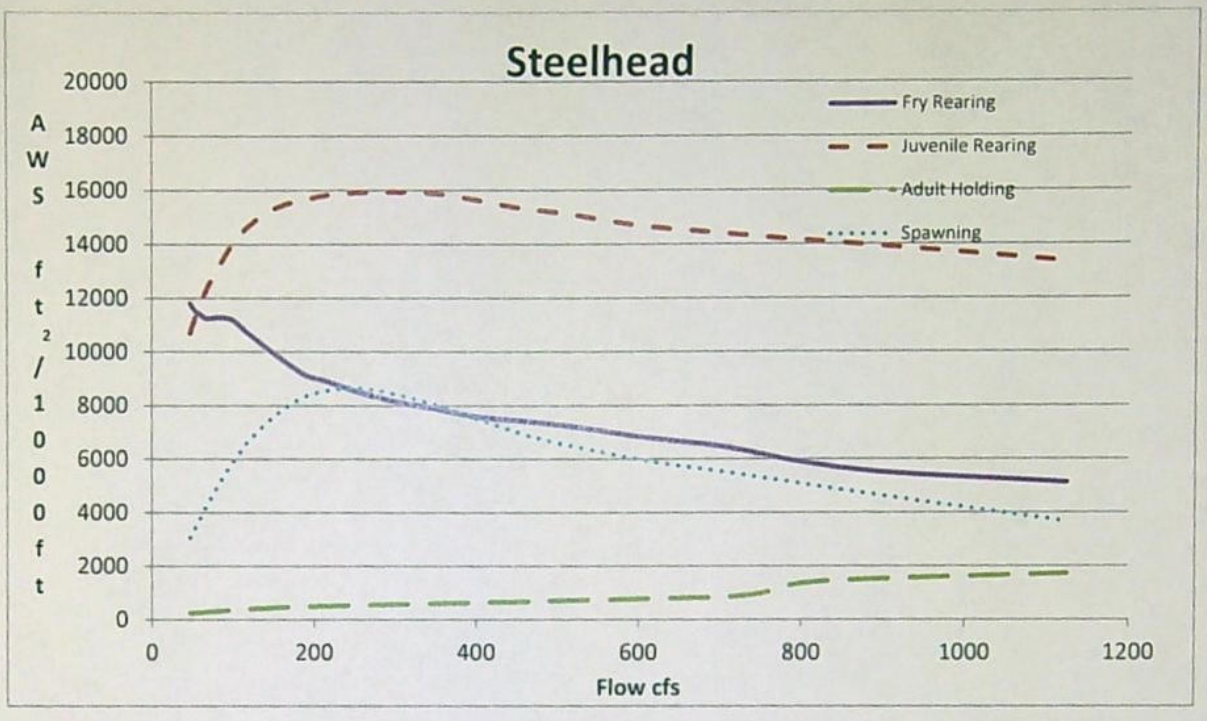


Figure 12. Chinook and coho AWS curves for W.F. Hood River.



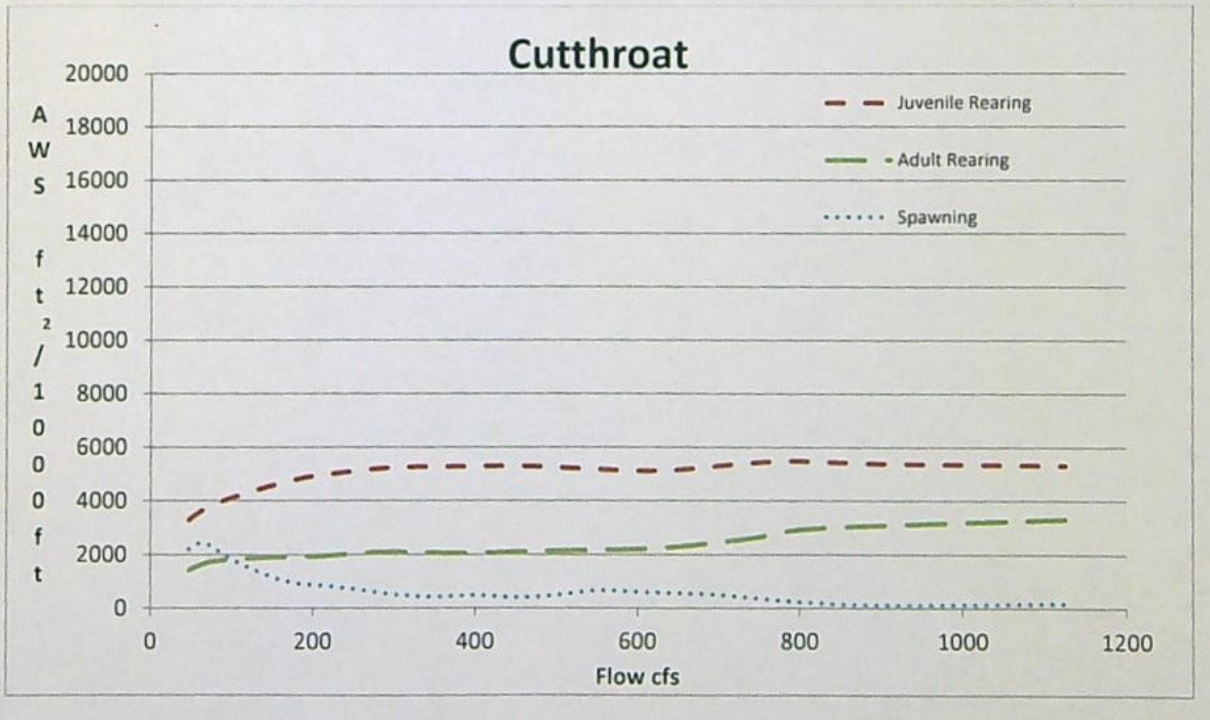


Figure 13. Steelhead and cutthroat AWS curves for W.F. Hood River.

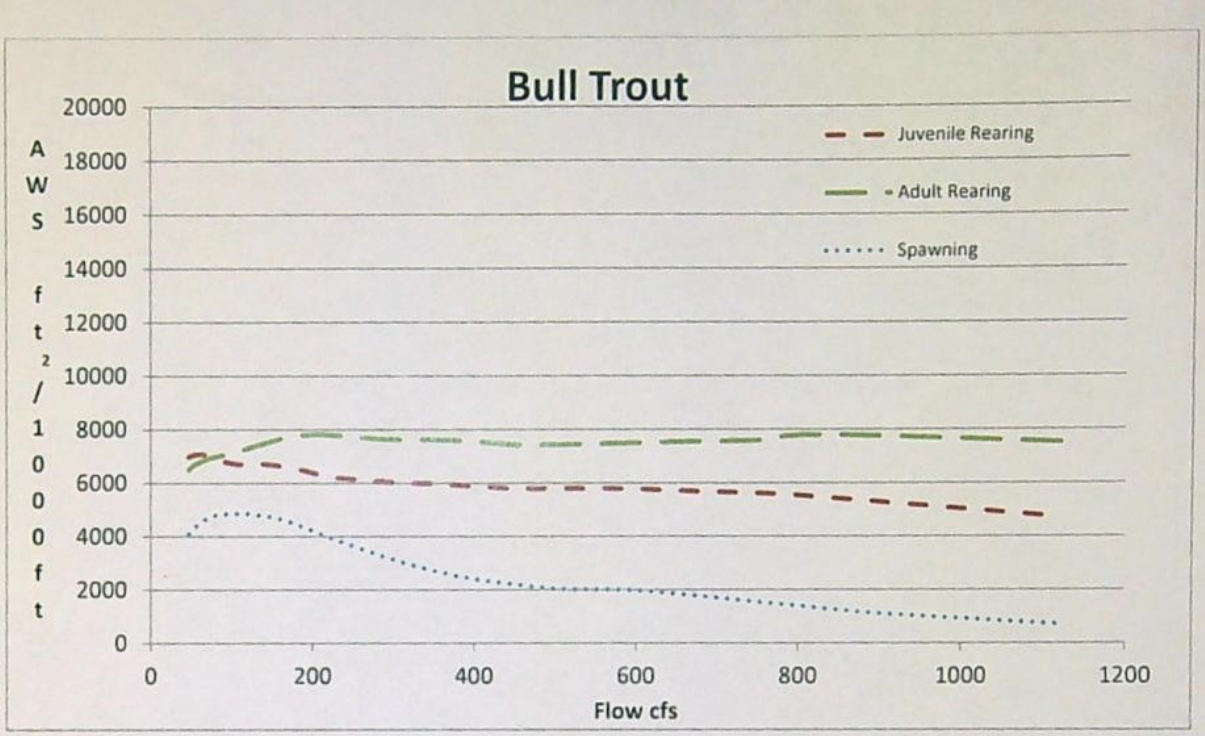


Figure 14. Bull trout AWS curves for W.F. Hood River.

Habitat Time Series Analysis

Species and life stages identified for time series habitat analysis in the five stream reaches are shown in Table 16. Spawning and rearing habitat for two species, Coho salmon and steelhead were evaluated in all reaches. Chinook salmon spawning and rearing was assessed in four reaches and bull trout spawning and rearing in a single reach. Based on the five reaches, 13 flow scenarios and 30 species/life stages being evaluated, a total of 390 individual habitat time series were run. Rearing habitat was analyzed for all months while spawning habitat was examined for the time periods identified in Table 17.

Table 16. Stream reaches, species and life stages utilized in habitat time series.

Species	Life Stage	Stream Reach					
		EF-Upper	EF-Lower	West Fork	Green Point	Neal Creek	Total for Life Stage
Spring Chinook	juvenile rearing	x	x	x	x		4
	spawning	x	x	x	x		4
Coho	juvenile rearing	x	x	x	x	x	5
	spawning	x	x	x	x	x	5
Steelhead	juvenile rearing	x	x	x	x	x	5
	spawning	x	x	x	x	x	5
Bull trout	adult rearing			x			1
	spawning			x			1
						Total	30

Table 17. Species and life stage periodicity table for the Hood River Tributaries Instream Flow Study time series.

Species	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spring Chinook	juvenile rearing												
	spawning												
Coho	juvenile rearing												
	spawning												
Steelhead	juvenile rearing												
	spawning												
Bull trout	adult rearing												
	spawning												

The results of the 390 separate habitat time series are presented in interactive Excel files included in Annexes B1 – B5. Each Annex contains a habitat time series Excel file for a single reach. In order to provide an example of output and interpretation, results are presented here are for Chinook spawning and juvenile rearing for the upper East Fork Hood River. Additional discussion is presented in Annex C, a presentation to the HRCWPG. A new method of presenting habitat time series data, raster plots, was utilized to present the results to the HRCWPG. Raster plots are pixel-based plots for visualizing and identifying variations and changes in large multidimensional data sets.

Originally developed by Keim (2000) they were first applied in hydrology by Koehler (2004) as a means of highlighting inter-annual and intra-annual changes in streamflow. The raster hydrographs in WaterWatch (http://waterwatch.usgs.gov/?id=wwchart_rastergraph), like those developed by Koehler, depict years on the y-axis and days along the x-axis.

Hydrology

Hydrology was developed for the five stream reaches identified in Table 18. Long term synthesized daily streamflows for 12 future scenarios (2030 to 2060) were used to forecast conditions based on climate change, water year type (median, hot/dry and warm/wet), water usage and additional storage (Table 18). Daily streamflow for historical existing conditions (1980 to 2009) are used as a baseline for comparisons to these future streamflow scenarios.

Table 18. Hydrology scenarios used to evaluate potential changes in flow and habitat of selected fish species and life stages in the Hood River tributaries study.

Scenario	Climate	Water Demands	Water Conservation	Water Storage
1	Historical	Existing	Existing	Existing
2.1	Future scenario 1 median	Existing	Existing	Existing
2.2	Future scenario 2 hot/dry	Existing	Existing	Existing
2.3	Future scenario 3 warm/wet	Existing	Existing	Existing
3.1	Future scenario 1 median	Future – (increase)[1]	Existing	Existing
3.2	Future scenario 2 hot/dry	Future – (increase)[1]	Existing	Existing
3.3	Future scenario 3 warm/wet	Future – (increase)[1]	Existing	Existing
4.1	Future scenario 1 median	Future – (increase)[1]	Future – (conserve)[2]	Existing
4.2	Future scenario 2 hot/dry	Future – (increase)[1]	Future – (conserve)[2]	Existing
4.3	Future scenario 3 warm/wet	Future – (increase)[1]	Future – (conserve)[2]	Existing
5.1	Future scenario 1 median	Future – (increase)[1]	Future – (conserve)[2]	Existing & New Storage[3]
5.2	Future scenario 2 hot/dry	Future – (increase)[1]	Future – (conserve)[2]	Existing & New Storage[3]
5.3	Future scenario 3 warm/wet	Future – (increase)[1]	Future – (conserve)[2]	Existing & New Storage[3]

[1] potable and irrigation [2] irrigation [3] larger FID & MFID, new FID

Streamflow and Habitat Time Series

An example flow time series for the historic scenario and corresponding Chinook juvenile habitat time series are presented in Figure 15. When dealing with an extensive period of 30 years, details can be lost but certain events stand out, high peak flows in 1994 and 1995, relatively higher summer flows and lower peak winter flows in 1996 and 1997, extremely low winter flows in 2000 and low summer flows in 2000 and 2001. These events are depicted in more detail in Figure 16. As can be seen, lower habitat values occur at flows over 300 cfs, with near zero habitat indexes at extreme peak flows, and the highest habitat index values are during lower flow periods (e.g. summer). But low habitat values can also occur at very low flows, in this case flows less than 10 cfs as in the summers of 1994 and 2001. An alternative visually enhanced means of identifying these events are illustrated in Raster hydrograph (Figure 17) and

habitat (Figure 18) plots. The high flows of February 1996 and November of 2006 are easily identified in Figure 17.

By examining the relationship between flow and habitat for Chinook juvenile, the basis for these events becomes apparent (Figure 19). From the peak of the curve to an inflection point around 300 cfs, AWS is relatively high. Past this point AWS gradually decreases. Similarly AWS is relatively high at the low end of the curve before its drops precipitously at flows less than 10 cfs.

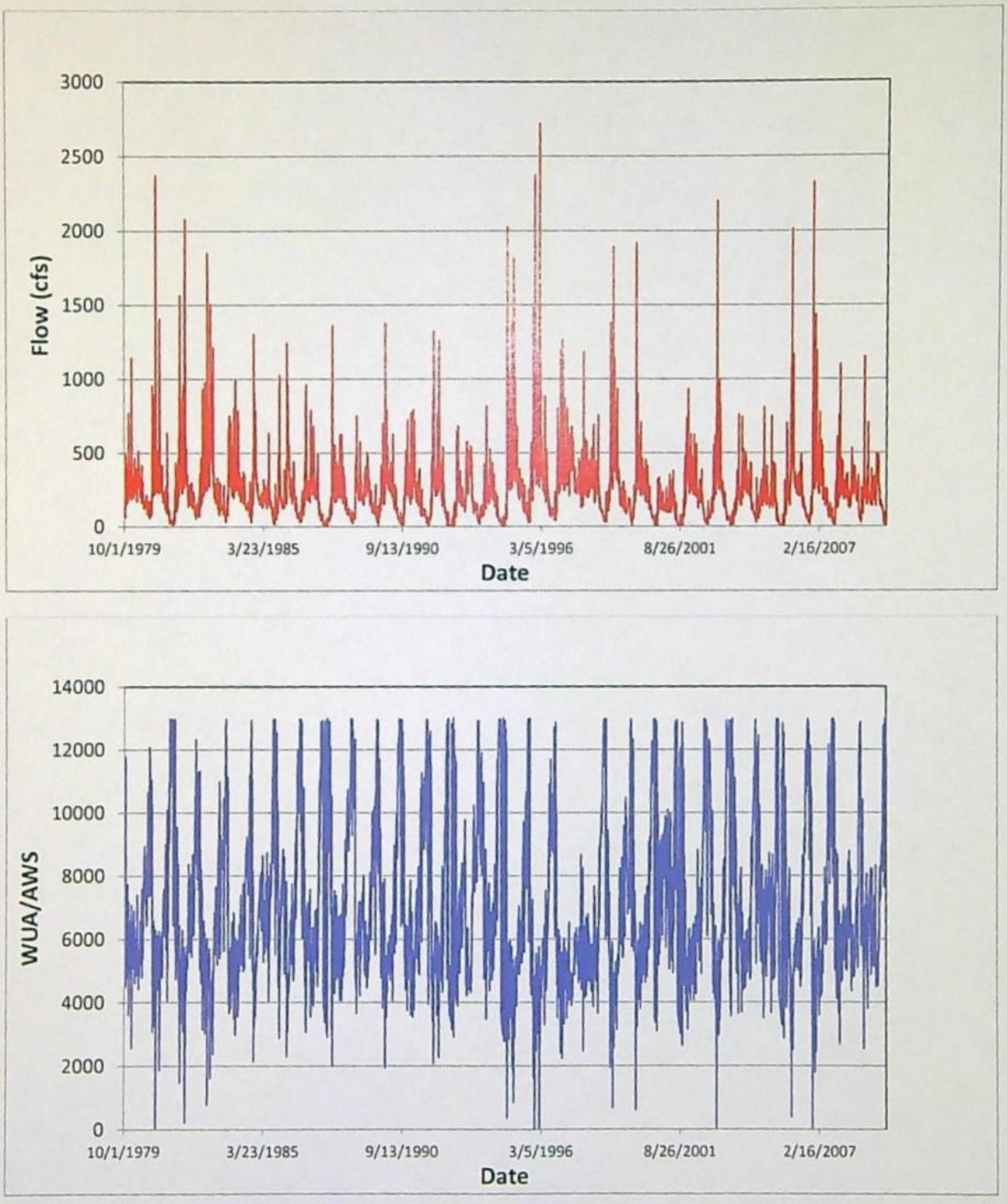


Figure 15. Flow time series (top) and Chinook juvenile habitat time series (bottom) for 30 years of historic flow in the East Fork Hood River..

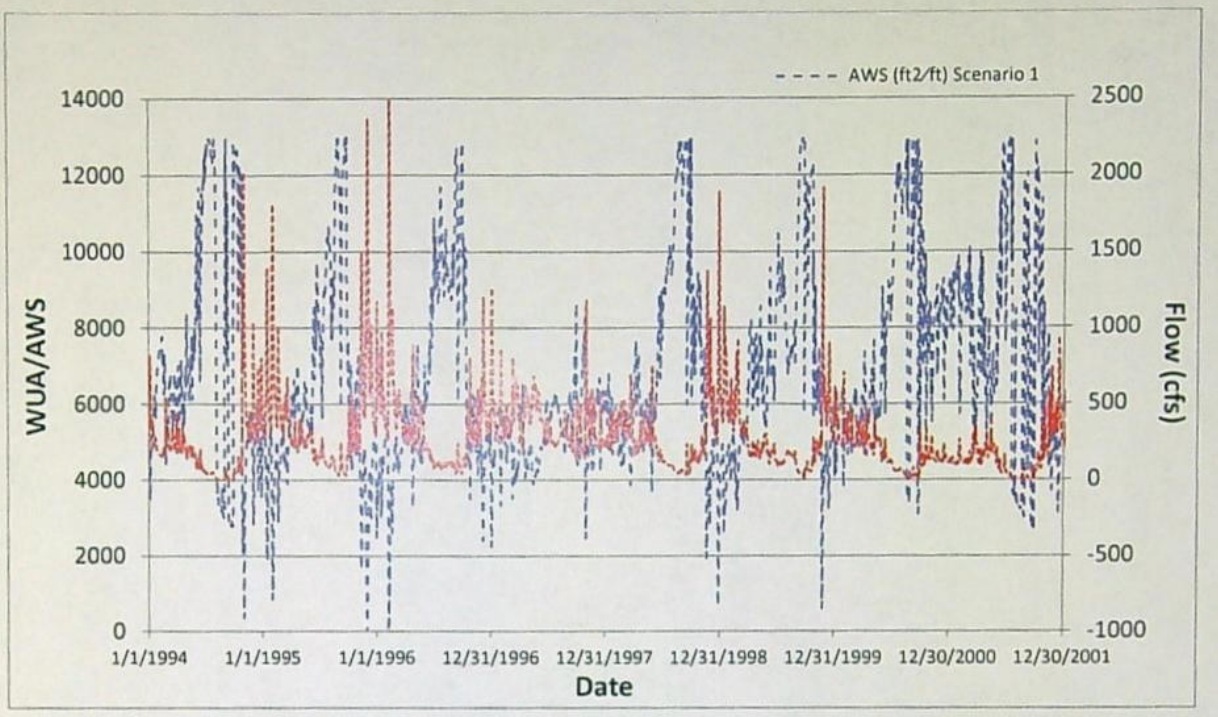


Figure 16. Overlay of flow time series and Chinook juvenile habitat time series for a selected time period from the upper East Fork Hood River.

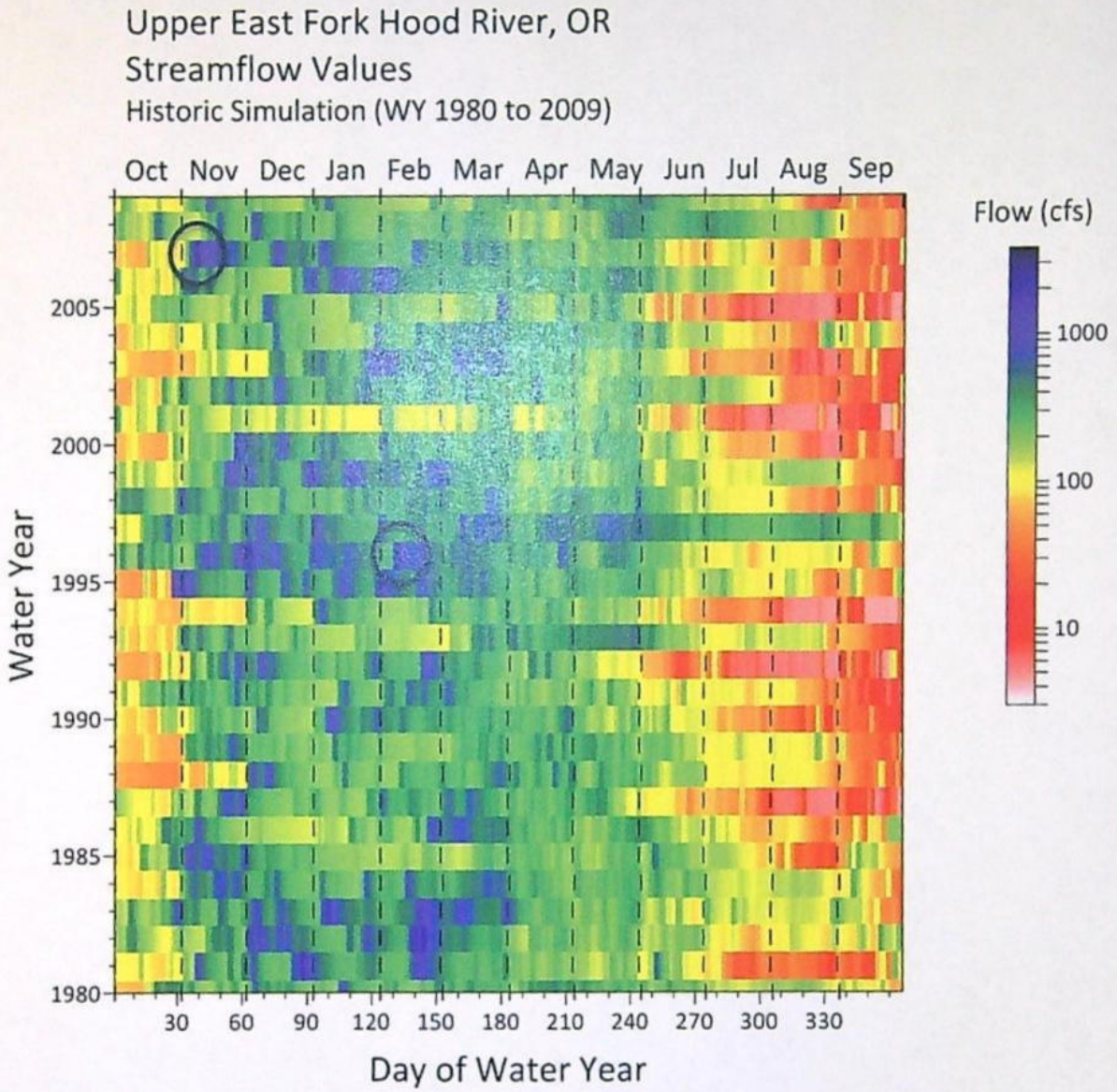


Figure 17. Raster hydrograph of historic flows in the Upper East Fork Hood River.

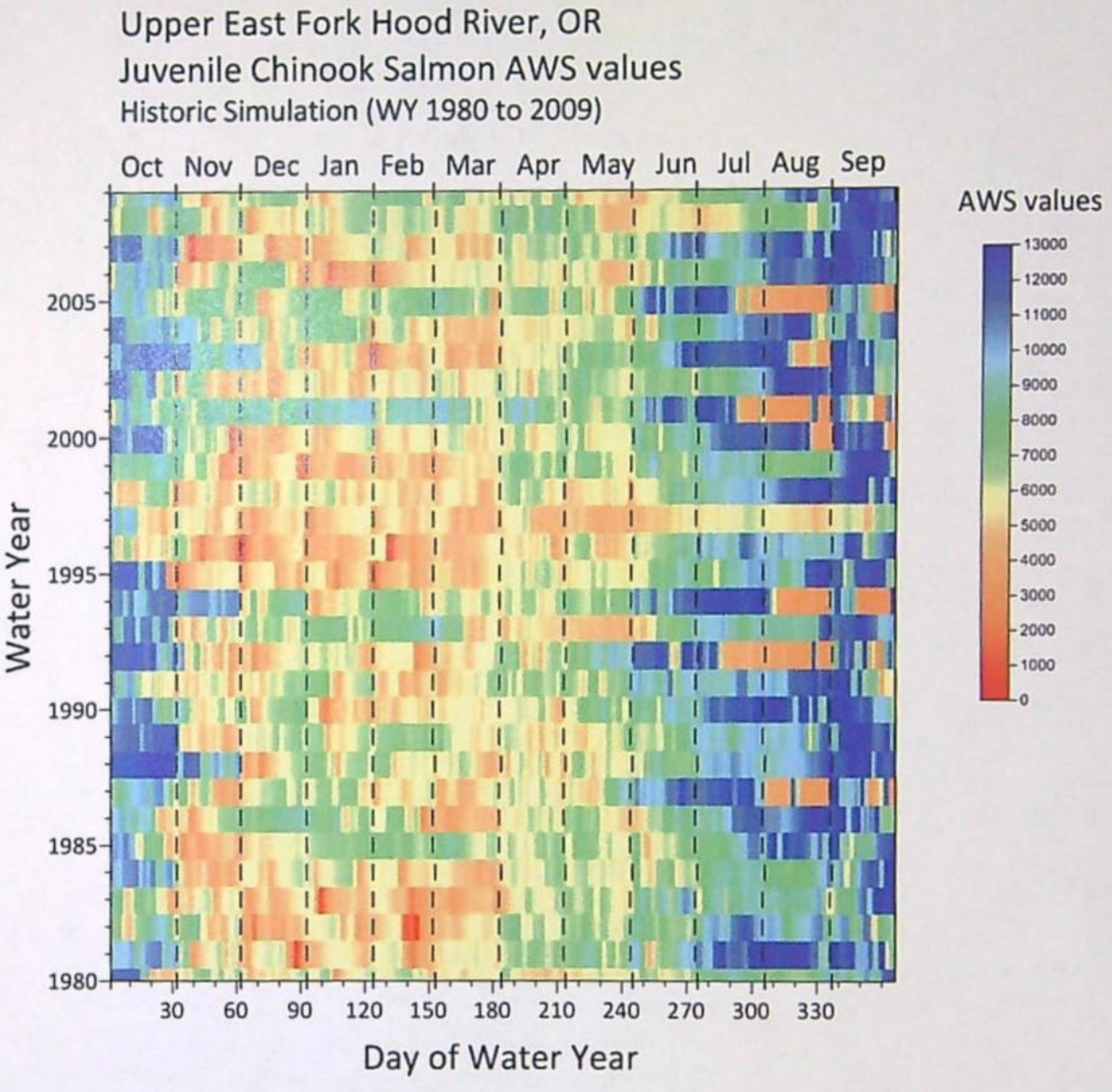


Figure 18. Raster plot of Chinook juvenile habitat (AWS) for historic flows in the Upper East Fork Hood River.

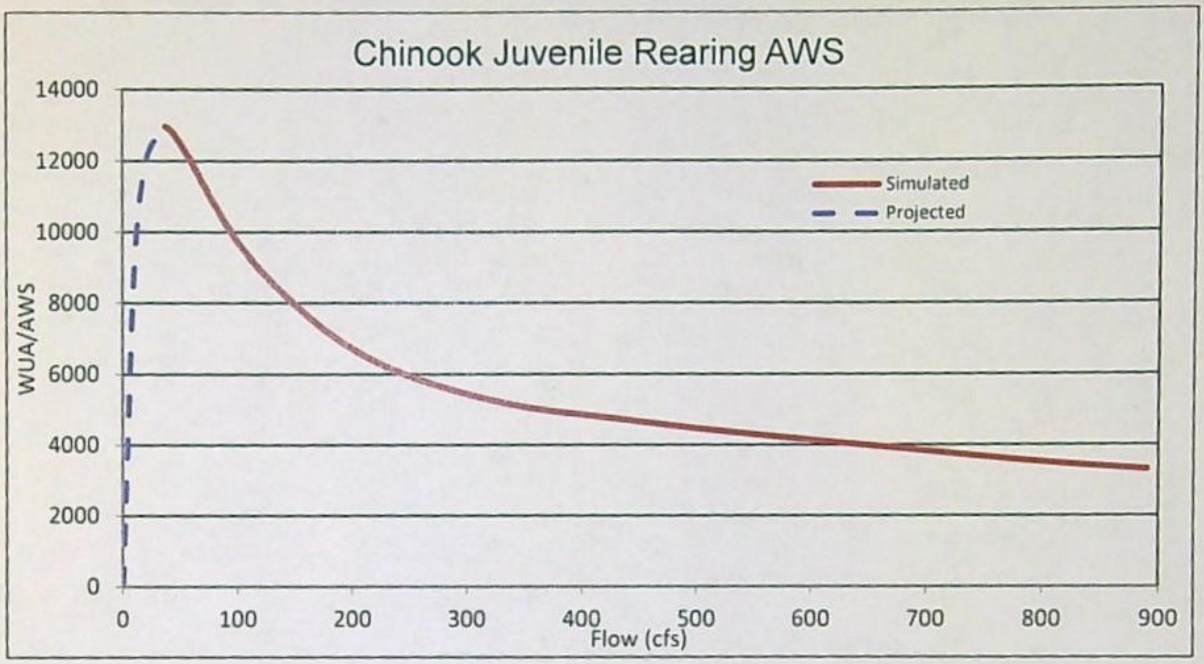


Figure 19. Chinook juvenile WUA/AWS curve for the upper East Fork Hood River.

Flow and Habitat Duration

Flow duration curves provide a means to compare different flow regimes with respect to the amount of time certain flow levels occur. For the upper East Fork Hood River graphs are provided that depict flow exceedance from 0-100 % and 5-95 % for the period of record (Figure 20). Future hydrology for all scenarios shows an increase in high flows and somewhat lower low flows for most of the scenarios compared to historical. Examination of Chinook juvenile habitat duration curves shows slightly more habitat 25% of the time and slightly less 50% of the time for all future scenarios over historical (Figure 21). Because it has been shown that both high flows and very low flows can lower the habitat index, this follows what is shown in the flow duration curve.

Flow duration curves for spring Chinook spawning cover a short period of time (August 15 to October 15) and flows exceed 250 cfs just 5% of the time (Figure 22). Future flow scenarios based on climate change (2.1-2.3) and water demand (3.1-3.2) display lower flows than historical all the time. Scenarios based on water conservation and storage exhibit higher high flows, but also greater low flows. The overall lower flows under climate change and water demand scenarios result in a reduction of spawning habitat (Figure 22). Under water conservation and storage scenarios spawning habitat is greater for approximately 50% of the time for scenarios 4.1 and 4.2, and most of the time for scenarios with water storage incorporated.

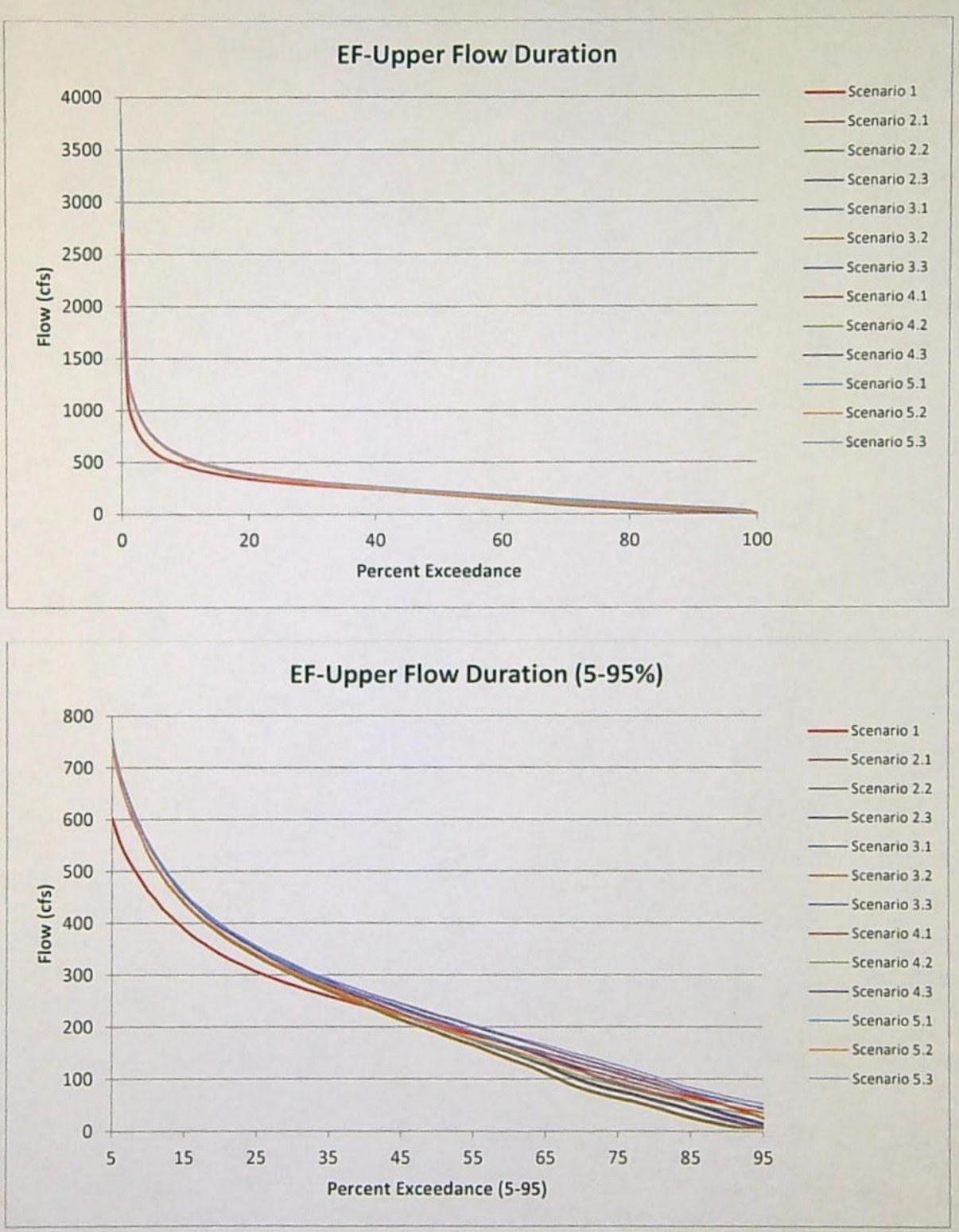
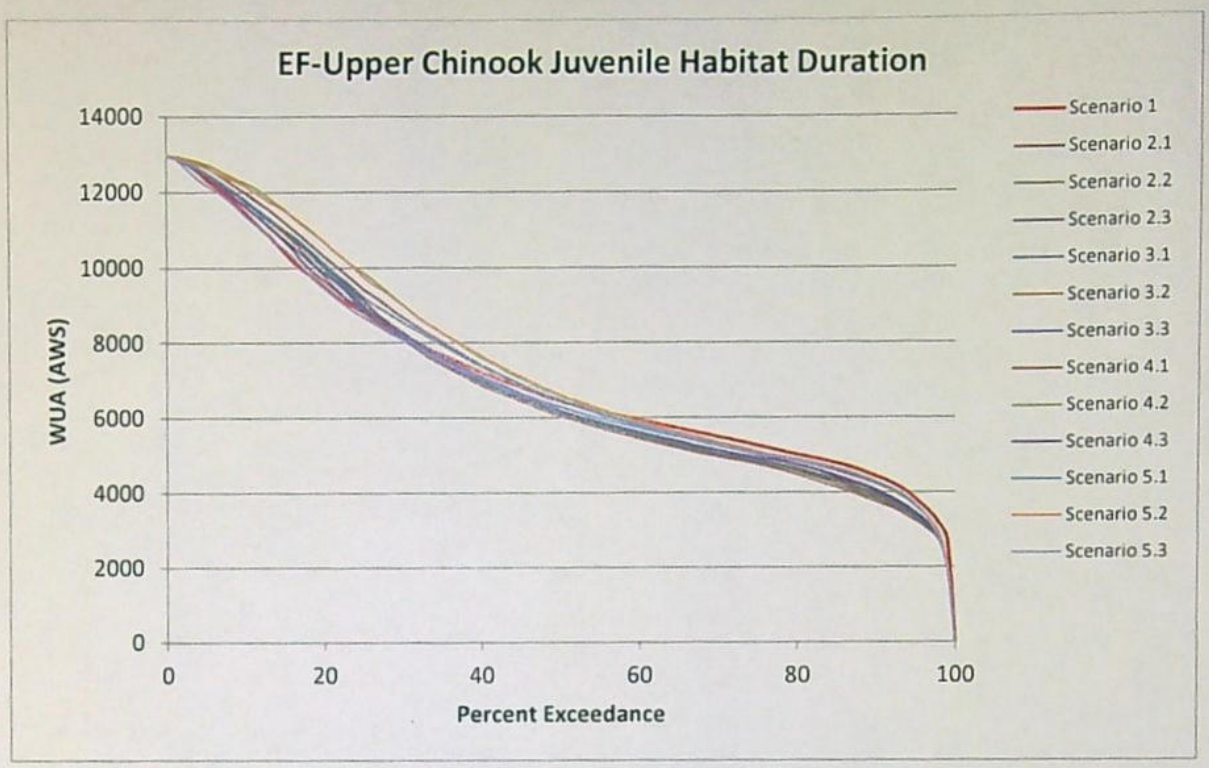


Figure 20. Flow duration curves for 13 flow scenarios on upper East Fork Hood River. Top, 0-100% exceedance; bottom, 5-95% exceedance.



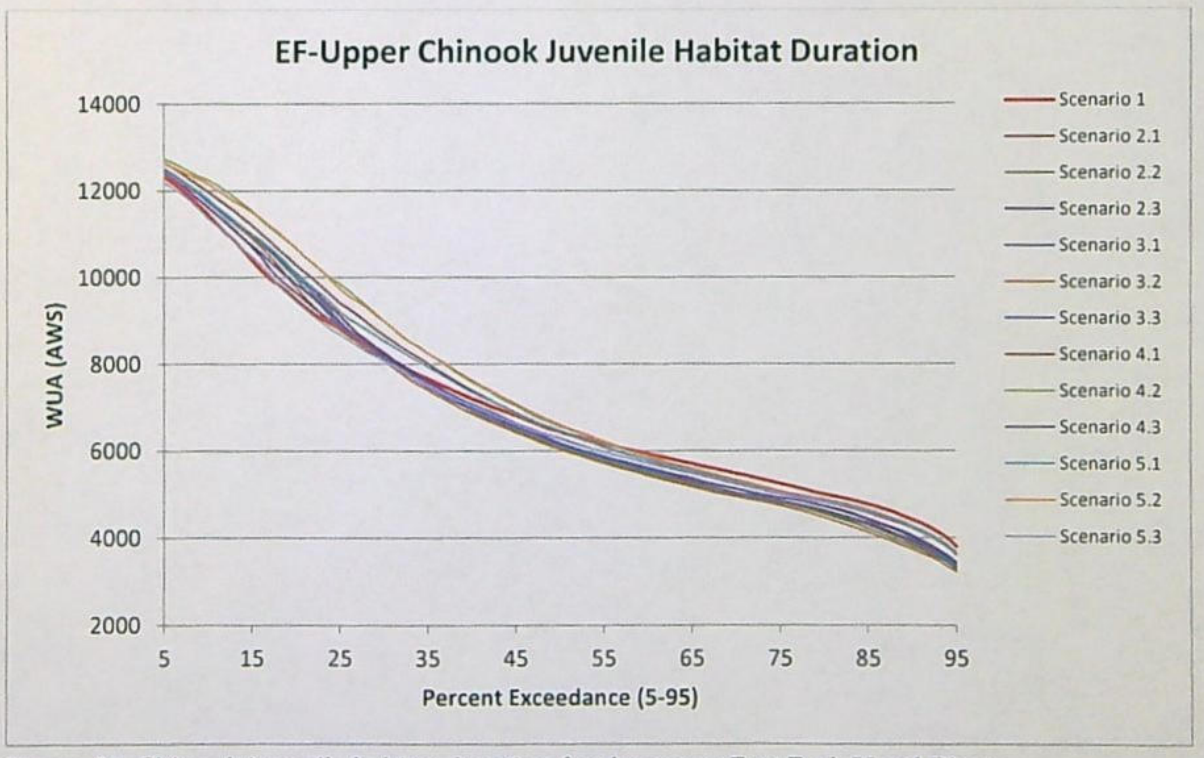


Figure 21. Chinook juvenile habitat duration for the upper East Fork Hood River.

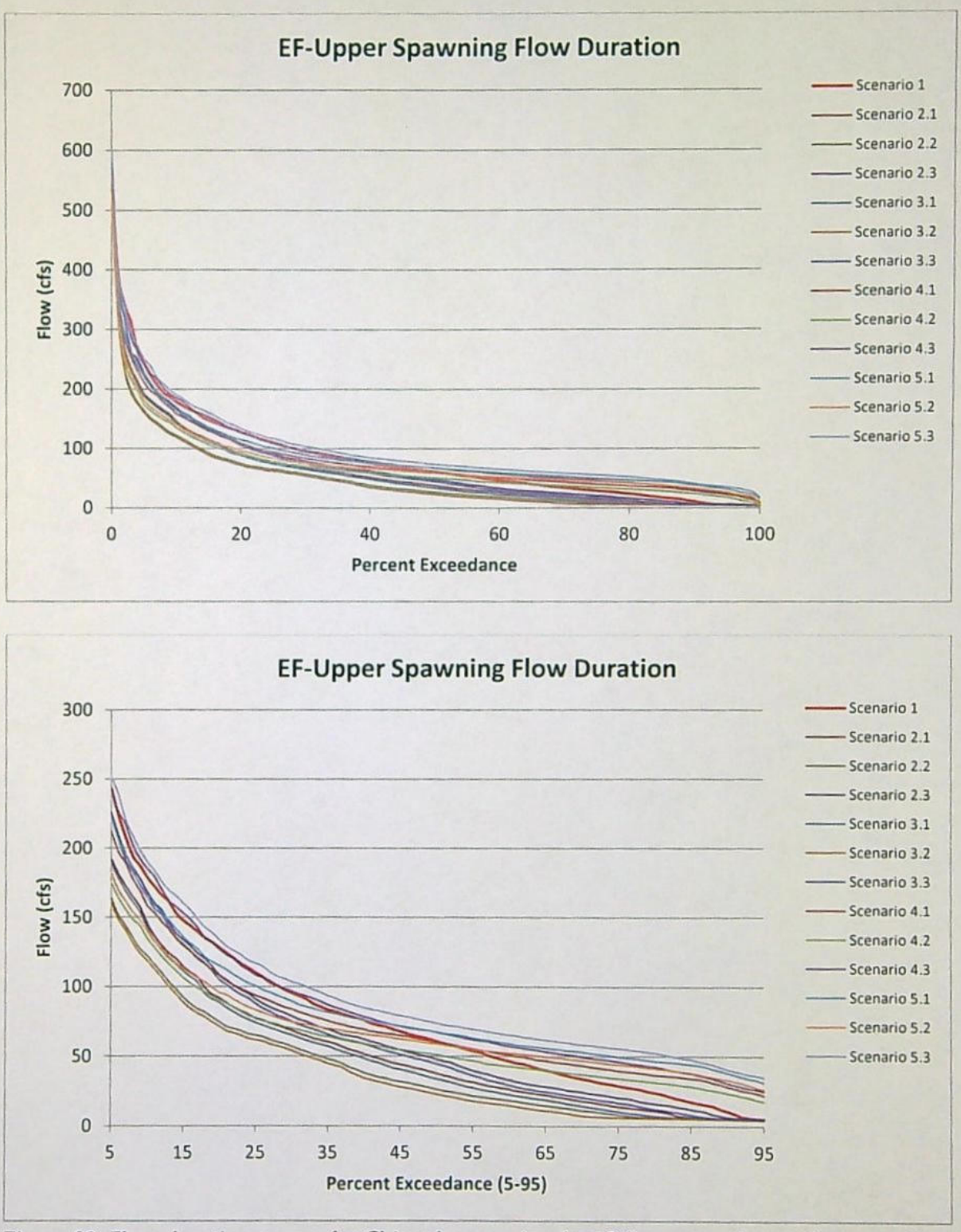


Figure 22. Flow duration curves for Chinook spawning for 13 flow scenarios on the upper East Fork Hood River. Top, 0-100% exceedance; bottom, 5-95% exceedance.

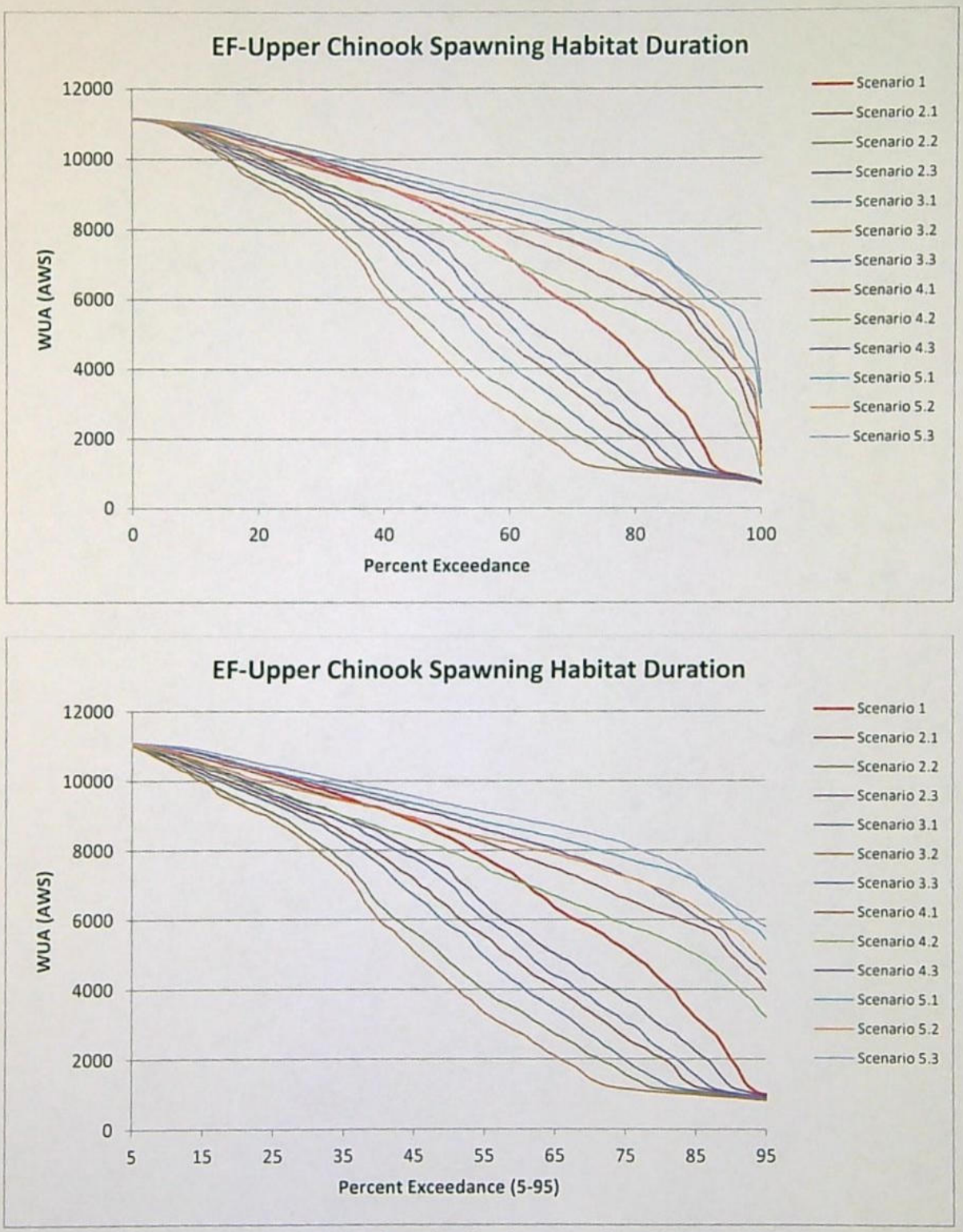


Figure 23. Chinook spawning habitat duration for the upper East Fork Hood River.

Discussion

Although we are reporting on all four streams in a single report, there are four separate instream flow studies; one each for Green Point Creek, Neal Creek, East Fork Hood River, and West Fork Hood River. Even though all four streams are tributaries of the Hood River in the same vicinity, they vary in size and respond differently to hydrologic events. This became painfully evident when we mobilized for the field work targeting the calibration flows. Subsequent to a rain event after which we hoped to measure high flow data, both the East and West Forks responded and became torrents, Green Point Creek responded moderately, and Neal Creek flow barely increased. Of course the elevation, size, and orientation of each watershed are responsible for the different hydrologic responses to the same rain event. Likewise, the hydraulic habitat characterized by each instream flow study will vary differently in response climatic induced changes in flow.

There is one conclusion common to all streams: the hydraulic habitat index, AWS, indicates low habitat suitability for adult holding in all reaches for all reasonable flows. Low, flat AWS curves indicate that changes in flow have little influence on adult holding habitat. Deep habitats are scarce. If feasible, restoration of holding habitat would have more influence on the availability than changes in flow.

A controversial indication of the AWS/flow relationship for adult and juvenile salmonids in the East Fork is the favourability of low flows (Annex A1 and D). This resulted in changing the Chinook spawning HSC for the larger East and West Forks from the MFID HSC to the WDFW River HSC. It was noted early in the HSC discussion (Annex A) that the MFID Chinook spawning HSC indicated shallow suitability. Although appropriate for the smaller streams, the shallow suitability was not appropriate for the larger streams. No rational changes could be made to the juvenile or fry HSC. Analysis of the depth and velocity components of the transect data show that the East Fork reaches (particularly the Upper site) are shallow and fast limiting suitability at higher flows (Annex A1). Recent channel changes and aggradation may contribute to this. Expansion of the reaches to include more of the river and additional transects would will help determine if the AWS/flow relationships are influenced by sites randomly selected.

Instream flow studies rarely answer the question, "What is the best flow?" That question is answered by balancing biological, social, and economic needs. Even when considering only a single species, the index of hydraulic habitat for different life-stages will respond differently to changing flow and no one flow will be the best for all life-stages. The results of these instream flow studies provide tools to assess the biological impacts to hydraulic habitat for the species of interest in each stream. The primary tools for assessing responses to changing flow are the Excel files in Annexes B1 through B5. Each file contains the results for one study reach. Each specie/life-stage habitat time series exceedance statistics and habitat duration graphs are presented in separate worksheets. The habitat duration graphs are presented both as a group of all climate scenarios and as interactive graphs enabling the user to select a scenario to compare to the historical graph. The user can select any one of the 12 climate altered scenarios to

compare with the historical scenario. Each of the graphs are also presented including all exceedance values (0% to 100%) and the 5% to 95% range of exceedance values. The 5% to 95% graph eliminates the extremes and enables the range scale to be reduced for greater resolution of the graphs when comparing scenarios.

An overview of the instream flow studies and detailed comparisons of the climate scenarios and habitat time series for Chinook spawning and Chinook juvenile rearing in the Upper East Fork Reach is presented in Annex C, the final presentation to the HRCWPG. The presentation relies heavily on raster plots, a new way to visualize the time series data set. In presentation mode, the user can toggle between two comparative raster plots on the same slide and see where and when changes to the raster hydrograph and hydraulic habitat index occur anywhere in the time series. Another use of the raster plot is to plot the difference in habitat index values between a climate scenario and the historical record. Figure 24 depicts decreases in Chinook rearing AWS comparing the future 5.3 climate scenario to the historical record for most of the East Fork Hood River time series. However, increases in AWS due to scenario 5.3 occur in the summer concurrent with low flow and the lowest habitat values. The increases in habitat values, although much less frequent, may be of greater biological significance occurring in a potential habitat bottleneck. This is further demonstrated by Figures 25 and 26. The times when the 50% AWS value (historical) are equalled or exceeded are plotted with a black dot over the raster hydrograph of the historical (Figure 25) and 5.3 (Figure 26) scenarios. The July through September low habitat values in the historical scenario (Figure 25) correspond to dry periods without the black dot overlay. Those low AWS values are not existent in the 5.3 scenario summer (Figure 26).

It is important to note that for a flow prescription in any of these streams, additional habitat mapping and potentially additional transects will be required to determine the applicability of the AWS/flow relationship to reaches not habitat mapped in this study. Due to available funding each reach was limited to one mile of stream. Many considerations were included in the reach selection process and reaches that are productive and representative were chosen. This does not, however, guarantee that each reach will represent the entire stream. Additional habitat mapping will either verify the representativeness or indicate the need for additional transects.

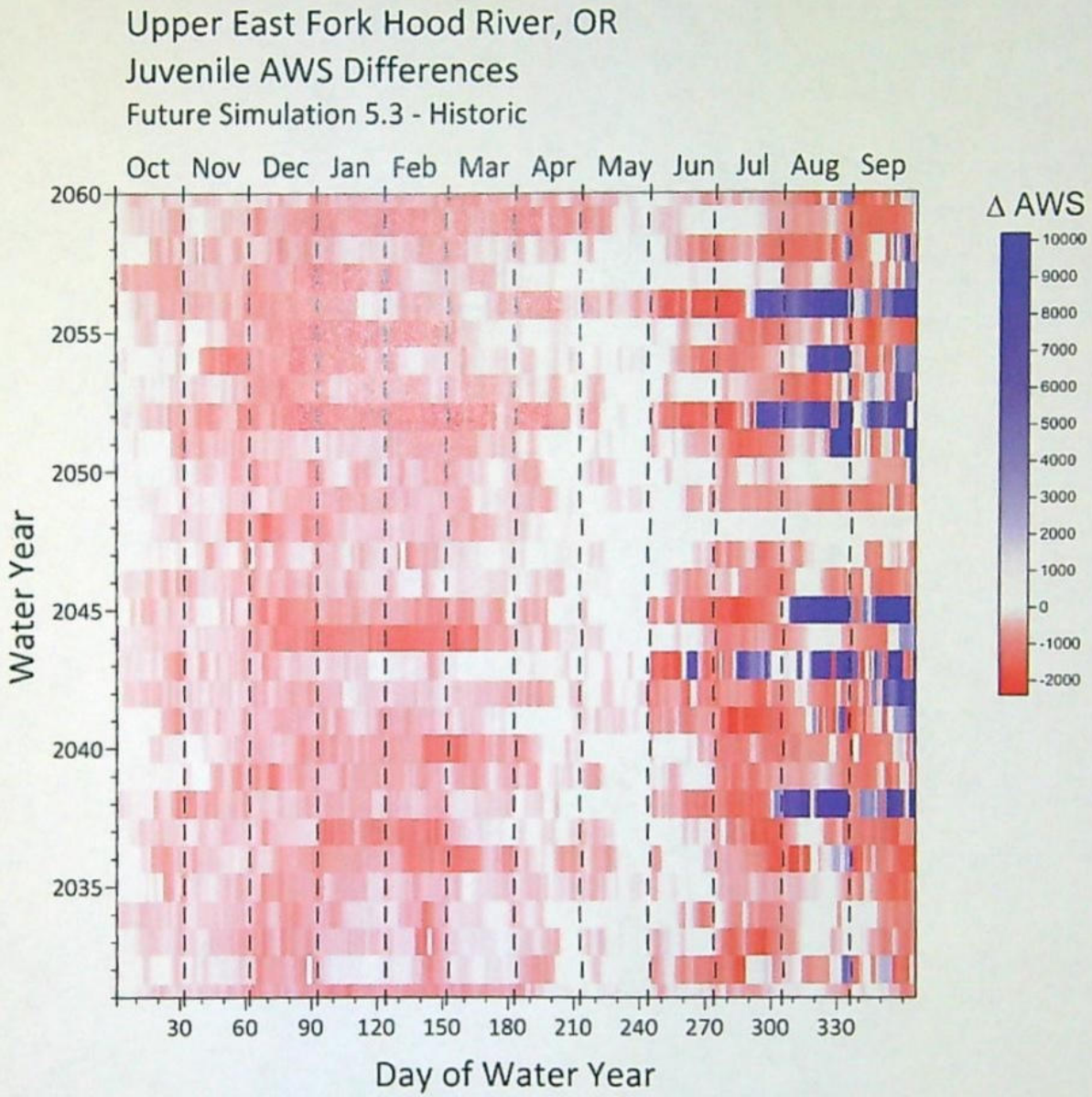


Figure 24. Change in AWS between the historic climate scenario and scenario 5.3 for Chinook rearing habitat in the East Fork Hood River.

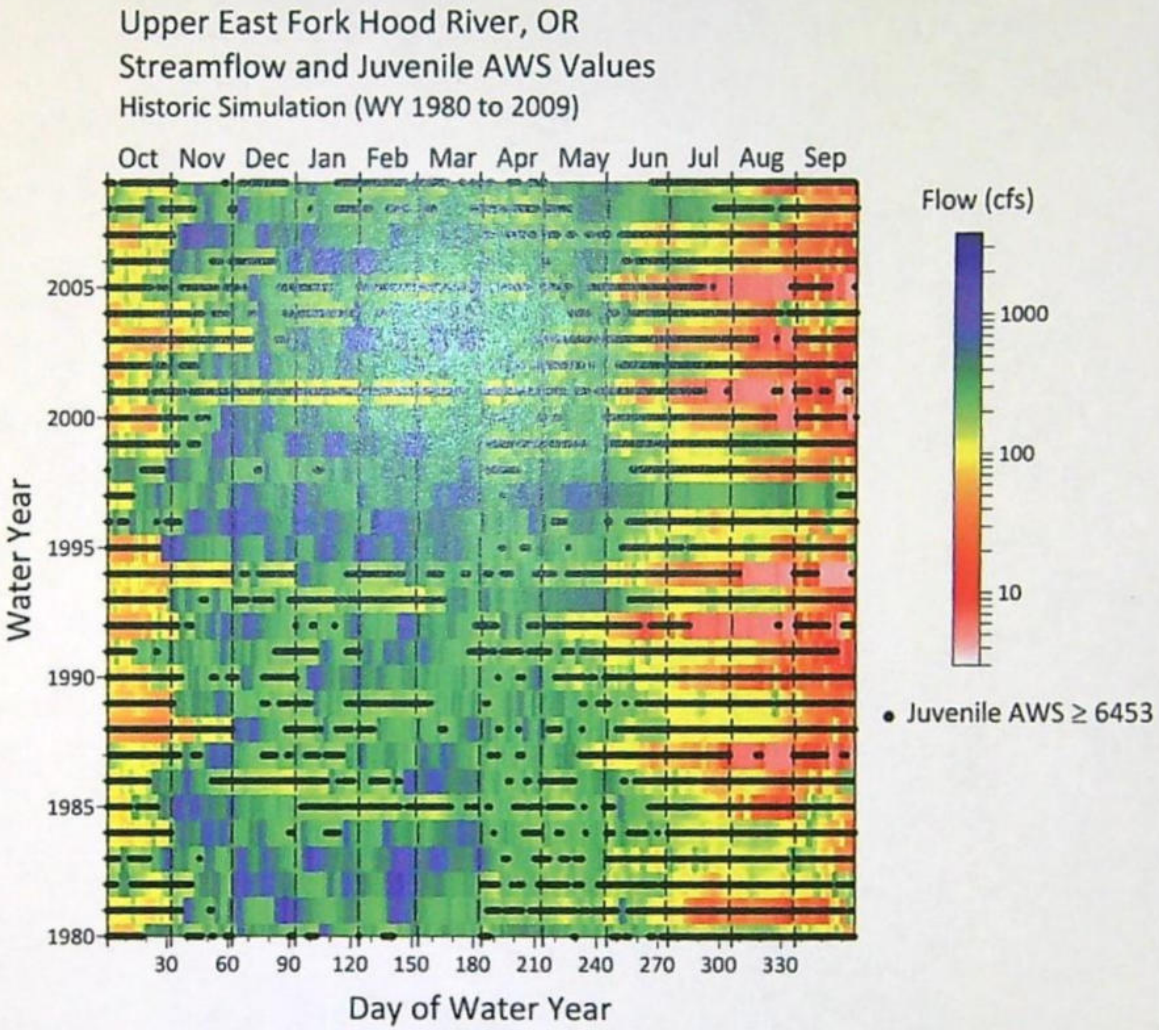


Figure 25. Upper East Fork Hood historical raster hydrograph with black dots plotted for each day that the AWS is greater or equal than the 50% exceedance value for juvenile Chinook rearing.

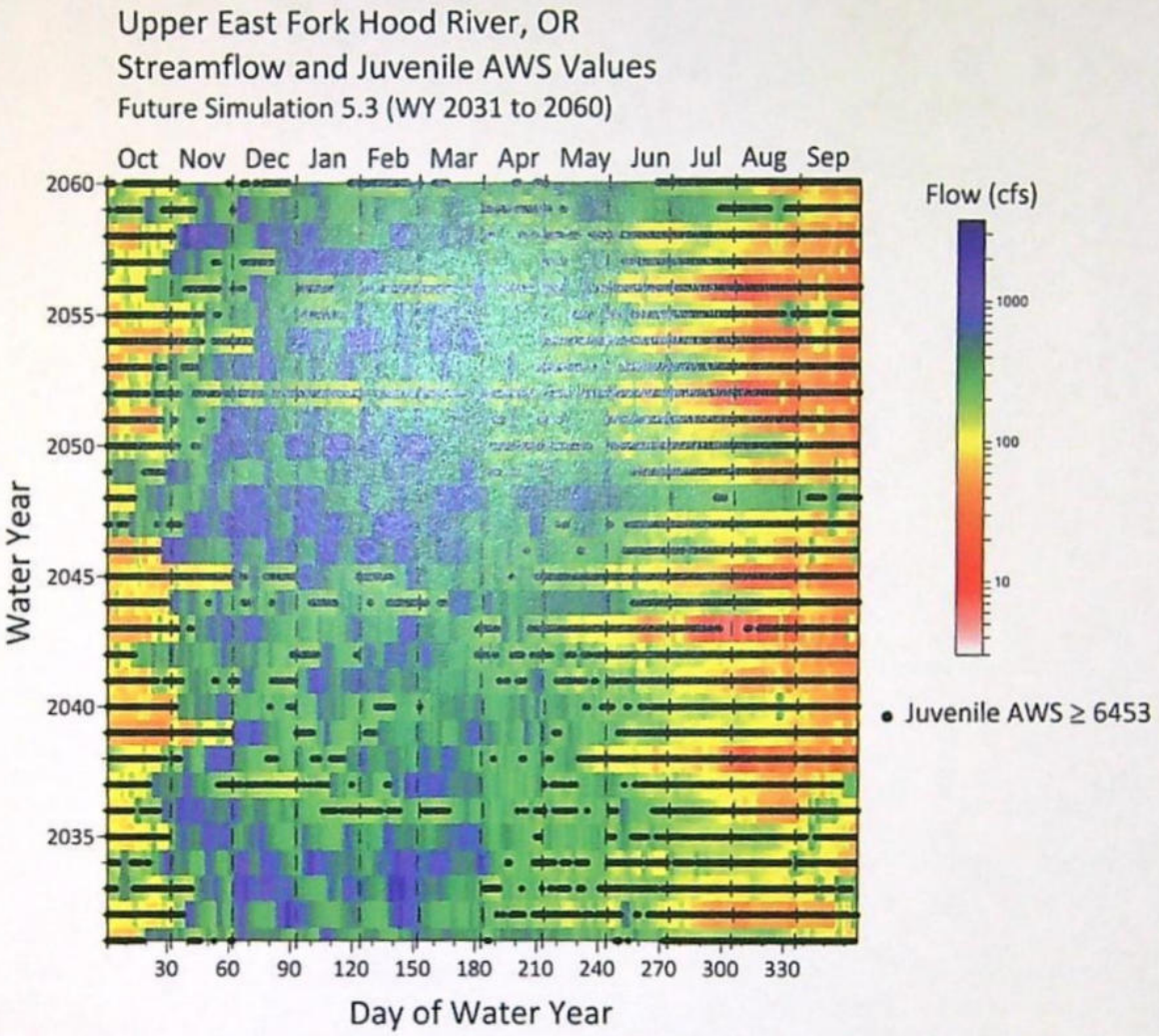


Figure 26. Upper East Fork Hood climate scenario 5.3 raster hydrograph with black dots plotted for each day that the AWS is greater or equal than the 50% exceedance value for juvenile Chinook rearing.

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Appendix A: Habitat Mapping

Appendix B: Transect Profiles, and Calibration Flow Velocities and Water Surface Elevations

Appendix C: PHABSIM Calibration Summaries

Appendix D: Simulated Water Surface Elevations and Velocities

Appendix E: Tabular AWS Values

Environmental Investigations

HOOD BASIN Supplement

FISH AND WILDLIFE RESOURCES AND THEIR WATER REQUIREMENTS

OREGON STATE GAME COMMISSION

P.O. BOX 3503, 1634 S.W. ALDER STREET
PORTLAND, OREGON 97208

SUPPLEMENT

to

THE FISH AND WILDLIFE RESOURCES OF THE HOOD BASIN, OREGON, AND THEIR WATER USE REQUIREMENTS, DECEMBER 1963

By

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Environmental Management Section
William E. Pitney, Chief

A Report with Recommendations to the
OREGON STATE WATER RESOURCES BOARD

From the

Oregon State Game Commission
John W. McKean, Director

FEDERAL AID TO FISH RESTORATION
Completion Report
Fisheries Stream Flow Requirements
Project 69410, Job Number 12
Supplement to
Project F-69-R-1, Job Number 1

Portland, Oregon

April 1973

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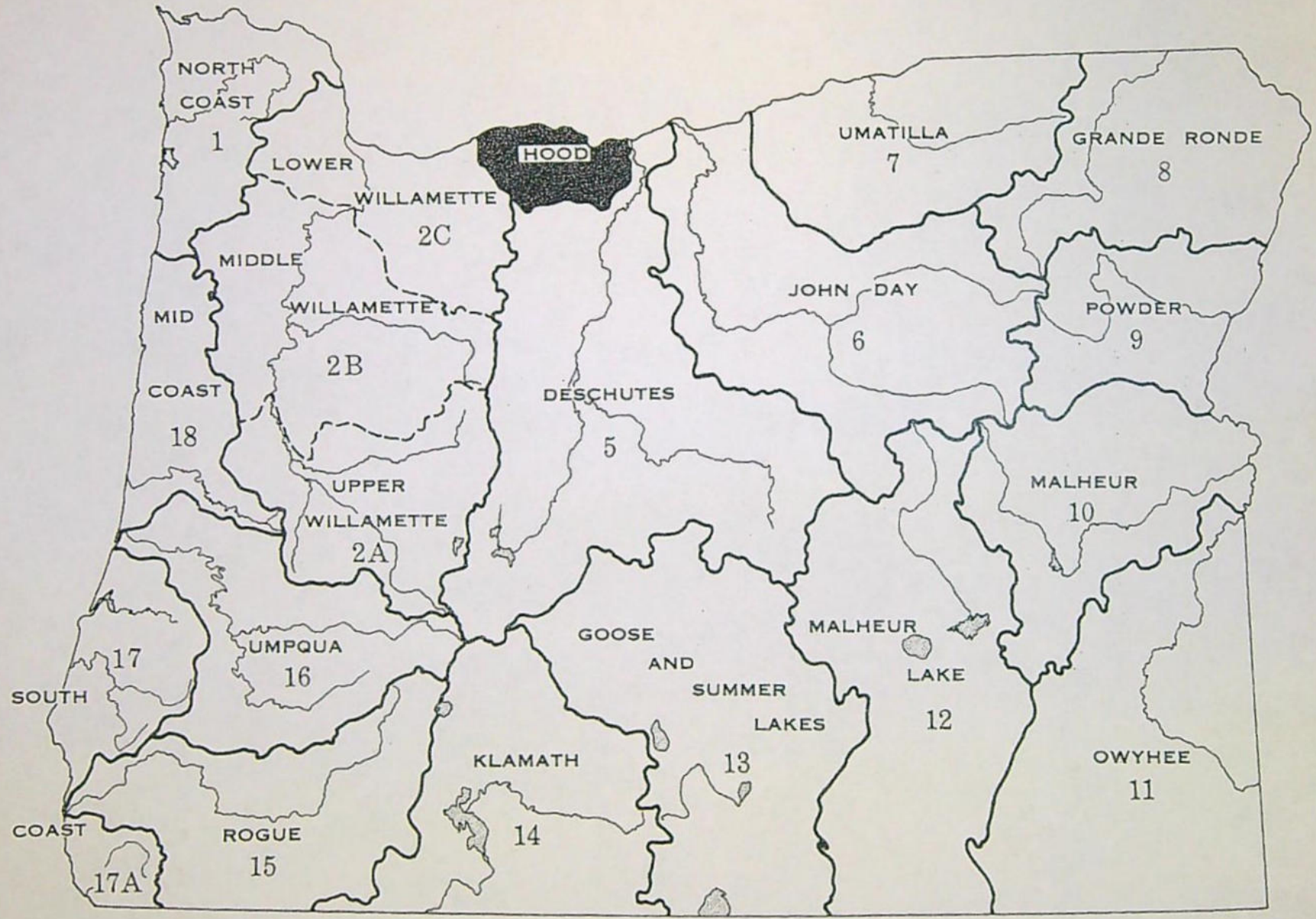
INTRODUCTION

The Oregon State Game Commission report entitled, "The Fish and Wildlife Resources of the Hood Basin, Oregon, and Their Water Use Requirements" and this supplement to that report are designed to assist the State Water Resources Board with the programming of Oregon's water resources. This supplement provides some economic and recreational considerations of the basin's fish and wildlife resources and updates sections of the original report. No data are presented on the Columbia River which borders the Hood Basin.

The Fish Commission of Oregon concurs with the flow recommendations for fish life. Recommendations were also made for recreational and esthetic uses of water not directly related to fish and wildlife water requirements.

Important contributions to the report were made by Game Commission district biologists Allan B. Lichens and William E. Olson. Editing reviews were made by William E. Pitney and Kenneth E. Thompson, Environmental Management Section.

Fig. I. Oregon drainage basins.



EXPLANATION OF DATA

Inasmuch as ORS 536.310 (7) directs the State Water Resources Board to consider "The maintenance of minimum perennial stream flows sufficient to support aquatic life...", minimum flows have been recommended which would support a reasonable level of fish production (App. 1). In addition, optimum flow recommendations are presented which are designed to satisfy all currently understood aspects of fish production (App. 2, Fig. 3).

The recommended stream flow quantities are principally designed to accommodate the environmental requirements of salmonids because these fish receive management emphasis in the Hood Basin. Summer flow requirements of anadromous fish and resident trout are essentially the same, but the larger anadromous fish need more water during periods of migration and spawning (Fig. 2).

The minimum flow recommendations for Hood River below Powerdale Dam are the result of a unique study involving Pacific Power & Light Company, Oregon Game Commission, and the Fish Commission of Oregon (App. 1). The study field-work took place in 1964-66 and involved fishery biologists from the three agencies. An agreement was reached in 1971 for minimum flow releases below Powerdale Dam and improvement of fishways.

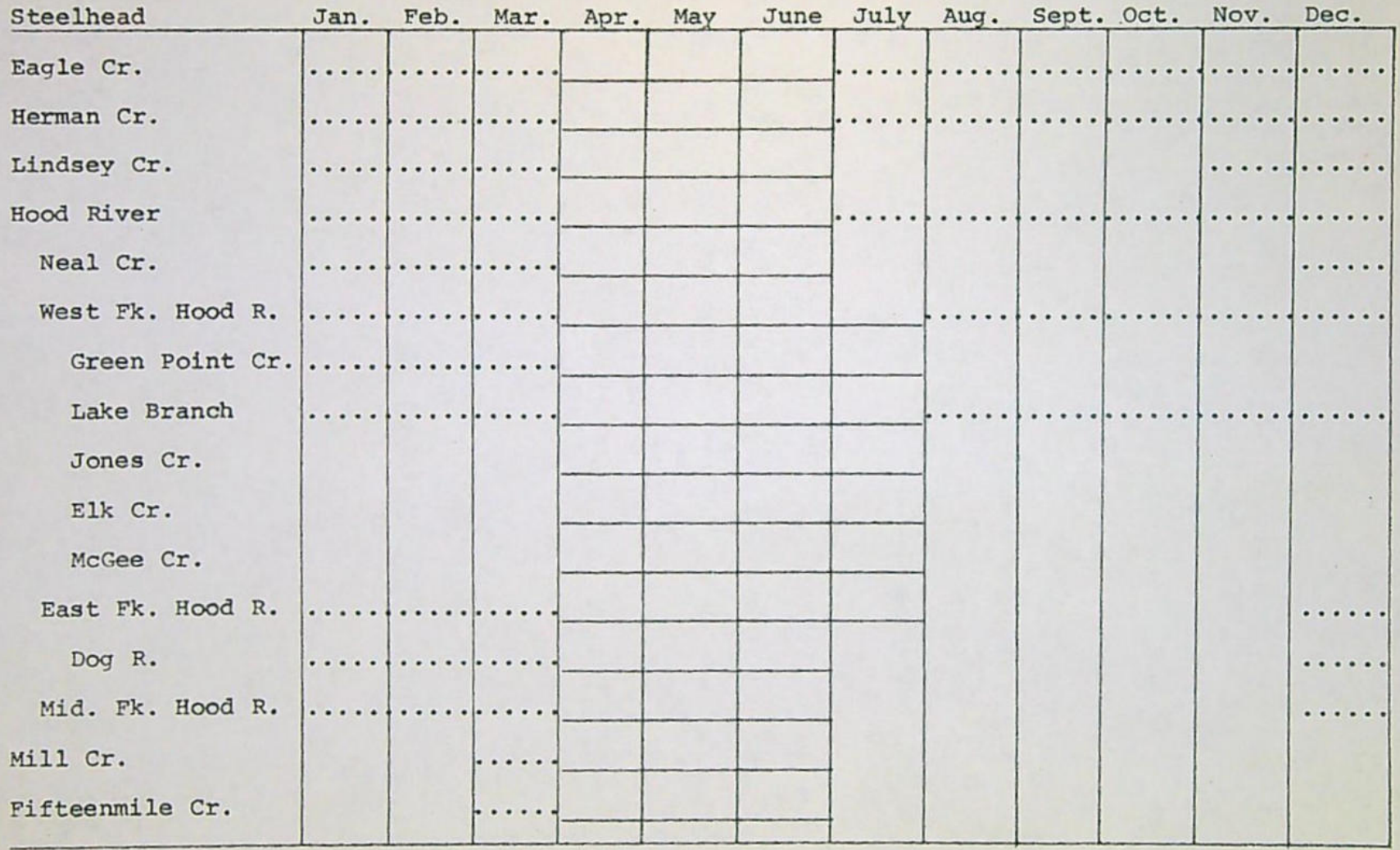


Fig. 2. Periodicity chart for adult anadromous salmonids, Hood Basin (dotted lines indicate presence in streams and solid lines indicate spawning periods).

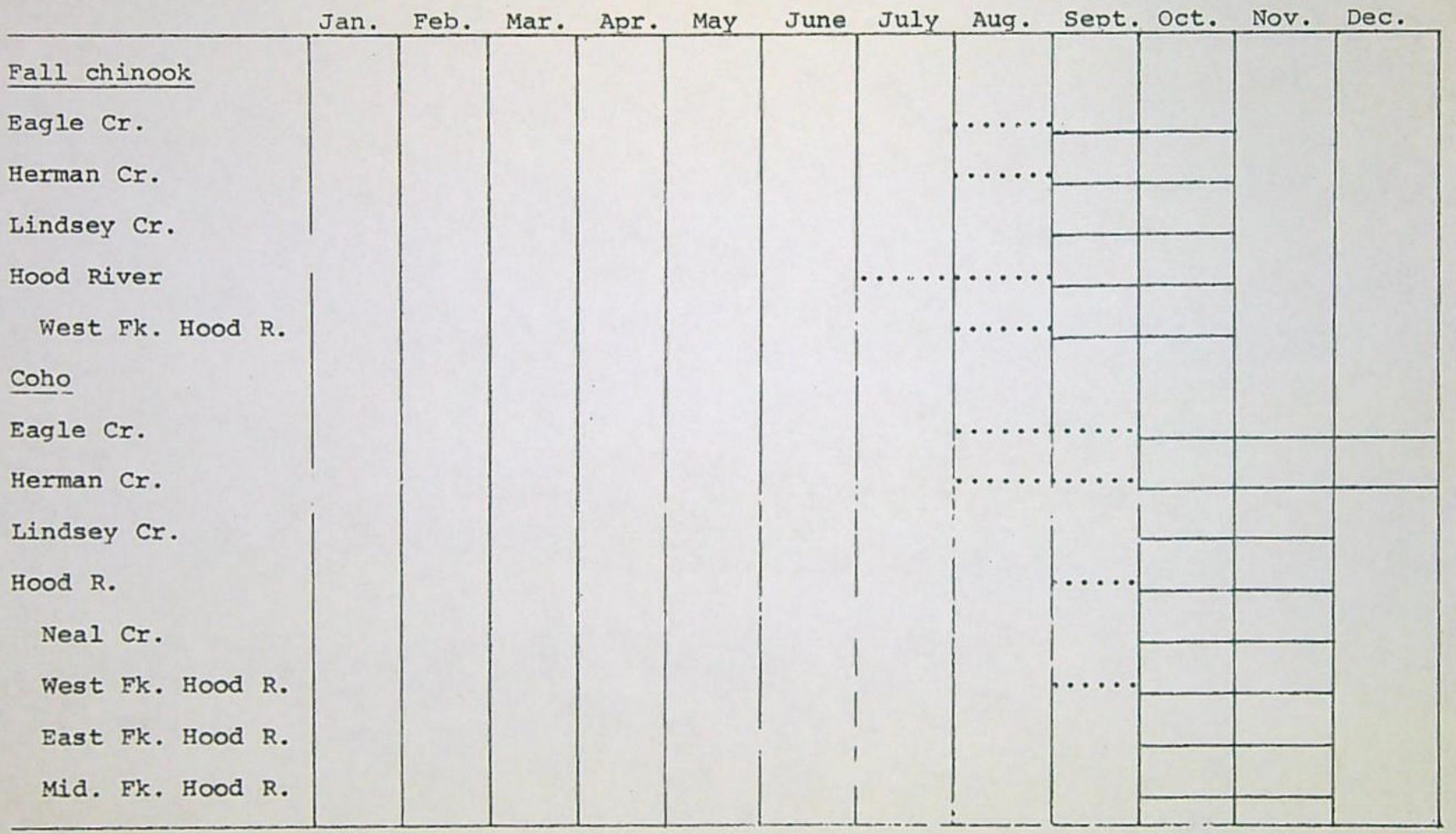


Fig. 2. (continued)

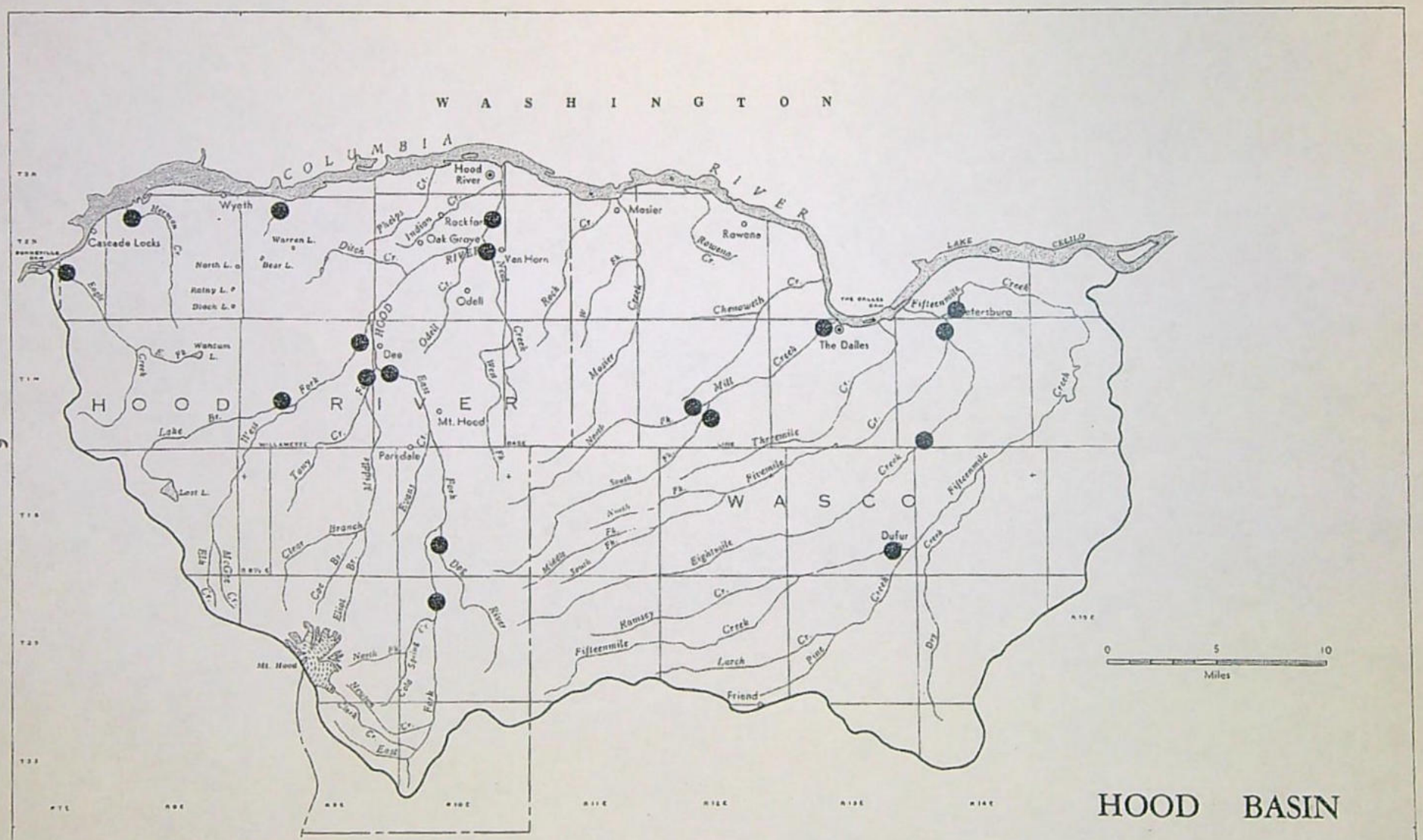


Fig. 3. Location of flow recommendations for fish life, Hood Basin.

The recommended flow regimen, although based on all biological requirements currently understood, do not consider two signficant effects of natural stream flows. High flows are generally believed necessary to stimulate upstream migrations of adult salmon and steelhead and to flush out sediments which settle into the gravel during low discharge periods.

The 1966 State Water Resources Board program for the Hood Basin included only three streams (Hood River, West Fork Hood River and East Fork Hood River) for minimum flow protection of fish. However, there are at least 23 streams in the basin with anadromous fish (Fig. 4 and 5). The Game Commission recommends that minimum flows be established for 15 streams (App. 1). Some, especially those in Wasco County, are overappropriated. An effort should be made to protect the remaining unappropriated water and to make existing water use more efficient. A combination of protecting unappropriated water and more efficient use of the currently appropriated water will help guarantee a continuing fish and wildlife resource. In addition, constructing reservoirs designed to store excess winter and spring run-off and releasing it during the summer could help alleviate water shortage problems (App. 5).

Spawning escapement estimates of anadromous salmonids are presented in Table 1. Detailed distribution of steelhead

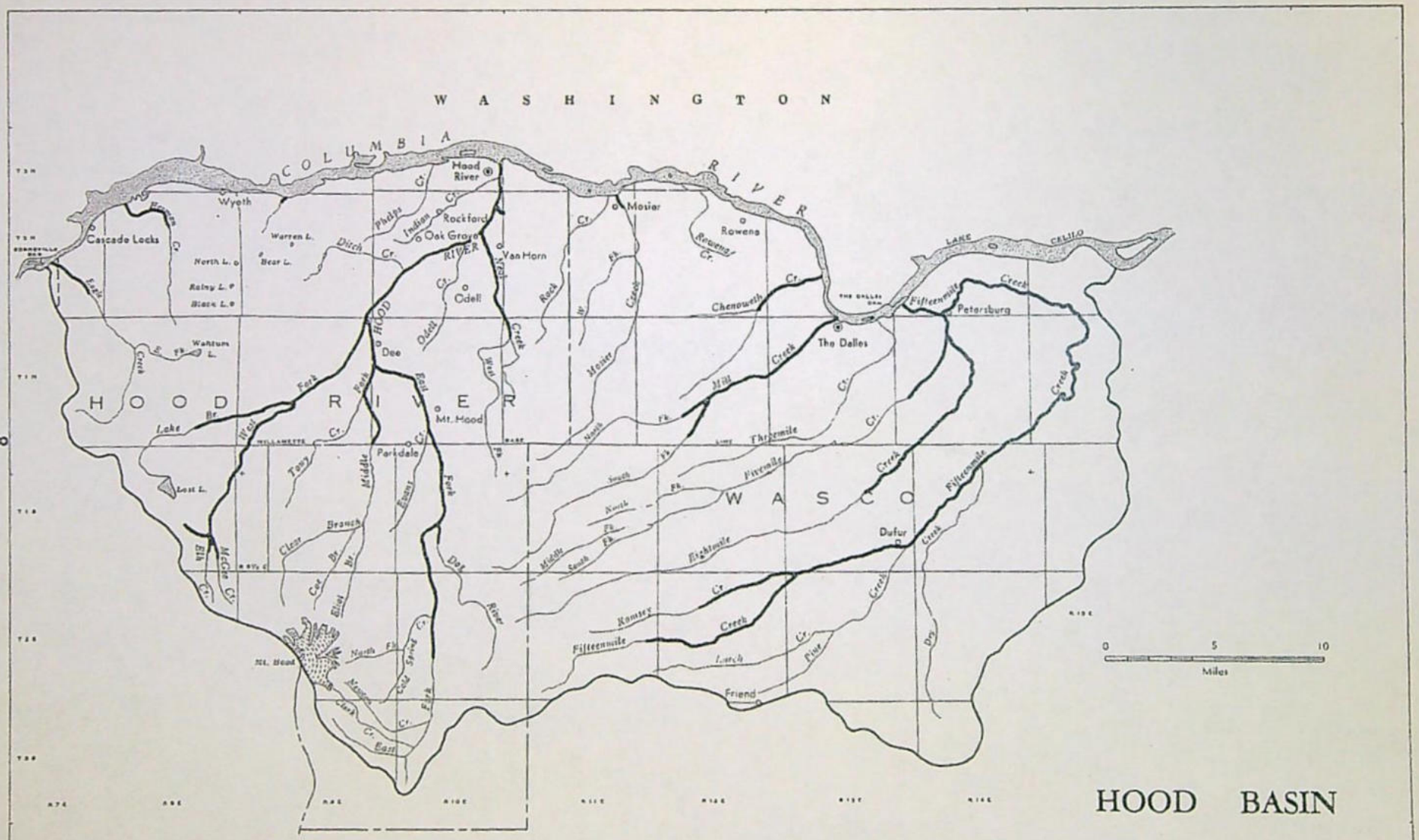


Fig. 4. Summer and winter steelhead distribution, Hood Basin.

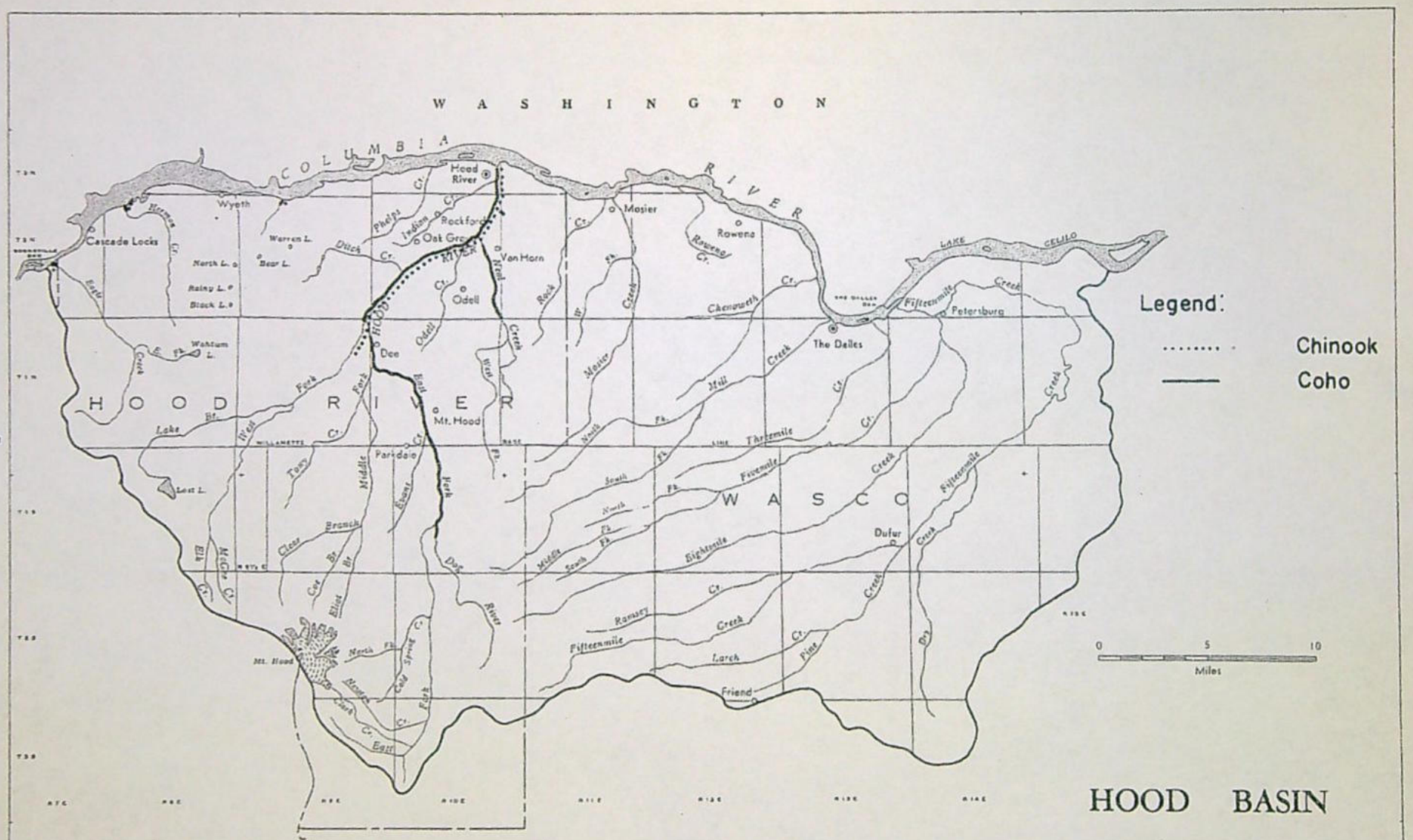


Fig. 5. chinook and coho salmon distribution, Hood Basin.

and salmon is shown in Figures 4 and 5. There probably are remnant runs of spring chinook and sockeye salmon in Hood River.

The importance of angling and hunting is reflected in Tables 2 and 3. Fur harvest value appears in Table 4.

More people with more leisure time will greatly increase future angling pressure. A three-fold increase in license sales is expected in the next 30 years. Stream flow levels are vital not only for maintaining desirable fish populations, but also to provide proper water conditions for angling. Consequently, the Game Commission has developed angling flow recommendations which could help accommodate the growing demand for more sport fishing opportunities (App. 3).

One indication of the intensity of recreational usage is shown by use figures of parks, waysides and campgrounds furnished by Oregon Division of Highways, Hood River County and U. S. Forest Service. These areas within the basin received over 930,000 day-visits in 1971. Many visits are directly related to fish and wildlife or water-based recreation. Therefore, adequate stream flows and lake levels which contribute significantly to the maintenance of aquatic life and esthetic appeal must be protected to assure these values (App. 4).

Table 1. Estimated number of anadromous salmonids spawning in Hood Basin streams 1/

Stream system	Salmon		Steelhead		Sea-run cutthroat trout
	Fall chinook	Coho	Winter	Summer	
Eagle Creek	1,000	3,000	1,480	0	0
Herman Creek	500	250	Present	0	0
Lindsey Creek	100	200	Present	0	0
Hood River (Main stem and unlisted tributaries)	220	1,158	561	75	96
West Fork Hood R.	0	14	50	485	0
East Fork Hood R.	0	96	246	0	0
Middle Fork Hood R.	0	34	100	0	0
Hood River system total	220	1,302	957	560	96
Mill Creek	0	0	200	0	0
Fifteenmile Creek	0	0	550	0	0
GRAND TOTAL	1,820	4,752	3,187	560	96

1/ Estimates by Game Commission biologists.

The numbers indicate spawning escapement. The total run would be computed by adding appropriate sport, commercial and Indian harvest figures.

Estimates include hatchery contributions.

Table 2. Estimated annual harvest, angler-days and gross expenditures for angling, Hood Basin (App. 6) 1/

Area	Harvest	Angler-days	Gross Expenditures
Hood River system			
Salmon	50	250	$ 3,700
Steelhead	2,039	10,195	150,886
Other Columbia R. tributaries			
Salmon	0	0	
Steelhead	110	450	8,140
Entire basin			
Resident trout	128,489	78,045	491,684
Warm-water game fish	70,200	14,040	88,452
TOTAL			$ 742,862

1/ Hood Basin produced salmon are caught in the ocean and Columbia River. Steelhead are caught in the Columbia River. The number and value of these fish are presently impossible to determine.

Table 3. Estimated annual harvest, hunter-days and gross expenditures for hunting, Hood Basin, 1970-71 (App. 6)

	1970			1971 1/		
Species	Hunter-days	Harvest	Gross Expenditures	Hunter-days	Harvest	Gross Expenditures
Deer	18,957	812	$ 564,919	---	532	---
Elk	4,025	46	107,065	4,120	43	$ 109,592
Bear	1,697	18	56,001	---	---	---
Pheasant	11,926	6,924	71,556	6,585	4,793	39,510
Quail	3,030	3,308	18,180	1,666	2,272	9,996
Chukar	2,442	3,595	14,652	1,358	1,925	8,148
Hungarian partridge	980	520	5,880	545	325	3,270
Grouse	1,467	1,110	8,802	816	610	4,896
Dove	2,654	7,224	15,924	---	4,216	---
Pigeon	669	358	4,014	---	---	---
Turkey	1,222	109	7,332	742	56	4,452
Duck	5,354	3,114	42,832	---	1,312	---
Goose	3,465	839	27,720	---	323	---
Squirrel	1,963	1,656	11,778	1,022	800	6,132
Coyote	205	77	1,230	---	---	---
Bobcat	175	53	2,450	---	---	---
TOTAL			$ 960,335			

1/ Data incomplete for 1971.

Table 4. Estimated furbearer harvest and value to trapper, Hood Basin, 1970-71 and 1971-72

	1970-71		1971-72	
Species	Harvest	Value	Harvest	Value
Beaver	45	$ 428	77	$ 1,070
Otter	2	47	8	255
Mink	7	23	19	94
Muskrat	45	41	99	126
Raccoon	22	44	34	128
Marten	1	6	0	0
Skunk	1	1	1	1
Weasel	0	0	2	1
Wildcat	5	68	8	168
Coyote	28	194	1	9
TOTAL	156	$ 852	249	$ 1,852

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Oregon State Game Commission. 1963.
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Hood Basin. Salem. 114 p. and app.

State Water Resources Board of Oregon. 1966.
Hood Basin program (mimeo).

Appendix 1. Recommended minimum stream flows for fish life, Hood Basin 1/

Stream	Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Eagle Creek	Above hatchery dam intake	47	47	47	70	70	70	47	56	84	84	70	70
Herman Creek	Mouth	40	40	40	60	60	60	40	48	72	72	60	60
Lindsey Creek	Mouth	15	15	15	20	20	20	15	15	24	24	20	15
Hood River 2/	Below Powerdale Dam	170	270	270	270	170	170	130	100	100	100	100	170
Neal Creek	Mouth	13	13	13	20	20	20	13	13	5	20	20	13
West Fork Hood River	USGS Gage 14-1185	100	100	100	150	150	150	100	120	180	180	150	120
Lake Branch	Mouth	67	67	67	100	100	100	100	67	67	67	67	67
East Fork Hood River	Above Middle Fk. Hood R.	100	100	100	150	150	150	150	100	100	150	150	150
East Fork Hood River	Above Pollalie Creek	50	50	50	75	75	75	75	50	50	40	40	50
Dog River	Mouth	8	8	8	12	12	12	8	8	4	12	12	8
Middle Fork Hood River	Mouth	100	100	100	150	150	150	100	100	40	150	150	100
Mill Creek	Mouth	4	4	10	15	15	15	10	10	4	4	4	4
North Fork Mill Creek	Mouth	2	2	5	7	7	7	5	5	2	2	2	2
South Fork Mill Creek	Mouth	2	2	7	10	10	10	7	7	2	2	2	2
Fifteenmile Creek	Above Eightmile Creek	4	4	13	20	20	20	13	13	4	4	4	4
Fifteenmile Creek	Dufur	2	2	10	15	15	15	10	10	2	2	2	2
Eightmile Creek	Mouth	2	2	10	15	15	15	10	10	2	2	2	2
Eightmile Creek	Highway 197	2	2	7	10	10	10	7	7	2	2	2	2

1/ Flows are expressed in cubic feet per second. Recommended flows should arrive at the point of recommendation and continue to the mouth or to the next point for which a different flow is recommended. Recommended minimum flows are designed to provide instream conditions capable of maintaining a minimum desirable level of fish production. No consideration is given to beneficial impacts of winter freshets. The recommended flows may not be desirable flow releases below future impoundments. Recommended reservoir releases for fish would require further investigation. These recommendations supersede interim minimum flow recommendations dated January 20, 1965.

2/ These minimum flow releases were agreed upon in 1971 by Pacific Power & Light Company, Oregon Game Commission, Fish Commission of Oregon and National Marine Fisheries Service.

Appendix 2. Recommended optimum stream flows for fish life, Hood Basin 1/

Stream	Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Eagle Creek	Above hatchery dam intake	70	70	70	120	120	120	70	84	143	143	120	120
Herman Creek	Mouth	60	60	60	102	102	102	60	72	122	122	102	72
Lindsey Creek	Mouth	20	20	20	34	34	34	20	20	41	41	34	20
Hood River	Below Powerdale Dam	270	270	270	460	460	460	325	325	552	552	460	325
Neal Creek	Mouth	20	20	20	34	34	34	20	20	13	34	34	20
West Fork Hood River	USGS Gage 14-1185	150	150	150	255	255	255	150	180	306	306	255	180
Lake Branch	Mouth	67	67	67	170	170	170	170	100	100	100	67	67
East Fork Hood River	Above Middle Fork Hood R.	150	150	150	255	255	255	255	150	150	255	255	255
East Fork Hood River	Above Pollalie Creek	75	75	75	127	127	127	127	75	75	50	50	75
Dog River	Mouth	12	12	12	20	20	20	12	12	8	20	20	12
Middle Fork Hood River	Mouth	150	150	150	255	255	255	150	150	100	255	255	150
Mill Creek	Mouth	10	10	15	26	26	26	15	15	10	10	10	10
North Fork Mill Creek	Mouth	5	5	7	12	12	12	7	7	5	5	5	5
South Fork Mill Creek	Mouth	7	7	10	17	17	17	10	10	7	7	7	7
Fifteenmile Creek	Above Eightmile Creek	13	13	20	34	34	34	20	20	13	13	13	13
Fifteenmile Creek	Dufur	10	10	15	26	26	26	15	15	10	10	10	10
Eightmile Creek	Mouth	10	10	15	26	26	26	15	15	10	10	10	10
Eightmile Creek	Highway 197	7	7	10	17	17	17	10	10	7	7	7	7

1/ Flows are expressed in cubic feet per second. Recommended flows should arrive at the point of recommendation and continue to the mouth, or to the next point for which a different flow is recommended. Recommended optimum flows are designed to provide instream conditions capable of maintaining an optimum level of fish production. No consideration is given to beneficial impacts of winter freshets.

Appendix 3. Recommended angling flows for selected Hood Basin streams 1/ 2/

Stream	April-October	November-March
Eagle Creek	30	75
Herman Creek	25	
Hood River	300	300
East Fork Hood River (at mouth)	100	200
" " " " (above Pollalie Cr.)	75	
West Fork Hood River	200	
Lake Branch	60	
Middle Fork Hood River	50	
Mosier Creek	15	
Mill Creek	15	
Fifteenmile Creek	30	60

1/ Flows are expressed in cubic feet per second.

2/ Flows are to reach the mouth of the stream or to the next point of recommendation.

Appendix 4. Selected Hood Basin streams that should be protected for their esthetic value

Stream	Section
Eagle Creek	Above the hatchery
Hood River	Above river mile 4
West Fork Hood River	Entire
Lake Branch	Entire
Middle Fork Hood River	Above river mile 4
South Fork Mill Creek	Above river mile 1

Appendix 5. Reservoir sites presently thought compatible with fish and wildlife, Hood Basin 1/

Stream	River system	Location
Indian Creek	Hood	T 2 N, R 10 E, Sec. 2
"	"	" " Sec. 3
"	"	" " Sec. 17
Neal Creek	"	T 1 N, R 11 E, Sec. 7
"	"	T 1 N, R 10 E, Sec. 11
Mosier Creek	Columbia	T 2 N, R 12 E, Sec. 31
Chenoweth Creek	Columbia	T 2 N, R 12 E, Sec. 36
Jap Hollow	Fifteenmile	T 1 N, R 14 E, Sec. 31
Dry Creek	"	T 1 S, R 14 E, Sec. 10
"	"	" " Sec. 21
"	"	" " Sec. 20
"	"	T 2 S, R 14 E, Sec. 7
Mays Canyon Creek	"	T 2 S, R 13 E, Sec. 1
Pine Creek	"	T 2 S, R 13 E, Sec. 15
Larch Creek	"	T 2 S, R 13 E, Sec. 19
"	"	T 2 S, R 12 E, Sec. 28

1/ Detailed studies should be conducted to determine total impact on fish and wildlife before any of the above sites are considered for development.

Appendix 6. Values used in Tables 2 and 3

Species	Gross Expenditure
Salmon and steelhead	$74.00 per fish harvested
Trout and warm-water game fish	6.30 per angler-day
Mule deer	29.80 per hunter-day
Roosevelt elk	26.60 " " "
Black bear	33.00 " " "
Bobcat	14.00 " " "
Coyote	6.00 " " "
Upland game	6.00 " " "
Waterfowl	8.00 " " "