United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
620 SW Main Street, Suite 201
Portland, Oregon 97205-3026

9043.1
IN REPLY REFER TO:
ER14/0467

Electronically Filed

October 23, 2014

William W. Stelle, Jr.
Regional Administrator
National Marine Fisheries Service, West Coast Region
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE, Building 1
Seattle, WA 98115-0070

Dear Mr. Stelle:

The Department of the Interior (Department) has reviewed the Draft Environmental Impact Statement on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs, Washington. The Department has no comments on the document at this time.

We appreciate the opportunity to comment.

Sincerely

Allison O'Brien
Regional Environmental Officer

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
ECOSYSTEMS,
TRIBAL AND PUBLIC
AFFAIRS

January 23, 2015

William W. Stelle, Jr.
Regional Administrator
National Marine Fisheries Service, West Coast Region
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE, Building 1
Seattle, Washington 98115-0070

Re: EPA comments on the Draft Environmental Impact Statement (DEIS) on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs. EPA Project Number: 04-033-NOA.

Dear Mr. Stelle:

We have reviewed the July, 2014 National Marine Fisheries Service (NMFS) Draft Environmental Impact Statement on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs (DEIS). Our review was conducted in accordance with the EPA's responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act. Section 309 specifically directs the EPA to review and comment in writing on the environmental impacts associated with all major federal actions. Our review of the draft FR/EIS considers the expected environmental impacts of the proposed action and the adequacy of the EIS in meeting the procedural and public disclosure requirements of NEPA.

Project summary
The DEIS informs NMFS, hatchery operators, and the public about the current and anticipated direct, indirect, and cumulative environmental effects of operating Puget Sound salmon and steelhead hatchery programs under a range of alternatives.

Under the Proposed Action, NMFS would evaluate two proposed Puget Sound hatchery Resource Management Plans (RMPs) and 117 Hatchery Genetic Management Plans (HGMPs) for Endangered Species Act (ESA) compliance. The two RMPs and HGMPs would be implemented by the co-managers: the Washington Department of Fish and Wildlife and Puget Sound Treaty Tribes.

NMFS' purpose for the Proposed Action is to ensure the sustainability and recovery of Puget Sound salmon and steelhead by conserving the productivity, abundance, diversity, and distribution of listed species of salmon and steelhead in Puget Sound. NMFS' need for the Proposed Action is to respond to the request of the co-managers for an exemption from the take prohibitions of section 9 of the ESA for their hatchery program proposals; and to provide appropriate tribal and non-tribal fishing opportunities.

The DEIS analyzes four alternatives: Alternative 1 (No Action), Alternative 2 (Proposed Action), Alternative 3 (Reduced Production), and Alternative 4 (Increased Production). Under No Action, the DEIS assumes that hatchery production would continue at current levels and proposed adaptive management provisions would not be applied. The Proposed Action would maintain current hatchery production. Alternative 3, Reduced Production, would provide greater conservation benefits to salmon and steelhead by reducing hatchery production for the purpose of harvest in select watersheds by 50 percent. Alternative 4, Increased Production, would provide more harvest benefits by increasing production where facility and funding capacity exists. The DEIS assumes that adaptive management conservation measures would be applied under all of the action alternatives.

Responsiveness to scoping comments

In our August 29, 2011 scoping comments we recommended that the DEIS include: discussion of how the co-managers' proposals support NMFS' ESA goals, and the relationship with recovery plans; discussion of the co-managers' objectives and how they relate to an overall strategy to promote viable salmonid populations; a strategic prioritization of salmon production programs that will provide harvest fish for Tribes and promote ESA salmon recovery; demonstration of how Clean Water Act requirements would be met, including consideration of effluent limits and National Pollutant Discharge Elimination System (NPDES) permit requirements; consideration of temporary hatcheries in strategic locations; and, information on habitat protection/restoration. The DEIS is responsive to all of our 2011 scoping recommendations.

Our comments below identify our primary environmental concern with the Proposed Action, and detail additional information which we believe NMFS' should consider including in the EIS.

Environmental concerns – Increased Production Alternative

While we appreciate that all of the action alternatives would increase the likelihood that adaptive management mitigation measures would be implemented over the long-term, we are concerned that Alternative 4's shorter term and more direct impact would be to increase hatchery-related detrimental effects on natural populations. Alternative 4, as proposed, would cause environmental impacts that should be avoided in order to fully protect the environment.

Framing the Alternatives

We are concerned that the EIS does not provide sufficient examples or rationale to support the No Action alternative's key assumption that "...hatchery adaptive management processes may not be similar to what is described in the RMPs and HGMPs...that the watershed management strategies by recovery category and the formal adaptive management process would not be in place..."[1]

To more sufficiently support this key assumption, consider including an example or examples of how hatchery adaptive management processes are not currently or have not been similar to what is described in the RMPs and HGMPs.

We are also concerned that the EIS does not sufficiently explain why, "NMFS cannot make any assumption about alternative permitting processes, potential litigation, or possible enforcement actions

[1] DEIS, p. 2-18

that could occur if NMFS fails to approve the RMPs under Limit 6 of the ESA 4(d) rule."[2] While we appreciate that NMFS cannot go into hypotheticals, we believe additional explanation would be helpful.

Consider including in the EIS information on how, absent assumptions about litigation or enforcement, NMFS believes granting ESA assurances ensures full implementation of the RMPs and their adaptive management framework.

Range of alternatives

We are concerned that the Increased Production Alternative would increase overall hatchery production by 16 percent, while the Reduced Production Alternative would decrease overall hatchery production by only 8 percent. While we agree that an 8 percent reduction in hatchery production is a useful amount for analysis and the decision maker, we believe an alternative with further reductions may provide a clearer basis for choice among options. For example, an alternative with further reductions than the Reduced Production Alternative could change a "Moderate" rating for overall hatchery-related risk to the Puget Sound Chinook Salmon ESU to a "Low" rating. Getting to a "Low" overall risk rating would differentiate a new alternative because all of the current DEIS alternatives' ratings are "Moderate" for overall hatchery-related risk to the Puget Sound Chinook Salmon ESU.

Relationship between the ESA and the NEPA

We believe that the EIS would benefit from additional clarifying information on how the ESA and the NEPA processes align. Consider including a flowchart or table which shows the sequencing of past and future process steps for NMFS' NEPA compliance, ESA Section 4(d), and ESA Section 7 work on Puget Sound Salmon and Steelhead hatchery programs.

The EIS's ESA and NEPA process chart, table or other information should highlight the sequence of key past and future process relationships, including that the NEPA Record of Decision (ROD) will be completed only after the ESA determinations for both RMPs and all 117 HGMPs are complete.

The chart, table or other process-related additional information should add details for when or at what stage future public review opportunities will occur, including at what stage(s) of the NEPA process will NMFS prepare and make available for comment Evaluation and Recommended Determination (ERD) documents. Will NMFS prepare and release ERDs before or after the Final EIS (FEIS)? If certain sequences are unknown or processes are wholly independent of one another, this information should be disclosed in the EIS.

The EIS should also more clearly describe whether NMFS will prepare and make available for public comment draft ESA decision documents for each of the 117 HGMPs or whether the RMP's ERDs will cover them as groups.

Water quality

We appreciate the DEIS's substantial water quality information, including Appendix J Water Quality and Regulatory Compliance for Puget Sound Hatchery Facilities. We have a few editorial comments for the FEIS's version of Appendix J.

Section 1.5 - Delete "Offline" from the last sentence, or, add "in-line". Settling basins can be either.

[2] DEIS, p. 2-18

Section 1.8 - Address whether Puget Sound hatcheries administer growth hormones, such as estradiol.

Section 2.1 - Note that NPDES permits expire after 5 years but are administratively extended until the permit is reissued. And, Washington State Department of Ecology has an upland fin-fish hatchery and rearing general permit which is currently in effect.

Section 2.1, p. J-9 - Delete "The use of hatchery treatment chemicals is closely regulated by EPA," It is true that there are reporting requirements, but the EPA does not currently require any monitoring or have permit levels for these chemicals. Also, there is no specific definition or supporting information for the phrase "closely regulated by EPA". In addition, the Food and Drug Administration approves various aquaculture drugs used in hatcheries, and, Washington State does not have water quality criteria for chemicals such as iodine and formaldehyde.

Adaptive management and mitigation measures

Implementation of changes to hatchery program actions

We appreciate and understand that, under the Proposed Action, the RMPs call for hatchery programs to evolve as needed in response to monitoring, research, and evaluation, conducted through the adaptive management process. We support this general approach and would like to highlight our support for several types of improvements in hatchery management, such as:

- changes in juvenile fish production;
- changes in release locations;
- increased use of locally adapted stocks and integrated production strategies;
- changes in marking and tagging recovery processes;
- facility improvements (water intake screen and weir improvements, pollution abatement systems, repair of rearing containers);
- reductions of hatchery-origin fish in natural spawning areas;
- construction of ponds to improve homing of hatchery-origin adults;
- revised co-manager fish health policies; and,
- increases in the proportion of natural-origin fish in hatchery broodstock.[3]

All of these changes have the potential to, as the DEIS repeatedly states, further reduce hatchery related risks and negative impacts and increase benefits.

In addition to describing mitigation measures generally, the DEIS references existing BMPs that are not currently in use at all hatchery operations as well as examples of updated and new BMPs, including many site-specific measures. We are especially interested in site-specific measures, as described throughout Appendices C, G, and H. Many of the appendices' site-specific measures appear to be just the kind of changes to hatchery programs - based on monitoring, research and evaluation - that the DEIS is depending upon for the assumption that adaptive management would further reduce hatchery related risks and negative impacts and increase benefits.

The DEIS does not, however, sufficiently describe how Appendix C, G and H's site-specific mitigation measures would be implemented under the Proposed Action. Does NMFS plan to include them as a kind of checklist when granting ESA assurances to specific HGMPs? Is there a timeframe over which the co-managers' should be considering or implementing them?

[3] DEIS, p. 2-14

Additional information on how site-specific mitigation will be implemented is important because, without the implementation of proposed or similar mitigation measures, hatchery-related competition, predation, and genetics risks to - for example, the Puget Sound Chinook Salmon ESU - remain moderate or high for all alternatives.[4]

Develop more efficient fisheries
We appreciate the potential mitigation measure, "Develop more efficient fisheries", because it reduces genetic and competition risks and increases socioeconomic and environmental justice harvest benefits.

We are unsure, however, how the Proposed Action itself would contribute to the development of more efficient fisheries. To add clarity for this potential mitigation measure, we recommend that the EIS include additional information on how evaluating the RMPs and granting ESA assurances would directly or indirectly contribute to the development of more efficient fisheries. We are particularly interested in how the Proposed Action could contribute to the development of more efficient fisheries with low potential for incidental harvest impacts to natural-origin fish.

Rating
We are rating the DEIS Environmental Concerns – Insufficient Information (EC-2). A copy of our rating system is enclosed. Our "EC" rating is based on our review of Alternative 4, the Increased Production Alternative. Alternative 4's increased hatchery production for the purposes of harvest would cause environmental impacts that should be avoided in order to fully protect the environment. Our "2" rating relates to our interest in:

- additional information on the No Action alternative's assumption that adaptive management 'may not be similar';
- consideration of a new alternative with further reductions for hatchery production;
- a flowchart or table addressing ESA and NEPA sequencing;
- additional information on the process for considering and potentially implementing site-specific mitigation measures from DEIS Appendix C; and,
- additional information on the "Develop more efficient fisheries" mitigation measure.

Thank you for this opportunity to comment and if you have any questions, please contact me at (206) 553-1601 or by electronic mail at reichgott.christine@epa.gov, or Erik Peterson, the lead reviewer for this project. Erik can be reached at (206) 553-6382 or peterson.erik@epa.gov.

Sincerely,

Christine B. Reichgott

Christine Reichgott, Unit Manager
Environmental Review and Sediment Management Unit

Enclosure:
1. EPA Rating System for Draft Environmental Impact Statements

[4] DEIS, Table C-174

U.S. Environmental Protection Agency Rating System for
Draft Environmental Impact Statements
Definitions and Follow-Up Action*

Environmental Impact of the Action

LO – Lack of Objections

The U.S. Environmental Protection Agency (EPA) review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC – Environmental Concerns

EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce these impacts.

EO – Environmental Objections

EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU – Environmentally Unsatisfactory

EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

Adequacy of the Impact Statement

Category 1 – Adequate

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2 – Insufficient Information

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses or discussion should be included in the final EIS.

Category 3 – Inadequate

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the National Environmental Policy Act and or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment. February, 1987.

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Lower Elwha Klallam Tribe's Comments on Puget Sound Region Hatchery DEIS

1 message

Steve Suagee <steve.suagee@elwha.org> Fri, Jan 23, 2015 at 2:06 PM
To: "PSHatcheryEIS.wcr@noaa.gov" <PSHatcheryEIS.wcr@noaa.gov>
Cc: Doug Morrill <doug.morrill@elwha.org>

Dear NMFS:

Attached please find the comments of the Lower Elwha Klallam Tribe on NMFS's Puget Sound Hatchery DEIS, signed by the Tribe's Natural Resources Director Doug Morrill.

Thank you,

Steve Suagee

Stephen H. Suagee

Office of General Counsel

Lower Elwha Klallam Tribe

2851 Lower Elwha Road

Port Angeles, WA 98363

360-452-8471, ext. 7435—phone

360-452-3428—facsimile

360-461-2989—cell

steve.suagee@elwha.nsn.us

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Lower Elwha Comments on PS RMP DEIS-final-01-23-2015.pdf
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Lower Elwha Klallam Tribe

ʔəʔɬx̣ʷə nəxʷsƛ̓ay̓ əm *"The Strong People"*

2851 Lower Elwha Road **360.452.8471**
Port Angeles, WA 98363 **360.452.3428**

Via email to PSHatcheryEIS.wcr@noaa.gov

January 23, 2015

William W. Stelle
Regional Administrator
National Marine Fisheries Service, West Coast Region
7600 Sand Point Way NE, Building 1
Seattle, WA 98115-0070

Dear Mr. Stelle:

The Lower Elwha Klallam Tribe operates four conservation-based hatchery programs for native Elwha River steelhead and coho, pink, and chum salmon pursuant to Hatchery and Genetic Management Plans (HGMPs) approved by the National Marine Fisheries Service (NMFS). NMFS initially approved these resource management plans under Limit 6 of the 4(d) Rule on December 11, 2012, and the agency affirmed its approval on January 9, 2015. For up-to-date descriptions and analyses of the Tribe's programs, please consult the following NMFS documents:

- *Supplemental Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service Determination that Five Hatchery Programs for Elwha River Salmon and Steelhead as Described in Joint State-Tribal Hatchery and Genetic Management Plans and One Tribal Harvest Plan Satisfy the Endangered Species Act Section 4(d) Rule* (December 2014) [hereinafter "Supplemental EA"];
- *Endangered Species Act (ESA) Section 7 Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Reinitiated Consultation on Elwha Channel Hatchery Summer/Fall Chinook Salmon Fingerling and Yearling, Lower Elwha Fish Hatchery Steelhead, Lower Elwha Fish Hatchery Coho Salmon, Lower Elwha Fish Hatchery Fall Chum Salmon, and Elwha River Odd and Even Year Pink Salmon Programs* (December 15, 2014) [hereinafter "Reinitiated Consultation BiOp"];

- *4(d) Rule Limit 6 Evaluation and Recommended Determination for Joint Hatchery and Genetic Management Plans for Elwha Channel Hatchery Elwha River Summer/Fall Chinook Fingerlings and Yearlings, Lower Elwha Fish Hatchery Native Steelhead, Lower Elwha Fish Hatchery Coho Salmon, Lower Elwha Fish Hatchery Fall Chum Salmon, and Elwha River Odd and Even Year Pink Salmon* (January 8, 2015) [hereinafter "4(d) Approval"]; and
- *Decision Memorandum for Joint State/Tribal Hatchery and Genetic Management Plans Submitted by the Lower Elwha Klallam Tribe and the Washington Department of Fish and Wildlife for Chinook, Coho, Fall Chum and Pink Salmon, and Steelhead Production in the Elwha River, Washington, Under Limit 6 of the Endangered Species Act 4(d) Rule"* (January 9, 2015).

Because the Tribe's approved programs have already undergone full analysis under both the National Environmental Policy Act and the Endangered Species Act, they are not part of the proposed action in the July 2014 *Draft Environmental Impact Statement on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs* (July 2014) [hereinafter "DEIS"]. *E.g.*, DEIS at 1-3, 1-35, C-260, H-105. Notwithstanding this fact, the DEIS includes descriptions of the Tribe's programs at various points in the analysis, and this letter is intended to identify and correct inaccuracies in those descriptions. In order to ensure continuity and accuracy in NMFS's analyses and to avoid confusion to the public, we request that the following statements be corrected.

DEIS Page #s	*Inaccurate Statement in DEIS*	*Correction and Citation*
3-180 (Table 3-37), 3-189, A-9 (Table A-3), I-35	Misstates the native Elwha coho salmon program's type and purpose	The Lower Elwha coho program is an integrated recovery program, and its program purpose is conservation. *e.g.*, Coho Salmon HGMP, p. 3; Supplemental EA, pp. 3, 24
A-9 (Table A-3), D-28, D-95, H-103	Misstates release dates for native Elwha coho salmon	Coho salmon are released from the hatchery based on smolt readiness to maximize survival and minimize risk to river-born salmon and steelhead, typically beginning in March or April. *e.g.*, Coho Salmon HGMP, p. 28-29; Reinitiated Consultation BiOp, pp. 21-22
A-6 (Table A-2), C-252, C-254	Misstates release dates for native Elwha steelhead	Steelhead are released from the hatchery based on smolt readiness to maximize survival and minimize risk to river-born salmon and

		steelhead, typically beginning in April. *e.g.*, Steelhead HGMP, p. 28; Reinitiated Consultation BiOp, pp. 20-21
C-255	References in-river weir that has been abandoned due to river conditions	Use of the experimental in-river weir was discontinued after 2013 due to high flows and sediment levels in the mainstem river that hindered its effectiveness. Data the weir was intended to collect is now obtained using other methods, including DIDSON sonar. *e.g.*, Reinitiated Consultation BiOp, pp. 11-12
D-28, H-103	Misstates distance from release point at Lower Elwha Fish Hatchery to estuary confluence	The Lower Elwha Fish Hatchery is located at River Mile 1.25. *e.g.*, Coho Salmon HGMP, p. 3; 4(d) Approval, p. 51
D-95, D-99, H-102, I-35	Misstates native Elwha coho release numbers	Release levels of up to 425,000 native Elwha coho smolts have been approved by NMFS. *e.g.*, Coho HGMP, pp. 6, 8, 28; Supplemental EA, pp. 3, 20
I-38	Misstates native Elwha chum release level	Release levels of up to 450,000 native Elwha chum fry have been approved by NMFS for the preservation phase. *e.g.*, Chum HGMP, p. 23; Supplemental EA, p. 30
I-41	Misstates native Elwha steelhead program type	The native Elwha steelhead program is an integrated recovery program. *e.g.*, Steelhead HGMP, p. 3; Supplemental EA, p. 3
I-41	Misstates native Elwha steelhead release level	Release levels of up to 175,000 native Elwha steelhead smolts have been approved by NMFS. *e.g.*, Steelhead HGMP, pp. 5-7, 28; 4(d) Approval, p. 32

If you have any questions regarding this letter, please contact me at 360-457-4012 x7485 or doug.morrill@elwha.org. Thank you for your attention to this matter.

Sincerely,

Doug Morrill, Natural Resources Director
Lower Elwha Klallam Tribe

cc: Steve Suagee, Lower Elwha Klallam Tribe General Counsel

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Tulalip Tribes' Comments on DEIS Joint State and Tribal Resource Management Plans and NOAA Draft EA of Snohomish Basin Hatchery Programs

1 message

Libby Nelson <lnelson@tulaliptribes-nsn.gov> Fri, Jan 23, 2015 at 10:37 AM
To: "PSHatcheryEIS.wcr@noaa.gov" <PSHatcheryEIS.wcr@noaa.gov>
Cc: Ray Fryberg <rayfryberg@tulaliptribes-nsn.gov>, Terry Williams <TerryWilliams@tulaliptribes-nsn.gov>, "terrysuew@aol.com" <terrysuew@aol.com>, Tim Brewer <tbrewer@tulaliptribes-nsn.gov>, Daryl Williams <darylwilliams@tulaliptribes-nsn.gov>, Mike Crewson <mcrewson@tulaliptribes-nsn.gov>

Please see the attached comments from the Tulalip Tribes on the *Draft Environmental Impact Statement (DEIS) on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs*. Where the same concerns exist, we also include comments pertaining to the *Draft Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service Determination that Six Hatchery Programs for Snohomish River Basin Salmon as Described in Joint State-Tribal Hatchery and Genetic Management Plans Satisfy the Endangered Species Act Section 4(d) Rule*.

If you have any questions pertaining to these comments, please contact Mike Crewson, Tulalip Tribes, Salmon Enhancement Scientist, Cultural and Natural Resources Dept., 6406 Marine Drive, Tulalip, WA. 98271; (360) 716-4626; mcrewson@tulaliptribes-nsn.gov"

Tulalip Comments 1-23-2015.pdf
746K

THE TULALIP TRIBES

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Misty Napeahi- Tribal Government General Manager Interim

6406 Marine Dr.
Tulalip, WA 98271-9694
(360) 716-4000
FAX (360) 716-0628

The Tulalip Tribes are the successors in interest to the Snohomish, Snoqualmie, and Skykomish tribes and other tribes and band signatory to the Treaty of Point Elliott

January 23, 2015

William W. Stelle, Jr.
Northwest Regional Administrator
National Oceanic and Atmospheric Administration
Fisheries Service
7600 Sand Point Way NE
Seattle, WA 98115-0070

The Tulalip Tribes' appreciate the opportunity to review and submit the following comments on the *Draft Environmental Impact Statement (DEIS) on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs.* Where the same concerns exist, we also include comments pertaining to the *Draft Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service Determination that Six Hatchery Programs for Snohomish River Basin Salmon as Described in Joint State-Tribal Hatchery and Genetic Management Plans Satisfy the Endangered Species Act Section 4(d) Rule.* We greatly appreciate the efforts of NOAA Fisheries personnel for the extensive amount of work that has gone into these documents; particularly in evaluating 133 hatchery programs and associated hatchery and genetic management plans (HGMPs), even as state and tribal managers continue to incorporate more refined scientific tools and the best available scientific information to adapt and change these same hatchery programs. While it is our understanding that the State of Washington and the Puget Sound Treaty Tribes ("the comanagers") are withdrawing the two RMPs for Puget Sound Chinook salmon hatcheries and Puget Sound steelhead, coho, chum, sockeye and pink salmon hatcheries and the associated HGMPS for review and consideration under the 4(d) Rule that were submitted more than 10 years ago, and instead are requesting they be replaced with the revised joint resource management plans that are being submitted by the comanagers under Limit 6 of the 4(d) Rule on a watershed-specific basis, we are providing these edits and comments to help improve these documents because we feel confident that much of the analysis completed in the DEIS will prove useful in reviewing and completing environmental analyses for the watershed-specific management plans, providing us with an even stronger basis for enhancement that supports our wild stock recovery goals as well as or treaty reserved rights to fish.

While we can appreciate the incredible amount of work that has gone into these evaluations, we strongly feel that the approach being taken by NOAA Fisheries leaves out the most important principles and concepts that need to be articulated, understood, and included in the proposed alternatives. This does not comport with NEPA regulations, which require that alternatives analysis "Rigorously explore and objectively evaluate all reasonable alternatives and for alternatives which were eliminated from detailed study, discuss the reasons for their having been eliminated" (40 CFR 1502.14 ; CEQ 2012).

1. **The DEIS did not accurately reflect the relationship between the Federal Government's conservation mandate under the Endangered Species Act and its treaty trust responsibilities**

The National Marine Fisheries Service (NMFS) cites Secretarial Order 3206 as being a basis for both the DEIS and the *Draft* Snohomish salmon hatchery EA (hereafter "EA"), however, we believe NMFS policy opinion ignores crucial provisions of the Secretarial Order. Secretarial Order 3206 reflects the intent of the Departments of Interior and Commerce to strive "to ensure that Indian tribes do not bear a *disproportionate share of the conservation burden* for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation." The Order prescribes a process by which the Departments will assure that any conservation measures they believe should be applicable to treaty-reserved activities are consistent with the principles that have been established to assure that restrictions on treaty-reserved fisheries are both necessary and non-discriminatory. As stated in the Order, these principles are:

1) The restriction is reasonable and necessary for conservation of the species at issue;
2) The conservation purpose of the restriction cannot be achieved by reasonable regulation of non-Indian activities;
3) The measure is the least restrictive alternative available to achieve the required conservation purpose;
4) The restriction does not discriminate against Indian activities, either as stated or applied; and
5) Voluntary tribal measures are not adequate to achieve the necessary conservation purpose.

Rather than calling for the Departments to provide less protection for listed species than is required in the interest of providing limited treaty fishing opportunity, the Secretarial Order calls for the Departments to follow the above procedures, including reasonable regulation of non-Indian activities, before calling for restriction of treaty-secured activities.

As discussed in other sections of these comments, the EA and the DEIS fail to provide an adequate analysis of baseline and cumulative impacts of past, current and future habitat degradation, climate change, and the adequacy of regulatory effectiveness to reduce the risks to listed salmon from non-Indian sources. NMFS's opinion that it must allow increased risk to listed species to meet treaty rights is therefore not supported by any analyses and is not consistent with the principles of the Secretarial Order. It appears to assume in policy that NMFS is unable to achieve the conservation purpose by reasonable regulation of non-Indian activities. We strongly disagree with this assumption and approach.

As NMFS is aware, many Puget Sound hatcheries, including those in our region, were constructed to compensate for lost fish production due to the impacts of non-Indian habitat degradation on naturally-spawning salmon and steelhead.[1] Therefore, reductions in hatchery production must be preceded or accompanied by meaningful protection and restoration of habitat. These fish count as part of the tribes' treaty-secured allocation just as much as naturally-spawning fish. The EA and DEIS both provide alternatives that would reduce or eliminate hatchery production, resulting in fewer fish available for treaty harvest. The Snohomish region comanagers have already gone through great lengths to optimize and adjust regional hatchery production to meet bare minimum escapement and terminal area fishery goals, which have consistently not been met in recent years largely due to greatly reduced marine survival. The "reduced production" and "no production" alternatives in both the EA and DEIS are completely unacceptable to the Tulalip Tribes and without the habitat scenarios, they aren't compatible with NEPA mitigation requirements described in Section 6.9 Mitigation of WH-IAEWG (2009).

[1] *See United States v. Washington*, 759 F.2d 1353, 1360 (9th Cir. 1985)(en banc)(Phase II) (Hatchery programs have served a mitigating function since their inception in 1895 and are intended to replace naturally-spawning fish lost due to non-Indian habitat degradation). This perspective is completely absent from the DEIS historical discussion on page 1-21.

"Mitigation involves taking steps to avoid, minimize, rectify, reduce, eliminate, or compensate for the impact of an analyzed alternative (40 CFR 1508.20)." "Mitigation measures must cover the range of impacts of the analyzed alternatives, and such measures should be considered even for impacts that by themselves would not be considered "significant" (Question 19a, "CEQ's Forty Questions"). There is ample evidence that creation of salmon hatcheries in our region was closely-linked to loss of salmon habitat due to resource extraction after the Stevens Treaties opened this area to non-Indian settlement. In fact, the promise that hatcheries could replace natural production allowed society to be comfortable with large-scale destruction of salmonid-producing habitat due to logging, mining, and conversion of land to agricultural and residential uses (Lichatowich 1999, Nicholas 2010a, 2010b). While hatchery production did not live up to its promise of replacing natural production, it was certainly successful in enabling a huge loss of salmonid habitat. If there are valid reasons to reduce hatchery production today then there are equally valid reasons to reverse the conditions that caused the need for the salmon hatcheries in the first place and to protect habitat from further destruction.

While the EA does a better job, the DEIS fails to adequately emphasize that hatchery production in Puget Sound is fundamentally essential to preserving the opportunity for tribes to exercise their treaty rights. If NMFS is to consider decisions to reduce hatchery production with the voluntary agreements of the tribes, NMFS must justify these as being necessary for conservation following the Secretarial Order. This means that any such justification must include a thorough analysis of the conservation risks and benefits of the change in hatchery releases versus the conservation risks and benefits associated with other sources of impacts on salmon, including habitat degradation, climate change, and the inadequacy of regulatory protections. Until sound scientific analyses quantify the entire suite of pressures and impacts on ESA-listed and unlisted salmon and these provide NMFS with a defensible basis for deciding whether genetic and ecological risks of artificial production and fisheries truly impede the recovery of listed or other wild populations because nothing else can be done, Federal treaties with Indian Tribes and Congressional intent to mitigate degraded habitat mandates that hatchery production continue at current levels to enhance fishing opportunity and to protect wild populations from extinction.

We noted and appreciated in the EA the inclusion of a comprehensive list of habitat problems that impact Chinook in the Snohomish system, which appeared to be taken in large part from our watershed recovery plan and supporting documents. We also noted and appreciated that the EA states in a few places that these habitat problems are the primary inhibitors of recovery. However, the overall approach to analyzing hatchery impacts does not reflect this idea. The EA and the DEIS carefully scrutinize hatchery (and to some degree, harvest) impacts, while mentioning habitat restoration in the EA mainly by referencing the Snohomish plan, without taking ownership of it as part of the recovery plan that your agency has adopted, and completely ignores habitat protection. What we need more than anything in these evaluations is to see an approach that makes protection and restoration of habitat the primary driver of recovery and to evaluate hatchery and harvest actions on the basis of whether or not they will prevent the habitat actions from being effective.

While we appreciate that the preferred alternative in the EA is to approve our hatchery plan, it should also include a commitment on the part of NOAA to assure that existing productive habitat does not decline and that a portion of degraded and lost habitat is restored, per the Puget Sound Chinook Recovery Plan. Our hatchery plan was developed assuming that concurrent habitat restoration and protection actions would be undertaken to promote recovery. Therefore, our plan cannot be adequately evaluated without considering the expected net condition of habitat, including the possibility that habitat restoration may not meet the schedule initially proposed. It is also clear to us that an improved condition for habitat cannot be expected without a commitment from NOAA to see to it that habitat improves. An analysis of the other alternatives in any NEPA evaluation must include this and at least one other habitat scenario; one in which habitat continues to be lost at the current rate (although we do not, obviously, prefer that scenario, this is unfortunately the current trend given the ongoing lack of adequate regulatory mechanisms). Based on work we have already completed with our partners in the Snohomish watershed, key items in our hatchery plan, such as broodstock integration and limitation of hatchery production,

will have little beneficial effect for wild stock recovery unless net habitat condition improves at the same time. We are still planning to extend this work via a Total Viability Analysis (TVA) designed to look at all of the interactive effects of hatchery, harvest, and habitat management (under current conditions and future scenarios) on salmon recovery that would include both the positive and negative effects of hatchery, harvest, and habitat management and the different combinations of these factors unique to each watershed.

If we are serious about salmon recovery, and if habitat condition is the primary driver of salmon recovery, as we believe and NOAA Fisheries states, then it follows that current and projected future habitat conditions must be realistically described in any analysis of hatchery alternatives, as they should also be for harvest alternatives. The ESA provides that the status of habitat and the adequacy of regulatory mechanisms are the two factors that should be evaluated for habitat. It is as true for hatchery management as it is for harvest management that these habitat factors must be shown to be improving before the success of hatchery or harvest actions can be realized, much less evaluated. Our Snohomish recovery plan and the Tulalip chapter of the tribes' State of our Watersheds report provide evaluations of the current status of habitat in the Snohomish watershed. As some of the introductory material to the DEIS and EA discuss, there are many problems with the current status of habitat and much room for improvement. Our point here is that our hatchery plan, even with the many actions it includes to support wild stock recovery, cannot succeed without a strong commitment on the part of NOAA to support the protection and restoration needed for the necessary habitat improvements. **To put it another way – why do all of this if the habitat is going to continue to decline anyway?** This is the analysis we need to see included in the EA and in any future watershed-based EIS.

The refinement of this analysis in future revisions of any watershed-based EA and EIS should better reflect the trust responsibilities of federal agencies in the context of implementing the ESA and the mandate to minimize effects on tribal trust resources in pursuit of the common goals of salmon recovery. Outside of the very general discussion of treaty rights and federal trust obligations to the tribes in the Purpose and Need chapter, the EA and the DEIS fail to adequately assess effects on reserved tribal fishing rights and the associated impacts on tribal culture. These effects should be shown in greater detail beyond the specific economic impacts, but also relative to the cultural and social value of the fish and fisheries.

2. Any future DEIS must be consistent and realistic in how habitat protection and restoration measures in the Puget Sound Chinook Salmon Recovery Plan are being implemented

The DEIS implies that the Chinook Recovery Plan will be fully implemented. In its evaluation of Recovery Plan implementation, however, NMFS found that salmon habitat continues to decline and that many of the habitat strategies and actions called for by the Recovery Plan are "largely nonexistent."[2] The Puget Sound Salmon Recovery Council and Recovery Implementation Technical Team's annual review of implementation of the Recovery Plan document major, unresolved challenges to full implementation of the Plan. Similarly, the tribes' State of the Watershed Report finds that after five years of Recovery Plan implementation, habitat continues to be degraded faster than it can be restored.[3] Although we hope the Recovery Plan will be fully implemented, as previously stated for the Snohomish Recovery Plan, any future EIS needs to describe how NMFS will ensure that this will happen so that it can support this assumption.

We support NMFS conclusions in the cumulative effects analysis of the DEIS that habitat continues to decline and that habitat protection tools currently in place need to be improved. That salmon numbers decline in all alternatives – even under alternative 3 which NMFS describes as having the lowest hatchery-related risk – illustrates the importance of reversing the trends in habitat productivity. While hatcheries can,

[2] *See* NMFS, 2011 Implementation Status Assessment final Report: A Qualitative Assessment of Implementation of the Puget Sound Chinook Salmon Recovery Plan (Millie Judge Report) at 6.
[3] See Western Washington Treaty Tribes, State of Our Watersheds Report (2012) (Executive Summary). This report can be found at: http://nwifc.org/publications/sow/

and are, helping salmon to continue to hang on, this effort cannot mitigate for poor habitat management. Conversely, improving habitat productivity will support both hatchery and natural-origin fish to be more successful.

Although we acknowledge NMFS' assertion in the DEIS that impacts to salmon and steelhead habitat continue to suppress prospects for recovery, the representation of the current environmental baseline and existing conditions for fish inaccurately represents historic actions that have led to the current conditions. Section 3.2.2, General Factors that Affect the Presence and Abundance of Salmon and Steelhead, suggests that hatchery programs have affected fish presence and abundance. However, it fails to acknowledge that hatchery production is a mitigation tool employed to provide harvest opportunities for treaty tribes and non-treaty fishers as a result of lost natural production due to non-Indian impacts to habitat. Although this section lists the individual habitat impacts (i.e. habitat, water quality and quantity, dams and diversions, culverts, shoreline modification, and oceanic conditions), the treatments of these as distinct impacts to fish presence and abundance masks the cumulative effects of these impacts. It fails to account for multiplicative, compounding effects that occur in ecological systems. It masks the actual decline in the ecosystem that salmon rely on. This section should assess and describes how all these factors collectively affect salmon in an ecologically meaningful way.

Given the extensive impact of habitat degradation on overall habitat, the continued decline of salmon and steelhead, and its overarching limitation on successful recovery of listed salmon and steelhead, similarly to our recommendation for the EA, we recommend that additional alternatives be evaluated in any future EIS that 1) assess the comanagers proposed hatchery production levels and in which habitat across the Puget Sound has been fully restored and Chinook salmon abundances are at recovery, and 2) assess the comanagers proposed hatchery production levels and in which habitat across the Puget Sound continues to be lost at the current rate.

3. Any future DEIS alternatives need to describe how NMFS will use its regulatory authorities to protect and restore salmon habitat under each alternative.

NMFS has significant authorities at its disposal that could significantly increase salmon habitat protection and restoration and that would better protect and promote rebuilding of listed naturally-spawning salmon and steelhead than merely decreasing hatchery releases. Section 7(a)(1) of the ESA provides broad authorization to NMFS – and other federal agencies – to proactively use their authorities to contribute to the conservation (both survival and recovery) of listed species:

> *The Secretary shall review other programs administered by him and utilize such programs in furtherance of the purposes of this chapter. All other Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this chapter by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 1533 of this title.*

The authority of NMFS – or any other federal agency – to utilize their programs to promote the survival and recovery of listed species is not limited to the specific actions on which they may be conducting a consultation pursuant to §7(a)(2).[4] Consequently, NMFS, and other federal agencies whose actions affect Puget Sound salmon and steelhead habitat, are authorized to utilize their authorities in a manner that promotes recovery of listed species, even if the action under consultation is much narrower than their authorities. In the context of the DEIS, NMFS has found that the impacts of climate change and development will result in lower salmon survival under all alternatives. NMFS is not "helpless" in the face of this finding. It has numerous authorities and options for action.

As part of their effort to persuade the federal government to take actions to recover salmon and protect treaty rights, the Western Washington Treaty Tribes initiated their Treaty Rights at Risk initiative. Many recommendations for federal action were included within the Tribes' original "white paper." A follow-up letter was sent in response to requests from the federal government for more specific recommendations for federal actions to protect and restore salmon and treaty rights.[5] These documents are incorporated by reference into our comments. The recommendations in these letters include many actions that are within the authorities of the federal government and that could help promote salmon recovery as well as ameliorate the impacts of climate change and reduce the impacts of new and existing development on salmon and treaty rights. The tribes stand ready to work with NMFS and other federal agencies to implement these recommendations for reasonable non-Indian activities that would reduce or eliminate the need to restrict treaty-secured activities for conservation purposes.

4. The DEIS must use appropriate tools and include descriptions of the limitations of any tools used in future analyses

Any future EIS must only use appropriate tools and must include descriptions of the limitations of the tools that were used. All scientific evaluation tools or models balance the competing demands of precision, accuracy, and generality. For example, some are coarse-grained and useful for general guidance; some are precise and useful for allocation purpose but cannot forecast future trends or impacts well; some provide more accurate predictions but the predicted range of the impacts is very broad because of data or model limitations. We do not believe the tools used in the DEIS analyses were appropriate and the strengths and weakness of the tools that were used were not clear. Even for the coarse-grained analysis such as evaluating proposed alternatives at the ESU level, we do not believe the tools used were appropriate and would be unacceptable if attempted to be used as some more deterministic prediction of impacts at a finer scale such as needed in a biological opinion. We indicate some our concerns with the tools used in the DEIS below.

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[4] *See e.g., Defenders of Wildlife v. U.S. Environmental Protection Agency,* 420 F.3d 946, 965 (C.A.9,2005) *rev'd on other grounds, National Assn' of Homebuilders v. Defenders of Wildlife*, 551 U.S. 644 (2007) (distinguishing between §7(a)(1) authorization to review and implement programs and §7(a)(2) obligation to consult on specific actions to avoid jeopardy and adverse modification). *See also City of Santa Clarita v. U.S. Dept. of Interior*, 2006 WL 4743970, (C.D.Cal.,2006) (Section 7(a)(1) does not pose substantive requirements on federal agencies relating to specific actions. Rather, it imposes a requirement on the Secretaries to "review other programs" (i.e. programs not arising under the ESA), and to utilize these programs in furtherance of the goals of the ESA. 16 U.S.C. § 1536(a)(1). Section 7(a)(1) mandates broader programmatic conservation efforts, while Section 7(a)(2) applies to specific projects).

[5] *See generally* Report from the Treaty Indian Tribes of Western Washington, Treaty Rights at Risk: Ongoing Habitat Loss, the decline of the Salmon Resource, and Recommendations for Change (July 2011); *see also* Letter from Billy Frank, Jr., Chair, NWIFC, to Dennis McLerran, EPA; Roylene Rides at the Door, NRCS; and William Stelle, Jr., NMFS (March 2, 2012).

a. Consistency with Hatchery Scientific Review Group Recommendations

As indicated in the DEIS, tribal hatchery operators considered Hatchery Scientific Review Group (HSRG) recommendations published in 2004 in developing HGMPs. As noted by the HSRG, the intent of the HSRG review was "to *advise* fishery managers, agency scientists, legislators, and the public about the benefits and risks of alternative actions that could be undertaken to meet goals for salmonid resources." The HSRG published review summarizes tribal comments on the 2004 recommendations. Although the HSRG has continued to develop additional recommendations more broadly, the tribes reaffirm the role of the HSRG and other science panels as scientific advisors. Science is essential for making informed decisions but it cannot replace policy. Although other agencies may choose to use HSRG recommendations as prescriptions for their activities, the tribes believe that attempts to apply these prescriptively to tribal programs in analyses or as rules without tribal consent are inappropriate and dismissive of the tribes' role as co-managers.

b. Use of Hatchery Scientific Review Group metrics of risk, pHOS and PNI

Since developing recommendations for Puget Sound hatcheries, the HSRG proposed several metrics and benchmarks for assessing the success of hatchery programs in minimizing adaptation to hatchery environments and promoting adaptation in the wild. These metrics were never agreed-to by the tribes and in fact, were strongly opposed for numerous reasons. These metrics include "$pHOS_D$", which is the demographic-based proportion of hatchery origin spawners, and "PNI_D", which is the demographic-based "Proportion of Natural Influence", which is supposed to be a surrogate index of the degree to which a population may be moving toward, or away from, local adaptation. PNI_D uses estimates of $pHOS_D$ and $pNOB_D$ (the demographic-based proportion of natural-origin broodstock in the hatchery program)[6] and HSRG guidelines are based on a simple, heuristic genetic model of fitness in two environments[7]. The HSRG uses $pHOS_D$ as an estimate of gene flow to evaluate risk. The mere presence of hatchery-origin fish on the spawning grounds, however, does not indicate successful reproduction, gene flow, or genetic impacts. Genetic theory, modeling, and data show that using these census data to estimate gene flow results in biased, unrealistically high estimates of gene flow in natural populations and that the estimates of impacts are highly uncertain. For example, in spite of the expectation of substantial contribution of early winter steelhead to natural steelhead production based on returns to rivers where they were released, genetic analysis showed the effective contribution of hatchery steelhead to natural production was very low.[8] Likewise, Chilcote et al. (2011) found that a $pHOS_D$ of 0.1 corresponded to productivity estimates of approximately 5-6 recruits per spawner and that productivity did not fall below replacement level (due to hatchery effects alone before adding habitat degradation or obstructions) until $pHOS_D$ approached 0.8.[9]

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[6] Hatchery Scientific Review Group. 2009. Columbia River Hatchery Reform System-Wide Report. Appendix A. http://www.hatcheryreform.us.

[7] Ford, M.J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology 16: 815-825.

[8] Warheit, K.I. 2014. Measuring Reproductive Interaction Between Hatchery-Origin and Wild Steelhead (*Oncorhynchus mykiss*) from northern Puget Sound populations potentially affected by segregated hatchery programs. Unpublished Final Report. Washington Department of Fish & Wildlife, 600 Capitol Way N, Olympia, WA 98501. 91 pp.

[9] Chilcote, M.W., K.W. Goodson, & M.R. Falcy. 2011. Reduced recruitment performance in natural populations of anadromous salmonids associated with hatchery-reared fish. Can. J. Fish. Aquat. Sci. 68: 511-522.

If NMFS wants to rely on demographic data to calculate gene flow and make inferences from these, it needs to use the correct calculation, which we provide below:

$$pHOS = (RRS_{HH} \times HOS_{HH}) + (RRS_{HW} \times HOS_{HW}) + (RRS_{WH} \times HOS_{WH}) / ((RRS_{HH} \times HOS_{HH}) + (RRS_{HW} \times HOS_{HW}) + (RRS_{WH} \times HOS_{WH})) + ((RRS_{WW} \times NOS_{WW}) + (RRS_{HW} \times NOS_{HW}) + (RRS_{WH} \times NOS_{WH})),$$

where RRS[10] is the relative reproductive success of each breeding type, *NOS* is natural-origin spawners, $_H$ means hatchery and $_W$ means wild. This information can be obtained from genetic studies.
Because $pHOS_D$ as an estimate for gene flow as currently measured is a biased metric with large but unquantifiable error, analyses using census pHOS and $pHOS_D$-derived PNI indices in the DEIS are not appropriate even for the very coarse-grained evaluations in the DEIS. For example, our analyses indicate that the categorization of risk levels from pHOS (<1% = Negligible, 1-5% = Low, 5-10% = Moderate, and >10% = High) based on the HSRG guidelines for gene flow are mostly not differentiable in predicting real impacts given the broad confidence intervals for estimates of gene flow using measurements of census pHOS in the wild. Consequently, this analysis may be appropriate for qualitatively evaluating the intent of programs but it cannot even come close to accurately predicting the actual impact and should not be represented in this way to state that certain practices will result in negligible or high levels of risk or in specific changes in productivity of natural-origin spawners.

The key purpose of these crude analyses is to evaluate the genetic impacts on fitness – the ability to survive and reproduce - from interbreeding with hatchery raised salmon. Because these crude risk analyses are not validated empirically, the interpretation in the DEIS needed to be tempered by real data and the range of results from the scientific literature. Although the scientific literature demonstrates that domestication selection occurs among salmon in the hatchery environments, the consequences of interbreeding with natural populations on fitness where that has been studied are highly variable. The degree to which hatchery fish may pose a threat to natural population fitness when they interbreed with fish from natural populations is highly uncertain and is dependent on numerous factors such as watershed habitat conditions present/not present to support natural production, the species, stock origin and genetic similarity/ dissimilarity to the target natural population, the number of generations and length of time per generation exposed to the artificial hatchery environment, the intensity of hatchery selection for maladaptive traits, and upon release, the relative genetic effective population size, rate of effective migrants per generation, and the degree of gene flow between hatchery- and natural-origin fish. These uncertainties need to be reflected in the interpretation, and clearly, the effects on fitness of natural populations are not anywhere near the same for the different hatchery programs that employ different spawning, incubation, rearing and release practices on different species and races of fish. In addition, a significant component of fitness is determined by phenotypic plasticity, the variable expression of a population's gene pool across a range of environments. A key HSRG conclusion is: **Productive habitat, in which a salmon population conducts the various phases of its life cycle, is necessary to the success of any hatchery program.** "*The fitness of the naturally-spawning population, its productivity, and the number of adult salmon (artificially or naturally produced) returning to the watershed ultimately depend on the natural habitat, not on the output of the hatchery*"[11].

The analysis of the environmental effects on fitness were largely absent from the DEIS analyses. Consequently, the DEIS was a biased, incomplete analysis of fitness effects that used inappropriate tools in a one-size-fits-all approach that is inappropriate for evaluating the varying array of hatchery programs and resultant effects on populations under varying watershed conditions in Puget Sound. Any future DEIS should not use these tools but if it is done, they should not be applied across all populations and if used at all, NMFS needs to address the shortcomings. NMFS, for example, found that survival rates of hatchery-

[10] Estimates of RRS must be appropriate for the species, life-histories, watershed characteristics, and hatchery programs.

[11] Hatchery Scientific Review Group. 2004. Hatchery Reform: Principles and Recommendations of the HSRG. Long Live the Kings, 1305 Fourth Avenue, Suite 810, Seattle, WA 98101 (www.hatcheryreform.org).

and natural-origin Hood Canal summer chum were similar.[12] This could be because selection intensity is low when hatchery chum salmon spend little of their juvenile life history in the hatchery environment or because environmental effects overwhelm any genetic effects. Chinook hatchery programs in Puget Sound also release sub-yearling smolts after a similar short period of rearing and there is no evidence to date that selection intensities in Chinook salmon hatcheries are any different than chum hatcheries. Likewise, in a reciprocal transplant study of coho salmon, there were no differences among fish in fitness correlated traits and the effects of rearing environment far outweighed any genetic effects.[13] Similarly, other studies showed that first generation hatchery-origin Chinook males had reduced reproductive success, perhaps due to environmentally caused increased rate of early maturation, but that those hatchery-origin males that did successfully spawn produced natural-origin progeny whose reproductive success did not differ from natural-origin fish with natural-origin grandparents. [14]

Finally, we note that the narrative associated with these effects often refers to loss of fitness because of domestication and subsequent interbreeding as loss of genetic diversity. This confounds two different genetic impacts and is confusing. Although loss of within-population genetic diversity is a potential impact of hatchery programs, the genetic mechanism is different than loss of fitness from domestication. There is no real empirical evidence based on nearly 40 years of measuring heterozygosity and allelic diversity that loss of within-population genetic diversity from hatchery production is a significant impact in Puget Sound Chinook salmon. In the few cases, where these indicators of genetic diversity are low, such as for White River or Nooksack River Chinook salmon, they are associated with very low population abundances stemming from other causes that reduced genetic diversity and hatcheries were subsequently started to prevent extinction of the populations. We suggest you have a NMFS population geneticist review any future DEIS.

c. Use of the Hatchery Scientific Review Group's All-H Analyzer Model

The DEIS based a number of analyses on output of the All-H-Analyzer Model. This model has been reviewed by at least two independent panels of scientists.[15,16] In very limited instances, it may be useful as an heuristic tool for examining broad scenarios and combinations of hatchery, harvest, and habitat. However, its weaknesses for other purposes are significant and well-known. The Puget Sound Technical Recovery Team's 2005 review of the "All-H Analyzer Model" (PSTRT 2005) concluded that the model cannot be used to determine acceptable levels of integration, cannot be used to predict fitness or assess extinction risks, cannot be used for recovery planning or assess VSP criteria (i.e. abundance, productivity etc), can't be used to assess the risks or benefits of hatchery programs, can't be used to assess the merits of segregated or integrated hatchery strategies, it is NOT an all-H tool, and it is inappropriate to call it such. Ford's (2002) approximation of fitness as a single trait with discrete optima for the hatchery and natural

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[12] Berejikian, B.A., D.M. Van Doornik, J.A. Scheurer, & R. Bush. 2009. Reproductive behavior and relative reproductive success of natural- and hatchery-origin Hood Canal summer chum salmon (*Onchorynchus keta*). Can. J. Fish. Aquat. Sci. 66: 781-789

[13] Chittenden, C.M, C.A. Biagi, J.G Davidsen, A.G. Davidsen, H. Kondo, A. McKnight, O-P Pedersen, P.A. Raven, A.H. Rikardsen, J. M. Shrimpton, B. Zuehlke, R.S. McKinley, & R.H. Devlin. 2010. Genetic versus rearing-environment effects on phenotype: hatchery and natural rearing effects on hatchery- and wild-born coho salmon. PLoS One 5:8 August 2010 http://www.plosone.com

[14] Ford, M., A. Murdoch, & S. Howard. 2012. Early male maturity explains a negative correlation in reproductive success between hatchery-spawned salmon and their naturally spawning progeny. Conservation Letters 5: 450-458.

[15] Independent Scientific Advisor Board. 2005. Review of the All-H-Analyzer (AHA). Northwest Power and Conservation Council, Portland, OR. http://www.nwcouncil.org/fw/isab/.

[16] Recovery Implementation Science Team. 2009. Hatchery reform science: a review of some applications of science to hatchery reform issues. National Marine Fisheries Service, Seattle, WA. http://www.nwfsc.noaa.gov/trt/puget_docs/hatchery_report_april92009.pdf

environments and constant strength of selection across environments toward each environment's optimum is useful heuristically to generate 'what if' scenarios. But because true 'fitness' results from multiple traits with varying (and unknown) degrees of interactions, heritability, strength of selection and, most importantly, phenotypic plasticity (variation in expression of a fixed trait with respect to the environment) – which it does – then it may not be prudent to draw specific management conclusions from a qualitative summary of the model's quantitative output. In a review by the Independent Scientific Review Panel (ISRP/ISAB 2005), notable observations included: *"It is important to note that the AHA model itself does not determine acceptable levels of integration between natural and hatchery production elements for a given population or subbasin area", "The documentation of the model does not provide explicit guidance for key input parameters or driving elements (e.g., fitness model parameters)", "From this perspective, it is clear that requiring hatchery managers to mine the wild population to make up 10% of their hatchery broodstock is NOT a conservation measure...", "It is extremely important to recognize up front that the AHA model was designed as a tool for use in hatchery reform efforts - not as a generalized recovery planning model...it is not designed to do all H analyses on populations designated for wild production", "Weaknesses - the model is not designed to directly simulate quasi-extinction risks or within population level interactions between hatchery and natural production. The simple genetic impacts mechanism incorporated into the model is limited in scope- does not address the potential impact of multiple genetic factors, differences in phenotypic characteristics such as adult spawn timing, etc", "The model is NOT a stand alone approach for evaluating performance against VSP criteria...", "I believe that it is inappropriate to call this version of the model an ALL H tool - it simply doesn't have the level of detail in key parameters to serve that function across the range of situations involving populations of listed ESUs."* The DEIS fails to acknowledge any of these weakness in the description of the tool or in subsequent interpretation of the model results even though NMFS commissioned these reviews. We believe it is inappropriate to use AHA for ESA evaluation purposes for the above-mentioned reasons and if it is ever used, NMFS must address its numerous shortcomings.

d. Use of the PCD-1 Model

The PCD-1 Model is used for estimating the risk of loss of production from predation, competition, and disease in freshwater.[17] It allows users to provide information about the abundance of hatchery and natural fish, size and age of the fish, residence time in freshwater, degree of overlap in time and space, habitat complexity, water temperature, and piscivory rate. Unfortunately, most of these parameters are unknown. In the DEIS analyses, some of these parameters were derived from EDT model analyses, which have certain weaknesses.[18] In addition, the model has never been validated using real-world data to evaluate predation and competition, and real-world data suggest that predation and competition are not significant impacts from hatchery fish. We believe it is inappropriate to use the PCD-1 Model for ESA risk evaluation purposes but if it is ever used, NMFS must describe these limitations and how these were considered in the interpretation of the analyses.

e. Use of the HPV Tool

Understanding uncertainty of implementation is an important component of assessing risk. The specific use of the HPV tool and the application of the results in this regard are unclear. The method for assigning risk based on the HPV compliance rating is confusing. Although the expected risk levels are apparently linked to HSRG metrics and analyses (see previous comments), the description of the tools fails to relate the quantitative risk levels used in these analyses to biological outcomes that are actually supported by data. The DEIS did not specify how and when individual data were acquired. It is further stated that the HPV

[17] Pearsons, Todd N., and Craig A. Busack. "PCD Risk 1: a tool for assessing and reducing ecological risks of hatchery operations in freshwater."Environmental biology of fishes 94.1 (2012): 45-65.

[18] McElhany, P., A. Steel, D. Jensen, and K. Avery. 2009. Uncertainty in a complex salmon habitat model. American Fisheries Society Symposium 71. http://www.secure.fisheries.org/proofs/pse/mcelhany.pdf.

survey data used for the analysis includes a mix of either 87 (Appendix F) or 90 (section 3.1.3.1) biological, operational, and infrastructure questions regarding eight of the eleven HPV phases of hatchery operations. The program assigns a weighted value to each response which is then used to derive a "compliance" rating and then translated into a qualitative value of risk and benefit to impact categories of the targeted population. As stated in Appendix B, page B-55: *"Hatchery facilities and operation risks associated with each hatchery program are determined to be negligible, low, moderate, or high depending on the compliance of the hatchery program with the HPV Tool BMPs, and the extent to which changes in the level of hatchery production differ from alternative 1 (Table B-17)."* However, the criteria for all risk levels (Table B-17) share the same language regarding compliance, i.e. "*Compliance for the hatchery is low for one or more operational phases...*". The language in Table B-17 goes on to describe that risk level as negatively correlated with production level. Therefore, a single "*Low*" compliance rating in one phase of hatchery operations results in an *Overall Facility Risk* level of "*Moderate*" for every facility under Alternative 2. This analysis must be seen as highly speculative.

5. Reduced and no production alternatives fail to accurately assess effects on Tulalip Tribe's terminal area harvest program and Snohomish basin monitoring programs

Another major point missing from the DEIS analysis is the interaction between harvest and hatchery management. This was initially missing from the EA as well, and while we note and appreciate that effects from reduced production and no production alternatives to the terminal area harvest program were recently added to one section in a more recent draft, we do not believe they were adequately assessed. We've documented a significant decline in wild stock harvest rates since our Tulalip Hatchery started a Chinook program in the 1980s, from greater than 60% before the hatchery program started, down to an average of less than 5% over the past several decades. If the hatchery program were terminated, our terminal area fishery would no longer be able to target the hatchery production, much less with high efficiency, and therefore we would expect this wild stock harvest rate to increase, meaning either increased overall exploitation rates on wild stocks or a reduction in preterminal harvest opportunity to make up for the increased terminal area harvest in mixed stock areas. These consequences of eliminating the hatchery program should be highlighted in both analyses. The EA acknowledges the benefits of this program and lost benefits if it were terminated, however it does not adequately assess further impacts that would result to wild stocks if the tribe is forced to shift our fisheries back into the mixed stock area, or adequately assess the impacts of any reduced production alternative, which are not acknowledged, but which would be detrimental.

Another important effects evaluation that is missing from the analysis of options, particularly under any "no production" or "reduced production" alternatives is that the intensive monitoring that underlies our knowledge of the status of the Chinook salmon resource is closely tied in with the hatchery programs. We think that the analysis should clearly point out that one consequence of the "no production" alternative and the "reduced production" alternative will be not only the elimination of the hatchery programs but also the elimination of the intensive monitoring of spawning escapement that provides our information regarding the abundance and spatial distribution of natural- and hatchery-origin spawners. It should also not be presumed that other components of our intensive monitoring program would be continued, or continued in their current capacities. Elimination of Snohomish region hatchery production would not mean the elimination of hatchery-origin spawners in the watershed. But, without our monitoring, paid for with hatchery implementation funds, we wouldn't know how much, and this is just one example of how our current monitoring program could change. Some of the suggested insertions in our detailed comments address this. The monitoring program, currently supported largely by hatchery funding, includes assessments of population viability, including annual estimates of abundance and productivity of natural- and hatchery-origin Chinook salmon, assessments of spatial distribution, genetic diversity and population composition needed for DNA baselines, population substructure needed for salmon recovery purposes, effective population size, development and refinement of methods to estimate relative productivity, gene flow and genetic-based PNI (PNI_G) between hatchery- and natural-origin fish, genetically-effective abundance, the effective number of breeders, and estimation of successful and unsuccessful spawners for each naturally-spawning

Chinook population by hatchery- and natural-origin, time, location, sex, and age, and other studies and essential VSP monitoring such as juvenile monitoring needed to understand ecological interactions in freshwater, the estuary, and nearshore and offshore marine areas and the ability to assess post-release marine survival of natural- and hatchery-origin fish, which has become a significant limiting factor that is known to be influenced by changing marine environmental conditions affecting foodwebs and prey availability in Puget Sound.

6. Cumulative effects in both documents fail to adequately assess effects to the Tribal community, nor the synergistic cumulative effects of all hatchery releases (e.g., straying into other watersheds), and the relative cumulative impacts of the proposed alternatives to fish relative to net habitat condition, environmental stressors, climate change and other non-hatchery-related effects

We provided extensive comments on these in our edits to the draft BiOp, 4(d) rule and EA for the Snohomish basin, though they should be obvious inclusions in any NEPA evaluation. Clearly, cumulative impacts should be the key section in both of these documents, but instead, they are woefully short and lacking of substance.

The primary goal of the Tulalip Tribes is to protect and restore the habitat necessary to produce robust natural runs at a level necessary to support treaty rights and other benefits. Our primary management objective has always been natural production of all species of fish in all of the watersheds that we manage. It is the cornerstone to our recovery plans. Increasing natural spawner abundance, productivity, spatial structure and diversity through implementing salmon recovery efforts and associated habitat protection and restoration in conjunction with the proposed actions is the obvious solution to addressing concerns about productivity and diversity, or for example, reducing the fraction of hatchery fish on the spawning grounds. Not placing the primary focus on implementing habitat actions needed to increase natural spawner viability flies directly in the face of NOAA Fisheries' and the co-manager's mandate to implement salmon recovery plans using an all-H approach and all-viability effects analysis of those integrated actions. An alternatives analysis based solely on hatchery program effects fails to meet the bar.

Finally, we strongly disagree that hatchery fish pose a larger threat to salmon recovery than does the continued loss of habitat and ask NOAA Fisheries to further clarify its position on that issue as well by including habitat restoration and protection components relative to all of the alternatives and more adequately identifying the synergistic relationships among <u>all</u> "H" factors on <u>all</u> viability parameters, given that our shared goal is salmon recovery, not hypothetical, presumed (but unsubstantiated) "long-term" genetic effects on productivity that are supposedly caused by hatchery fish. The alternatives must also include degraded net habitat condition protection components. Lacking that approach, all of this greatly damages and minimizes many years of work and expense we have devoted toward our habitat protection and restoration efforts (we estimate the tribe has expended between 15-20 million dollars, and regionally among all agencies and entities, upwards of 50 million dollars, in the past ten years on salmon recovery in our region), which the Tribes are dedicated to achieve no matter what obstacles we may encounter on the way. We know this to be the key to recovering ALL of our salmon populations. All of the evidence, including all of the "All-H" integrated modeling that we have done to date, shows that habitat is the primary limiting factor to recovery of the listed populations we work with. Undoubtedly, this is the case for most of the other populations throughout the state where it has been estimated that the vast majority of the freshwater rearing and spawning habitat has been lost and the remainder severely qualitatively degraded, which is driving egg-to-smolt productivity, while greatly reduced marine survival observed particularly in recent years, is the main factor affecting smolt-to-adult productivity. Given that the primary limiting factors are habitat-related and sustainable recovery requires meaningful and effective habitat protection and active restoration actions, the EA for the six HGMPs for Snohomish basin hatchery programs, and any future EIS for the watershed or other "action area" absolutely must include habitat actions and a strong commitment and approach to "All-H" management, habitat protection and active habitat restoration under the preferred alternative. Any future we envision that includes a sustainable salmon resource must include a greatly improved approach to habitat

management than we now see; "habitat reform", if you will. Without Habitat Reform, the assumption stated in the DEIS and EA that "*...net habitat condition would remain the same or improve...*" is erroneous.

Thank you for the opportunity to improve the EIS. We expect further consultation on these issues and those in the attached comments as NMFS further develops this EIS for salmon and steelhead hatchery programs in the Puget Sound under the ESA. We look forward to an accurate and useful final environmental impact statement.

Sincerely,

Ray Fryberg
Executive Director of Natural and Cultural Resources, Tulalip Tribes

Cc: Herman Williams Sr., Chairman; Tulalip Tribes, Tulalip Tribes Board of Directors
Terry R. Williams, Commissioner of Fisheries and Natural Resources, Tulalip Tribes
Jim Unsworth, Director, Washington Department of Fish and Wildlife
Jim Scott, Assistant Director, Washington Department of Fish and Wildlife
Mike Grayum, Executive Director, Northwest Indian Fisheries Commission
Rick Cook, Bureau of Indian Affairs
Rob Jones, Tim Tynan, NOAA Fisheries
Mason Morisset, Esq.; Tim Brewer, Mike Crewson; Tulalip Tribes
Annette Hoffman, Brodie Antipa, Brian Missildine; WDFW

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Attachment A: Sectional Comments

Chapter 1-Purpose and Need for Action

HGMPs

The DEIS analysis was conducted using outdated HGMPs and resource management plans (RMP) based on the HGMPs. The majority of facilities have updated their HGMPs and operational aspects to reflect hatchery conservation measures with respect to ecological and genetic risks, which are currently being evaluated at the watershed scale in "bundled" consultations such. Any future EIS should evaluate the watershed bundled programs in a manner that is consistent with the consultations that are already well underway (and their cumulative synergistic impacts) to provide the best available information for the analysis at the appropriate scale.

Pacific Salmon Treaty Obligations

The Pacific Salmon Treaty objectives for assuring equitable harvest opportunity in the U.S. and Canada are served by a large contribution of Puget Sound Chinook hatchery production. Hatchery production reduces overall impacts to fisheries on key wild Chinook stocks originating in B.C., Puget Sound, and the Columbia River. Reduced Puget Sound hatchery production alternatives would likely be inconsistent with the assumptions underlying the PST Chinook Agreement. Before NMFS advocates any changes to Puget Sound hatchery production, the potential effects on PST agreements should be more thoroughly explored.

Chapter 3-Affected Environment

Environmental Justice

The DEIS rightly identified tribal communities as entities for consideration under federal environmental justice statutes, but any FEIS analysis (i.e. baseline condition under Affected Environment) must first of all be based on data from the most recent census to accurately reveal the economic status (e.g. income and unemployment rates) of tribal communities. Any potential further deterioration of economic status for individual tribal communities associated with changes in fishing opportunity and fishing-related income should be apparent in any FEIS. The further detrimental effect on tribal communities (i.e., personal health, economic status, and cultural integrity) associated with reducing hatchery production was not adequately described in the DEIS, particularly for our basin where the hatchery production comprises upwards of 90% or more of the harvest depending on the species. To make that impact even worse, the poorest fishing families in the Tribe that only have very small skiffs, depend almost entirely on, and are almost exclusively the participants in, the terminal area setnet fishery in Tulalip Bay that is only minimally supported now by targeting the current level the hatchery production. So, these poorest fishing families would bear nearly ALL of the burden, and that burden - of any alternatives that would eliminate or reduce hatchery production by 50% - would result in a near total collapse of income to this sector of the Tribe, which have a far higher number of unemployed than the reported 92 tribal members (or 13%) that are purported to be unemployed, which is not acknowledged accurately in either document. An adequate analysis must be explicitly considered in the final EA and EIS identification of the preferred alternative and subsequent conclusions in records of decision.

Chapter 4-Environmental Consequences

Best Management Practices (BMP) for Hatchery Facilities

Potential mitigation measures for hatchery programs listed in Tables 4.2-7 and 4.2-15 of the DEIS, and noted on page 4-3 line 18-21 suggest termination of programs as potential measures for BMPs of hatchery programs. However, this is not an action identified as an adaptive management measure considered by co-managers for any of these programs, and particularly not for any Tulalip hatchery programs that are basically the only remaining source left to provide fish available for harvest needed to meet the Treaty Right. As noted earlier in Section 1, considering such a measure without analyses supported by the tribes is inconsistent with the Secretarial Order and therefore should not be included in

the EIS as possible mitigation measure. Program termination as a mitigation measure must be removed from this document.

Appendix B—Hatchery Effects and Evaluation Methods for Fish

Marine Derived Nutrients

The assessment of benefits from marine-derived nutrients does not adequately evaluate the proposed actions benefit to the environment. It assesses benefits across species and by carcasses placed across the landscape by hatchery. However, the DEIS does not evaluate the level of MDN input to local systems as a result of naturally-spawning, hatchery-origin fish in relation to the relative contribution of naturally-spawning, natural-origin fish. In order to accurately assess the benefit of the proposed action and respective alternatives, a full evaluation of hatchery versus natural-origin fish spawning in the natural environment and resulting MDN contributions, by respective origin and species, is warranted in addition to benefits from carcass placements.

HPV Tool

Although the expected risk levels assigned in the HPV Tool are apparently linked to HSRG metrics and analyses, which is problematic (see previous comments), the description of the tool also fails to relate the quantitative risk levels used in these analyses to biological outcomes that are actually supported by data. The program assigns a weighted value to each response which is then used to derive a "compliance" rating and then translated into a qualitative value of risk and benefit to impact categories of the targeted population. As stated in Appendix B, page B-55: *"Hatchery facilities and operation risks associated with each hatchery program are determined to be negligible, low, moderate, or high depending on the compliance of the hatchery program with the HPV Tool BMPs, and the extent to which changes in the level of hatchery production differ from alternative 1 (Table B-17)."* However, the criteria for all risk levels (Table B-17) share the same language regarding compliance, i.e. "*Compliance for the hatchery is low for one or more operational phases…*". The language in Table B-17 goes on to describe that risk level as negatively correlated with production level. Therefore, a single "*Low*" compliance rating in one phase of hatchery operations results in an *Overall Facility Risk* level of "*Moderate*" for every facility under Alternative 2. This analysis must be seen as highly speculative and we do not support the use of this model, which is unnecessary.

Appendix E- Overview of the All H Analyzer

Reference to Columbia River Hatcheries

Besides objecting completely to the use of this model to evaluate the effects of the proposed actions in this analysis, this Appendix consistently reflects references to hatcheries in the Columbia River and not the Puget Sound.

Appendix I – Socioeconomic Impact Methods

Socio-economic Effects

Evaluation of baseline fisheries-related economic activity, and activity associated with each Alternative, must use more recent data. Ex-vessel value of commercial salmon catch Baseline ex-vessel values derived from average weight per fish and average price per pound have not been updated to utilize a more recent historical period (i.e. 2004 – 2013). We strongly disagree with the approach that was being used in both the DEIS and the EA and question the validity of using grand average price across all fisheries, or relating the income of tribal fisheries (or in the EA, the underestimated income of the Tulalip Tribal fishery, to some median income of the residents of Snohomish County or worse, the State of Washington), when even relating it to the mean tribal income does not accurately reflect the effect of reduced production on the poorest sector (which is included in the definition) of the tribal community that would be disproportionately affected. Differential price structure among tribal fisheries (i.e., different gear types and pre-terminal vs terminal area fisheries) is not revealed in the DEIS analysis. The assumptions of the Input Output model used to expand ex-vessel value to fishing-related jobs and income should be ground-truthed against current processing and marketing conditions (i.e. real

estimates of the number of jobs associated with commercial fishing, processing, and marketing in the Puget Sound region, and for the Snohomish region NEPA assessments, particularly to the poorest sector of the Tulalip Tribal community that would be most affected). As stated previously, the local effects of reducing production vary greatly among tribes, but are highest for tribes with limited, terminal area U&A's such as Tulalip that almost solely depend on the hatchery production, making larger comparisons to regional economies totally irrelevant. The DEIS analysis discussed local effects qualitatively. Any future analysis should reveal in more detail the effects on tribes and local communities of implementing the no production or 50% reduction in hatchery production of Chinook and coho. Because of the boundaries of our usual and accustomed fishing areas, and the extremely depressed condition of natural salmon production of these species, tribes like ours are almost solely dependent on hatchery production to support our fisheries. Although commercial salmon fishing comprises a relatively insignificant part of the overall economic activity in the Puget Sound region, the effects of reducing hatchery production on local communities should be made very stark in any future EIS. A better description of methods to determine expected harvest under Alternatives 3 and 4 would be required in any future analysis, since the analysis assumed that fishing effort among different salmon and steelhead species would not vary based on hatchery production, which is the exact opposite of the case for many tribes, especially ours.

Appendix K – Chemicals Used in Hatchery Operations

Chemical Use and Handling

This section starts with the sentence: "*Hatchery operations routinely use a variety of chemicals to maintain a clean environment for the production of disease-fee fish.*" The adjective "routinely" gives the false impression that hatcheries liberally apply chemicals to their waters. The adjective "sparingly" would more accurately describe chemical use at hatcheries. Disinfectants are used primarily of gear and equipment, and disposed of in a way that does not enter the hatchery effluent. Therapeutics are only used when necessary, and their high cost provides extra incentive for judicial use. Table 3.7-1 lists several pesticides and herbicides. To our knowledge, none of these chemicals are currently applied aquatically at any Puget Sound tribal or WDFW fish hatcheries, or have been for the past two decades. Pesticides and herbicides are also discussed in Appendix K, section 1.4. The second sentence of the section states: *"Due to their toxicity, a number of these chemicals are not approved for use in the United States. For hatcheries, pesticides and herbicides are typically highly toxic and are used in small concentrations to control algae growth or aquatic week growth."* It then goes on to list the herbicides from table 3.7-1. The language gives the false impression that hatcheries may be applying illegal and highly toxic chemicals to our waters. As you may know, all of the listed herbicides are legal to use in the United States, most, if not all of these, can be purchased by the public, and some of them (2,4-D, dichlobenil, and glyphosate) are commonly used by the public for terrestrial weed control. As stated above, we are not of aware of any tribal hatchery that is currently using any of these in aquatic applications.

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Puget Sound Hatcheries Draft EIS & Resource Management Plans

1 message

Zach Widner <zach@sportsmenslink.org> Fri, Jan 23, 2015 at 1:13 PM
To: "PSHatcheryEIS.wcr@noaa.gov" <PSHatcheryEIS.wcr@noaa.gov>
Cc: Chris Horton <Chris@sportsmenslink.org>, Andy Treharne <Andy@sportsmenslink.org>, Gary Kania <Garyk@sportsmenslink.org>

William,

Please see attached for comments from the Congressional Sportsmen's Foundation on the Puget Sound Draft Environmental Impact Statement and associated Resource Management Plans for Puget Sound Chinook Salmon Hatcheries and Hatchery Strategies for Steelhead, Coho Salmon, Chum Salmon, Sockeye Salmon & Pink Salmon.

Best,

Zach Widner | Western States Coordinator | Congressional Sportsmen's Foundation

(AK, HI, ID, NV, OR, WA)

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Congressional Sportsmen's Foundation

Congressional Sportsmen's Foundation

Combined Federal Campaign #92624

January 23, 2015

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

Re: *Draft Environmental Impact Statement (DEIS) on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs*.

Dear Mr. Stelle:

Since its inception in 1989, the Congressional Sportsmen's Foundation (CSF) has worked to support the interests of hunters, anglers, trappers, and recreational shooters at the state and federal level. As part of this charge, CSF closely monitors issues affecting the recreational angling community, including those pertaining to state and federal hatchery production and management programs. Hatchery programs have played a critical role in helping to restore populations of steelhead, Chinook salmon, and other fish species in the state of Washington, leading to enhanced angling opportunities and an immense economic impact on Washington's economy. As noted in CSF's 2013 Sportsmen's Economic Impact Report, in 2011 alone, recreational angling accounted for nearly $1.19 billion in economic activity in Washington, employing over 16,000 Washingtonians and providing nearly $120 million in state and local tax revenues, in addition to over $150 million in federal tax revenues. Given the critical role that recreational angling plays in Washington, it is imperative that the National Marine Fisheries Service (NMFS), in its development of a final Environmental Impact Statement (EIS) and Record of Decision on the Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs, choose a preferred alternative that takes into strong consideration the interest of the state's recreational angling community. Please see below for our comments regarding the current Puget Sound Draft Environmental Impact Statement (EIS) and the aforementioned Resource Management Plans.

Salmon and steelhead populations in the Pacific Northwest have been the lifeblood and cornerstone of the area's economy and cultural heritage for centuries. The presence of healthy salmon populations, seemingly boundless other natural resources, an abundant water supply and the sheer beauty of the region undoubtedly contributed to accelerated settlement and development in the area's watersheds over the last century, particularly in the many tributaries to the Puget Sound. Unfortunately, this development has led to significant habitat alterations and resulting challenges to natural-origin fish

stocks, many of which have been irrevocably lost. Fortunately, the hatchery programs of the Washington Department of Fisheries and Wildlife (WDFW) and the Puget Sound treaty tribes have done a remarkable job of protecting the remaining natural-origin spawning stocks, while mitigating for the loss of naturally-sustainable salmon and steelhead populations and providing continued recreational angling, commercial fishing, and tribal harvest opportunities through production of hatchery-origin fish.

Many factors influence anadromous fish abundance and population health – habitat, water quality (inland, estuarine and marine), forage availability (inland, estuarine and marine), cyclic weather patterns, changes in carrying capacity, and exploitation, among others. However, of these, quality habitat is one of the principal, fundamental components that must be consistent to ensure the opportunity for sustaining current populations or the hope of recovering declining or extirpated fish stocks. For the latter, habitat must be recovered before any realistic expectations of natural-origin stock recovery can be determined. As stated in the Draft EIS, "NMFS concluded that the impacts to salmon and steelhead habitat continue to suppress prospects for recovery of listed natural-origin salmon and steelhead, including current and continuing degradation and loss of habitat essential for their survival and productivity." While we recognize that hatchery-origin fish may present some challenges to the recovery of natural-origin salmon and steelhead, and the Resource Management Plans (RMP's) and appended Hatchery Genetic Management Plans (HGMP's) more than adequately address these challenges, these concerns are greatly overshadowed by the lack of suitable habitat in many areas.

Without the contributions of the state and tribal hatcheries, the Puget Sound populations of some salmon species and steelhead would be but a fraction of what they are today. This fact is perhaps most evident in Chinook salmon, one of the most important species, both culturally and economically, to the region. Hatchery-origin Chinook make up 74%, on average, of the total returning adults each year. For Chinook to continue to exist and contribute to the more than $106 million in total economic effect from Puget Sound's hatchery operations and associated harvest, the state and tribes must be allowed to continue their tradition of responsibly providing for healthy Chinook and other salmon stocks through their highly successful hatchery programs.

For this reason, **we support Alternative 2 as the preferred alternative**. The well thought out RMP's and appended HGMP's will maintain current levels of production, sustain opportunities for recreational, tribal and commercial harvest, and continue to provide a significant economic impact to the area's economy. Furthermore, the adaptive management procedures and evolutionary problem solving contained in the RMP's and HGMP's will ensure that hatchery programs effectively meet conservation and harvest production goals by adapting hatchery programs to changing circumstances and information. Adaptive management is a deliberate process of using research, monitoring, and scientific evaluation in making decisions in the face of uncertainty.

In addition to Alternative 2, **we support elements of Alternative 4** (increased production) being incorporated in Alternative 2 where practical. For instance, recovery Category 3 watersheds did not historically support self-sustaining natural populations of Chinook salmon. Therefore, there would be no risk of deleterious impacts to natural-origin fish. Where there is low risk of negatively impacting other species in these watersheds, the possibility of increasing hatchery-origin Chinook releases should be evaluated. Likewise, as adaptive management processes determine that recovery Category 2 watersheds are not suitable for "recovery", or where recovery of indigenous populations will not be

significantly impacted by increased production, hatchery programs should have the flexibility to increase production in the watershed and provide for increased harvest opportunities.

The nearly 1 million recreational angling trips for salmon and steelhead in Puget Sound each year result in over $70 million in trip-related expenditures and a significant contribution to the region's economy. In addition, fishing license dollars and excises taxes returned to the state through the Sport Fish Restoration program are critical to continuing efforts to sustain healthy populations of salmon, including natural-origin stocks. Preserving and enhancing recreational opportunities, while implementing measures to conserve natural-origin salmon where practical through the co-managers RMP's and HGMP's, will ensure that Puget Sound salmon populations continue to provide their tremendous social, cultural, and economic benefits for future generations of Washingtonians and visitors to the state.

Sincerely,

Chris Horton
Midwestern States Director
Congressional Sportsmen's Foundation
M.S. Fisheries Biology

STEELHEAD TROUT CLUB of WASHINGTON

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West Coast Regional Office

January 20, 2015

Will Stelle, NOAA /NMFS West Coast Region
Regional Administrator
7600Sand Point Way NE
Seattle, WA 98115

PSHatcheryEIS.WCR@noaa.gov

Dear Mr. Stelle,

Thank you for the opportunity to submit public comment on the Hatchery & Genetic Management Plans (HGMP) noted above.

We are in support of the 5 up dated Hatchery & Genetic Management Plans (HGMP) for "early winter" Steelhead submitted by the Washington Department of Fish & Wildlife (WDFW) & Puget Sound Tribes (the co-managers).

We also understand that the WDFW & co-managers have modified the initial submissions for the Snohomish HGMP as of Jan. 12, 2015. We have received copies of the modified HGMP for both the Skykomish (Wallace & Reiter) hatcheries & Snoqualmie (Tokul) hatchery & are in full support of both of the modified HGMP's.

A concern as you move forward with the approval process is that these plans are given priority so that time lines for "early winter" hatchery release in April & May can be accommodated.

The WDFW has made considerable changes in hatchery practices & have followed the Hatchery Scientific Review Group (HSRG) recommendations over the past few years.

The changes are significant & include;

- Substantial reductions in the hatchery releases of "early winter" Steelhead
- Off station hatchery release sites of "early winter" Steelhead have been discontinued
- "Early Winter" Steelhead that are not harvested by sport fishers & co-managers are captured in hatchery traps & removed from the system (some are retained for future brood stock) with any surplus given to charitable groups.
- Any wild fish captured in hatchery traps are released unharmed back into the river
- Off station "early winter" acclimation or rearing sites have been discontinued
- Sport & co-manager fishing seasons are now restricted to target "early winter" Steelhead (most ending in Jan. or mid Feb.) Non retention of wild fish which cannot be removed from the water & must be released unharmed
- Only marked "early winter" fish are allowed to be harvested, further protecting wild fish

We applaud the WDFW for following & implementing these & other HSRG management tools to protect wild fish. The results have been positive with improved wild fish returns to these rivers.

HSRG was established by congress as a "Scientific" effort to help solve hatchery management problems. The HSRG charter (Section 3 page 36) does not require that science solely is the way to manage hatcheries. The document which sets forth the criteria for management specifically states that science alone does not provide all the answers!

Habitat is the major factor as stated over & over by the co-managers. Lost habitat, dams, water quality & pollution, residential & commercial development in our river basins & major issues with migrating fish passage through Puget Sound are the biggest factors in recovering fish. It is clear that it is not the introduction of "early winter" fish that causes the problem.

The Wynooche, Satsop hatcheries along with the Sol Duc (prior wild brood stock only) & other rivers are doing well with managed hatchery programs. The Skagit River (following HSRG guide lines) has grown from a low of 2500-2600 wild fish in 2006 to over 9,000 expected to return in 2014 – 2015. In contrast the rivers where "early timed" programs have been eliminated, the Nisqually River has gone from a robust run of 5,000 - 6000 wild fish to a few hundred! The Cedar River wild fish run is now considered functionally extinct! Examples on both fronts can be made but it is clear that the biggest issue is not hatcheries but is more directly related to habitat.

The point here is that there is room for both well managed "early winter" Steelhead programs that follow HSRG guide lines & management of our wild Steelhead stocks in the Puget Sound basin. More than simply using science (as noted earlier) needs to be considered in the equation for the needed hatchery permits.

Let's hope the process continues to move forward. We are in full support the Puget Sound hatchery submissions given to NOAA / NMFS by the WDFW & CO-MANAGERS. We trust you will move as quickly as possible with the information that has been provided.

Sincerely,

Al Senyohl, Pres. Steelhead Trout Club of WA (in our 87th year)

CC: Jim Scott, WDFW
Kelly Cunningham, WDFW
Bob Leland, WDFW
Sandy Mackie, Perkins Coie Law Firm
Ray Fryberg, Sr Tulalip Tribe
Merle Jefferson, Lummi Nation
Bob Kelly, Nooksack Tribe
Isabel Tinoco, Muckleshoot Tribe

[redacted]

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Comments on the Puget Sound Draft EIS - Steelhead Trout Club of WA

1 message

Margason, Aubri N. (Perkins Coie) <AMargason@perkinscoie.com> Fri, Jan 23, 2015 at 2:11 PM
To: "PSHatcheryEIS.wcr@noaa.gov" <PSHatcheryEIS.wcr@noaa.gov>

Mr. Stelle:

Perkins Coie submits the attached comment letter on NOAA Fisheries' Puget Sound Draft EIS on behalf of the Steelhead Trout Club of Washington.

Thank you,

Aubri Margason

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1-23-15 DEIS Comment Letter.pdf
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January 23, 2015

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Mr. William Stelle
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, Washington 98115
PSHatcheryEIS.wcr@noaa.gov

Re: Public Comment Regarding Wild Fish Conservancy's Comments on Draft Environmental Impact Statement on Two Joint Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs, NOAA Fisheries, July 2014

Dear Mr. Stelle:

Perkins Coie submits the following letter on behalf of its client, the Steelhead Trout Club of Washington ("STC"). STC has already submitted a comment letter regarding the draft environmental impact statement ("DEIS") noted above. STC's comment letter is in support of the Resource Management Plans ("RMPs") and Hatchery & Genetic Management Plans ("HGMPs") as proposed by the Washington Department of Fish & Wildlife ("WDFW") and encourages NMFS to review WDFW's plans as proposed. In the time since STC submitted its public comments on the DEIS, STC has had the opportunity to review public comments submitted by the Wild Fish Conservancy ("WFC"). It is in regard to WFC's comments that Perkins Coie submits this letter on behalf of STC.

STC was disappointed to read WFC's comments to the DEIS. STC's firm position is that NMFS should not delay past April 2015 in issuing its approval of the State's RMPs under the Endangered Species Act ("ESA") 4(d) rule, and specifically Limit 6 of the 4(d) rule. 50 C.F.R. § 223.203(b)(6). WFC's comments on the DEIS are an attempt to pressure NMFS into delaying its 4(d) approval by attempting to insert the 4(d) analysis into the NEPA process. *See* WFC Comment Letter, at 7-9. WFC claims that NMFS' entire DEIS is insufficient because it does not independently evaluate whether the proposed alternatives meet the requirements of the 4(d) rule. *Id.* WFC forgets that NMFS' 4(d) approval of the RMPs is separate from the NEPA process, which NFMS explicitly acknowledges in its DEIS. *See* DEIS, at 1-6 ("While this EIS outlines the effects of hatchery operations on the human environment, it is not the documentation that determines whether the two RMPs meet the requirements of Limit 6 [of the 4(d) rule]"). WFC would have NFMS include its 4(d) approval analysis within the DEIS—an inappropriate combination of two processes that NFMS has stated require separate decision documents.

WFC's comments are merely an attempt to delay NMFS' 4(d) approval of the RMPs past April 2015, which is when NMFS has indicated that it will make its 4(d) decision.

NMFS' timely 4(d) approval of the RMPs is necessary because it provides an exemption from the ESA's "take" liability for the release of early winter hatchery Steelhead. STC opposes any delay that would result in the loss of the 2015 hatchery production that needs to be released this spring. The early winter Steelhead release is essential for ensuring that sport-fishers, like the 50-60 members of STC, have access to Steelhead populations. STC's members rely on returning Steelhead populations for the enjoyment of fishing, as well as for revenue-generation through work as guides or as purveyors of fishing equipment. These interests will be severely impacted if NMFS does not issue 4(d) approval for the RMPs in time for the early winter hatchery release in April and May 2015. The State also stands to lose the valuable resources that it has put into raising hatchery Steelhead if it is not able to release those fish.

NMFS has already shown that it can issue 4(d) approval outside of the NEPA process through its 4(d) approval of the Elwha River hatchery programs. STC therefore encourages NMFS to move forward with its 4(d) approval of the RMPs, and to not allow the EIS process to delay that decision. WDFW's RMPs and HGMPs, as proposed, achieve the conservation standards of the ESA, and hatchery fish from WDFW's well-managed hatchery programs provide a harvestable alternative that is protective of wild fish populations. NMFS should act quickly and prudently in issuing its 4(d) approval as schedule this April, before the State and STC are irreparably injured by the loss of the 2015 early winter hatchery production. Delay in the 4(d) approval decision does not serve any public purpose and will not affect NMFS' ongoing EIS process.

STC thanks NMFS for the opportunity to submit public comments on the DEIS, and renews its support for NMFS' review of the RMPs and HGMPs as proposed by WDFW. STC hopes that NMFS will continue to separate the 4(d) approval process from the NEPA process, and will issue its 4(d) approval as planned in April 2015.

Very truly yours,

Louis J. Iani

LJI

Steve Leider - NOAA Federal <steve.leider@noaa.gov>

Comments on Puget Sound DEIS from Trout Unlimited

1 message

John McMillan <jmcmillan@tu.org> Tue, Jan 20, 2015 at 12:06 PM
To: "steve.leider@noaa.gov" <steve.leider@noaa.gov>
Cc: "barry.thom@noaa.gov" <barry.thom@noaa.gov>, "will.stelle@noaa.gov" <will.stelle@noaa.gov>, "james.scott@dfw.wa.gov" <james.scott@dfw.wa.gov>

Dear Steve Leider

Attached you will find comments from Trout Unlimited regarding the Puget Sound DEIS. We appreciate the opportunity to comment on this important process and look forward to working collaboratively on finding smart solutions to the problems facing ESA-listed steelhead in Puget Sound.

Have a great week.

Sincerely

John R. McMillan

John R. McMillan | Science Director, Wild Steelhead Initiative

TROUT UNLIMITED

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TU Comment on PS HGMP DEIS 1-19-15.pdf

January 23, 2015

Steve Leider
NMFS Sustainable Fisheries Division, West Coast Region
510 Desmond Drive SE, Suite 103
Lacey, WA 98503

Sent via email to: ***steve.leider@noaa.gov***

Re: Comments on Puget Sound Hatchery Program DEIS

Dear Mr. Leider:

Trout Unlimited (TU), the nation's largest coldwater fisheries conservation organization dedicated to protecting and retoring our nation's trout and salmon resources and the watersheds that sustain them, appreciates the opportunity to submit this letter as comment on NOAA's Draft Environmental Impact Statement regarding two Resource Management Plans developed jointly by the Washington Department of Fish and Wildlife and the Puget Sound treaty tribes (hereafter referred to collectively as the co-managers), covering more than 100 Puget Sound hatchery programs (hereafter referred to as the Hatchery DEIS). The Hatchery DEIS was published in July 2014, and the period for written public comment was extended to January 23, 2015.

Introduction

As noted in the document itself, "The purpose of an EIS under NEPA is to promote disclosure, analysis, and consideration of the broad range of environmental issues . . . by considering a full range of reasonable alternatives." (S-6) Moreover, the specific purpose this Hatchery DEIS is intended to serve is "to ensure the sustainability and recovery of Puget Sound salmon and steelhead by conserving the productivity, abundance, diversity, and distribution of listed species of salmon and steelhead in Puget Sound." (S-4) It is with these purposes in mind that TU submits its comments. Our objective is to ensure that the final Environmental Impact Statement analyzes an adequate range of alternatives and fully and accurately identifies and evaluates the potential effects of each alternative so that well-informed decisions regarding the consistency of the Resource Management Plans (RMP) with the Endangered Species Act and other applicable laws and policies can be made.

TU recently launched a coast-wide Wild Steelhead Initiative, which is designed to rebuild wild steelhead populations in rivers with high potential to support abundant, fishable wild steelhead populations. TU also recognizes that not all rivers that once supported wild steelhead have such potential due to severe habitat degradation, and that such systems

may be appropriate for steelhead hatcheries as a way to provide tribal and non-tribal fisheries. Reflecting our organizational emphasis on steelhead, our comments are focused on those aspects of the Hatchery DEIS pertaining to steelhead.

Before presenting commentary on specific issues, it is important briefly describe the current Puget Sound steelhead hatchery system and the purposes the hatcheries are intended to serve. Of the 23 steelhead hatchery programs in Puget Sound, only four have a conservation purpose; 19 are intended to produce fish for harvest (Table 2.2-3) using out-of-basin steelhead that originated in Chambers Creek (hereafter referred to as Chambers Creek stock). This means that only four of the programs have the potential to confer a recovery benefit to wild steelhead listed under the ESA. Based on the overwhelming scientific evidence regarding the effects of out-of-basin hatchery steelhead fish used to augment fisheries (e.g., Berejekian and Ford 2004; Chilcote et al. 2004, 2011; Kostow and Zhou 2006; RIST 2009), all such programs are negatively impacting wild steelhead, and the only question is the degree of harm.

Flaws in the Hatchery DEIS

1. <u>Aggregation of steelhead and salmon in alternatives analysis is contrary to NEPA's purpose because it hinders -- rather than enables -- informed decision-making regarding the effect of the RMPs on the productivity, abundance, diversity, and distribution of Puget Sound steelhead and their effect on potential steelhead fisheries.</u>

The fact that the Hatchery DEIS addresses RMPs that were first submitted to NOAA in 2004 makes commenting difficult due to major developments over the ensuing decade, not the least of which were the ESA-listing of the Puget Sound steelhead DPS (2007) and a wealth of new scientific research regarding the effects of hatchery steelhead on wild steelhead. Indeed, after NOAA issued the Hatchery DEIS, in November 2014 the co-managers submitted revised HGMPs for five winter steelhead hatchery programs. These revised HGMPs have not been evaluated in the Hatchery DEIS.

The decision to combine steelhead and all salmon species in a single EIS is problematic because steelhead differ from salmon in several important and consequential respects. First, they are trout, not salmon, and have significantly different life histories (Behnke 2002) and conservation needs (Busby et al. 1996). For example, unlike salmon, a significant portion of steelhead in any given population can spawn multiple times (Busby et al. 1996; Savvaitova et al. 2003). Second, steelhead, which are sea-run rainbow trout, mate (McMillan et al. 2007) and interbreed with resident rainbow trout populations (Seamons et al. 2004; Christie et al. 2011). As a result of these complexities steelhead display the most diverse set of life histories of any salmonid (up to 36 life histories: Thorpe 1998; Moore et al. 2014). Third, the diversity of steelhead (genetic, phenotypic, life-history), even more than for salmon, is key to maintaining productive wild populations because it helps buffer against environmental variability (e.g., Moore et al. 2014). Lastly, steelhead are particularly vulnerable to effects of hatchery practices (such

as selection for different growth rates: Reisinbichler et al. 1977) because they are one of the few species that require a prolonged rearing period (Berejekian and Ford 2004). As a result, hatcheries can dramatically simplify the natural life history diversity of steelhead (Tipping 1991), making the diverse wild steelhead particularly vulnerable to the deleterious effects of interbreeding with less diverse hatchery steelhead (Pearse et al. 2011).

There are also major differences in steelhead versus salmon fisheries. Unlike salmon, there are no commercial marine fisheries targeting steelhead. Also, there are no sport fisheries targeting steelhead in marine waters. Furthermore, most sport fishers targeting salmon prefer to kill and eat salmon – particularly chinook and coho – when regulations permit. In contrast, many steelhead anglers prefer to catch-and-release wild steelhead because they prize the opportunity to catch over the opportunity to harvest. This has significant socio-economic implications as discussed below.

These major differences are "washed out" in the Hatchery DEIS because the steelhead analysis is combined with the analysis of all salmon species. This renders the alternatives analysis inaccurate for steelhead, particularly conclusions regarding the likely effect of the alternatives on steelhead fisheries and socio-economic benefits and costs.

Due to the fact that there are five new HGMPs that were not analyzed in the Hatchery DEIS and the inaccuracies in the alternatives analysis resulting from both the aggregation of salmon and steelhead, we respectfully request that NOAA issue a supplemental DEIS addressing steelhead alone. A separate analysis that takes into account the unique biological needs of steelhead and the different socio-economics of steelhead fishing is essential to achieving NEPA's intended goal of promoting disclosue and analysis, and enabling informed decision-making.

2. <u>The Hatchery DEIS does not contain an adequate range of alternatives to fully and accurately analyze the likely effect on wild steelhead of different hatchery management options; one alternative that should be considered is the cessation of hatcheries in systems, such as the Skagit, with substantial wild steelhead populations and sufficient habitat to support wild fish.</u>

Analysis of alternatives is the "heart of the environmental impact statement." 40 C.F.R. § 1502.14. To that end, NEPA requires agencies to "[r]igorously explore and objectively evaluate all reasonable alternatives." *Id*. The "'existence of a viable but unexamined alternative renders an environmental impact statement inadequate.'" *Alaska Wilderness Recreation & Tourism Ass'n v. Morrison*, 67 F.3d 723, 729 (9th Cir. 1995).

The Hatchery DEIS fails to present and analyze an adequate range of reasonable alternatives. In fact, the alternatives considered are extremely limited. All alternatives assume continued operation of every existing steelhead hatchery, and all alternatives assume that the current purpose and operation of every steelhead hatchery remains the same. The result is only very minor differences among the alternatives due to changes in

only one variable – the number of juvenile fish released. Consequently, many other reasonable alternatives, including cessation of all isolated "harvest" steelhead hatcheries and conversion of isolated "harvest" hatcheries to integrated "conservation" hatcheries, are not rigorously explored and objectively evaluated as NEPA requires.

A specific alternative that should be considered in a supplemental DEIS is one that ceases steelhead hatchery operations in rivers, such as the Skagit, with substantial wild steelhead populations and sufficient habitat to support abundant, fishable wild steelhead populations, while using steelhead hatcheries to provide fisheries in river systems that, due to severe habitat degradation, no longer have potential to support fishable populations of wild steelhead. Such an alternative would appropriately take into account the major differences in habitat quantity and quality among Puget Sound rivers, and would better serve the goal of healthy, fishable and harvestable wild steelhead that is shared by tribal fishers and recreational anglers, and would be much more consistent with Washington's Statewide Steelhead Management Plan than any of the current alternatives presented.

Lastly, we disagree with NOAA's reasons for rejecting an alternative that would fully implement Hatchery Scientific Review Group's (HSRG) recommendations, which was an alternative requested during scoping of the DEIS. Such an alternative should be included because it is markedly different than the alternatives in the Hatchery DEIS and warrants consideration along with others to present a full range. The reason that NOAA gives for rejecting the option – that the co-managers are presently implementing all HSRG recommendations and will continue to do so through adaptive management therefore such an alternative need not be considered (p. 2-27) – is wrong for several reasons. First, the factual basis for the rejection is erroneous. Based on the record of implementation to date, correspondence with participants in the HSRG process, and the HSRG's recent report, *On the Science of Hatcheries: An updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest* (October 2014), many of the recommendations are not being implemented by the co-managers and there is no basis for assuming that they will be in the future. Second, even assuming that the HSRG recommendations will be fully implemented, none of the Hatchery DEIS alternatives embody those changes and therefore they are not analyzed and cannot inform decision-making, which is the central purpose of an EIS.

For the reasons discussed above, the alternatives presented in the Hatchery DEIS fall far short of NEPA's requirement that a full range of alternatives be considered to enable informed decision-making. Accordingly, NOAA should issue a supplemental DEIS with additional alternatives, including those requested here, that present and analyze a full range of steelhead hatchery options.

3. <u>The Hatchery DEIS uses inaccurate and outdated scientific information regarding the effects of Puget Sound steelhead hatcheries on wild steelhead productivity, abundance, diversity and spatial distribution.</u>

The DEIS makes several statements that are contradicted by recent peer-reviewed scientific literature and evaluations of hatchery influences on wild steelhead.

a. The Hatchery DEIS inaccurately states that run-timing of segregated steelhead hatcheries prevents harm to wild winter steelhead (p. 3-166).

The above statement is not accurate for several reasons. First, there is overwhelming evidence that a substantial portion of wild steelhead historically entered rivers from late-November through January. Steelhead fishing seasons typically closed at the end of February in Washington State, and thousands of steelhead were caught annually in December and January, prior to the advent of Chambers Creek hatchery stock (Larson and Ward 1955; WDG 1956;Taylor 1979; McMillan 2008). In fact, estimates of steelhead catch in many of the streams were higher in December and January than they were in March (WDG 1956; Royal 1972; Taylor 1979). The historically earlier return timing would have provided substantial opportunities for wild steelhead to overlap and interact with Chambers Creek steelhead. Hence, present assumptions in the DEIS about run-timing differences between hatchery and wild steelhead are being made after decades of harvest fisheries, and potential interbreeding and competition with Chambers Creek steelhead.

Despite alterations to historic population attributes, Seamons et al. (2012) still found that using early-timed stock did not prevent interbreeding between wild and hatchery steelhead and that up to 80% of the offspring in a given year were from hatchery x wild matings. Recent observations in tributaries to the Skagit River also found substantial temporal overlap in spawn timing of hatchery Chambers Creek and wild steelhead (McMillan 2014). Such overlap likely explains the results of a recent report by Warheit (2014), which found substantial genetic interactions between hatchery (Skamania and Chambers Creek stocks) and wild steelhead in several Puget Sound streams. As a result the author concluded that segregated hatchery programs in the Green, Snohomish, Stillaguamish, Skagit, and Nooksack River basins have affected the genetic structure of the wild steelhead populations in those rivers. Although the Hatchery DEIS only considers hatchery winter steelhead, the results of Warheit (2014) suggest it is also necessary to include data on the effects of hatchery summer steelhead. Lastly, the Hatchery DEIS underestimates the harmful effect of hatchery steelhead on wild steelhead because most hybrids do not survive to adulthood (Chilcote et al. 1986; Leider et al. 1990), which means that the introgression measured in Warheit (2014) only considers the few that survived to become adults and does not account for all the other hybrids that perished as juveniles. In sum, the Puget Sound segregated steelhead hatcheries have had a profound negative impact on wild steelhead – particularly the historically large early-timed component of wild run.

Second, while run-timing is partly under genetic control (Hendry et al. 2002) and hatchery managers have attempted to select for early-timed adults in Chambers Creek stock, steelhead and rainbow trout of different life histories commonly give rise to alternatives (Kendall et al. 2014). Further, spawn timing is also influenced by water

temperature (Brannon et al. 2004) and relatively warmer or cooler thermal regimes could facilitate greater overlap between hatchery and wild steelhead. These factors could help explain why spawning hatchery and wild steelhead overlapped in Seamons et al. (2012) and McMillan (2014).

Third, a proportion of hatchery smolts never migrate to the ocean and instead remain in freshwater as residents or "residuals" (McMichael et al. 2000). Residency is more common in males than females (Rundio et al. 2012) and hatchery steelhead are known to produce mature residual males (hereafter referred to as precocious males: Schmidt and House 1979; Tipping et al. 2003). Precocious hatchery males are released into the river during or near the peak spawn time for wild steelhead and have been observed spawning with wild female steelhead (McMillan et al. 2007). Thus, selection for timing of return by adult steelhead does not eliminate precocial males with different spawn timing, indicating the potential spawn timing for Chambers Creek steelhead is broader than stated in the Hatchery DEIS. Considering that 2.5 million steelhead are released annually into Puget Sound streams, even a small percentage of residual males could represent a substantial portion of male mates in the wild populations.

Fourth, the return timing does not eliminate potential effects of competition and predation between wild and hatchery smolts, which is acknowledged by NOAA in the Hatchery DEIS. Importantly however, just because a Chambers Creek steelhead may spawn earlier than a wild steelhead does eliminate effects later in the life cycle. In fact, it may exacerbate them. For example, offspring from salmonids that spawn earlier in the season are typically larger entering their first summer than those offspring from adults that spawned later in the year because they had greater time for growth (Groot and Margolis 1991; Quinn 2005). We assume, then, that offspring from Chambers Creek steelhead are likely to be larger in size early in summer because they emerge earlier than offspring from the proportion of the wild steelhead population that spawns later in the spring (Noble 1991). The larger size provides competitive benefits to hatchery fry, which can displace or dominate smaller wild individuals and ultimately influence the distribution and growth of wild fry (Noble 1991).

b. The Hatchery DEIS inaccurately states that life history attributes and distribution of natural-origin steelhead are not influenced by releases of hatchery steelhead (p. 4-438-39).

As just discussed, there was a large early-timed component of wild steelhead in November, December and January in Puget Sound prior to the advent of the Chambers Creek hatchery stock (Larson and Ward 1955; Taylor 1979). And, there is currently more extensive overlap in spawn timing of Chambers Creek and wild steelhead than is acknowledged in the draft Hatchery DEIS (e.g., McMillan 2008, 2014). Thus, interbreeding between Chambers Creek stock and wild steelhead, as well as the harvest of wild steelhead in fisheries targeting hatchery fish, has already strongly altered the run-timing of wild steelhead in Puget Sound (e.g., McMillan 2008), which is a critical aspect

of life history diversity. Additionally, interbreeding and competition with Chambers Creek steelhead has the potential to influence the spatial distribution of wild steelhead (e.g., Pearse et al. 2011) in locations where they spawn at similar times, which appears more common (e.g., Seamons et al. 2012; McMillan 2014) than the Hatchery DEIS suggests. Consequently, we strongly disagree that Chambers Creek steelhead have not and do not have the capacity to deleteriously influence life history diversity and distribution of wild steelhead. In fact, the overwhelming evidence suggests that deleterious effects are substantial and pervasive.

Changes to life history diversity and distribution have important implications for the future viability of wild steelhead in Puget Sound. Indeed, the Hatchery DEIS states that life history differences within and among steelhead in the river basins represent the genetic and behavioral diversity that allows the species to adapt to short-term and long-term habitat changes over time (p. 4-438). As an example, shifts in stream temperature and flow regimes related to climate change pose threats to wild steelhead (Waples et al. 2009), particularly in Puget Sound due to factors such as increased high flows during spawning and decreased summer low flows during rearing (Wade et al. 2009). Steelhead display remarkable plasticity and their life histories can change with a changing environment, but only if they have a full reservoir of genetic and phenotypic diversity to draw upon (Moore et al. 2014; Kendall et al. 2014). Earlier spawning may be part of the solution for wild steelhead persistence as it is now in warmer climates of coastal Oregon and northern California (Busby et al. 1996). It would provide juvenile fish the benefit of earlier emergence and greater growth entering summer, which will be critical to maintaining an evolutionary pace with the earlier onset and greater duration of summer low flows. This will not be possible however if the genetic and phenotypic diversity of steelhead continues to be limited and constrained by the early-timed Chambers Creek stock.

4. <u>The Hatchery DEIS analysis of the potential effects of changes in hatchery management on steelhead fisheries is based on outdated and inaccurate information, and fails entirely to consider catch and release fishing opportunity and its socio-economic benefits.</u>

The analysis of the socio-economic impacts of the alternatives with regard to steelhead fisheries is deeply flawed for several reasons and must be remedied in a supplemental DEIS.

a. The aggregation of salmon and steelhead fisheries results in a highly biased and inaccurate analysis of the socio-economic effects of changes in steelhead fisheries under each alternative.

As discussed above, the draft Hatchery DEIS inappropriately aggregates all salmon species and steelhead in its alternatives analysis. Nowhere are the problems with this "lumping" more pronounced than in the socio-economic analysis. By far the biggest

problem is that salmon and steelhead fisheries are very different in terms of location, size, purpose and gear. Two major differences include: (1) steelhead are not commercially or recreationally harvested in the marine environment; (2) commercial harvest of steelhead is limited to in-river tribal fisheries.

These major differences are simply lost in the Hatchery DEIS because of the aggregated analysis of salmon and steelhead in the four alternatives. The practical effect of this aggregation is to imply significant negative socio-economic effects of the reduction in hatchery production of steelhead called for in Alternative 3, and, conversely, to imply that Alternative 4 would have substantial socio-economic benefits related to steelhead fisheries. (Tables 4.3-6, 4.3-7). Neither of these implications is accurate. This thwarts, not enables, informed decision-making.

Table 3.3-3 shows just how minor the economic benefits of the commercial steelhead fishery is today and would be under any of the analyzed alternatives. The total number of fish caught annually projected to be between 600 and 810 fish under the four alternatives, with an economic value of only between $4,400 and $5,600. In contrast, the commercial salmon fisheries are many orders of magnitude larger. And, of course, when the cost of producing these hatchery fish is factored into the analysis, the cost of producing wild steelhead far exceeds their commercial value.[1]

b. The method chosen for valuing recreational fisheries in the Hatchery DEIS fails entirely to account for catch-and-release fisheries focused on wild steelhead and the socio-economic benefits they provide, while also vastly inflating the contribution of the extant steelhead hatchery programs to recreational opportunity and socio-economic benefits.

Appendix 6 to the Hatchery DEIS describes the methods used to estimate the economic value of recreational fisheries in Puget Sound. The particular methodology used was to look at harvest data to estimate angler trips, and then monetize the value of those trips. (p. I-8) The major flaw in this approach is that it completely ignores catch-and-release fisheries,[2] which are highly popular and are focused on wild steelhead, not hatchery fish.

The effect of this lopsided analysis is to vastly over-value steelhead harvest fisheries provided by the current hatchery system, and, in turn, the importance of hatcheries to

[1] The Hatchery DEIS does not provide monetary estimates of the value of recreational steelhead fisheries in Puget Sound. Instead, all that is presented is aggregated information (Tables 4.3-4, 4.3-5). Thus, it is not possible to identify the economic value of recreational steelhead fisheries alone based on the information presented.

[2] Federal policy expressly promotes the use of catch-and-release fisheries as a way of providing fishing opportunity while ensuring the conservation of fish resources. Specifically, the Magnuson Stevens Act states that recreational fisheries should be managed "under sound conservation and management principles, including the promotion of catch and release programs in recreational fishing." (16 U.S.C. Section 1801(b)(3)).

providing fishing opportunity. The problem goes even deeper, however, because, as we have presented, the widespread use of isolated harvest hatcheries with Chambers Creek stock has been a major factor in the decline of wild steelhead populations on rivers like the Skagit and Snohomish, through interbreeding and competition with wild fish, as well as through mixed-stock harvest fisheries focused on hatchery fish that took a heavy toll on early-timed wild steelhead.

The decline of wild steelhead steelhead has led to severe restrictions on catch-and-release fisheries which, in turn, has resulted in major losses in recreational steelhead fishing opportunity and the substantial socio-economic benefits those fisheries provide. Indeed, it is highly probable that, in river systems like the Skagit and Snohomish, the cessation of problematic isolated hatcheries and harvest fisheries targeting hatchery fish would enable wild steelhead abundance to increase (e.g., Chilcote et al. 2004, 2011; Kostow and Zhou 2006) and thus provide more fishing opportunity and economic benefit than status quo management. Evidence of this can be found in the Skagit, where, as the number of Chambers Creek hatchery plants have decreased, wild steelhead abundance has swelled to over 9,000 fish – 3,000 over the escapement goal. In fact, analysis by Ruff et al. (2014) found a statistically significant negative relationship between the number of hatchery fish released and wild steelhead productivity in the Skagit River, and urged careful consideration of hatchery policy. Given that such a pattern exists in the Skagit River it is probably that wild steelhead could respond similarly in other rivers with adequate habitat.

The flaw of viewing fishing opportunity as contingent on harvest opportunity also results in inaccurate conclusions regarding the importance of steelhead hatcheries to fishing opportunity. Specifically, the the Hatchery DEIS describes the potential effect of reductions in hatchery steelhead releases under Alternative 3 as likely to result in a "major" reduction in recreational fishing opportunity in many Puget Sound. (Table 4.3-10). This erroneous conclusion is stated multiple times at various points throughout the DEIS (e.g., 4-114 (statement that steelhead fishing trips would decrease if hatchery production decreased); 4-144 (statement that North Sound steelhead fisheries are "enhanced" by hatcheries; 5-17 (same)). This conclusion is flawed in two respects. First, it assumes that there will be no catch-and-release steelhead fisheries providing recreational opportunity. Second, it reflects an inaccurate, overly optimistic view of of the contribution of isolated hatcheries to fisheries.

Far from providing a lot of angler opportunity, the fact is that hatchery steelhead adult returns are typically low providing little in the way of quality fishing opportunity in Puget Sound rivers. The Hatchery DEIS acknowledges that the overall total return benefit is low, largely because smolt-to-adult survival rates for the Chambers Creek stock are generally one percent or less (3.2.7.4.5). This is well below the survival rate goal of 5% for hatchery steelhead (Table B-8). This raises the question of whether the small number of adults provides any real benefits, particularly considering the risks to wild steelhead and the frequent recreational fishing closures. For example, the recreational steelhead fishery was closed in the Nooksack River this year due to low hatchery adult returns. In addition, attached to this comment letter is a graph of adult returns of hatchery and wild

steelhead in the Skagit River plotted against releases of hatchery juveniles, which clearly shows that adult returns are inversely related to hatchery plants. Indeed, Ruff et al. (2014) quantified this relationship and found that the return of wild adult steelhead in the Skagit River was negatively associated with increasing hatchery smolt plants. This suggests that the segregated hatchery program has actually reduced fishing opportunity on the Skagit, and it certainly has not improved it.

In summary, the central problem with NOAA's analysis of recreational steelhead fisheries is that the analytical construct is deeply flawed. By looking exclusively at how existing harvest fisheries based on segregated hatchery programs are affected by increases or decreases in hatchery production at those facilities, the conclusion is pre-determined: reductions in hatchery releases will reduce <u>that</u> opportunity. By conducting such a narrow analysis, NOAA utterly fails to take the required hard look at how the full range of recreational steelhead fisheries have been impacted by the existing hatchery system and would likely be impacted under the alternatives considered. Indeed, the evidence strongly indicates that the isolated steelhead hatcheries have had a negative impact on catch-and-release recreational angling opportunity with substantial negative socio-economic consequences. Accordingly, NOAA, consistent with the policy and requirements set forth in the Magnuson Stevens Act, needs to make a much more comprehensive and better substantiated analysis of recreational steelhead fishing and related socio-economic benefits in a supplemental EIS to meet NEPA requirements.

5. <u>The Hatchery DEIS fails entirely to address the effects of mixed-stock steelhead fisheries on wild steelhead.</u>

As discussed previously, a major shortcoming in the Hatchery DEIS is the failure to acknowledge the importance of the early-timed portion of the wild steelhead run to the health of Puget Sound wild steelhead populations and the impact the isolated hatcheries have had on early-timed wild fish. In fact, as mentioned earlier, the Hatchery DEIS explicitly -- and erroneously -- states that the early run timing of the Chambers Creek stock used in the isolated hatcheries prevents harm to wild winter steelhead because they are temporally segregated. (3.3.26). Historic records show clearly that there was a major early-timed component of wild steelhead in Puget Sound river systems, including the Skagit and Snohomish, proving false the assertion of temporal segregation (WDG 1956;Taylor 1979; McMillan 2008). In fact, for Puget Sound Larson and Ward (1954) found that over 80% of the steelhead catch in 1953 was between December and February and that the percentage of total catch per month was 27.7% in December, 21.0% in January, 31.7% in February, 18.2% in March, and 1.4% during April. There is also evidence that strong selection for early-timed breeding in Chambers Creek stock cannot enitrely eliminate interbreeding with wild steelhead and that levels of interbreeding can be quite high in some years (Seamons et al. 2012). This means that there has likely been high potential for competition and mating since the Chambers Creek stock was initially planted in Puget Sound River over 60 years ago.

The failure to recognize the existence, let alone significance, of the early-timed portion of Puget Sound wild steelhead populations, is a serious flaw in the Hatchery DEIS. Further, the scientific research that has come to light since the RMPs were first submitted to NOAA in 2004 clearly establishes the importance of life-history diversity to abundant, productive and resilient populations (Christie et al. 2011; Moore et al. 2014). Given that the purpose of preparing the EIS is "to ensure the sustainability and recovery of Puget Sound salmon and steelhead by conserving the productivity, abundance, diversity and distribution of listed species of salmon and steelhead in Puget Sound," (S-4, emphasis added) the state of the early-timed portion of the run is a highly relevant issue.

The evidence clearly indicates that isolated steelhead hatcheries have harmed wild steelhead, particularly the early-timed portion of the run through mixed-stock harvest fisheries targeting hatchery steelhead produced at the isolated facilities. The harvest data for rivers like the Skagit shows that for many years there was intensive harvest of hatchery and wild steelhead in the early winter when hatchery fish were returning (WDG 1956; Taylor 1979). These high harvest rates ultimately fell dramatically as the abundance of both wild and hatchery adults dropped precipitously. The Hatchery DEIS is completely silent on this issue, and NOAA needs to address it fully in a supplemental DEIS because the early-timed component of the population may be particularly important to rebuilding and sustaining wild steelhead in light of climate change and increased human population in Puget Sound.

6. The Hatchery DEIS fails to address how hatchery operations impact the large investments being made in Puget Sound habitat restoration, in particular whether hatcheries are reducing the benefits of habitat restoration for ESA-listed stocks and the return on those habitat investments to taxpayers.

Over the past decade, hundreds of millions of taxpayer dollars have been spent to restore salmon and steelhead habitat in Puget Sound to recover ESA-listed salmon and steelhead. TU supports these investments, which are necessary to restore the processes and structure of Puget Sound rivers that enable wild fish to flourish.

Of course, restored habitat itself does not produce more wild fish. Wild fish using that habitat increases the abundance, productivity, diversity and spatial distribution of wild fish. Thus, if taxpayers are to realize the full value of their habitat restoration investments, we must ensure that our hatchery practices do not significantly impair the ability of wild fish to use the productive capacity of the habitat we are working very hard to restore. This point was emphasized by the Hatchery Scientific Review Group in its recent report, *On the Science of Hatcheries: An updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest* (October 2014).

The Hatchery DEIS is completely silent on this topic. With regard to steelhead hatcheries, 19 of the 23 are operated to provide harvest opportunity using out-of-basin

Chambers Creek stock, as opposed to serving a conservation purpose. Scientific research has shown quite clearly that non-native hatchery stock survive at substantially lower rates than wild fish (Chilcote et al. 1986; Leider et al. 1990; Hulett et al. 1994; McLean et al. 2003, 2004; Araki et al. 2007). As a result, interactions with hatchery fish may impair and depress productivity of wild populations through various mechanisms (Chilcote et al. 2004, 2011; Kostow and Zhou 2006; Ruff et al. 2014), including genetic introgression (Pearse et al. 2011) and competition (Kostow and Zhou 2006).

So, for example, if a significant amount of new spawning habitat is opened up through habitat investments, to get the full benefit of those investments that habitat should be used by wild fish so that the offspring are fit and likely to survive and return as adults. If, however, a significant percentage of the spawners using that habitat are hatchery fish, the reproductive success of the spawners using that habitat will be significantly lower (Chilcote et al. 2004, 2011) because hatchery x wild hybrids have lower fitness (Araki et al. 2007) and, to the extent hatchery fish are interbreeding with wild fish, the genetic integrity of the wild population will be diluted (Pearse et al. 2011). The negative effects are carried through future generations reducing viability of the population (Goodman 2005), thereby impeding or preventing recovery (RIST 2009)

If those of us who care about the health of rivers and wild fish want to see public investments in habitat restoration continue – and that is all stakeholders, then we must demonstrate that hatchery and harvest actions are not undermining those investments. Indeed, NOAA has a legal mandate under the ESA to ensure that actions, such as the RMPs that are the subject of the Hatchery DEIS, not only do not result in extinction, but that they also are consistent with recovery of listed fish. This issue must be addressed in a supplemental DEIS.[3]

7. <u>The Hatchery DEIS fails to identify or analyze the cost of producing steelhead at Puget Sound hatcheries, which precludes a cost-benefit analysis that is essential for informed decision-making.</u>

Lastly, the socio-economic analysis lacks a cost-benefit analysis that is necessary to provide decision-makers with an understanding of the economic efficiency of hatchery operations. In particular, NOAA should calculate the cost of producing an adult hatchery steelhead at Puget Sound hatchery facilities. This information is important because it will reveal how effective license-holder and taxpayer investments in hatcheries are with respect to meeting their intended purpose. For 19 of the 23 steelhead hatcheries, that purpose is fish for harvest.

[3] We recognize that it probably is not possible to quantify the impacts of isolated steelhead hatchery operations on the efficacy of habitat restoration investments, but it certainly is possible to express qualitatively such impact based on peer-reviewed scientific literature. This information should be included in a supplemental DEIS.

Given the poor performance of isolated hatcheries in producing steelhead for harvest, such an analysis will almost certainly show that isolated steelhead hatcheries are not cost effective. When this information is coupled with the following facts: (1) that the fish produced in isolated hatcheries harm wild steelhead; (2) that the commercial value of harvested steelhead is projected to be less than $10,000 annually under all alternatives; and (3) that harvest is not necessary to realize major socio-economic benefits from recreational fishing opportunities -- none of the four alternatives analyzed in the Hatchery DEIS look appealing.

Conclusion

For all of the reasons explained in detail above, the draft Hatchery DEIS needs considerable improvements before it is consistent with NEPA requirements and will enable informed decision-making. In light of the depth and breadth of the flaws in the draft Hatchery DEIS, the appropriate course is for NOAA to issue a supplemental DEIS rectifying the numerous shortcomings.

A supplemental EIS must be prepared when necessary to serve the dual purposes of NEPA: "to assure that the public who might be affected by the proposed project be fully informed of the proposal, [and] its impacts…; and to give the agency the benefit of informed comments and suggestions as it takes a 'hard look' at the consequences of proposed actions." *Dubois v. U.S. Dep't of Agric.*102 F.3d 1273, 1291 (1st Cir. 1996).

With the the future of wild steelhead and steelhead fishing opportunity at stake, as well as the success of the public's enormous investment in Puget Sound habitat restoration, it is imperative that NOAA analyze a full range of reasonable alternatives using an approach that illuminates -- rather than obscures -- the effects of Puget Sound steelhead hatcheries, and that it utilize the best available scientific and economic information in conducting its analysis.

Thank you for your consideration.

Sincerely,

Rosendo Guerrero
Chair, Washington Council of Trout Unlimited

John McMillan
Science Director, Wild Steelhead Initiaitve

Cc: William W. Stelle, Jr., NOAA
Barry Thom, NOAA
Jim Scott, WDFW

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PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Comments on Draft Environmental Impact Statement for Puget Sound RMP and HGMPs

1 message

Brian A. Knutsen <briank@igc.org> Thu, Jan 22, 2015 at 11:34 AM
To: PSHatcheryEIS.wcr@noaa.gov
Cc: briank@igc.org

Please find attached public comments submitted with regard to NMFS' Draft Environmental Impact Statement for two Resource Management Plans and associated Hatchery and Genetic Management Plans for Puget Sound hatcheries.

Thank you, Brian.

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DEIS Comments.pdf
7447K

Wild Fish Conservancy
NORTHWEST
SCIENCE EDUCATION ADVOCACY

January 22, 2015

William W. Stelle, Jr.
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RE: Public Commentary submitted with Respect to Draft Environmental Impact Statement on Two Joint Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs, NOAA Fisheries, July 2014

Dear Regional Administrator Stelle:

Thank you for providing the opportunity to submit public comments on the draft environmental impact statement referenced above ("DEIS"). These comments are submitted on behalf of the Wild Fish Conservancy.

The task presently before the National Marine Fisheries Service ("NMFS") is momentous. The request to authorize "take" of threatened salmonids under the Endangered Species Act ("ESA") resulting from 133 hatchery programs is unprecedented. As the DEIS notes, this is the first evaluation under the National Environmental Policy Act ("NEPA") on the effects of the hatchery programs operating within the entire geographic boundaries of the affected listed species—the Puget Sound Chinook salmon evolutionary significant unit ("ESU") and the Puget Sound steelhead distinct population segment ("DPS"). NMFS' determination of whether, and if so, how, the Puget Sound hatchery programs can continue to operate without jeopardizing the survival and recovery of these threatened species is a critical decision affecting the entire region.

Unfortunately, the DEIS does not even attempt to provide the analyses necessary for such a determination. The DEIS is instead entirely divorced from the actual standards that govern the determinations that NMFS must make. The DEIS also does not provide the quantitative risk assessment needed to evaluate the risks associated with the Puget

Sound hatcheries at issue. We are hopeful that NMFS will address these significant shortcomings in manner that fulfills the requirements and intent of NEPA.

I. INTRODUCTION.

The DEIS has been prepared in response to the submission of two joint state-tribal RMPs for Puget Sound salmon and steelhead hatcheries. These RMPs and the Hatchery Genetic Management Plans ("HGMPs") associated with them have been submitted to NMFS for review and approval under the ESA 4(d) Rule, specifically Limit 6 of the 4(d) Rule. *See* 50 C.F.R. § 223.203(b)(6). NMFS' approval would provide conditional exemptions from liability for "take" of threatened species resulting from the hatchery programs. 50 C.F.R. § 223.203(c).

The purpose of NEPA is, *inter alia*, to declare a national policy that will encourage productive and enjoyable harmony between man and his environment, to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man, and to enrich the understanding of the ecological systems and natural resources important to the Nation. 42 U.S.C. § 4321. NEPA requires federal agencies undertake processes to "insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken" and that are "intended to help public officials make decisions that are based on understanding of environmental consequences." 40 C.F.R. §§ 1500.1(b) and (c).

To accomplish these purposes, NEPA requires federal agencies to prepare a "detailed statement" regarding all "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. § 4332(2)(C). The "detailed statement," commonly known as an environmental impact statement or EIS, is to describe the environmental impact of the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, alternatives to the proposed action, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. The requirement to prepare an EIS serves two important purposes: 1) it ensures the agency, in reaching its decision, will have available, and will carefully consider, detailed information concerning significant environmental impacts, and 2) it guarantees that the relevant information will be made available to the larger audience that may also play a role in both the decision making process and the implementation of that decision. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989).

NEPA imposes a requirement, independent of the need for an EIS, that agencies "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources." 42 U.S.C. § 4332(2)(E); *Bob Marshall Alliance v. Hodel*, 852 F.2d 1223, 1228-29 (9th Cir. 1988).

II. PURPOSE AND NEED.

The purpose and need statement is a crucial part of crafting and evaluating a reasonable range of alternatives because only a sufficiently broad statement will allow full development of an adequate range of alternatives. *See, e.g., Simmons v. U.S. Army Corps*, 120 F.3d 664 (7th Cir. 1997); *Davis v. Mineta*, 302 F.3d 1104, 1118 (10th Cir. 2002). Agencies cannot unnecessarily limit or interpret their purpose and thereby place unnecessary limits on the range of alternatives. *Id.*; *see also Van Abbema v. Fornell*, 807 F.2d 633, 638 (7th Cir. 1986), *see also 'Ilio'ulaokalani Coalition v. Rumsfeld*, 464 F.3d 1083 (9th Cir. 2006).

NMFS' description of the purpose and need is too vague to conduct any meaningful analysis of the alternatives. NMFS describes its purpose of the action as to "ensure the sustainability and recovery of Puget Sound salmon and steelhead by conserving the productivity, abundance, diversity, and distribution of listed species of salmon and steelhead in Puget Sound. *DEIS*, p. 1-8. NMFS explains its need as to:

- Respond to the request of the co-managers for an exemption from the take prohibitions of section 9 of the ESA for their hatchery programs triggered by submission of RMPs and appended HGMPs under Limit 6 of the 4(d) Rule.

- Provide, as appropriate, tribal and non-tribal fishing opportunities as described under the state and tribal co-managers' Puget Sound Salmon Management Plan implemented under *United States v. Washington*.

Id. However, NMFS does not provide any quantitative description of what is necessary to achieve these objectives. NMFS' failure to adequately define the purpose and need of the programs prevents any meaningful evaluation of the alternatives.

Importantly, the DEIS states that "NMFS, as a matter of policy, will accept some impacts that may result in increased risk to the listed species to provide limited tribal fishing opportunity. This approach recognizes that the treaty tribes have a right to conduct their fisheries within the limits of conservation constraints." *Id.* at p. 1-9. Yet, NMFS provides no quantitative criteria related to risk to the ESA-listed species at issue and no description of quantitative criteria by which NMFS determines how tribal fisheries contribute to such "increased risk," nor how that incremental level of risk is determined, and how it is further determined that the incremental risk falls within the "conservation constraints." Similarly, the DEIS provides no description, quantitative or otherwise, of what level of "fishing opportunities" are necessary or appropriate. The failure to provide such criteria is inevitable, given NMFS' refusal in the DEIS to employ a quantitative risk assessment.

In order to evaluate the alternatives for hatchery production listed in the DEIS, there needs to be a common currency in terms of which each alternative is measured in order that the probable outcomes of adopting one or another of the alternatives can be

estimated and compared to one another. The requisite currency must be objective and quantitative if the comparison is to provide a basis for sound and responsible public decision making, as required by NEPA. Where several objectives are to be pursued—for example, avoiding extinction, preserving the genetic diversity, fitness, and evolutionary potential of the extant wild salmon and steelhead populations, meeting Federal trust responsibilities to treaty tribes—these objectives must also be interpreted in terms of a common currency that is directly relevant to ESA concerns and evaluated accordingly. The DEIS fails to approach the comparison of alternatives in this way.

Many of the hatchery programs are funded by the United States (*e.g.,* by the Bureau of Indian Affairs). Is this NEPA process intended to fulfill NEPA requirements for such funding? If so, the purpose and need section of the DEIS should address this issue.

III. ALTERNATIVES.

"NEPA requires an EIS to describe and analyze 'every reasonable alternative within the range dictated by the nature and scope of the project.'" *Alaska Survival v. Surface Transp. Bd.*, 705 F.3d 1073, 1087 (9th Cir. 2013). The "touchstone" for evaluating the adequacy of an agency's NEPA efforts is whether the "selection and discussion of alternatives fosters informed decision-making and informed public participation." *California v. Block*, 690 F.2d 753, 767 (9th Cir. 1982); *see also Nat'l Highway Traffic Safety Admin.*, 538 F.3d at 1217 (describing the alternatives analysis as the "heart" of a NEPA evaluation). "[A]gencies should 'rigorously explore and objectively evaluate all reasonable alternatives' that relate to the purpose of the project." *Alaska Survival*, 705 F.3d at 1087.

A. <u>The "No Action" Alternative</u>.

The DEIS fails to identify and describe a proper "no action" alternative for several reasons. Under the "no action" alternative, NMFS would not make a determination on the RMPs, but the hatchery programs would continue to operate at the levels described in the RMPs and HGMPs.

Agencies must include a no action alternative in their NEPA analyses and give the no action alternative "meaningful consideration" in order to avoid violating NEPA's mandates. *See Bob Marshall Alliance v. Hodel*, 852 F.2d 1223, 1230 (9th Cir. 1988). "The no action alternative is meant to provide a baseline against which the action alternative . . . is evaluated." *Ctr. for Biological Diversity v. U.S. Dep't. of Interior*, 623 F.3d 633, 642 (9th Cir. 2010). A no action alternative is supposed to "facilitate comparison of the environmental impacts of the proposal and the alternatives." *Valley County v. United States Dep't of Agric.*, 2012 U.S. Dist. LEXIS 106667 (D. Idaho July 27, 2012) (citing 40 CFR § 1502.14) (internal quotation omitted). NEPA's required no action alternative "is meaningless if it assumes the existence of the very plan being proposed." *Friends of Yosemite Valley v. Scarlett*, 439 F. Supp. 2d 1074, 1105 (E.D. Cal.

2006) (finding that a no-action alternative could not properly include elements of an illegal plan).

The DEIS improperly assumes that the hatchery operations would continue operating in the manner described in the RMPs and HGMPs absent NMFS' approval. These programs have been conducted illegally without approval under the ESA 4(d) Rule. Further, many of the hatchery programs have been funded by the United States without NEPA and/or ESA compliance for such funding. The "no action" alternative should assume the programs will be discontinued. By failing to include a true "no action alternative," NMFS did not compare the effects of the proposed action against the effects of taking no action, thereby rendering NMFS' analysis virtually meaningless. As a result, the DEIS fails to meet the NEPA's purpose and mandate regarding the no action alternative.

Even if it were appropriate to identify the "no action" alternative in the manner proposed in the DEIS, the DEIS' description of this alternative is deficient because it does not account for changes in hatchery programs that have occurred since the RMPs and HGMPs were submitted—such as the reductions in the Chambers Creek steelhead hatchery programs—and it does not account for the fact that there are currently releases of Chambers Creek steelhead from only one program in Puget Sound (that in the Skykomish River) under the terms of a Consent Decree enter in *Wild Fish Conservancy v. Anderson*, W.D. Wash. No. 2:14-CV-00465-JLR (April 28, 2014), and that, due to the potential for future litigation, the Chambers Creek steelhead hatchery programs are not likely to operate again without ESA authorization. Accordingly, the "no action" alternative does not even describe current hatchery production as the DEIS purports.

B. <u>Reasonable Alternatives Not Included</u>.

The DEIS is also deficient for failing to consider a reasonable range of alternatives, including alternatives that were eliminated from detailed analysis. Such alternatives include (1) one where all hatchery program currently in violation of the ESA would be terminated; (2) one that maximizes the recovery potential for ESA-listed species; and (3) one that eliminates the use of non-native stocks (*e.g.*., the Chambers Creek steelhead and the Skamania steelhead programs, and Chinook programs using unlisted out-of-basin hatchery stocks detailed in DEIS Table 1.5-1, pages 1-14 to 1-19).

Under Alternative 3—Reduced Production—hatchery programs would be reduced by 50% in watersheds having Chinook salmon populations in recovery categories 1 and 2. This alternative should be made much more specific to ESA recovery concerns by including the requirement that additional program reductions would be required in all basins in which the 50% reduction fail to reduce pHOS of non-listed hatchery stocks to 5% or failed to achieve a PNI of at least 0.50 where listed hatchery stocks were involved and served a conservation purpose. There should also be alternatives considered that are intended to benefit the recovery of threatened Puget Sound steelhead and an alternative that is intended to benefit both threatened Chinook salmon and steelhead in a similar manner.

The alternatives selected for further consideration predetermine that, to the extent that NMFS acts on the submitted RMPs, it will approve them in some manner. It is inconsistent with NEPA for NMFS to determine that the RMPs comply with the requirements of the 4(d) Rule before completing the NEPA processes. There should be alternatives considered under which NMFS would determine that the RMPs and appended HGMPs are not approved because they do not meet legal requirements and/or that they are approved upon requirements to ensure that the RMPs and HGMPs comply with the 4(d) Rule.

The reasons provided in section 2.5 for not considering other specific alternatives are unconvincing. In particular, the alternative to incorporate all HSRG recommendations (section 2.5.2) is rejected on the grounds that "the co-managers are already implementing HSRG recommendations" (page 2-27). This is simply false. Most Chinook salmon hatchery programs are in violation of the HSRG's pHOS standards for segregated hatchery programs or the HSRG's PNI standards for integrated conservation hatchery programs (see our Comments below on the Green River Chinook salmon hatchery programs and the discussion of it in Appendix C of the DEIS). The HSRG repeatedly identifies the importance of local adaptation and reiterates the need to avoid transfer of hatchery fish among watersheds, yet many Puget Sound hatcheries routinely violate this principle. In any case, an alternative requiring compliance with the HSRG's out of basin transfer and pHOS and PNI standards that have been accepted by NMFS scientists should be fully developed and included among the alternatives.

An alternative to eliminate Chinook salmon hatchery programs from watersheds with recovery categories 1 and 2 Chinook salmon populations (section 2.5.4) is rejected for a variety of conflicting reasons: "because it would not meet the purpose and need … and would not meet ESA requirements of conserving listed Chinook populations supported by conservation hatcheries…." and "it may not meet treaty trust responsibilities." DEIS, p. 2-27. A modified alternative or set of alternatives should be developed that retain conservation hatcheries narrowly configured to meet only conservation purposes (not both harvest and conservation) for specific populations. Such an alternative could apply to both category 1 and 2 populations or only to category 1 populations, as suggested above for Alternative 3.

Further, the rejection of this alternative on grounds that it "may not meet" treaty trust responsibilities begs the question of what precisely these responsibilities are: specifically, how many hatchery fish must be produced and harvested by each Treaty Tribe in order to meet minimum trust responsibility requirements? This level of specificity is critical in order for the public to understand the precise nature and magnitude of the trade-offs between furthering recovery and satisfying legal trust obligations that NMFS may claim are involved in any specific case.

Climate change poses a considerable risk to the recovery of listed Puget Sound Chinook and steelhead populations. Among the most significant threats are increases in summer and fall water temperatures in freshwater rearing habitats and reduced summer

baseflow, both of which will reduce rearing capacity (for example, Mantua et al. 2010). Most hatchery facilities throughout Puget Sound obtain the majority of their water from surface water withdrawals from streams and rivers. These are considerably wasteful and will be increasingly so as the streamflow impacts of climate change advance. Water use reduction measures, such as water reuse and recirculation, will likely be required if hatchery facilities are to sustain even reduced levels of production in the near future while maintaining critical levels of instream flow to sustain wild fish. The DEIS should consider this critical issue. Alternatives that involve timely transitions to water supply and water use technologies for specific hatchery facilities should be developed and included in the DEIS. Economic impacts analyses should also be developed to account for the costs associated with the need to employ such water conservation technologies in order to more accurately reflect the cost of sustaining the levels of hatchery production associated with each alternative.

IV. ENVIRONMENTAL CONSEQUENCES.

"NEPA requires that a federal agency 'consider every significant aspect of the environmental impact of a proposed action…[and] inform the public that it has indeed considered environmental concerns in its decision-making process.' In order to accomplish this, NEPA imposes procedural requirements designed to force agencies to take a 'hard look' at environmental consequences." *Earth Island Inst. v. U.S. Forest Serv.*, 351 F.3d 1291, 1300 (9th Cir. 2003) (internal citations omitted). An EIS must provide full and fair discussion of significant environmental impacts and shall inform decision-makers and the public of reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment. 40 C.F.R. § 1502.1.

"The 'hard look' must be taken objectively and in good faith, not as an exercise in form over substance, and not as a subterfuge designed to rationalize a decision already made." *W. Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 491 (9th Cir. 2011). The EIS must include a discussion of adverse impacts that does not improperly minimize negative side effects. *Id.* "Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA. General statements about possible effects and some risk do not constitute a hard look absent a justification regarding why more definitive information could not be provided." *Id.* (internal citations omitted).

As described below, the DEIS fails to take the required hard look at the environmental consequences of NMFS' proposed action.

A. <u>The DEIS Does Not Adequately Address Whether the Alternatives Will Meet the Requirements of the 4(d) Rule.</u>

The proposed action for which the DEIS has been prepared is NMFS' review and evaluation of two RMPs and appended HGMPs submitted under Limit 6 of the 4(d) Rule. Yet, the DEIS does not contain analyses of whether any of the alternatives satisfy the requirements for approval under the 4(d) Rule. The DEIS is therefore insufficient.

An EIS must adequately address the statutory or regulatory considerations that govern the proposed federal actions. The Ninth Circuit Court of Appeals has observed:

> "In order to decide what kind of an environmental impact statement need be prepared, it is necessary first to describe accurately the 'federal action' being taken." Thus, just as "where an action is taken pursuant to a specific statute, the statutory objectives of the project serve as a guide by which to determine the reasonableness of objectives outlined in an EIS," so too do the statutory objectives underlying the agency's action work significantly to define its analytic obligations. Put differently, because "NEPA places upon an agency the obligation to consider every significant aspect of the environmental impact of a proposed action," the considerations made relevant by the substantive statute driving the proposed action must be addressed in the NEPA analysis.

Or. Natural Desert Ass'n v. Bureau of Land Mgmt., 625 F.3d 1092, 1109 (9th Cir. 2010) (internal citations omitted).

Here, the "federal action" for which the DEIS has been prepared is:

> [NMFS'] review and evaluation of two resource management plans and appended hatchery and genetic management plans submitted jointly by the fishery co-managers for hatchery programs in Puget Sound, under Limit 6 of the 4(d) rules for Puget Sound Chinook salmon and steelhead that are listed under the Endangered Species Act.

The DEIS further states that NMFS' purpose and need for the proposed action is to "[r]espond to the request of the co-managers for an exemption from the take prohibitions of section 9 of the ESA for their hatchery programs triggered by submission of RMPs and appended HGMPs under Limit 6 of the 4(d) rule. DEIS, p. 1-8.

The 4(d) rule includes criteria for NMFS' approval of RMPs under Limit 6. NMFS may approve RMPs where:

> (i) The Secretary has determined pursuant to 50 CFR 223.209 and the government-to-government processes therein that implementing and enforcing the joint tribal/state plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs.
>
> (ii) The joint plan will be implemented and enforced within the parameters set forth in *United States v. Washington* or *United States v. Oregon*.

50 C.F.R. § 223.203(b)(6). Further, as NMFS has noted, any HGMPs submitted as part of a RMP under Limit 6 of the 4(d) Rule must meet the criteria of Limit 5. *E.g.*, DEIS, p. 1-11. This requires that the HGMP: clearly state goals and performance indicators,

utilize concepts of viable and critical salmonid population threshold, appropriately reflect priorities through the broodstock collection programs, include specified protocols, evaluate, minimize, and account for genetic and ecological effects on natural populations, describe the interrelationships and interdependencies with fisheries management, apply to adequate artificial propagation facilities, include adequate monitoring and evaluation that exists to detect and evaluate the success of the program and any risks to the recovery of listed ESU, and provide for evaluating monitoring data and making revisions to assumptions, management strategies, or objectives. 50 C.F.R. § 223.203(b)(5)(i).

There are thus extensive regulatory criteria that apply to the proposed "federal action"—NMFS' review and evaluation of the RMPs and HGMPs under the 4(d) Rule. The DEIS does not adequately address these criteria and whether or how any of the alternatives or the RMPs and HGMPs meet the criteria. Remarkably, the DEIS does not include an analysis of whether the alternatives will appreciably reduce the likelihood of survival and recovery of threatened salmonids. In fact, the DEIS states that it will not document whether the RMPs and HGMPs meet the requirements of the 4(d) rule, but that those issues will be addressed in ESA documents. *E.g.,* DEIS, pp. 1-10 to 1-12. This does not fulfill the requirements of NEPA and it frustrates the ability of the public to understand and comment on NMFS' proposed action and alternatives thereto.

The DEIS should make more extensive use of the four Viable Salmonid Population (VSP, sensu McElhany et al. 2000) parameters in its analyses of the impacts of specific hatchery programs on individual populations within the Puget Sound Chinook ESU and steelhead DPS. These parameters are population abundance, population growth rate, population spatial structure and population diversity. The latter includes diversity in life history parameters such as age-at-smolting, age-at-first maturation, frequency of repeat spawning (steelhead), fecundity, run timing, morphology, and genetic diversity (VSP, pp. 12-20). Assessments of the impacts of each alternative on specific populations should include analyses of the probable impacts of hatchery programs on each of the four parameters of individual wild populations likely to be directly and indirectly affected by the program. Such analyses would provide critical information of particular relevance to the ESA-related impacts of the programs, and thus to the assessment of the likelihood of take and jeopardy resulting from NMFS' approval of particular HGMPs and RMPs. In addition, such analyses of the impacts of alternatives on specific populations would also facilitate the analysis of the impacts of alternatives on the listed species under climate change impacts, as well as the analysis of cumulative effects.

B. <u>The DEIS is Deficient for Failing to Include a Robust Quantitative Risk Assessment</u>.

A complete and accurate quantitative risk assessment is necessary to fulfill NEPA's mandate to take a "hard look" at the environmental consequences of the hatchery programs. The DEIS is deficient in this regard.

The DEIS notes that the "specific focus of this EIS is how the alternatives affect existing risks and benefits to listed salmon and steelhead, with emphasis on natural-origin

Chinook salmon." *DEIS*, p. 4-5. Yet, risks to listed salmon and steelhead are neither described in an appropriately quantitative manner, nor in terms clearly related to relevant categories of the ESA, such as take, recovery, risk of extinction, or jeopardy, that are the categories directly relevant to NMFS' evaluation of the RMPS and specific HGMPs. Nor are risks described quantitatively in terms of the VSP parameters or in terms of critical or viable thresholds of abundance as these terms are employed in the Puget Sound Chinook Recovery Plan or the Puget Sound Chinook Salmon Harvest RMP. The disclaimer, *DEIS*, pp. 4-7, is inadequate and does not represent the use of best available scientific and commercial data. The scientifically credible approach to risk assessment in the face of uncertainty (including "inadequate" or "insufficient data") is provided in the recent Report by the National Research Council "Assessing Risks to Endangered and Threatened Species from Pesticides" by the Committee on Ecological Risk assessment under FIFRA and ESA (FIFRA Report), National Academy Press 2013, Chapter 1 pages 14-15, and Chapter 5 pages 148-152.

The so-called "risk assessments" contained in the DEIS are not *bone fide* quantitative risk analyses, nor summaries of such analyses. They are at best qualitative characterizations of suspected levels of risk and, consequently, provide no way to determine whether or how future events would confirm or disconfirm the estimated "levels of risk."

Most significant to the ESA context that the DEIS should be assessing, these vague, qualitative assessments of risk fail altogether to account for uncertainty and its impact on the (quantitative) risk. The greater the absence of quantitative data and the more qualitative inference must be relied on to estimate the risk posed to listed populations of salmon and steelhead by specific hatchery programs and facilities, the greater the uncertainty and hence the greater the risk involved. Only an appropriate quantitative risk assessment framework, as discussed for example in the FIFRA Report, can accomplish this. By falsely contrasting quantitative data and analysis with "qualitative inference," the DEIS fails to recognize the need for, much less to employ, a quantitative risk assessment framework to conduct the risks assessments required and the subsequent specific evaluation of RMPs and HGMPs that NMFS must make, and for which it is the purpose of the DEIS to provide the necessary analytic framework.

Table 4.2.2, *DEIS*, p. 4-8, reflects this critical failure. The description of the basis upon which the assessments of the risks the alternatives pose to listed salmon and steelhead are made clearly shows that the assessments rely on purely qualitative or at best semi-quantitative methods. Further, the description shows that none of the risk assessments employ terms directly related to the ESA, such as the VSP concepts of productivity, abundance, spatial diversity, and genetic/life-history diversity.

Several sections of the DEIS reveal the vague, semi-quantitative, character of the so-called "quantitative" categories of risk employed in the DEIS and the determination of levels of risk. *E.g., DEIS*, pp. 4-9, 3-3 to 3-4, and Appendix B, pp. B-1 to B-34, B-46 to B-55, B-62 to B-69. The definition of 'risk' is inadequate. "A risk in this EIS is defined as the possibility of a loss or injury to natural-origin salmon and steelhead from the

development and use of hatchery facilities, hatchery programs, and hatchery-origin fish." A more specific, probabilistic definition or characterization of risk such as that provided by the FIFRA Report cited above is needed, and should be employed together with appropriately revised analyses in a new DEIS.

The DEIS fails to adequately define the objectives of the action or to conduct any meaningful assessment of the likelihood of the various alternatives at achieving the vague objectives that are stated. The DEIS is deficient for failing to conduct any quantitative risk assessment of the various alternatives.

The inadequacies of the risk assessment for the Green River Chinook Programs are illustrative of these deficiencies. The analyses of the impacts on juvenile wild (natural-origin) listed Green River Chinook salmon from competition or predation from the Green River Chinook and coho hatchery programs are based on simulation analyses of competition and predation using the PCD Risk model developed by Dr. Craig Busack and colleagues at WDFW. The PCD Risk model analyses reported in Appendix D are dated (possible outdated), as they were conducted in 2006 and thus do not include any updated information for 2006 through 2013. The documentation for the model explicitly qualifies the conclusions that can be supported by the results of the model, noting that the model "does not attempt to capture effects due to indirect ecological mechanisms" and merely attempts to "provide a heuristic toll for risk assessment and reduction, not a complete ecological model of the mortality process it simulates," and concludes by cautioning that "results from this assessment should be treated as risk indices in evaluating fish production programs." *DEIS*, Appendix D, p. D-2, lines 10 - 17.

Thus, the assessments derived from application of this model to evaluate the risks of competition and predation on juvenile natural-origin (ESA-listed) Chinook salmon in freshwater from Puget Sound coho and Chinook salmon yearling and sub-yearling hatchery programs are not quantitative, probabilistic risk analyses of the kind that is needed to fully describe and estimate these risks in the context of the ESA as described previously in these Comments. In fact, none of the results from analyses using the PCD Risk model reported in Appendix D provide quantitative estimates of take due to competition or predation impacts of juvenile hatchery fish on listed juveniles nor do they even indicate how the index scores (the only metrics reported as the output from the model simulations) are or might be related to take, jeopardy, and related ESA categories. It is also important to note that no PCD Risk model analyses of the competition and predation risks posed to listed Chinook salmon juveniles by steelhead hatchery programs were conducted, even though hatchery steelhead juveniles pose the greatest predation risk to listed juvenile Chinook salmon of all hatchery species in most river basins. *See, e.g., DEIS*, Appendix C, Table C-93, for Green River Chinook salmon.) The absence of such analyses is further evidence that analyses of these risks in the DEIS are not fully up to date.

The discussion of risks to natural-origin Green River Chinook from Green River Chinook and coho hatchery programs is described in Appendix C of the DEIS, pages C-144 to C-163. Highlights from these analyses not only demonstrate the failure of the

DEIS to conduct appropriate quantitative risk analyses but the inability of the DEIS to derive a consistent and risk-averse conclusion from the analyses it does conduct.

It is important to note that Green River hatchery Chinook subyearling and yearling programs are considered to be part of the Puget Sound Chinook salmon ESU and are therefore listed under the ESA together with their natural-origin conspecifics. Although the majority of returning hatchery-produced adults are intended for harvest in marine and in-river tribal and non-tribal commercial, tribal ceremonial and subsistence, and recreational fisheries, they are also considered by NMFS to contribute to the recovery of the natural-origin Green River Chinook population. Consequently, theses hatchery programs are evaluated under "benefits" for their contribution to the viability of the natural-origin population as well as to harvest. *See DEIS*, Appendix C, Sections 4.10.3.2, pp. C-155 to C-161.

The results for competition risks posed by Green River Chinook, coho, and steelhead programs are summarized as "High" under alternatives 1, 2, and 4 and "Moderate" under Alternative 3. *DEIS*, Appendix C, Table C-92. The results for predation risks posed by the Chinook, coho, and steelhead programs are summarized as "High" under all alternatives. The results for genetic risks posed to Green River natural-origin Chinook from Green River hatchery Chinook are summarized as "High" under Alternative 1, 2, and 4, and "Moderate" under alternative 3. *DEIS*, Appendix C, Table C-94. These risk levels are based on a presumed risk-averse approach whereby if one of the component risk categories in the Tables is rated "high," the overall risk level is rated "high." However, even these overall ratings do not reflect the cumulative risk because they do not include results from other risk categories that are estimated to occur in addition to competition and predation risk categories. So, even these "high" semi-quantitative overall risk levels do not fully reflect the risk posed and thus the overall "high" risk ratings should be considered under-estimates.

The genetic risks are particularly important to an overall assessment of risks and benefits when, as in the case of Green River Chinook salmon, the hatchery programs are alleged to serve a conservation purpose and to provide a viability benefit to the listed population. The assessment of genetic risks posed to natural-origin Green River Chinook salmon "are primarily based on PNI estimates from the AHA Model…". These are considered "High" under alternatives 1, 2 and 4, and "Moderate under alternative 3. The high rating appears to be based on a PNI of 0.23 and the moderate on an estimate of PNI of 0.36. Both of these are well below the minimum threshold of 0.50 recommended by the Hatchery Science Review Group ("HSRG"), whose standards in this regard NMFS has adopted for the HGMPs. These low PNI values reflect the fact that more than 50% of natural-origin spawners each year are returning first-generation (F1) hatchery fish (*See, e.g,* Table 2.2.2.6, p. 5, of the Green River Soos Creek fall Chinook HGMP final of December 2012 and appendix C, page C-156).

Moreover, there is no protocol requiring that a minimum proportion of the annual broodstock of Green River hatchery Chinook be natural-origin adults. Green River hatchery Chinook have very low smolt-to-adult return rates, suggesting low overall

fitness due to domestication selection of the hatchery broodstock over many generations. The high proportion of F1 hatchery fish spawning in the Green River is therefore likely to have driven down the fitness of the remaining natural-origin Green River Chinook population. The continuation of high levels of F1 hatchery spawners under all alternatives will most likely continue to keep the fitness of the natural-origin population depressed, and may drive it even lower. When added to the competition and predation risks from all of the Green River hatchery programs, the genetic risk imposed on the natural-origin Green river Chinook population has a high probability of preventing the recovery of this key member of the Puget Sound Chinook salmon ESU.

The high risk of significant past and continuing adverse genetic impact make it very unlikely that the Chinook hatchery programs are providing a significant conservation, viability, benefit. However, the DEIS (appendix C) does not come to this conclusion. Rather, the DEIS rates the viability benefit as "Moderate" for alternatives 1, 2, and 4, and "Low" for alternative 3 under which hatchery release numbers would be reduced, but not low enough to significantly raise the PNI level to the minimum level of 0.50 recommended by the HSRG, much less to the level of 0.67 recommended for integrated conservation hatchery programs.

The benefit of a (conservation) hatchery program to the viability of the affected listed natural-origin population is to be based on the four Viable Salmonid Population (VSP) parameters: abundance, (genetic) diversity, spatial structure (distribution of spawners and rearing juveniles in the river basin), and productivity (annual population growth rate). The DEIS rates the contribution to abundance a benefit based purely on the number of F1 hatchery spawners in the wild, which comprise over 50% of the total annual spawning population. *DEIS*, Appendix X, p. C-156, lines 14-19. As noted previously, this in large part accounts for the very low level of PNI, contrary to HSRG and, presumably NMFS' own, standards.

More importantly, the abundance of hatchery-origin (F1) spawners is only important when the short term abundance of the natural-origin population is dangerously low (near or below a critical abundance threshold), which is not at all the case with Green River Chinook salmon. In this circumstance, any contribution of hatchery-origin fish to total abundance of the natural-spawning population must consider the productivity (fitness) of the hatchery spawners and the total spawning population. There is every reason to believe that the large number and proportion of F1 hatchery spawners, which has occurred for multiple generations up to the present, has reduced the fitness of the remaining natural-spawning population through genetic introgression of maladapted genes. In such a case, a reduction in the number of hatchery-origin spawners (pHOS) is required. This is clearly feasible with low risk to the natural-origin population given natural spawning abundance of more than 1500. In fact, there can be even greater numbers of natural-origin (non-F1 hatchery) spawners if marine commercial (and perhaps also marine and freshwater sport) harvest were further reduced. *See DEIS*, Appendix C, Table C-97, p. C-155 (showing estimated total returns (harvest plus escapement) of Green River Chinook salmon). In short, given the genetic risks and the current data for

the Green river Chinook population, the contribution of the hatchery program to abundance is not an unambiguously positive viability metric.

That the risk that may actually be posed to the natural-origin population by the large absolute and relative number of F1 hatchery Chinook on the spawning grounds is likely to be significant is further indicated by the discussion of the productivity metric. "The benefit of the hatchery program to productivity is unknown." *DEIS*, Appendix C, p. C-157. The DEIS proceeds to dismiss any concern that the unknown productivity of hatchery fish poses a risk to the listed Chinook population by implying that habitat quality in the Green River is entirely responsible for the population's low productivity. The DEIS states that "the productivity of the natural-origin population in the existing habitat is poor….lambda of 0.84" (indicating a declining population), and noting that this estimate of lambda "assumed that the reproductive success of naturally spawning hatchery-origin fish was equivalent to that of natural-origin fish" and then asserts that this "assumption is reasonable because the program would release fish at the subyearling stage." The DEIS nonetheless acknowledges that if "the reproductive success of naturally spawning hatchery fish was assumed to be less than for natural-origin fish, then lambda would be larger." Yet, neither here nor elsewhere in the entire document does the DEIS suggest the importance of testing this by considerably reducing the number and proportion of F1 hatchery spawners and complying with the HSRG's PNI recommendations for conservation hatchery programs. This could be achieved under an alternative that combined reduction in the number of hatchery juveniles released with a set of selective fishery regimes and gear requirements.

As noted previously in these Comments, the uncertainties involved in the estimation of the productivity of Green River natural-origin and hatchery Chinook salmon need to be appropriately evaluated in a probabilistic risk assessment using available information and relevant auxiliary information. There are good reasons to think that reducing the numbers of hatchery-origin Chinook on the spawning grounds is necessary to improve the viability of the natural-origin Green River Chinook salmon population.

Regarding the diversity metric, the DEIS asserts that the program "would benefit diversity, as the hatchery program would continue to serve as a genetic reserve for the composite hatchery-origin and natural-origin population." *DEIS*, Appendix C, pp. C-157 to 158. This fails altogether to acknowledge, much less evaluate, that all that the hatchery program can maintain is the genetic diversity at neutral genetic markers that almost exclusively reflect the process of genetic drift between two or more populations, and that the high degree of gene flow from the hatchery to the natural-origin population that is an intentional outcome of the hatchery program will guarantee that the two populations will not diverge due to drift. This, however, does not at all exclude the possibility that high gene flow from the hatchery to the natural-origin population will disrupt locally adapted gene complexes in the natural-origin population and/or pass maladaptive genes that developed with high frequency in the hatchery population due to domestication selection to the natural-origin population, resulting in lowering the productivity of the natural-origin population. So, the cursory discussion of diversity in appendix C fails to provide a

thorough description of the genetic issues involved, and fails altogether to provide an appropriate probabilistic risk assessment that accounts for all of the data and the attendant uncertainties.

Regarding the spatial structure metric, the DEIS simply asserts that the hatchery program would benefit spatial structure because hatchery-origin spawners would stray to parts of the Green River basin that may be under-seeded by natural-origin spawners due to the low abundance (relative to potential spawning area presumably) of the natural-origin population. This is entirely unconvincing, given the uncertainty about the productivity (fitness) of naturally spawning F1 hatchery fish and the risk that this uncertainty poses to the fitness of the natural-origin population, combined with the uncertainty (and hence risk) concerning the productivity and abundance of the natural-origin population due to the high level of F1 hatchery fish on the spawning grounds and the risks from competition, predation, and gene flow posed by the hatchery programs.

The evidence presented and discussed qualitatively and semi-quantitatively in appendix C provides ample reason to conclude that the scale of the Chinook hatchery program under all alternatives (and especially under alternatives 1, 2, and 4) pose a risk to the viability of the natural-origin Chinook population. The full extent of the risk requires a quantitative, probabilistic risk assessment, that the DEIS entirely fails to provide. The failure to conclude that the hatchery programs pose overall risks to the natural-origin Chinook population is an indication that the largely qualitative approach to characterizing risks and benefits to listed natural-origin populations from hatchery programs is inadequate to serve the purposes of NEPA.

A final and closely related failure of the analysis of Green River Chinook in appendix C and of all related analyses in the DEIS is the failure to consider alternative harvest management strategies and methods of fishing as tools for addressing the risks posed by hatchery programs. Appendix C nowhere contains a discussion of alternative, selective fishing gear for tribal and non-tribal commercial fisheries targeting or incidentally encountering hatchery Chinook and coho produced by Puget Sound hatchery programs. Table C-97 and the related discussion of total returns of Green River Chinook clearly show the large number of natural-origin Green River Chinook produced that do not survive fisheries to end up on the spawning grounds. Yet, the appendix contains no discussion of why more natural-origin Chinook could not be allowed to return to the spawning grounds, or why more hatchery-origin fish could not be harvested using selective fishing gears that could release natural-origin (non-adipose-clipped) chinook unharmed, or why such adjustments to fisheries would not benefit the viability of natural-origin Green River Chinook. This is a serious flaw in the DEIS and fails to achieve the purposes of NEPA in the context of the ESA.

C. <u>The DEIS Relies on Stale Date and Outdated Studies</u>.

Several key documents pertaining to the recovery of Puget Sound steelhead and the continuation of segregated steelhead hatchery programs in Puget Sound have been published and/or circulated between NMFS and Washington Department of Fish and

Wildlife ("WDFW") in 2013 and 2014 that are not addressed in the DEIS that should be considered.

One is the Saltonstall-Kennedy (SK) Report on the three-year study of the impacts of the segregated Chambers Creek-origin Marbelmount Hatchery program on wild Skagit River steelhead (Ecological, Genetic and Productivity Consequences of Interactions between Hatchery and Natural-Origin Steelhead of the Skagit Watershed, March 2013).

A second document is the report "Measuring reproductive interaction between hatchery-origin and wild steelhead (*Oncorhynchus mykiss*) from northern Puget Sound populations potentially affected by segregated hatchery programs" by Kenneth I. Warheit of the WDFW Molecular Genetics Laboratory, dated October 10, 2014. This document has been submitted to NMFS as a supporting addendum to five revised steelhead HGMPs submitted at the time of or shortly following the publications of the DEIS.

A third document is a "letter (Sufficiency Letter) from Rob Jones of NMFS' Sustainable Fisheries Division to the Director of WDFW and the Chairwoman of the Northwest Indian Fisheries Commission acknowledging the sufficiency for continuation of ESA Consultation on five "updated Hatchery and Genetic Management Plans (HGMPs) for "early winter" steelhead…" The letter is dated November 12, 2014.

These documents demonstrate the new and controversial analyses of genetic samples from Puget Sound wild and hatchery steelhead that are being considered by NMFS in the context of the RMPs that are the subject of the DEIS. The DEIS should incorporate them and as well as the results of NMFS scientific analyses of them.

The SK report was available prior to the publication date of the DEIS and provides important data and information relevant to the genetic and competition risk Chambers Creek-origin hatchery steelhead pose to wild populations, including the largest extant wild steelhead population in the entire DPS. The DEIS should incorporate this critical information for the public to review. Further, some of the new analyses presented in the Warheit report appear to be in conflict with several of the results and conclusions of the SK Report regarding the threat to wild Skagit steelhead posed by the Marblemount Hatchery program. Since NMFS will be evaluating the five HGMPs referred to in the Sufficiency Letter in light of the conflicting information and analyses presented in the Warheit report, it is important for the public to have a clear understanding of how NMFS interprets the information provided by both reports. This requires that this information be analyzed and included in the DEIS.

D. <u>The DEIS Does not Adequately Describe Adverse Effects.</u>

NMFS recognizes that "hatchery programs can adversely affect natural-origin salmon and steelhead and their habitat through genetic risks, competition and predation, facility effects, natural population status masking, incidental fishing effects, and disease transfer." Despite acknowledging these adverse effects, the DEIS generally fails to provide a detailed discussion of the effects of hatchery programs on salmon, steelhead,

and their habitat that is based on an appropriately quantitative analysis of known or potential impacts and such discussion as does occur does not employ terms appropriate to the ESA context to which the DEIS applies. A more robust discussion is needed about the effects of hatchery operations on wild fish.

E. **<u>The DEIS Does Not Adequately Address Mitigation Measures</u>.**

"An EIS must contain 'a reasonably complete discussion of possible mitigation measures' and a record of decision must state whether 'all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not.'" *Cal. ex. rel. Imperial Cnty. Air Pollution Control Dist. v. U.S. Dep't of the Interior*, 767 F.3d 781, 797 (9th Cir. 2014) (internal citations omitted); *and see* 40 C.F.R. § 1505.2(c). "Without such a discussion, neither the agency nor other interested groups and individuals can properly evaluate the severity of the adverse effects." *Robertson*, 490 U.S. at 352. "Perfunctory descriptions or mere lists of mitigation measures are insufficient." *Alaska Survival*, 705 F.3d at 1088.

The DEIS is deficient for failing to adequately describe mitigation measures such as monitoring, evaluation, and adaptive management. The DEIS relies on monitoring, evaluation, and adaptive management plans that currently do not exist for most hatchery programs and that are not described in any detail for the few that might have identified monitoring needs. Funding for monitoring, evaluation, and adaptive management is either nonexistent, insufficient to accomplish the objective of the monitoring (particularly with respect to timely and accurate measurement of levels of take of listed species) and for the majority of hatchery programs is not reasonably likely to occur. In addition, the DEIS refers to adaptive management plans as central to evaluating and monitoring the impacts of hatchery facilities operations and programs on listed species; yet the plans are not described in any detail whatsoever, are entirely prospective, and have yet to be created much less evaluated for their scientific adequacy with respect to the ESA. This is clear in the descriptions of adaptive management and monitoring as risk mitigation in several sections of the HGMPs and the DEIS. *E.g., DEIS*, pp. 4-2 to 4-3, 4-24 to 4-25.

The description of adaptive management in chapters 2 and 4 are inappropriately general. They fail to provide specific, quantitative guidelines and criteria related to the risks posed to ESA-listed salmon and steelhead by hatchery programs and facilities. In general, this is the result of the DEIS' reliance on the vague language of "minimization" and the use of vague qualitative characterizations of the several categories of risk as "low," "moderate," and "high" as a substitute for the specification of risk-averse quantitative thresholds for parameters like competition, predation, genetic effects, and facility effects applied to specific populations of ESA-listed salmon and steelhead. Moreover, as already noted, none of these qualitative characterizations of risk are related to relevant terms of the ESA, which is the legal framework to which they should be related in order to satisfy NEPA.

Placed in the context of a quantitative risk assessment framework as described in our previous comments on the Draft Elwha EA and the NRC FIFRA Report referenced

above, risk-averse thresholds for the listed risk parameters would reflect relevant uncertainties that may affect the effectiveness of risk aversion measures. This would also include uncertainty regarding the ability of hatchery programs to secure adequate funding for the necessary monitoring that would be required to conduct a bone fide adaptive management program. In short, the DEIS altogether fails to provide any indication of how any specific levels of a risk factor are related to the maintenance and recovery requirements of affected populations. For example, the DEIS states that the "primary objective of incorporating adaptive management and associated mitigation would be to reduce deleterious impacts on natural-spawning fish, to more efficiently and effectively meet hatchery production objectives through changes in maintenance and operations and to better meet specific harvest objectives." *DEIS*, p. 4-3. No quantitative, risk-based, measures are discussed or provided to determine what levels of reduction of "deleterious impacts" are sufficient to achieve the purposes of the ESA with respect to take and jeopardy. This is true throughout the main body of the DEIS and the Appendices.

F. <u>The Economic Analysis is Inadequate</u>.

The DEIS' economic analysis is too narrow and fails to evaluate the economic benefits of recovery of listed ESA-listed salmon and steelhead. The DEIS should describe how the "harvestable surplus" is defined and quantitatively identified, and how this is related quantitatively to ESA issues such as take, recovery, and jeopardy. Chapter 3.3 does not provide commercial harvest data for individual tribes. The DEIS (chapter 3) does not describe/explain the relationship between tribal gross and per capita income from commercial fishery and hatchery operations and individual tribal per capita income, which is required to understand how alternatives affecting hatchery operations will translate to per capita income of individual tribes.

The economic analysis should also address lost opportunities from spending significant financial resources on the hatchery programs. For example, the economic analysis should address the economic and other consequences of diverting resources away from the hatchery programs and into habitat restoration and other efforts to support recovery of self-sustaining wild fish populations.

V. CUMULATIVE EFFECTS.

In a NEPA analysis, an agency must also consider the proposed action along with other actions, "which when viewed with other proposed actions have cumulatively significant impacts." 40 C.F.R. § 1508.25(a)(2). A cumulative impact is defined as "the impact on the environment which results from the incremental impact of the actions when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions." 40 C.F.R. § 1508.7. Under NEPA, cumulative impacts include direct as well as indirect effects, "which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." 40 C.F.R. § 1508.8(a).

In analyzing the cumulative effects of a proposed action, an agency must do more than just catalogue "relevant past projects in the area." *City of Carmel-by-the-Sea*, 123 F.3d 1142, 1160 (9th Cir. 1997). The EIS "must also include a 'useful analysis of the cumulative impacts of past, present and future projects.'" *Id*. This means a discussion and an analysis in sufficient detail to be "useful to a decision maker in deciding whether, or how, to alter the program to lessen cumulative impacts." *Id*. The cumulative impacts analysis for a proposed project must examine past, present, and proposed/reasonably foreseeable actions that have cumulatively significant impacts or are similar in timing or geography. 40 C.F.R. §§ 1508.7, 1508.25, 1508.27(b)(7); *Tomac v. Norton*, 433 F.3d 852, 864 (D.C. Cir. 2006).

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. 40 C.F.R. § 1508.7. The cumulative effects of the proposed action, combined with the cumulative effects of other proposed actions, must be described in detail and quantified. *Muckleshoot Indian Tribe v. U.S. Forest Serv.,* 177 F.3d 800, 810 (9th Cir. 1999). Broad and general statements, "devoid of specific, reasoned conclusions" are not sufficient; neither are one-sided cumulative impact statements. *Id*. at 811.

The DEIS is deficient in its failure to subject the cumulative effects that it identifies to sufficiently detailed analyses. The DEIS must do more than list a suite of general past, present, and likely future activities that may affect the listed species at issue and conjecture about the extent to which likely adverse effects may or may not be mitigated by existing law, rules and regulations. The DEIS must do more than list current and proposed land use rules and regulations and conjecture that they will provide protection of habitats and ecosystems important to salmon to an extent sufficient to assure the preservation and recovery of the listed species. The DEIS fails to provide any detail to demonstrate that it is at all reasonable to conclude that such protection will be secured.

Moreover, the DEIS acknowledges that "it is uncertain if all environmental goals and objectives can be successfully met by such processes… there will continue to be some cumulative environmental degradation in the future from development…". DEIS, p. 5-9. But beyond stating this, the DEIS provides no quantitative or semi-quantitative assessment of the likely magnitude of the impact of these and related regulatory failures on the status of the listed populations in context with the alternatives.

Similarly, in its discussion of Habitat Restoration, *DEIS*, pp. 5-9 to 511, the DEIS acknowledges that "based on a recent review of the implementation of the Puget Sound Chinook salmon recovery plan (NMFS 2011), habitat quality and quantity continues to decline and habitat protection tools currently in place continue to need improvement" *DEIS*, p. 5-10. The sentiment is forcefully reiterated in a report from the Treaty Indian Tribes in Western Washington (Treaty Rights at Risk, 2011). Yet, such admissions are not discussed in any further detail nor followed by any quantitative or semi-quantitative analyses of the likely impacts of these shortcomings on the status of the listed species in the context of the alternatives.

A particularly noteworthy feature of current funding and implementation of habitat restoration for the recovery of Puget Sound Chinook salmon and steelhead is the nearly complete failure of the Washington State Salmon Recovery Funding Board to fund monitoring and evaluation of the effectiveness of the majority of habitat restoration projects funded by the Board. This means that for most funded projects there is little or no information as to the effectiveness of these projects to improve the status of populations of the listed species. This makes it nearly impossible to estimate the extent, if any, to which any of the alternatives considered in the DEIS will avoid imposing additional adverse impacts on the listed species.

There is every prospect that this condition will persist into the foreseeable future. For example, the Puget Sound Partnership continues to propose that habitat restoration projects be funded in all Puget Sound WRIA's (Water Resource Inventory Areas, essentially watersheds). Given the limited funding annually available for these projects, this means that many small-scale projects will be funded rather than a few comprehensive, large-scale projects. NMFS' own scientists have shown that such small projects, even if completely successful, have near zero probability of detecting any positive impact on local salmon population in the face of normal levels of environmental variation affecting salmon survival and reproduction. *See* Roni et al 2010; Roni and Lierman 2008) (it is of note that neither of these relevant publications is cited in the DEIS). Consequently, even proposed or expected levels of current and future habitat restoration in Puget Sound cannot be counted on to compensate for the likely adverse impacts of hatchery programs and hatchery-subsidized harvest impacts on the listed species.

The discussion of the impacts of cumulative effects on listed Chinook and steelhead is altogether vague and non-quantitative. For example, section 5.6.1.1 of the DEIS devotes all of 2 paragraphs to describing the effects of hatchery production in Washington and British Columbia on listed Chinook and steelhead, concluding that these "hatchery releases…, along with other observed environmental trends as described in the following subsections, would affect continued long-term viability of natural-origin salmon and steelhead. Proposed changes in hatchery production under the alternatives analyzed in this EIS would affect risks and benefits, and proposed mitigation measures under adaptive management that are associated with the alternatives would help decrease the overall risk to salmon and steelhead." *DEIS*, p. 5-13. As already detailed in these Comments, there are in fact no specific, quantitative details regarding what kinds of measures are required in order for any particular (and entirely conjectural) adaptive management program to provide risk reduction sufficient for NMFS to approve an HGMP for a particular hatchery program. In any case, the mere assertion that such measures would "help decrease overall risks" is not an acceptable substitute for a quantitative risk assessment of each of the alternatives in the context of the general kinds of cumulative effects broadly described in Chapter 5 of the DEIS.

The DEIS devotes all of one paragraph (8 lines) to Climate change impacts, concluding that under "all alternatives, impacts to salmon and steelhead from climate

change are expected to be similar, because climate change would impact fish habitat for each alternative in the same manner." This is grossly inadequate. Section 5.6.1.1.4 of the DEIS (Competition and Predation Risks) adds little substantive detail, merely noting that "cumulative effects from climate change and development on competition and predation risks would add to the competition and predation risks described under Subsection 4.2, fish, and would be proportional to the amount of hatchery production under the alternatives." *DEIS*, p. 5-16. What is required is a quantitative analysis of the probable range of incremental climate change impacts over baseline conditions for each alternative on each individual component population of the Puget Sound Chinook ESU and steelhead DPS. Absent such an analysis, the public can have no idea of how each alternative will add impacts to baseline conditions under the range of impacts that are expected due to climate change alone. It is these incremental impacts from any alternative chosen that NMFS should evaluate under the ESA.

Similar shortcomings are characteristics of the other elements of subsection 5.6.1 of the DEIS. These comments illustrate how that the DEIS fails to address cumulate effects in the detail required under NEPA.

VI. PREDETERMINED OUTCOME.

Finally, this NEPA process is tainted by NMFS' approval of the Elwha River hatchery programs before completing this EIS process.

Preparation of an EIS is intended to ensure that the agency has and considers detailed information regarding environmental impacts when reaching its decision and it guarantees that information is made available to the larger audience that may also play a role in the decision making process. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989). NEPA procedures therefore must insure that environmental information is available *before* decisions are made and *before* actions are taken. 40 C.F.R. §§ 1500.1(b) and (c). A NEPA document must be "prepared early enough so that it can serve practically as an important contribution to the decisionmaking process and will not be used to rationalize or justify decisions already made.'" *Save the Yaak Comm. v. Block*, 840 F.2d 714, 718 (9th Cir. 1988) (quoting 40 C.F.R. § 1502.5)).

NMFS has already approved the Elwha River hatchery programs under the ESA 4(d) Rule, thereby pre-determining a significant aspect of the decision that is supposedly the subject of this current NEPA process. This violates NEPA and undermines these current NEPA efforts. For example, how can NMFS now consider alternatives to the hatchery programs that it has already approved for the Elwha River? NMFS' unlawful predetermination on the Elwha River hatchery programs likely has significant effects on its ability to consider alternatives for the hatchery programs throughout Puget Sound, thereby tainting this entire process.

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Treaty Indian Tribes in Western Washington. 2011. "Treaty Rights At Risk. Ongoing Habitat Loss, the Decline of the Salmon Resource, and Recommendations for Change." http://treatyrightsatrisk.org/

The following report is appended hereto for your consideration with these comments:

McMillan, B., The Reproductive Ecology of Oncorhynchus mykiss in Tributary Streams of the Mid Skagit River Basin (DRAFT as of January 15, 2015, a copy of which is attached hereto for your consideration)

The Reproductive Ecology of *Oncorhynchus mykiss*
in Tributary Streams of the Mid Skagit River Basin

Bill McMillan, (DRAFT as of January 15, 2015)

Photo 1: Skagit River Sexually Mature Wild Steelhead of 19 lbs 10 oz Caught January 25, 1959

Introduction

The Skagit River is the largest river basin of Washington's Puget Sound. The Mid Skagit River basin for purposes of this report is considered to be the 43 mile (67.6 km) length of the mainstem Skagit and smaller tributaries from the town of Sedro-Woolley (~RM 24) to the entry of the Sauk River (RM 67). At the time of 1895 the Skagit basin had an estimated mean return of over 105,000 wild steelhead (Gayeski et al. 2011). Current wild steelhead returns (2002-2011) are 5-6% of historic levels (Appendix C of McMillan 2012). Wild steelhead harvest alone from 1961-62 through 1965-66 was an average of nearly 13,000, and wild harvest as late as 1974-75 was over 15,000 (Phillips et al. 1981b; and Appendix E). As of 2007, Puget Sound (including the Skagit basin) steelhead have been listed as Threatened under the Endangered Species Act (ESA) (NMFS 2007).

Oncorhynchus mykiss (*O. mykiss* hereafter) is noted for great breadth of life history diversity and unusual plasticity among Pacific salmon species with the most southern range extent (Shapovalov and Taft 1954; Augerot 2005). Wild winter steelhead spawning time in western Washington has been documented as January to June-July by Washington Department of Natural Resources (WDNR) and through independent surveys by the Wild Salmon Center (WSC) (Cederholm 1984; McMillan 2007). The earliest description related to the reproductive ecology of the anadromous life history of *O. mykiss* in Mid Skagit River tributary streams is that of a U.S. Fish Commission egg-taking operation at Finney Creek in 1901 (Ravenel 1902):

Page 84: *"Early in March it was decided to again attempt the collection of eggs of the steelhead trout ... Phinney Creek ... was selected ... and by the middle of the month a rack was completed and net fishing*

commenced under the direction of Mr. Henry O'Malley. Only a few fish were caught, and it soon became evident that the run of steelheads was over. Exploration on Phinney Creek, Grandy Creek, and the Skagit River did not show any large numbers, all testimony seeming to prove that the principal run had gone up in January."

The indicated steelhead migration into Finney Creek prior to mid March, and principally in January, would be necessary to result in the initiation of steelhead spawning at the Sauk River of the Skagit basin reported by the Washington Fish Commissioner (Riseland 1907):

Page 23: *"The steelhead spawn from the first part of February until the 15th of June."*

The breadth of entry time of steelhead to the Skagit River in 1895, the earliest year of commercial catch record in the basin, was described in a U.S. Fish Commission report (Wilcox 1898):

Page 595: *"The several species of salmon and seasons when found are as follows: ... steelhead, from November 15 up to the following spring ..."*

The wild winter steelhead that reproduced in the Skagit basin near their peak historic abundance thought to end about 1895 (Gayeski et al. 2011) had migrations that commenced Skagit River entry in mid November with a major upstream migration in January, and included entry to Finney and Grandy creeks of the Mid Skagit basin. In the case of Finney Creek, steelhead spawning entry was nearly over by mid March. Although spawning time in Finney Creek (RM 47.5) was not mentioned, steelhead likely began spawning at least by early February and ended by mid June as described in 1907 for the Sauk River (RM 67.2) just upstream of the Suiattle River (RM 13.2), likely near today's Hatchery Creek (RM 13.4). This Sauk River location is 32 miles upstream from Finney Creek with an elevation gain of about 242 ft. Photo 1 depicts a wild steelhead in mature male spawning coloration taken near Rockport, WA on the Skagit River on January 25, 1959 by Russ Willis (Western Washington University, Bellingham, WA, 6th Floor of the Wilson Library, in the Heritage Resources, Fly Fishing Collections; additional information pers. com. Danny Beatty, Anacortes, WA who acquired it for the Collections). The 1959 steelhead exhibits the historic attributes earlier described in Skagit basin steelhead.

Between 1914 and 1920 steelhead egg-taking operations for hatchery rearing were recorded at three Skagit River tributary streams (Smith and Anderson 1921 in Table 1, Appendix B). Weirs are difficult to maintain during higher flow events and even today significant escapement of steelhead occurs around weirs (Seamons et al. 2012) despite easier access to weir sites and improved technology since the early 1900s. As a result, the early egg taking operations at Day and Illabot creeks may not have well represented actual return numbers of female steelhead and would be a minimal count. Grandy Creek was the central location at that time, however, for hatchery operations in the Skagit basin (Smith and Anderson 1921) and likely had a more efficient weir. Using the average number of eggs taken per female steelhead from Green River tributary streams between 1939 and 1941 (Pautzke and Meigs 1941), at Grandy Creek the number of female steelhead stripped of eggs ranged from 79 to 1,125 per year; at Day Creek from 29 to 100; and at Illabot Creek from 21 to 158. Even at minimal female numbers represented, it is apparent that Skagit River tributary streams supported considerable steelhead spawning at a date when overall salmon and steelhead numbers were described as already greatly depleted from former times (Smith and Anderson 1921).

As a result of the 1974 Boldt court decision and the subsequent steelhead management changes that occurred in the Boldt Case Area of Washington (Puget Sound and the Northwest Coast) thereafter, data began to be collected from which to manage for a 50% division of harvest between tribal and sport fisheries and eventual

determination of spawning escapements (Cohen 1986). In the case of the Skagit River basin, spawning survey data are available from 1978 to 1981, a time period when 65%-80% of steelhead spawning found was in the tributary creeks (Phillips et al. 1981b). The available evidence indicates that Skagit River tributary streams were historically vital to overall steelhead productivity, and included those of the Mid Skagit basin.

A basic Skagit River steelhead management assumption by Washington Department of Fish and Wildlife (WDFW) has been (WDFW 2004):

Page 118: "*Wild origin winter steelhead have been defined as those fish that spawn after March 15...* (and) *steelhead of hatchery origin that spawn in the wild are defined as those fish spawning before March 15, for management purposes on the Skagit (Woodin et al. 1984)."*

As a result, WDFW steelhead spawning surveys in the Skagit basin have commonly been initiated about March 15th in the assumption that wild steelhead do not spawn prior to that date. In the Skagit basin it was indicated in the same WDFW document:

Page 141: *"... introgression between hatchery and wild fish ... is believed to be low as there is currently substantial temporal separation of hatchery and wild spawn timings, and spawning overlap is believed to be less than 1% (C. Kraemer, WDFW, pers. comm., 12/12/03)."*

Page 142: *"The section of the Skagit River that has been the most heavily spawned by hatchery-origin adults is the area upstream of Grandy Creek between the Cascade and the Sauk rivers..."*

However, the above management assumptions have been largely made with an absence of spawning surveys that could actually document how much hatchery and wild spawning occurs in the Skagit basin prior to March 15th, and where it occurs. Oregon has developed a more thorough ground-truthed approach for monitoring steelhead of its Coastal streams (from Susac and Jacobs 1999):

Page 2: *"The percentage of hatchery origin steelhead spawning naturally in the wild poses a great deal of concern to fisheries managers. The Oregon Wild Fish Management Policy (OAR 635-07-525) sets guidelines as to the percentage of stray hatchery fish permitted to spawn naturally in individual basins and subbasins. It is important for fisheries managers to know the percentage of hatchery strays spawning naturally in the wild. Currently, all of the hatchery origin steelhead released in Oregon and destined to return as adults in 1998 are marked with an adipose fin-clip. We have started to evaluate the feasibility of using visual detection of marked and unmarked adults on the spawning beds to determine hatchery:wild ratios."*

Page 2: *" ... 1) steelhead spend only a short time on spawning beds, 2) fish not actively spawning are elusive, and 3) hard to count and steelhead do not necessarily die after spawning. In addition to difficulties associated with their behavior in spawning streams, the extensive temporal and spatial spawning patterns exhibited by coastal winter steelhead stocks create challenging survey conditions. The spawning season is generally quite protracted, lasting up to 6 months..."*

As a result there are no assumptions about hatchery and wild steelhead spawning that exclude any part of the potential spawning season as monitored in spawning surveys in Oregon:

Page 10: *"Surveys were conducted from mid January to mid May.*

Regarding steelhead spawning further north, winter steelhead spawning was documented to begin on central Vancouver Island's Cowichan River by January in the 1940s (Neave 1949), and in the 1980s was found to begin in January-February at the Queen Charlotte Islands (de Leeuw and Whately 1983; de Leeuw 1984; 1985; 1986; and 1987). At the Situk River of Southeast Alaska, steelhead spawning has initiated as early as February (Johnson 1991).

On becoming a resident of the Mid Skagit basin in 1998, it became of increasing interest what salmonid spawning was occurring at a number of local tributary streams. With a history of doing volunteer spawning surveys as a hobby biologist from 1979 to 1996 on Lower Columbia River streams, and professionally from 1997 to 1998 in the Snohomish basin and from 2000 to 2006 in the urban creeks of King County, the Mid Skagit tributary streams provided near-by interest due to differences in their hydrologic regimes, stream channel characteristics, and directional aspects to the sun. On retirement at the end of 2006 as a professional field biologist for a non-profit fish conservation organization, I had time to consider surveying streams again in the freedom of volunteerism as a hobby biologist.

I first came to familiarize myself with these streams and others in the Skagit basin through angling on moving to the Skagit Valley in 1998. It provided a means to determine *O. mykiss* and *O. clarki* species presence, potential fish passage barriers that may isolate them from each other, or overlaps within each stream that may otherwise occur. However, my commitment to doing regular surveys did not more consistently occur until the fall of 2009 and spring of 2010. These surveys continued to regularly occur through the spring of 2014 during the salmon and steelhead spawning periods at O'Toole, Mill, Savage, and Finney creeks, and at Dry Creek (tributary of lower Finney Creek) in 2013 and 2014. From October 3, 2013 through June 16, 2014 the surveys made at these five Mid Skagit tributaries were made with greater frequency compared to other years with particular intent to increase observations of active steelhead spawning if possible. Surveys were also made intermittently at several other Mid Skagit tributaries during the anticipated steelhead spawning period. The overall goal of the spawner surveys was to gain an understanding of the steelhead which spawn in these streams and to determine the following:

1) earliest and latest steelhead spawning by tributary
2) total steelhead spawning redds by tributary, or tributary reach surveyed
3) hatchery and wild steelhead during active spawning
4) the proportion of steelhead spawning before and after March 15th
5) *O. mykiss* life history mixes (i.e. anadromous and resident) during active spawning
6) steelhead spawn time differences between differing tributaries
7) environmental factors that may determine steelhead spawning time differences by tributary
8) steelhead spawn time overlaps with other salmonids
9) *O. mykiss* fry emergence dates

Determination of spawning prior to mid-March and potential overlaps between wild and hatchery *O. mykiss* were priority objectives due to the lack of historical spawning surveys that could document this in tributary streams of the Skagit basin (or elsewhere in most of Puget Sound and much of western Washington). Although *O. mykiss* reproductive ecology in these tributaries is the focus of this report, the surveys included a complete record of all salmonid spawning found from the beginning of the first autumn storm events that provided anadromous fish access into these tributary streams. In this way it was possible to ensure that the earliest *O. mykiss* spawning was found and how the timing of one species may overlap with another in the need to separately identify their redds based on differing redd characteristics. A further purpose for this report is to

stimulate data collection that over time can result in a broader understanding of the complexity of *O. mykiss* life history diversity necessary for productivity across a broad range of available habitats and to provide an improved template for future monitoring of steelhead in the Skagit basin that can more effectively guide management for wild recovery through a future predicted to include increasing climate change.

Methods

Streams Surveyed

Mid Skagit basin tributary streams were chosen for spawning surveys due to proximity to my place of residence at RM ~46 near the mouth of Savage Creek and from which daily weather and stream flow conditions could be quickly determined. Five of these streams are publicly accessible by walking for their entire anadromous length and met the criteria for either determining a good approximation of the total spawning use by each salmonid species, or a sufficiently long and typical stream reach from which a significant proportion of the spawning by each species could be determined. Table 1 provides the five main streams and 2013-2014 survey lengths; Table 2 provides streams intermittently surveyed. The stream lengths were determined by Google Earth measures in yards (yds) and kilometers (km). Table 2 of Appendix F provides the dates of each 2014 survey from January 1st through June 16th (and other information).

Table 1. Mid Skagit tributary creeks regularly surveyed in 2013-14

Tributary	Anadromous length	Length surveyed	Begin rkm	End rkm	Number of surveys	First survey	Last survey
Finney Ck	20,678 yds 18.908 km	3,825 yds 3.498 km	1.87	5.37	10	2-2-2014	5-30-2014
Dry Ck of Finney Ck	950 yds 0.869 km	950 yds 0.869 km	0	0.87	26	11-6-2013	5-30-2014
Savage Ck	>4,409 yds >4.032 km	4,409 yds 4.032 km	0	4.03	45	10-3-2013	5-6-2014
Mill Ck	1,850 yds 1.692 km	900 yds 0.823 km	0	0.82	29	10-3-2013	5-22-2014
O'Toole Ck	680 yds 0.622 km	680 yds 0.622 km	0	0.62	10	10-4-2013	6-16-2014

Table 2. Mid Skagit tributary creeks intermittently surveyed in 2013-14

Tributary	Anadromous length	Length surveyed	Begin rkm	End rkm	Number of surveys	First survey	Last survey
Quartz Ck of Finney Ck	Unknown	160 yds 0.146 km	0.34	0.49	1	5-16-2014	5-16-2014
Hatchery Ck of Finney Ck	>570 yds; 0.521 km	400 yds 0.366 km	0	0.37	2	3-23-2014	5-6-2014
Grandy Ck	7,950 yds; 7.269 km	2,000 yds 1.829 km	0.30	1.71.	1	2-20-2014	2-20-2014
Cumberland Ck	1,300 yds; 1.189 km	577 yds 0.528 km	0.25	0.78	1	5-2-2014	5-2-2014

Breadth of Time Period for Surveys

To assure that no atypically early steelhead spawning went unrecorded, the 2013/2014 Mid Skagit tributary

surveys began with the first series of storms that recharged the tributary streams in the fall to facilitate anadromous fish passage into them. This occurred early with over 12 inches (30.5 cm) of rain recorded in the Mid Skagit basin in September, the largest amount since I began recording September rainfall in the area in 2002 (Appendix A.). Surveys began in early October but missed the first few days of salmon spawning activity that likely occurred in Finney, Mill, and O'Toole creeks, but redds and carcasses remained to provide good counts of spawning that likely occurred.

In the case of Finney Creek, fall spawning surveys did not occur in 2013 due to the stream conditions often being too discolored to do so, but also because surveys in prior years had already indicated what spawning use occurs there prior to the initiation of steelhead spawning in winter. It was hoped that surveys targeting steelhead could begin in January of 2014, but water conditions were unfavorable to do so until February. At Finney Creek water conditions absolutely dictate survey times which can't be predetermined. Some years there may be too little survey time to provide useful information. This was not entirely the case in 2014 for steelhead at Finney Creek, but as previously indicated, some spawning in January and February may have been missed due to turbidity and this continued through March.

In the case of Dry Creek of lower Finney Creek, entry of pink salmon was not anticipated due to its small size and common dewatering. It was thought to be the last of local Mid Skagit tributary streams to recharge with fall rains and perhaps too little flow to coincide with pink salmon spawning use potential. However, when surveys began there in early November, at the end of anticipated pink salmon spawning, considerable prior use by pink salmon was found and future surveys will be adjusted accordingly.

The surveys remained sustained until the final spawning by steelhead was thought to be found. In most cases this was early to late May, but in the case of O'Toole Creek it had previously been noted that particularly late spawning can occur and a final survey there was made in mid-June. There was also a gap in surveys at O'Toole from November 12th of 2013 until March 12th of 2014. Past surveys of O'Toole Creek have found minimal coho spawning there and chum spawning is typically contained to October. Only twice was early steelhead spawning found there, in both instances near where it joins the Skagit River which may have included river backflow into it. It is one of the coldest streams as previously found and has a substrate where redds can remain visible for considerable time. Because it is somewhat out of the way geographically from the other streams regularly surveyed, it was the choice to exclude during a time period when the other streams were more anticipated to have spawning occurring. It was a choice of where available time was best spent.

My surveys were predicated on historic information that identified Puget Sound historic wild steelhead spawning began in January (Evermann and Meek 1898) and/or February (WDG 1931-1940). In the Skagit basin, Finney Creek steelhead entry for spawning was primarily in January (Ravenel 1902) and steelhead spawning began by at least early February in the Sauk River (Riseland 1907). I anticipated that January and February spawning still occurs and should guide present wild steelhead monitoring. Chambers Creek origin hatchery steelhead, as have been long planted in the Skagit basin, are also known to spawn by December and January and continue into March (Crawford 1979). Their extent of spawning can continue as late as April 27th as found at the Kalama River of the Lower Columbia (Crawford et al. 1978). My prior survey experience in the Mid Skagit basin tributaries found that steelhead do begin spawning in January and this continued to guide the decision to begin spawn surveys by that time in 2014.

Survey Frequency and Timing of Individual Surveys

The frequency of the surveys was determined by a combination of stream conditions from which new spawning entry might be anticipated, the need to survey the appropriate length of stream reach for the available time allotted, and the expected species to be found during a specified time period. Whenever possible surveys were timed to occur shortly after a peak flow event. During the typical fall/winter storm period of November through January this could result in peak flow events occurring and subsiding 2-3 times during a 10-day period. The 2014 storm events occurred in a way to provide difficult survey conditions for weeks at a time from January through March. Finney Creek is the largest of the creeks surveyed (average summer wetted width of 16 m at Quartz Creek entry at rkm 6.6 from Kiffney et al. 2006) and is particularly affected by lingering effects of heavy rainfall. Higher flow periods physically prevent the necessary wading to cover the survey reaches and turbidity is prolonged with inability to see redds. Thus considerable steelhead spawning is unavoidably missed in years of normal to greater winter precipitation. At the other end of the scale, Savage Creek has an extensive low gradient reach with wetlands and a series of ponds that it runs through resulting in moderation of its flows below those points with more gradual reactions to rainfall. It also has a significant upper fork that is particularly low gradient with wetlands and beaver ponds that it drains with related greater stability of flow characteristics. Dry, Mill, and O'Toole creeks all originate from steep mountain slopes which dominate their overall lengths with short 1 km sections or less of lower gradient where spawning occurs near their mouths. As a result their flows rise and fall quickly.

Because of the described differences in response to rainfall and drought, surveys had to be timed to these differences with variable frequency. At Finney Creek surveys were sometimes limited to zero per month or 1-2 per month in worst conditions. At smaller streams there could be as little as 1-3 days between surveys that occurred after a storm event in the hope of not missing any spawning activity prior to the next predicted storm. Any significant storm event could make some redds invisible thereafter. At the other extreme, during longer periods without significant rainfall the surveys could be delayed until a freshet occurred with a resulting wait of three weeks or more before anticipated new spawning. Some streams have particularly long survey reaches that may not fit the available time in a single day. In that case the survey lengths were broken up into shorter units that were done on multiple days within a short time of each other to capture the spawning for each stream reach between higher flow events. As a result of these considerations, surveys prior to March were often made at 3-4 day intervals if the sequence of rainfall and peak flow periods were frequent, after mid-March steelhead spawning survey intervals were often longer in more normal years (2014 being an exception) due to reduced high flow events, redd life being longer, and encountering hatchery steelhead and species other than steelhead less likely. As a result, active spawning sightings are less critical later in the survey season and the surveys were sometimes made further apart (10-14 days for instance).

Making wild and hatchery steelhead determinations was a primary survey objective of the spawner surveys. This meant maximizing the probability of finding active redds, or the presence of live steelhead during the surveys. However, finding active steelhead spawning in the Mid Skagit basin creeks has been a relatively uncommon occurrence. Live steelhead have also been noted as elusive sightings in other areas such as Oregon (Susac and Jacobs 1999). Active steelhead spawning was found in the Mid Skagit basin creeks to occur within 24-48 hours after a stream reaches a peak stream flow, which is typically considered to be the falling limb of the hydrograph. This rule of thumb largely concurs with the guidelines used in steelhead spawning surveys on the Oregon Coast (Susac and Jacobs 1999). In the case of Mid Skagit tributary steelhead, active spawning has most commonly been found during dimmer light conditions of cloudy days, and/or late afternoon and evening. At Prairie Creek in California steelhead spawning most commonly occurred at early morning and evening and steelhead vacated the redds at mid day to find cover for hiding (Briggs 1953). Needham and Taft (1934) found that the majority of steelhead redd construction at Waddell Creek occurred overnight under the confined

conditions of their observation method. The Waddell Creek example is an important consideration but doing the Mid Skagit surveys under the conditions of nightfall with extensive stream walks was not a realistic consideration. Given both past experience and guidance from the literature, cloudy days and late afternoon or evening were targeted for surveys at the Mid Skagit basin tributaries whenever possible as the best compromise regarding the apparent preference of steelhead to actively spawn at night or in otherwise dim lighting.

Estimating redd construction date

Steelhead redds are often found days to weeks after they were constructed. This can be due to unfavorable survey conditions due to high flows and lack of visibility, due to limited time to survey all streams within optimal conditions, or due to having missed sighting a redd until a later suvey date. When an inactive redd (i.e. no fish near the redd identified) was found, its age was estimated based on distinctiveness of the redd pit depth and tailing mound, and by winter or spring dates when the amount of algal growth on surrounding substrate and redds differ.

A redd was classified as built within a few days to a week of being identified if it was prior to March and the redd pit deep and tailing mound were well defined even though there was a small difference in the surrounding substrate coloration due to common absence of algal growth. A redd's age from March onward was similarly classified if it was of similar characteristics but the tailing mound was vey light coloration and surrounding substrate was distinctly darker due to the common presence of algal growth.

A redd was classified as being built one to two weeks earlier if it was prior to March and the redd pit was partially filled or less distinct and the tailing mound was less prominent even though there was little difference in the surrounding substrate coloration due to common absence of algal growth. A redd's age from March onward was similarly classified if it had similar pit and mound characteristics but the surrounding substrate was darker and some algal growth had initiated on the tailing mound.

A redd was classified as being built two to three weeks earlier if it was prior to March and the redd pit was more obscured and the tailing mound more dispersed. From March onward a redd's age was similarly classified if it had similar characteristics but the tailing mound was somewhat paler than surrounding darker substrate.

Redds identified before March were classified as built three to four weeks earlier if the redd pit was difficult to discern and the tailing mound was well dispersed but remained as visibly different from surrounding substrate despite lack of algal growth. From March onward a redd's age was similarly classified if it had similar characteristics but with algal growth on the tailing mound approaching that of the surrounding substrate.

These initial estimates of redd ages were noted in the field book. Subsequently, these redd age estimations were compared to streamflow and weather conditions that would have most likely stimulated spawning entry during or proximate to the estimated redd age range, and/or if it coincided with known spawning observed on the other streams or stream sections in that time frame. Thus final redd aging was based on a combination of these criteria.

Survey Procedure

Date and stream condition were recorded at the beginning of each survey. Flows were described as low, moderately low, normal for date, moderately high, high but surveyable, and high but unsurveyable. Water

visibility was described as clear (sufficient for survey), slightly discolored (sufficient for survey but impaired), and discolored (too diminished for a survey). Weather conditions such as amount of rainfall, snow, or freezing conditions in the days leading up to the survey were also noted. If ice conditions were present that was noted.

Along with a field notebook and a camera(s), surveys preferably began at the downstream end of the survey reach. The streambank was then walked upstream to the extent of the survey reach. However, in some instances of logistic necessity the survey was made by walking downstream. This occurred when access was limited to a bridge or culvert crossing upstream of the reach to be surveyed, or in the case of a larger stream (such as Finney Creek) when the only safe ford to cross the stream was upstream of the survey reach. In order to find passable terrain, the stream channel was crossed back and forth when possible. Care was taken to avoid live fish and redds. Each completed redd was recorded in the notebook by species and whether active or inactive. Sometimes older inactive redds could be difficult to determine, and/or by what species. These redds were typically counted based on probable species evidence, but the question was noted. Redds marked by previous surveyors were also counted (by WDFW in the case of Finney, O'Toole, and Mill creeks) if they similarly fit my redd identification criteria (generally so, but not always). If there was a ribbon associated with it, species and date was noted. If there was a flagged stone that was noted. Each carcass or live sighting was recorded by sex and hatchery or wild origin when possible. Unoccupied redds were considered completed if there remained evidence of a depression at the pit area and a gravel tailing behind. Active redds were counted as complete. A few active redds were difficult to otherwise determine in some habitat types where there are boulders that the spawning fish work around with several resulting scattered pits representing the egg laying by one female steelhead. This led to focused attention in these habitat types to determine if relatively small and scattered pits may be those of steelhead spawning. If several such small pits were found within a 15-30 meter reach of this type of stream habitat it was considered the egg laying of but one female steelhead. In other instances several fresh steelhead redds were found within a 50-100 meter stream reach but only one steelhead spawning pair was sighted. It is possible that just one female steelhead may have constructed all of the redds found (particularly in the smallest streams). However, without evidence to suggest otherwise, each redd found (unless within a few meters of each other) was counted as a separate redd representing that of one female steelhead. In the case of steelhead, coho, and cutthroat redds during overlapping spawning time periods, redd size was also recorded as a check on species use determinations.

I did not mark redds. One reason for this was so as not to confuse others who survey some of the same streams and do mark redds. Secondly, in the case of steelhead and cutthroat their redd infrequency did not require being marked and the number of streams surveyed was low enough so that memory did not tend to confuse newer redds from older ones if they remained visible between surveys at all. In the case of salmon, particularly coho and pink salmon, trying to flag all the redds would not have been particularly helpful due to frequent areas of superimposition or overlaps of redds. A combination of carcass, live fish, and redd counts was made each survey by species. The survey data from the field notebook were then analyzed and recorded at the end of each survey day so as to determine how well the carcass and live counts may or may not fit with the number of redds counted for salmon in particular. The primary purpose was to identify as well as possible steelhead spawning redds from the other species. This required careful examination of each redd by size, depth, and substrate used, and to further determine the most likely species use at that time interval which salmon live sightings, carcass presence, and live steelhead and/or cutthroat sightings helped to provide conclusions.

Determining Species Use by Redd Evidence

As noted in Oregon's steelhead spawning surveys (Susac and Jacobs 1999), because steelhead are so briefly in small streams for spawning, and due to their elusiveness and hiding compared to salmon, one is commonly left with only the remaining redds from which to make counts. Vacated redds pose the problem of determining the species that made them. Coho and sea-run cutthroat are the two species that more commonly spawn in the Mid Skagit basin tributaries during overlapping periods with steelhead. As the surveys have progressed the past five years some differences have been found to guide the methods for determining the species that have left vacated redds. Burner (1951) indicated that of the salmon redds assessed by species, only coho had as much as 10% mud in the substrate used and that they used slower flows than others. He also indicated that redd sizes generally reflect the size of fish (the larger the salmon the larger the redd, all else being equal) and that redd size is inverse to substrate size (the larger the gravel substrate the smaller the redd, all else being equal). These proved to be good guidelines.

In the case of the Mid Skagit tributaries, based on active spawning observations by each species, the smallest redds found were considered those of resident cutthroat (redds less than 1.5 ft x 1.5 ft, 0.25 sq. yds. considered such) or sea-run cutthroat (from 1.5 ft x 1.5 ft to 2 ft x 2.5 ft, 0.25 sq. yds. to 0.56 sq. yds.). Redds considered to be coho were larger (2 ft x 2.5 ft to 4 ft x 6 ft, 0.25 sq. yds. to 2.67 sq. yds.), and those considered to be steelhead larger yet (2 ft x 2.5 ft to 6 ft x 10 ft, 0.25 sq. yds. to 6.7 sq. yds.). Active cutthroat and coho redds were commonly at current edges or in slower currents. Such placements further guided determinations of inactive redds for those species while active steelhead redds were more commonly at mid channel or at edges to stronger currents and in larger substrate which further guided inactive steelhead redd determinations. Active coho redds were particularly found in side channels, even those down to wetted widths a meter or less with substrates that included considerable fine sediment and/or mud rarely if ever used by steelhead which further guided inactive redd decisions per species. Based on these criteria, inactive redd determinations made by species were made with relatively high confidence. Nevertheless, during a one to two week transitional period between coho and steelhead spawning in the Mid Skagit tributaries (latter January to mid February, depending on year and by tributary) a few vacated redds remained of some question regarding species origin. If active spawning was found by one or the other (coho or steelhead) during this period in one of the other four streams, it was considered likely that the questionable inactive redd found in the stream of question was likely made by the same species unless other criteria (such as redd size, location, or substrate size) indicated otherwise.

Determining Hatchery from Wild

Determining hatchery fish from wild was done by observing the presence (wild) or absence (hatchery) of the adipose fin by focused observation of individual fish during live sightings. Steelhead carcasses have yet to be found and can't be anticipated as an aid for determining hatchery or wild origin. Adipose fin presence or absence on live fish sighted has provided the only means to determine spawning time differences between wild and hatchery fish. Concentrated observation is required to determine steelhead adipose presence or absence, yet great care must be taken not to approach so closely as to cause flight and difficulty in finding the steelhead again. This can entail up to 1.5 hours of observation, but 20 to 40 minutes is often enough. It is particularly difficult in larger streams such as Finney Creek, but in the smaller streams the steelhead often spawn in shallow depths of 0.2-0.3 meters and eventually may lift the caudal fin out of the water providing clear momentary view of the adipose fin area. Determination of adipose presence or absence can be greatly facilitated by use of two digital cameras (Canon Power Shot SX50 HS digital camera and Go Pro, Hero 3 digital camera with underwater housing, the latter requiring a four foot long rod of to mount it on to more closely approach the fish beneath the water). The first camera was used for taking photographs of the spawning steelhead from above the surface and the second one for doing so beneath the surface and which was also the sequence used. The potential for

sending an adult steelhead into flight is greater with the underwater camera use, and therefore the choice to use it last. The latter camera was not used until the latter part of the spawning season but was found to be an important tool for both species determinations and whether of wild or hatchery origin.

Findings

Redd Counts

From October 3, 2013 through June 16, 2014, a total of 125 spawning surveys were made at five Mid Skagit basin tributary streams on a regular basis and at four other tributaries on an intermittent basis (Table 1 of Appendix C). The steelhead redds were enumerated by both the 7-8 day period found and adjusted to the estimated spawning date period during 2014 (Table 3).

Table 3. 2014 Mid Skagit Basin Steelhead Redd Counts by 7-8 Day Period

Steelhead redd counts by period found
Steelhead redd counts adjusted to estimated spawning period

Period	Savage		Mill		O'Toole		Finney		Dry		Total	
Dec 24-31												
Jan 1-7												
Jan 8-15		1										**1**
Jan 16-23	1								1	1	**2**	**1**
Jan 24-31								1		2		**3**
Feb 1-7							1		2		**3**	
Feb 8-15												
Feb 16-23	2	2							1	1	**3**	**3**
Feb 24-29												
Mar 1-7												
Mar 8-15	2	2						1	2	2	**4**	**5**
Mar 16-23								2				**2**
Mar 24-31						2	1	4			**1**	**6**
Apr 1-7					2			1			**2**	**1**
Apr 8-15				1			8	1			**8**	**2**
Apr 16-23												
Apr 24-30			2	1						1	**2**	**2**
May 1-7					1	1		3	1	1	**2**	**5**
May 8-15							7	6	5	4	**12**	**10**
May 16-23					1	1	3	1			**4**	**2**
May 24-31												
Jun 1-7												
Jun 8-15						1						**1**
Jun 16-23					1						**1**	
Jun 24-30												
Jul 1-7												
Total	**5**	**5**	**2**	**2**	**5**	**5**	**20**	**20**	**12**	**12**	**44**	**44**

Figure 1.

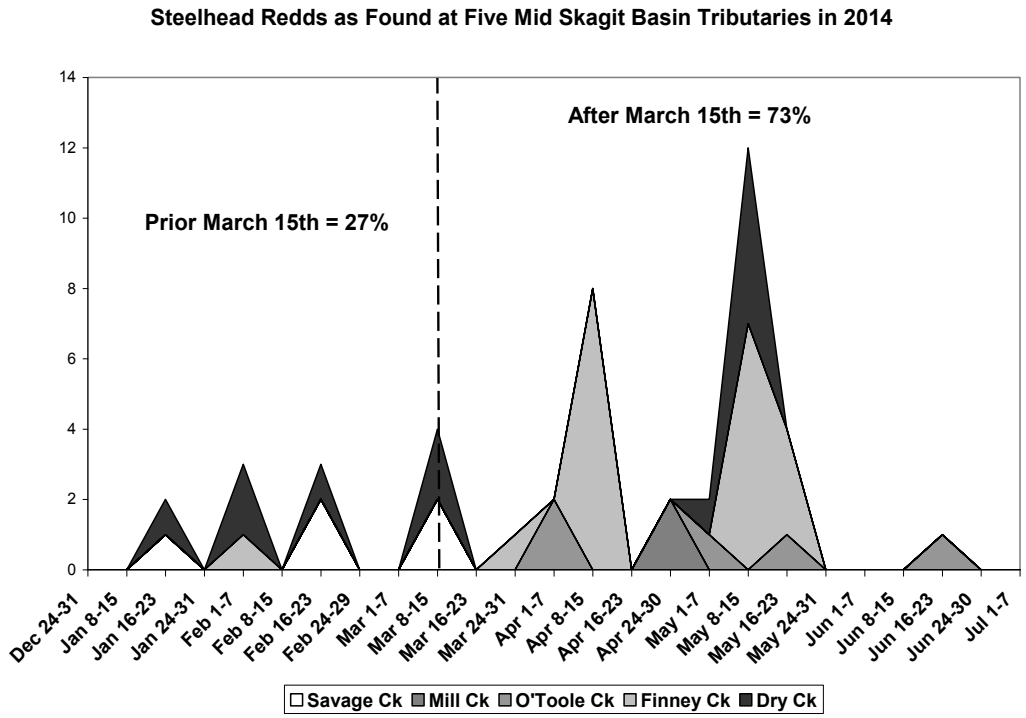


Figure 2.

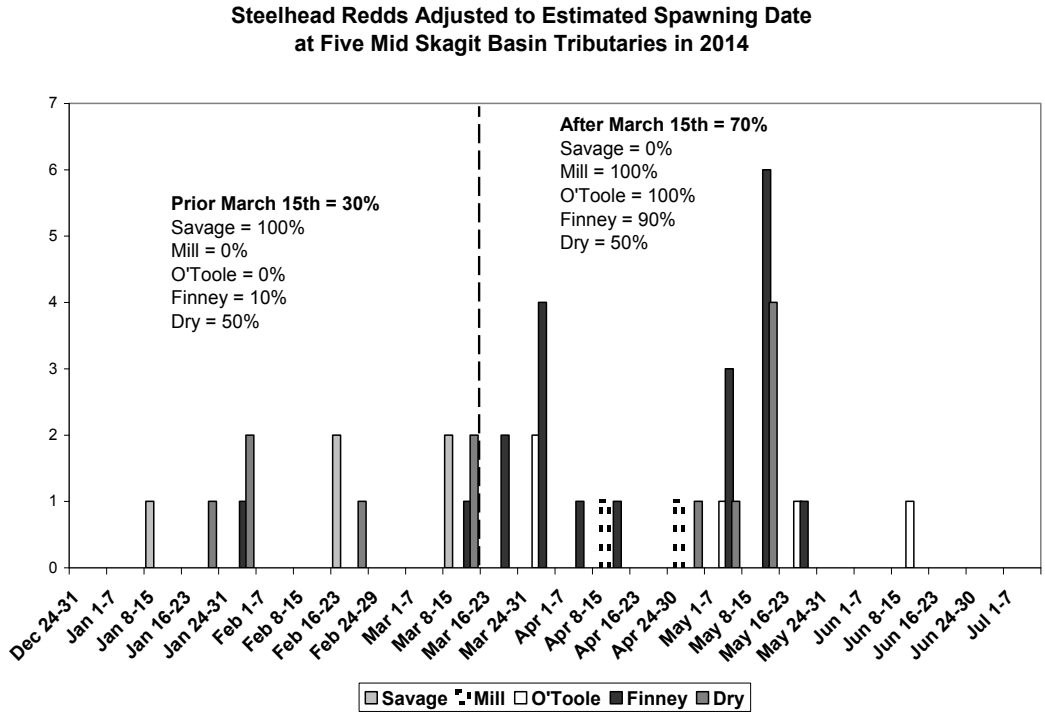


Table 4. Mid Skagit tributary steelhead spawning at streams regularly surveyed in 2014

Mid Skagit tributary	Earliest redd	Latest redd	Total redds	Redd upstream extent	Redds/km
Savage Ck	Jan 23, 2014	Mar 15, 2014	5	Mainstem = 1,997 yds; 1.826 km West Fork = 420 yds; 0.384 km	1.4/km
Mill Ck	Apr 30, 2014	Apr 30, 2014	2	578 yds; 0.529 km	2.4/km
O'Toole Ck	Apr 7, 2014	Jun 16, 2014	5	680 yds; 0.622 km	8.0/km
Finney Ck	Feb 1, 2014	May 22, 2014	20	3,825 yds; 3.498 km	5.7/km
Dry Ck	Jan 16, 2014	May 14, 2014	12	950 yds; 0.869 km	13.8/km

Table 5. Mid Skagit tributary steelhead spawning at streams intermittently surveyed in 2014

Mid Skagit tributary	Survey date(s)	Total redds	Redd upstream extent	Redds/km
Quartz Ck of Finney	May 16, 2014	0	none found	0
Hatchery Ck of Finney	Mar 23, 2014 & May 16, 2014	2	185 yds; 0.169 km	5.5/km
Grandy Ck	Feb 20, 2014	1	1,136 yds; 1.039 km	0.6/km
Cumberland Ck	May 2, 2014	2	852 yds; 0.779 km	3.8/km

Table 6. 2010-2014 Cumulative Mid Skagit Basin Tributary Steelhead Redd Counts by 7-8 Day Periods

Steelhead redd counts by period found

Steelhead redd counts adjusted to estimated spawning period

Date	Savage		Mill		O'Toole		Finney		Dry		Total	
Dec 24-31												
Jan 1-7												
Jan 8-15		1						1				**2**
Jan 16-23	3	2		2					1	2	**4**	**6**
Jan 24-31	1	3	6	4		1		3		4	**7**	**15**
Feb 1-7	1	3			1		3	2	2	2	**7**	**7**
Feb 8-15	4	2		1		1	6	4	5		**15**	**8**
Feb 16-23	4	2	4	3	1				1	1	**10**	**6**
Feb 24-29								1				**1**
Mar 1-7							3	1			**3**	**1**
Mar 8-15	2	2		3			1	2	2	2	**5**	**9**
Mar 16-23								2				**2**
Mar 24-31			4	1		2	1	4			**5**	**7**
Apr 1-7				1	2			2			**2**	**3**
Apr 8-15	1	1	1	3			11	5			**13**	**9**
Apr 16-23						1	1	1			**1**	**2**
Apr 24-30			3	3			2	1		1	**5**	**5**
May 1-7			1	1	1	2		4	1	1	**3**	**8**
May 8-15			3		2		7	6	5	4	**17**	**10**
May 16-23					1	1	5	1			**6**	**2**
May 24-31												
Jun 1-7												
Jun 8-15						1						**1**
Jun 16-23					1						**1**	
Jun 24-30												
Jul 1-7												
Total	**16**	**16**	**22**	**22**	**9**	**9**	**40**	**40**	**17**	**17**	**104**	**104**

The earliest and latest steelhead spawning redds, total steelhead redds, extent of steelhead spawning, and steelhead redds per kilometer by regularly surveyed tributary in 2014 are listed in Table 4 with a resulting six month breadth of steelhead spawning evidence found. The total length of the survey reaches is provided in Table 1 from which steelhead redds per kilometer were determined, except for Savage Creek where the steelhead survey length was 3,805 yds (3.479 km), or 604 yds (0.552 km) less than for total surveys included in Table 1 (Table 1 includes coho surveys further up the West Fork of Savage Creek). The steelhead spawning found at the Mid Skagit tributary streams intermittently surveyed are enumerated by date, total steelhead redds found, upstream extent, and steelhead redds per kilometer in Table 5. Although these surveys were too limited to be of comparative value to those streams regularly surveyed, in the cases of Cumberland and Hatchery Creek significant steelhead spawning per km was found. Grandy Creek was surveyed only once primarily to determine if early steelhead spawning had occurred. Only a little over 1 km of its lower section was surveyed of a total potential steelhead spawning length of at least 5.5 miles (8.85 km) to Grandy Lake. Although Quartz Creek was surveyed during a period when steelhead were spawning elsewhere in Finney Creek basin that it is tributary to, less than 0.20 km was surveyed of what is considered to be 0.80 km spawning habitat available to a cascade (Williams et al. 1975).

The cumulative steelhead redds at each of the five Mid Skagit tributaries regularly surveyed in the longer 2010 to 2014 period were enumerated by 7-8 day periods when they were found and also as adjusted to reflect their estimated spawning date in Table 6. The cumulative redds and live fish sightings for all species by tributary stream during this longer 5-year period along with notes about actual dates of redds and details related to live fish sightings are in Tables 1, 2, 3, 4, and 5 of Appendix C. At the five Mid Skagit basin tributaries regularly

Figure 3.

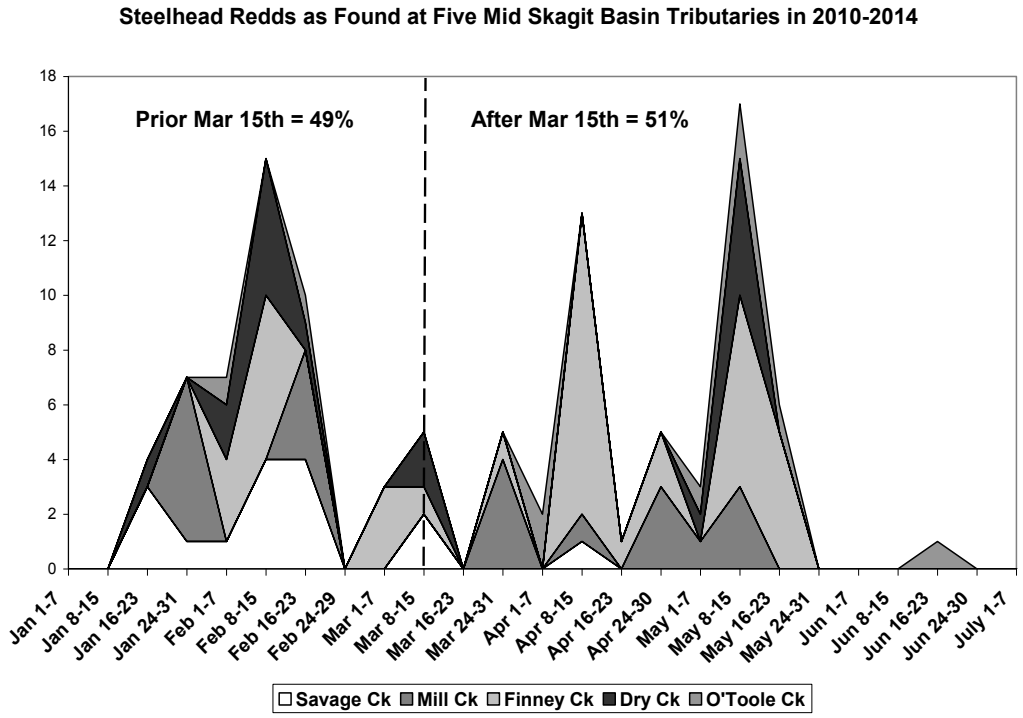


Figure 4.

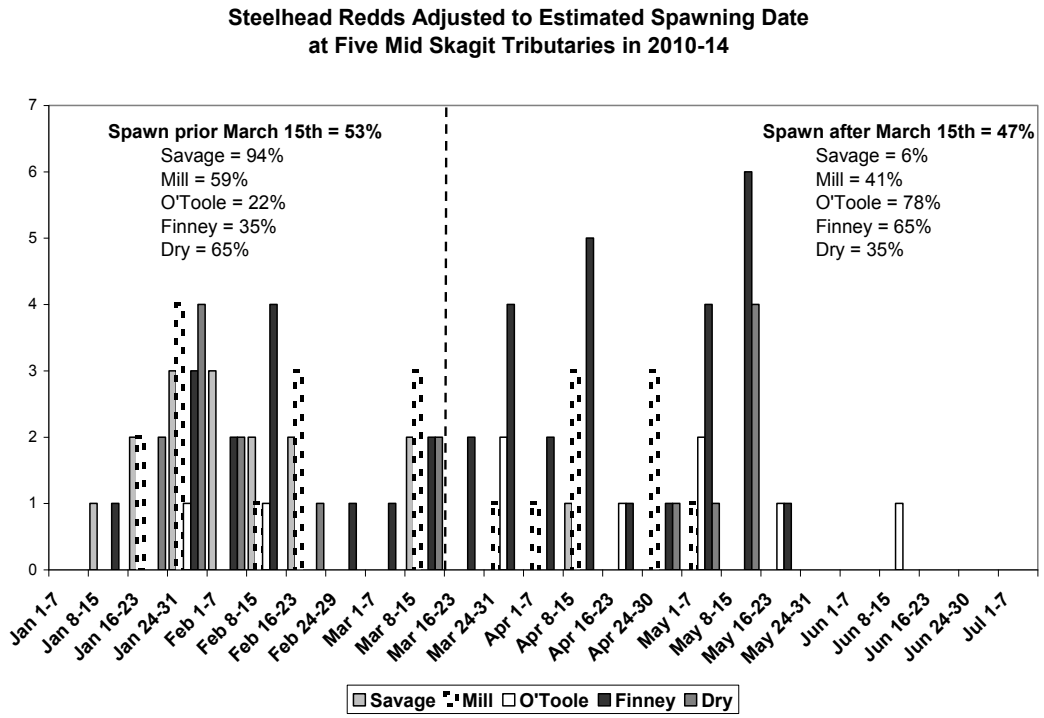


Table 7. Finney Creek Redd Counts by Time Period Found and as Adjusted to Reflect Estimated Spawning Period in 2010 and 2014

7-8 day period	2010 redds by period found	2010 redds by spawn period	2014 redds by period found	2014 redds by spawn period
Jan 16-23				
Jan 24-31		1		1
Feb 1-7	1		1	
Feb 8-15		1		
Feb 16-23				
Feb 24-29		1		
Mar 1-7	3	1		
Mar 8-15	1	1		1
Mar 16-23				2
Mar 24-31			1	4
Apr 1-7		1		1
Apr 8-15	3	4	8	1
Apr 16-23	1	1		
Apr 24-30	2	1		
May 1-7		1		3
May 8-15			7	6
May 16-23	2		3	1
May 24-31				
Totals	**13**	**13**	**20**	**20**

Figure 5.

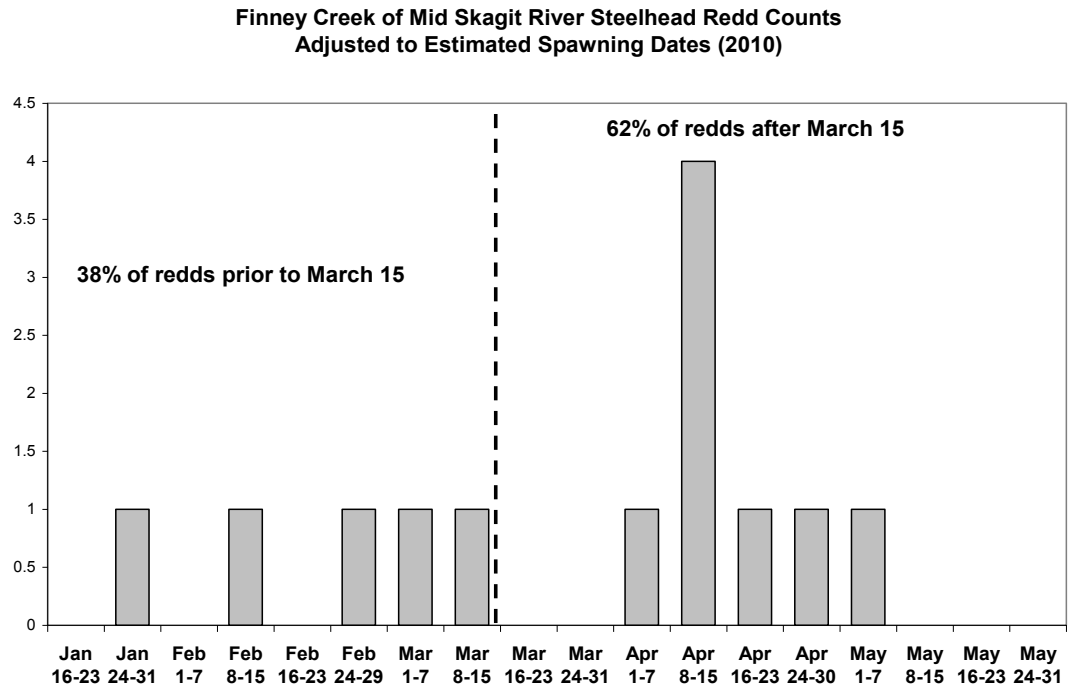
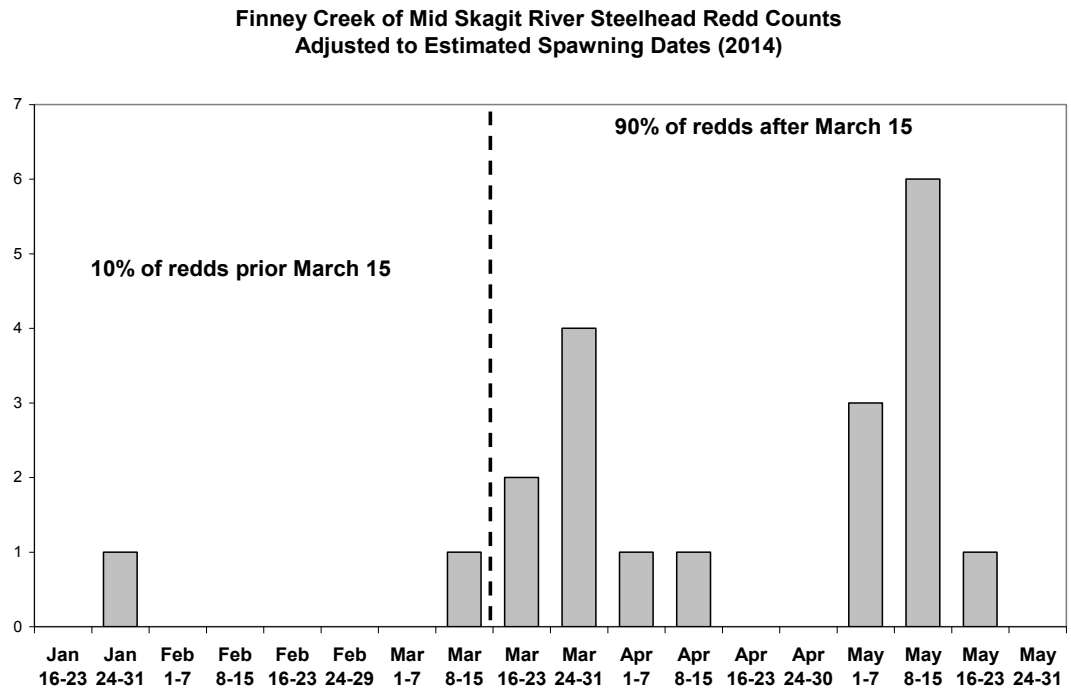


Figure 6.



surveyed from 2010 to 2014 the percentage of redds as found by 7-8 day intervals prior to and after March 15th are in Figure 3, and the percentages similarly found prior to and after March 15th in 2014 are in Figure 1. The

cumulative redds at each tributary from 2010 to 2014 as adjusted to reflect the estimated spawning date by 7-8 day intervals with percentages prior to and after March 15th are in Figure 4.

Finney Creek is the largest of the tributary streams regularly surveyed. Relatively similar intensity and duration of redd counts occurred at Finney Creek in 2010 and 2014 in which the age of each redd was also evaluated for its actual spawning date (Table 7). In 2010, 28% more spawning occurred prior to March 15th than in 2014 (Figures 5 and 6). Peak spawning in 2010 (early to mid April) was a month earlier than in 2014 (early to mid May), but the initiation of spawning was the same both years (late January).

Spawning Times Found for Wild and Hatchery Steelhead, Resident *O. mykiss*, and Other Salmonid Species

A primary purpose of the Mid Skagit basin tributary spawning surveys was to document whether hatchery steelhead spawning occurs, and if it overlaps with wild spawning. This could only be determined through visual observations of active spawning. A particular emphasis was placed on making active steelhead spawning observations during the 2014 steelhead spawning period of January through March when wild and hatchery overlaps in spawning time were thought to most probably occur. This entailed spending 0.5-1.5 hours of observation time when active spawning was found to make wild from hatchery determinations.

Sighting steelhead on spawning streams has been reported as relatively uncommon on the Oregon Coast, not only due to relatively small numbers compared to salmon but due to their nature to flee and hide (Susac and Jacobs 1999). This was similarly found in the Mid Skagit basin tributary surveys. During Mid Skagit tributary surveys active spawning was most commonly observed at late afternoon/evening and/or on cloudy days. It was also found that active spawning was most likely to occur within a 24-36 hour period after significant rainfall with streamflows dropping after their peak. The timing of the 2014 surveys was particularly adjusted to reflect this whenever possible. However, diminished lighting that steelhead apparently prefer for spawning has inherent limitations in visually determining the presence or absence of the adipose fin necessary for wild or hatchery identifications. Photographs were taken when active spawning was found as an aid to determine adipose presence or not, but absence of light also results in photographs with less definition than in brighter light. Nevertheless, photographs proved of great value. The active steelhead spawning found in Mid Skagit tributaries from 2010 to 2014 by sex and whether of wild, hatchery, or unknown origin is provided in Table 8. The resident *O. mykiss* life history is identified and listed if found as part of the active spawning mix. Also, the active spawning of *O.clarki* that is known to hybridize with *O. mykiss* is listed as observed.

The increased frequency of spawning surveys in 2014 resulted in the sighting of five incidences of female steelhead actively digging redds, or in the vicinity of where recent redd activity occurred. Four of these sightings occurred at Dry Creek, the smallest of the streams surveyed and the one where the greatest percentage of survey time occurred in ideal survey conditions of relatively low and clear flows very shortly after storm events. Spawning surveys at Dry Creek were not initiated until mid February of 2013 in the prior assumption that it was not a steelhead spawning stream based on earlier indications by other Skagit basin surveyors and due to my own brief observations contained to a bridge crossing near its mouth. Therefore the Dry Creek data is limited to two years, but it is now apparent that it is not only an important steelhead spawning stream but one which may provide a particularly reliable stream for effective monitoring of steelhead spawning at Mid Skagit tributaries. In the previous four years of surveys active steelhead spawning was only observed twice, once at Savage Creek and once at Finney Creek.

The resident form of *O. mykiss* was part of, or potentially a part of the spawning life history mix as determined at both Dry and Finney creeks. At upper Dry Creek, on January 16th of 2014 the only mate found with a hatchery female steelhead actively digging a redd was a wild male resident *O. mykiss*. However, the actual spawning act was not observed and could have potentially included a male steelhead thereafter. Another resident male *O. mykiss* was observed as part of the steelhead spawning mix at Dry Creek on March 12th of 2014. At Finney Creek on March 4th of 2010 and March 28th of 2014 a potential resident *O. mykiss* may have been present as part of each spawning mix. Throughout the adult steelhead collection period on Finney Creek in 2010 (related to the Skagit River steelhead acoustic tracking and tissue sampling for genetic analysis) a

Table 8. Species, life history, sex, and origin of live fish observed on redds occupied by female steelhead by tributary in cumulative surveys of the Mid Skagit basin in 2010-2014

Tributary	Date	Wild sthd ♀	Wild sthd ♂	Hat sthd ♀	Hat sthd ♂	? sthd ♂	Wild res *O. mykiss* ♂	Wild *O.clarki* ♂
Finney Ck	3/4/2010	1*				1*		
Savage Ck	1/19/2011			1	1	2**		
Dry Ck	1/16/2014			1			1	
Dry Ck	2/19/2014	1				1		1*****
Dry Ck	3/12/2014			1		1	1	
Finney Ck	3/28/2014	1***	1***			1****		
Dry Ck	5/12/2014	1	1					
Total		4 (21%)	2 (10.5%)	3 (15.8%)	1 (5.3%)	6 (31.6%)	2 (10.5%)	1 (5.3%)

* A large wild female darted off a redd along with the wake of at least one other fish as the mate; whether a male steelhead or larger resident *O. mykiss* was unknown; it was counted as a male steelhead of unknown origin

** These 2 male steelhead were vividly red-striped and fled on being sighted; the 2 hatchery steelhead did not flee; behavior suggested that the 2 fleeing fish were wild males but no sure visible evidence of adipose fin presence was made

*** This female and male steelhead were in slightly turbid water conditions that prevented seeing adipose fin presence or absence; due to their large size of an estimated 81-86 cm or more they were considered probable wild steelhead

**** It was not possible to determine if this was a smaller male steelhead or large resident male *O. mykiss* of an estimated 46-51 cm or if of wild or hatchery origin; a significant number of resident *O. mykiss* were sampled in Finney Creek in the winter and spring of 2009 for DNA analysis of similar size as were a few steelhead in the mainstem Skagit from 2008 through 2011

***** Probable male sea-run cutthroat based on finding a male *O.clarki* of similar size in the same place the next day spawning with a female *O.clarki*

significant number of resident *O. mykiss* of 15-20 inches (38.1-50.8 cm) was sampled (Pflug et al. 2013). Nearly all were males and most were in mature spawning maturation in the same time period as when the steelhead sampling occurred from early March to early May. As found on the Washington Olympic Peninsula Coast, the resident life history of *O. mykiss* found spawning was gender specific, males apparently mating with female steelhead (McMillan et al. 2007). This also concurs with observations at Waddell Creek in California in one of the earliest studies of steelhead spawning that included presence of male resident *O. mykiss* as part of the presumed spawning mix (Needham and Taft 1934).

The period of overlap for hatchery and wild *O. mykiss* spawning was January 16th through March 12th as found in the Mid Skagit tributaries, a total of 56 days (about two months). If the male *O. mykiss* of unknown origin

and life history that was part of the spawning mix at Finney Creek on March 28, 2014 was a hatchery origin steelhead it would lengthen the time period another 16 days (2.5 months total).

Figure 7.

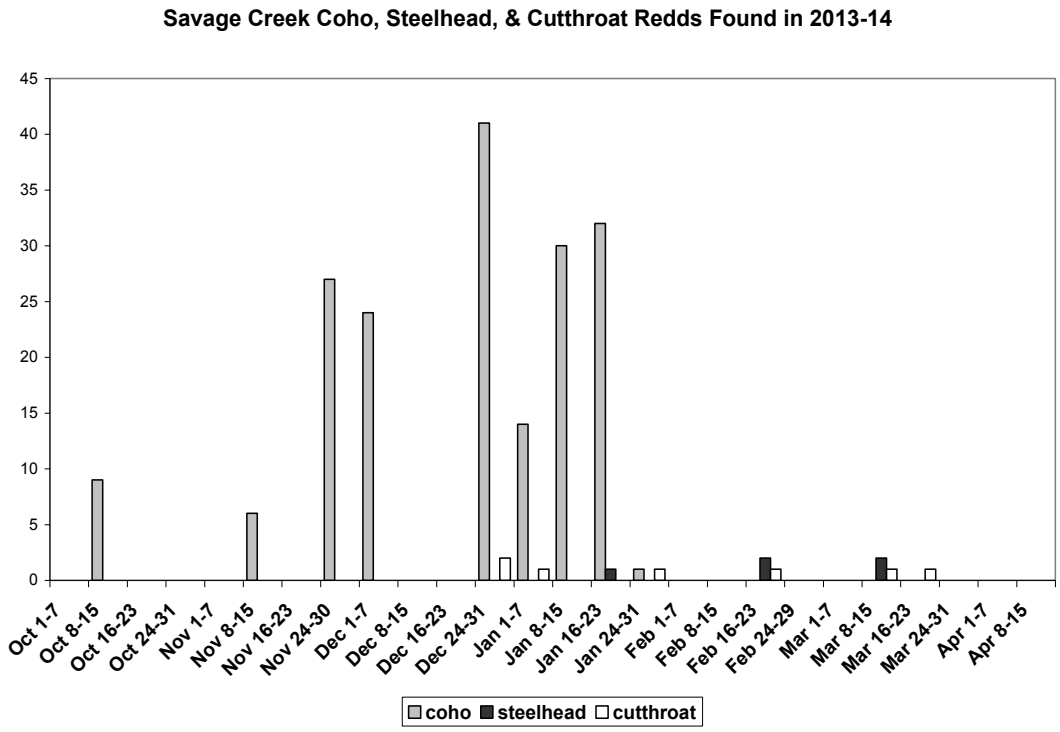


Figure 8.

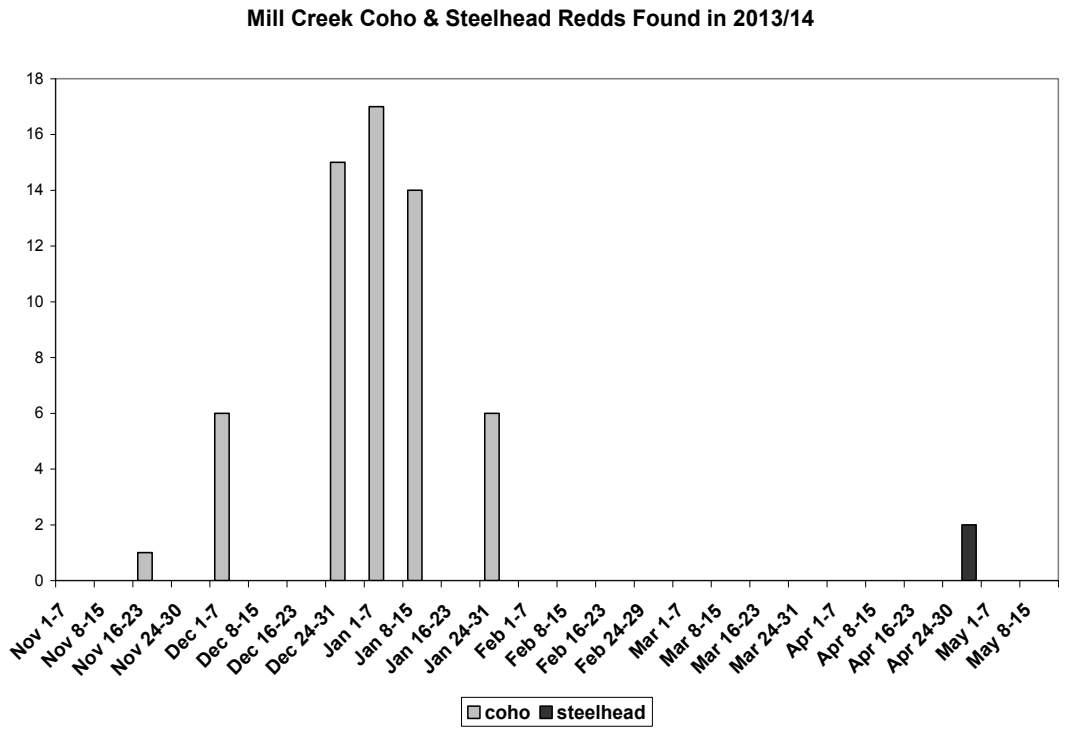


Figure 9.

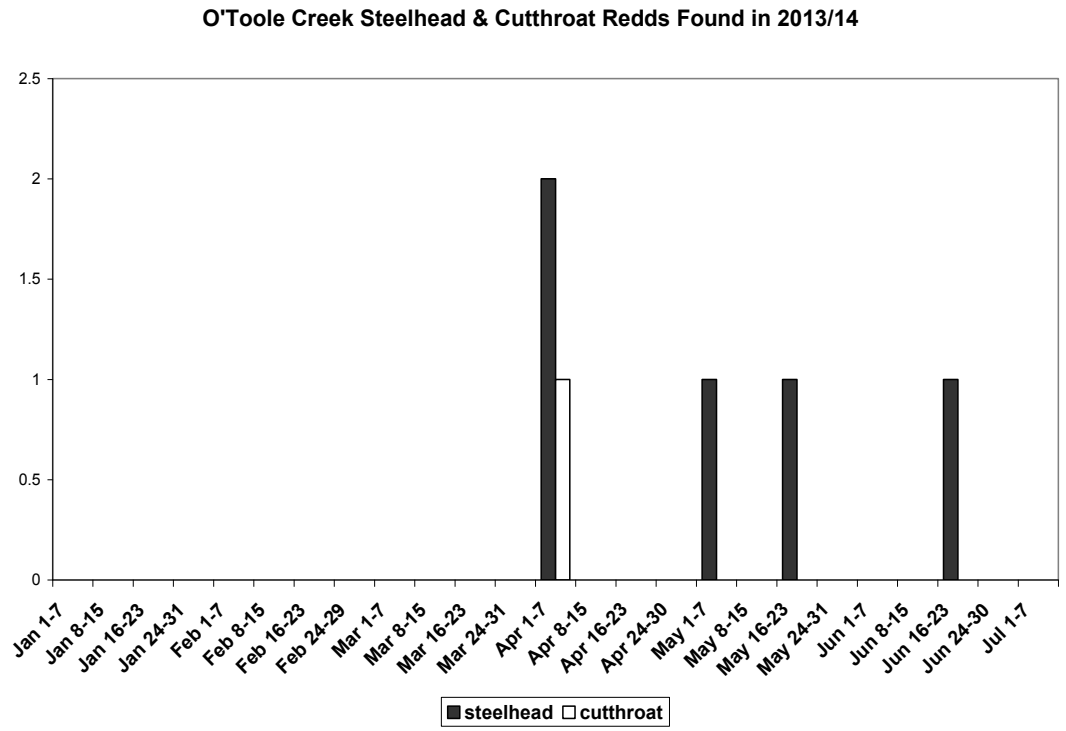


Figure 10.

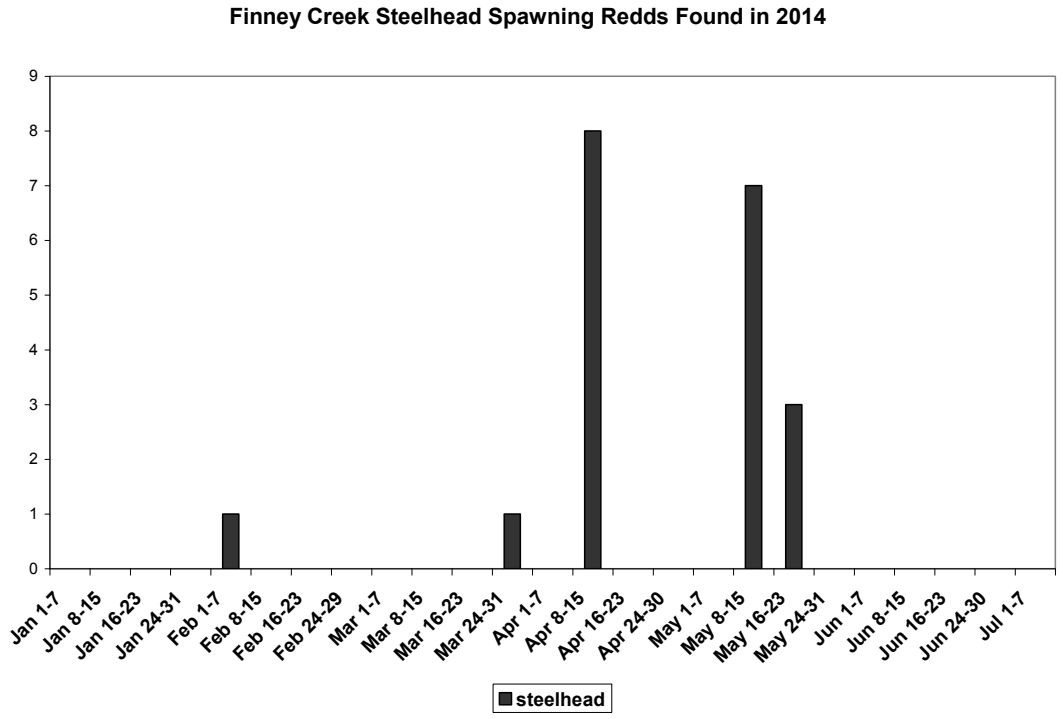
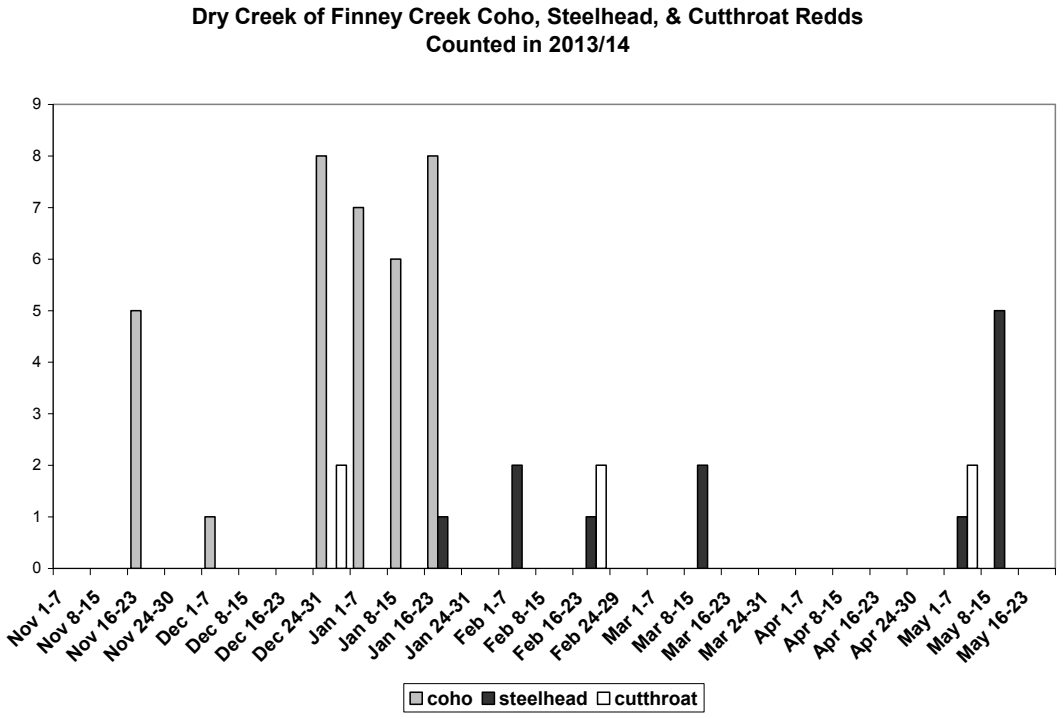


Figure 11.



In 2013-14 particular emphasis was also placed on determining what spawning overlaps may occur between steelhead and other species. Two other species of salmonids were found to have overlapping spawning periods

with steelhead (and resident *O. mykiss*), coho salmon (*Oncorhynchus kisutch*) and sea-run cutthroat (*Oncorhynchus clarki clarki*). This temporal overlap was more so for cutthroat than for coho. The first redd thought to be that of a sea-run cutthroat was latter December at both Dry and Savage creeks. The first and only active sea-run cutthroat spawning was found at Dry Creek on February 20th. The final redd thought to be that of a sea-run cutthroat was at Savage Creek in latter March, and a probable sea-run or resident cutthroat, or *O. mykiss* redd was found at Dry Creek in early May. The last live sea-run cutthroat was a male photographed at O'Toole Creek on May 15th. Figures 7-11 portray the overlaps with the other species as found at Dry, Mill, Savage, and O'Toole creeks during the 2013-14 October through early June survey period. In the case of O'Toole Creek, coho spawning has not been found to be very prevalent in previous years of surveys and in the 2013-14 surveys the temporal window of their potential overlap may have been missed due to a survey gap there from November 12, 2013 to March 12, 2014. At Finney Creek no surveys were made from October through January, primarily due to the difficulty of finding temporal survey windows that provided sufficient clarity to see redds or fish. In all instances in 2014, the transition from coho spawning to steelhead spawning was abrupt and well defined with but a minimal overlap over a one to two week period in mid to latter January.

Differences in Steelhead Spawning Time Found by Tributary

The differences in steelhead spawning times by tributary found in 2014 can be determined from the list of redd counts that have also been adjusted to estimated spawning dates in 7-8 day intervals in Table 3, and the differences by tributary over the five year period of 2010-14 are in Table 6. Steelhead redds as found by specific day for all years are listed in Appendix C, and in 2010 and 2014 in Appendix F (Tables 1 and 2). In 2014, the percentages of steelhead spawning prior to March 15th by tributary were: Savage Creek, 100%; Mill Creek, 0%, O'Toole Creek, 0%, Finney Creek, 10%, and Dry Creek 50% (Figure 2). Over the five year period of 2010-14, the percentages of steelhead spawning prior to March 15th by tributary were: Savage Creek, 94%; Mill Creek, 59%; O'Toole Creek, 22%; Finney Creek, 35%; and Dry Creek, 65% (Figure 4).

Determining Why There Were Steelhead Spawn Time Differences and Why It May Differ by Tributary

It was hypothesized that steelhead spawning time is determined by adaptations to environmental characteristics of spawning location among which are: temperature and streamflow/precipitiation during the spawning period, and perennial/intermittent flows that may determine egg-to-fry survival success. Each of these three factors was separately considered and evaluated from the data that were available, although in the cases of temperature and precipitation/streamflow the data available were not site-specific (Appendix G, Tables 1, 2, and 3 provide air temperature, precipitiation, and streamflow data primarily used from 2010 to 2014). However, even if more precise measures had been available by day and by hour it remained that the great majority of redds found were inactive and not in active spawning use. In some cases redds were estimated to not only be several days old, but weeks old. Without doing daily spawning surveys (commonly impossible due to adverse stream conditions) it may be impossible to develop a precise enough measure of when steelhead spawning actually occurs to be statistically informative enough to determine if correlations to environmental factors such as water temperature, air temperature, precipitation, or streamflow are significant or not. Nevertheless, each of these factors was considered and evaluated from what was available.

a) Temperature: stream temperatures were not measured during each spawning survey due to occurring at varied times of day, and differing days, at each tributary and would not necessarily provide equal comparative factors. There was no access to temperature loggers that could have been placed in each of the five primary tributary streams surveyed that would have been useful for recording water temperatures over the entire

spawning season of surveys. However, as previously indicated, even given a good measure of stream temperature per day and by hour, it remained that the great majority of redds found were inactive and not in active spawning use and a more precise measure of daily and hourly stream temperatures may not have resulted in any more informative comparison of water temperature to spawning time than the less direct methods used.

What was available was a former baseline of stream temperatures that I took in a number of Mid Skagit basin tributary streams in 2002 in preparation for spawning surveys that were then first planned. They were taken at 10-12 day intervals during a significant portion of the steelhead spawning season at near expected daily temperature peaks in latter afternoon (Table 9). While no record was found of stream temperatures for any of the tributary streams surveyed for 2010-2014, there is a long-term daily record of high, low, and mean air temperatures taken at the lower Baker River in Concrete, WA of the Mid Skagit basin that dates back to 1905 and with an interval of complete data from 1909 to 1915 and continuous information from 1931 to the present (WRCC). This historic baseline of air temperature information was used as a potential proxy for water temperature patterns that would have occurred, if not specifically the temperature of each stream. Monthly mean air temperatures were compared to the monthly steelhead redd counts and evaluated with Pearson's correlation coefficient to determine if there was a significant relationship or not.

b) Streamflow/Precipitation: there is presently no streamflow gaging station on any of the Mid Skagit tributaries that were surveyed. However, there was such a station at Finney Creek with streamflow recorded in cubic feet per second (cfs) in the period of 1943-48 (USGS 1943-1948). The North Fork Stillaguamish River has a streamflow gage between Arlington and Oso with streamflow data in cfs that is continuous dating from 1928 to the present. North Fork Stillaguamish streamflows have been considered to provide a surrogate for Finney Creek streamflows (USGS 1928-2014), and from which streamflow patterns during the steelhead spawning period at Finney Creek can be considered relatively equal (and potentially other Mid Skagit basin tributary streams). Alternatively, at the lower Baker River in Concrete, WA there is a long-term mean precipitation record kept that is of the same duration as previously described for air temperatures. It was hypothesized that precipitation pattern may provide a proxy for streamflow patterns at some Mid Skagit basin tributaries where the North Fork Stillaguamish/Finney Creek streamflow relationship may not as well fit. As with air temperatures, both monthly mean streamflow and precipitation were compared to the monthly steelhead redd counts and evaluated with Pearson's correlation coefficient to determine if there were significant relationships or not.

c) Perennial/Intermittent: it was hypothesized that steelhead spawning may be particularly limited in duration at those tributary streams that go intermittent by late June to early July due to the lack of subsequent egg-to-fry survival that may occur if spawning took place beyond a certain point in time. To test this, each creek that was regularly surveyed was subsequently examined after the end of the 2014 steelhead spawning season at regular intervals through June, July, and August to determine if any part went intermittent, when, where, and how far the intermittency occurred both downstream and up. Perennial streams were also determined in this same period.

Stream Temperature Findings

Reasons for the differences in steelhead spawning time found among the Mid Skagit tributaries could be related to water temperature as one measurable environmental effect (Cederholm 1984). Among the considerations for temperature differences by tributary was the buffering effect on flows and temperature during the spawning period as a result of ponds, lakes, or wetlands that may affect spawning time, or the directional orientation of a

tributary watershed (facing north and away from winter sun, or facing south and into the winter sun, for instance) may result in warmer or lower average temperatures, or the proportional distribution of the watershed area between higher and lower elevations.

The Table 10 stream temperatures were recorded on a Fahrenheit (F) scale with added conversions to Centigrade (C). Bell (1973) indicates that steelhead spawning occurs at 3.9-9.4 C (39.0-48.9 F). Bovee (1978) indicates steelhead spawning occurs at 4-13 C (39.2-55.4 F). These sources likely capture the general range of steelhead spawning temperatures found in Washington. Temperatures greater than 4.0 C (39.2 F) were considered adequate to initiate steelhead spawning. Temperatures of 3.9 C (39.0 F) were considered marginal for initiation of steelhead spawning. Using these criteria, Grandy Creek in 2002 would have provided adequate peak spawning temperatures throughout the February 9 to April 15 period. If the marginal temperature peaks are included, both the mainstem Mid Skagit River and Finney Creek could have initiated steelhead spawning through most of that same period. Mill and Pressentin creeks had adequate to marginal temperature peaks to initiate steelhead spawning for three of the seven temperature points in that period. O'Toole Creek had only two of those seven temperature periods adequate for spawning. In all three of the latter creeks, these temperature periods were confined to latter March onward. In the case of Grandy Creek (only rarely surveyed), with warmer water temperatures within the range for steelhead spawning throughout the February to April period of 2009, important considerations are a lake in its headwaters and a south facing aspect of the drainage into the winter sun on the north side of the Skagit Valley. The combined lake and orientation to the sun is a likely combination from which to anticipate the warmer winter/spring stream water temperatures found and that steelhead spawning temperatures occur there at what may be a particularly early date. Although Grandy Creek was surveyed early in the spawning season (February) in 2010, 2011, 2013, and 2014 with steelhead redds found in the surveys three of those years (2010, 2013, and 2014) whose estimated spawning dates included January, no later surveys were done for comparison (Appendix C). Nevertheless, it is apparent that Grandy Creek is one of the Mid Skagit basin tributaries where steelhead spawning prior to March 15th is common.

While the Table 10 data is generally useful as a potential guide to determining what stream characteristics and subsequent peak spawning temperatures might temporally stimulate steelhead spawning to occur in the Mid Skagit area, it includes only three of the five creeks regularly surveyed in 2014 (Finney, Mill, and O'Toole creeks) and one creek rarely surveyed (Grandy Creek).

Table 9. Mid Skagit basin peak stream temperatures at 10-12 day intervals

Stream Orientation & etc.	**Temp F/C**	**Water temperature by 10 day intervals February 9 to April 15, 2002**							**Mean Temp**
		2/9	**2/19**	**3/2**	**3/12**	**3/24**	**4/3**	**4/15**	
Grandy Ck (faces south & lake & wetland headwaters)	F C	40.5 4.72	40.5 4.72	41.0 5.00	40.0 4.44	44.25 6.81	46.0 7.78	42.25 5.69	42.08 5.60
Skagit River (5 dams & reservoirs)	F C	39.0 3.89	39.5 4.17	39.5 4.17	38.5 3.61	43.75 6.53	44.0 6.67	40.5 4.72	40.68 4.82
Finney Ck (faces n.w. & long lower reach of low gradient)	F C	39.0 3.89	39.5 4.17	38.5 3.61	38.5 3.61	42.5 5.83	45.0 7.22	40.75 4.86	40.54 4.74
Mill Ck (faces north)	F C	38.5 3.61	38.5 3.61	37.5 3.06	38.0 3.33	40.0 4.44	40.0 4.44	39.5 4.17	38.86 3.81

Pressentin Ck	F	38.0	38.5	36.5	37.5	39.75	40.25	39.0	38.50
(faces north)	C	3.33	3.61	2.50	3.06	4.31	4.58	3.89	3.61
O'Toole Ck	F	38.0	38.0	36.0	37.0	39.5	39.75	38.75	38.14
(faces north)	C	3.33	3.33	2.22	2.78	4.17	4.31	3.75	3.41

Temperatures shaded in light gray are within the common range of steelhead spawning (Bell 1972, 3.9-9.4 C; Bovee 1978, 4-13 C) and dark gray marginally included. (Orcutt, 1968, indicated Idaho steelhead in the headwaters of the NF Clearwater River spawn at 2.2-8.3 C, but it is at a much higher elevation than Western Washington streams. Nevertheless, it suggests that steelhead can spawn at lower temperatures.)

From summer temperature data at the five Mid Skagit tributaries regularly surveyed in 2014 (Table 10), on June 16th of a cloudy, cool day Finney Creek was again the warmest temperature and O'Toole Creek the coldest with Mill Creek slightly warmer than O'Toole. However, the mainstem Mid Skagit River was nearly as cold as O'Toole Creek. This was to be expected in June due to peak snowmelt from the North Cascade Mountains then occurring with several headwater origins from glaciers. Savage Creek, which runs through a series of ponds and wetland areas from 0.5 to 1.0 kilometer (km) above entry to the Skagit River, was 4.4 C warmer 135 meters (m) below the largest main pond than 125 m above it. Dry Creek, an otherwise unnamed tributary of lower Finney Creek, was colder than Finney and lower Savage Creek, but warmer than Mill, O'Toole, and upper Savage Creek.

Flows rapidly diminished and heated from late June to mid July, except in the mainstem Mid Skagit River. The period from July 9 to July 14 of 2014 on the Mid Skagit Valley floor had afternoon peaks of 80-85 F (26.7-29.5 C) as taken near the mouth of Savage Creek. While the mid June temperatures were taken during a cooler and stable temperature day, as can be common in June in the Mid Skagit Valley, the mid July temperatures represent what is a common high temperature period during most summers in the Mid Skagit Valley. Morning temperature was taken at Mill Creek on July 13th as representative of cooler tributary streams during warmer

Table 10. Mid Skagit River and five tributary creek air and water temperatures in summer of 2014

warmest by date coolest by date

Creek	Section	Date	Time	Weather	Air Temp		Water Temp	
Finney Ck	3.5 km above mouth	6-16-2014	4:05 pm	cloudy cool	57.0 F	13.9 C	57.0 F	13.9 C
Dry Ck of Finney	250 m above mouth	6-16-2014	4:00 pm	cloudy cool	57.0 F	13.9 C	51.5 F	10.8 C
Mill Ck	90 m above S. Skagit Hwy	6-16-2014	4:20 pm	cloudy cool	57.0 F	13.9 C	49.5 F	9.7 C
Savage Ck	125 m above main pond	6-16-2014	5:15 pm	cloudy cool	57.0 F	13.9 C	51.0 F	10.6 C
Savage Ck	135 m below main pond	6-16-2014	5:10 pm	cloudy cool	57.0 F	13.9 C	59.0 F	15.0 C
O'Toole Ck	70 m above S. Skagit Hwy	6-16-2014	4:40 pm	cloudy cool	57.0 F	13.9 C	48.5 F	9.2 C
Mid Skagit Riv	Savage Bar	6-16-2014	6:15 pm	cloudy cool	58.0 F	14.4 C	49.0 F	9.4 C
Mill Ck	25 m below S. Skagit Hwy	7-13-2014	10:20 am	sunny warm	69.0 F	20.6 C	57.5 F	14.2 C
Savage Ck	250 m above main pond	7-13-2014	9:35 am	sunny warm	66.0 F	18.9 C	54.5 F	12.5 C
Savage Ck	135 m below main pond	7-13-2014	10:00 am	sunny warm	68.0 F	20.0 C	69.5 F	20.8 C
Finney Ck	4.0 km above mouth	7-13-2014	8:30 pm	sunny warm	70.0 F	21.1 C	70.5 F	21.4 C
Dry Ck of Finney	450 m above mouth	7-13-2014	8.15 pm	sunny warm	70.0 F	21.1 C	63.5 F	17.5 C
Savage Ck	135 m below main pond	7-13-2014	8:48 pm	sunny warm	69.0 F	20.6 C	75.0 F	23.9 C
Mill Ck	25 m below S. Skagit Hwy	7-13-2014	8:52 pm	sunny warm	68.0 F	20.6 C	59.5 F	15.3 C
O'Toole Ck	70 m above S. Skagit Hwy	7-13-2014	9:00 pm	sunny warm	68.0 F	20.0 C	59.5 F	15.3 C
Mid Skagit Riv	Savage Bar	7-13-2014	9:15 pm	sunny warm	68.0 F	20.0 C	55.0 F	12.8 C
Savage Ck	135 m below main pond	7-14-2014	8:13 pm	sunny warm	70.0 F	21.1 C	75.5 F	24.2 C

Savage Ck	450 m above main pond	7-14-2014	8:30 pm	sunny warm	68.0 F	20.0 C	58.0 F	14.4 C
Finney Ck	3.5 km above mouth	8-16-2014	4:45 pm	cloudy warm	69.5 F	20.8 C	68.0 F	20.0 C
Dry Ck of Finney	350 m above mouth	8-16-2014	4:30 pm	cloudy warm	69.5 F	20.8 C	62.0 F	16.7 C
Mill Ck	30 m above S. Skagit Hwy	8-16-2014	3:00 pm	cloudy warm	69.5 F	20.8 C	59.5 F	15.3 C
Savage Ck	450 m above main pond	8-16-2014	5:20 pm	cloudy warm	69.5 F	20.8 C	58.0 F	14.4 C
Savage Ck	below main pond dry	8-16-2014	5:05 pm	cloudy warm	69.5 F	20.8 C	dry	
O'Toole Ck	70 m above S. Skagit Hwy	8-16-2014	3:20 pm	cloudy warm	69.5 F	20.8 C	59.0 F	15.0 C
Mid Skagit Riv	Savage Bar	8-16-2014	5:45 pm	cloudy warm	69.5 F	20.8 C	59.5 F	15.3 C
Finney Ck	3.5 km above mouth	8-28-2014	8:00 pm	cloudy warm	65.0 F	18.3 C	70.0 F	21.1 C
Dry Ck of Finney	400 m above mouth	8-28-2014	7:50 pm	cloudy warm	65.0 F	18.3 C	62.0 F	16.7 C

summer weather periods, and at Savage Creek to measure both the inflow temperature to its pond/wetland reach as well as the outflow. Evening temperatures were taken on July 13-14 at all of the streams to represent water temperatures at near their peak during warmer summer periods (although evening may represent some slight cooling from what may be an actual peak a few hours earlier). The highest temperatures were at Finney Creek (70.5 F; 21.4 C) and Savage Creek below the uppermost pond (75.5 F; 24.2 C). At the latter juvenile coho and undetermined species fry were active and seemingly healthy. The coolest temperatures were at O'Toole Creek (59.5 F; 15.3 C) and the Mid Skagit River (55.0 F; 12.8 C). The summer peak air temperature occurred on August 11th at 93 F (33.9 C) near the mouth of Savage Creek (near Birdsview) and was preceded by several days in mid to high 80 F (26.7 C) range. Unfortunately, no time was available to take stream temperatures in that time period, but Finney Creek would have peaked considerably higher than on July 13th as the stream with the probable warmest summer peak temperature of those that remained wetted. Savage Creek below the ponds went dry by early August as the previous water temperature peak. On August 28, even at late evening after a mild late afternoon high of 70 F (21.1 C), Finney Creek was also 70 F, while Dry Creek was 62 F (16.7 C) just upstream of where it was dry.

The combined findings of water temperatures taken from early February to Mid April (Table 9) in the steelhead spawning period at Mid Skagit Basin tributaries and the shift to mid June and later (Table 10) indicate that the shift to maximum water temperatures beyond which steelhead spawning may cease at 9.4-13.0 C (48.9-54.5 F) as previously indicted by Bell (1973) and Bovee (1978) likely begins sometime between May and mid June at four tributaries (Savage, Mill, Finney, and Dry creeks), while continuing into June at O'Toole Creek. The actual steelhead spawning found in these same five tributaries further confirms this likelihood (Table 7).

Between 2000 and 2011 stream water temperatures were recorded at several Mid Skagit tributary streams at broadly spaced times while doing sampling or spawning surveys (Table 11). For the most part they merely confirm the previous temperature findings in Tables 10 and 11. However, it includes the active spawning period of January 19, 2011 at Savage Creek with the water temperature taken at the spawning location below

Table 11. Mid Skagit Basin Tributary Water Temperatures Taken at Varied Times Compared to Air Temperatures

Active steelhead spawning period

Tributary	Date	Time	Water temp (F)	Concrete air temp (F) low-high	Birdsview air temp (F)	Notes
Mill	7-21-2000	2:20pm 4:30pm	55 55	n/a	80 afternoon high	....

Mill	7-3-2007	3:45pm	54	52-78.1	....	....
O'Toole	2-3-2010	3:00pm	42	37-48	....	El Nino year
Mill	2-4-2010	2:30pm	42	37-44	....	El Nino year
Finney	2-6-2010	1:30pm	44	35-50	....	El Nino year
Pressentin	2-8-2010	1:30pm	41.5	41-48	....	El Nino year
Grandy	2-8-2010	2:15pm 3:30pm	44 44	41-48	....	El Nino year
Finney	4-13-2010	afternoon	44	39.9-60.1	....	El Nino year
Cumberland	6-25-2010	12:30pm	54	55-75.9	....	....
Mill	1-19-2011	4:50pm	39	36-39.9	....	....
Savage	1-19-2011	4:40pm	42	36-39.9	....	active spawning below pond outlet & where temperature taken
Mid Skagit	1-19-2011	5:00pm	40	36-39.9	....	....
Grandy	2-2-2011	2:00pm	40	27-39.9	21 morning low	very cold morning

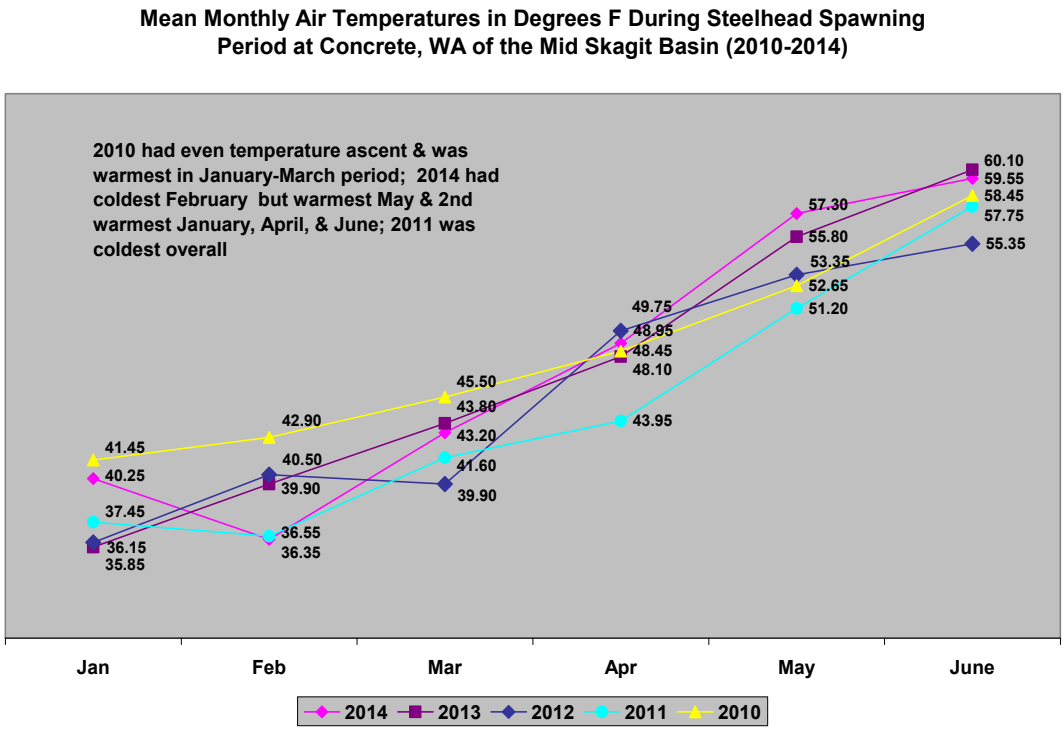
upper Savage pond. The water temperatures were similarly taken at the same day and time at nearby Mill Creek and the Mid Skagit River. The table also includes the Concrete, WA air temperature range (low and high) for each day (north side of the Mid Skagit River) and that at Birdsview, WA (south side of the Mid Skagit River) if available for the same days. The active spawning found at Savage Creek was on a relatively cool day (air temperature at Concrete being a low of 36 F and a high of 39.9 F) and at a water temperature of 42 F. At the same time, Mill Creek was 39 F and the Mid Skagit River 40 F, both cooler. Savage Creek was well within the temperature range indicated in the literature for steelhead spawning (depicted in Table 9) while that at Mill Creek and the Mid Skagit River were at the low to marginal end of the spawning temperature range. Between February 4 and 8 of 2011 there was a period of relatively stable air temperature and weather conditions during which afternoon water temperatures were taken at Mill (42 F), O'Toole (42 F), Finney (44 F), Grandy (44 F), and Pressentin (41.5 F) creeks of the Mid Skagit basin.

While the above stream temperature findings provide indicators of when typical steelhead spawning time windows can begin in Mid Skagit basin tributary creeks according to literature sources, and which of the streams tend to run cooler or warmer, there was only the one active spawning-to-temperature comparison made that also included temperatures taken at other nearby tributaries and the Skagit River during the 2010-14 cumulative spawning surveys made, that being Savage Creek on January 19, 2011 as compared to Mill Creek and Skagit River temperatures at the same time (Table 11).

Air Temperature Findings

Although average monthly water temperatures were not kept for any of the tributaries surveyed, and no similar data have been found available, monthly air temperature data is available for Concrete, Washington of the Mid

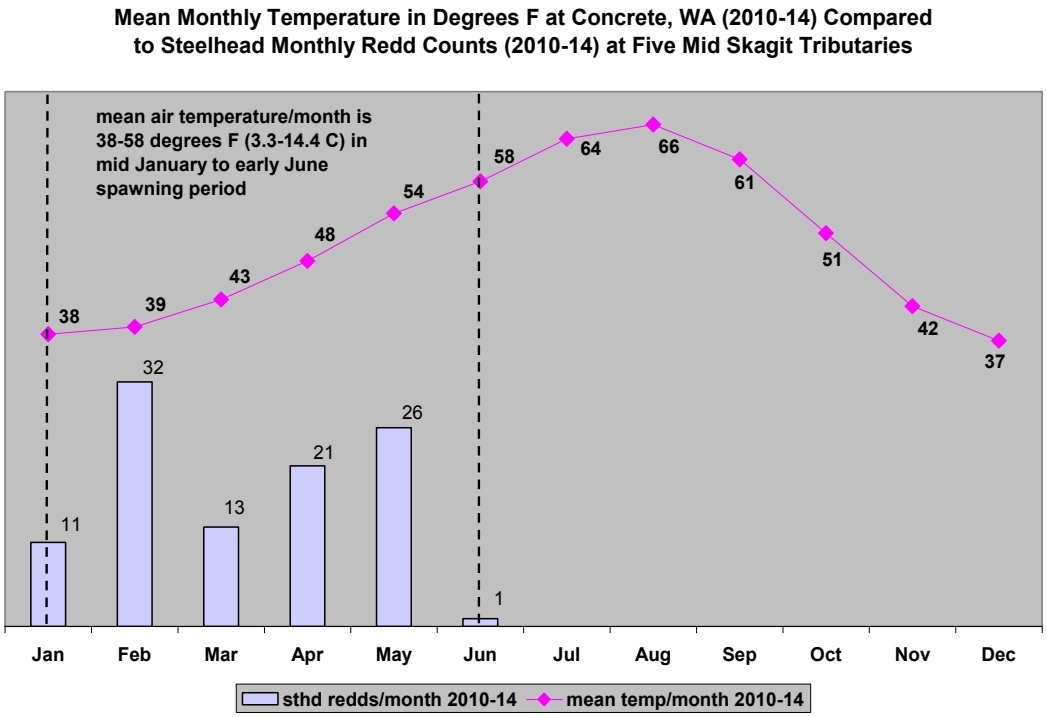
Figure 12.



Skagit basin (WRCC 2014) and may provide a proxy for water temperature trends if not water temperatures themselves. Figure 12 provides the mean monthly air temperature patterns for each year at Concrete during the steelhead spawning period from 2010 to 2014 (Appendix G, Table 1 provides the temperatures per month). The monthly air temperatures in 2010 were higher from January to March than the other years and progressed upward at a gradual and even rate that ended up cooler in May compared to other years. The February mean air temperature was colder in 2014 than the other years but warmest in May and second warmest in January, April, and June. On whole, 2011 was the coldest of the years during the steelhead spawning period.

Steelhead spawning redds per month by date found at the Mid Skagit basin tributaries as compared to monthly mean air temperatures during the steelhead spawning period of the 2010-2014 surveys (Figure 13) suggest that steelhead spawning generally increases as mean air temperatures do from January (38 F, or 3.3 C) through May

Figure 13.



(54 F, or 14.4 C). The exception to what is otherwise an even progression of steelhead redds to increasing mean monthly air temperature is February as the month found with the single greatest number of steelhead redds. However, when the 2010-2014 steelhead redds found were adjusted to estimated spawning date, presumably the more relevant comparison, it results in what appears to be a slight inverse relationship to mean temperature per month with spawning apparently diminishing as temperatures rise (Figure 14).

While it was obvious during the surveys that a number of redds found were several days to several weeks old, the actual spawning time could only be estimated by personal judgment based on amount of algae on the redd, how vague its pit or tailing had become, and/or the prior periods when there had been spawning in near-by tributaries or otherwise what had seemed the best stream conditions for steelhead entry into these streams. In a number of instances, the judgments made regarding spawning date could have been pushed forward into the next month or dropped back into the following month. In this regard, spawning survey methods as limited by weather/water conditions do not lend to precision of spawning date determination by month for all redds. For this reason, both the dates when the redds were found and the estimated spawning dates have been comparatively evaluated for temperature (as well as for precipitation and streamflow).

A further evaluation of the potential relationship of air temperatures to the steelhead redds by date found in the primary steelhead spawning period from January to June was made (Figure 15) with a resulting Pearson's correlation coefficient, or "r", of - 0.3501, which is not statistically significant using critical values from the

Figure 14.

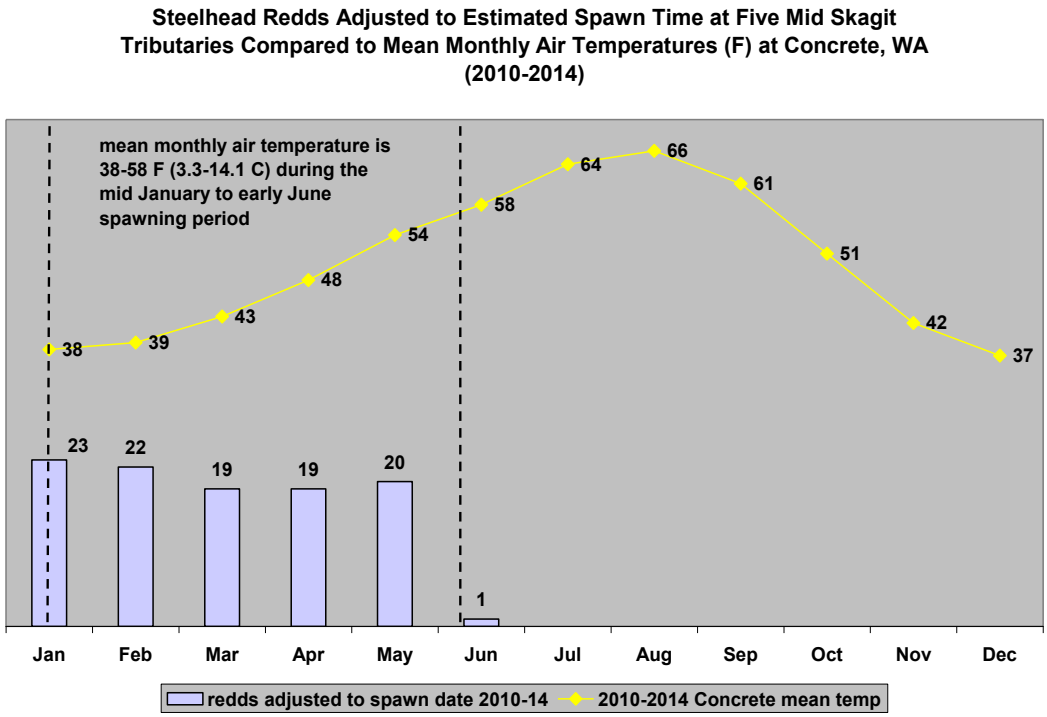


Figure 15.

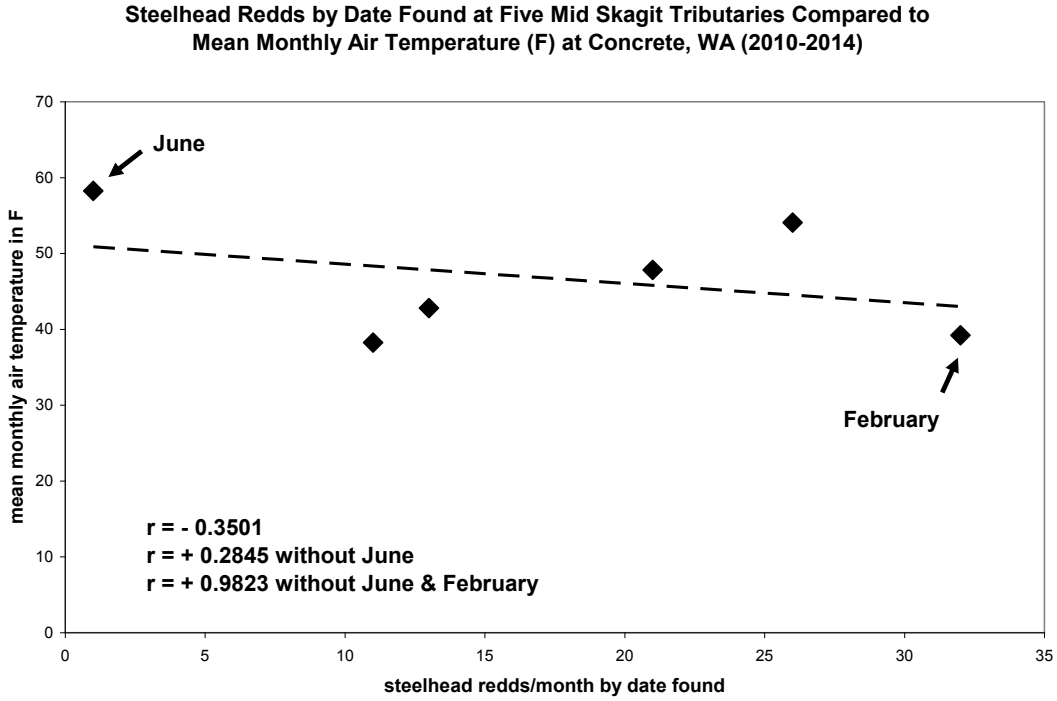
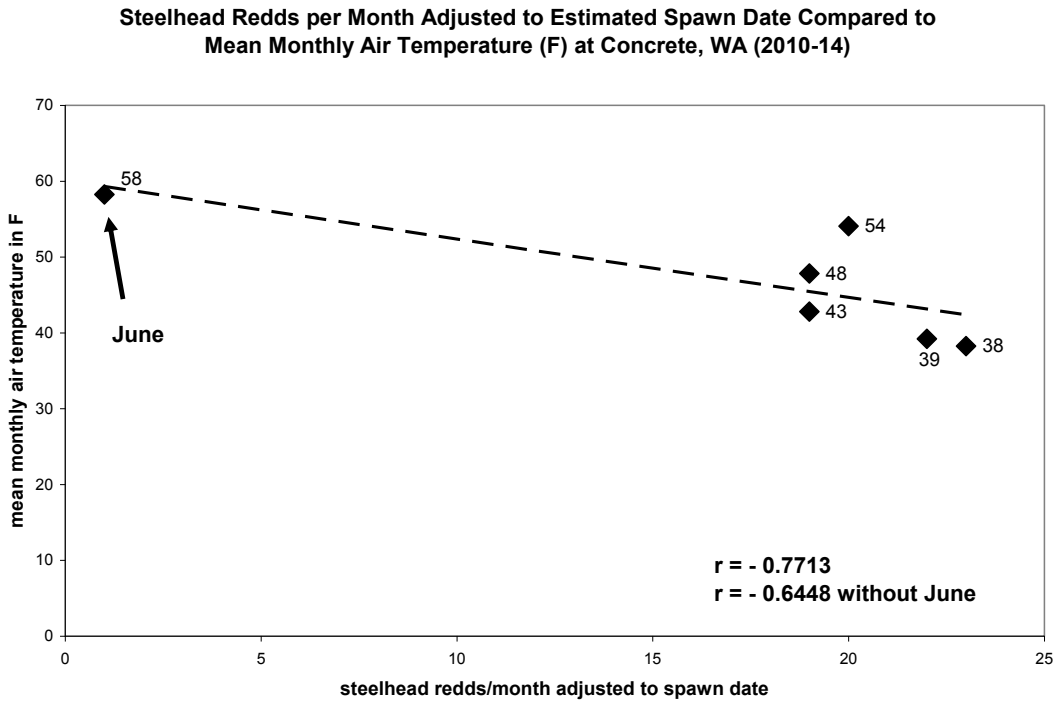


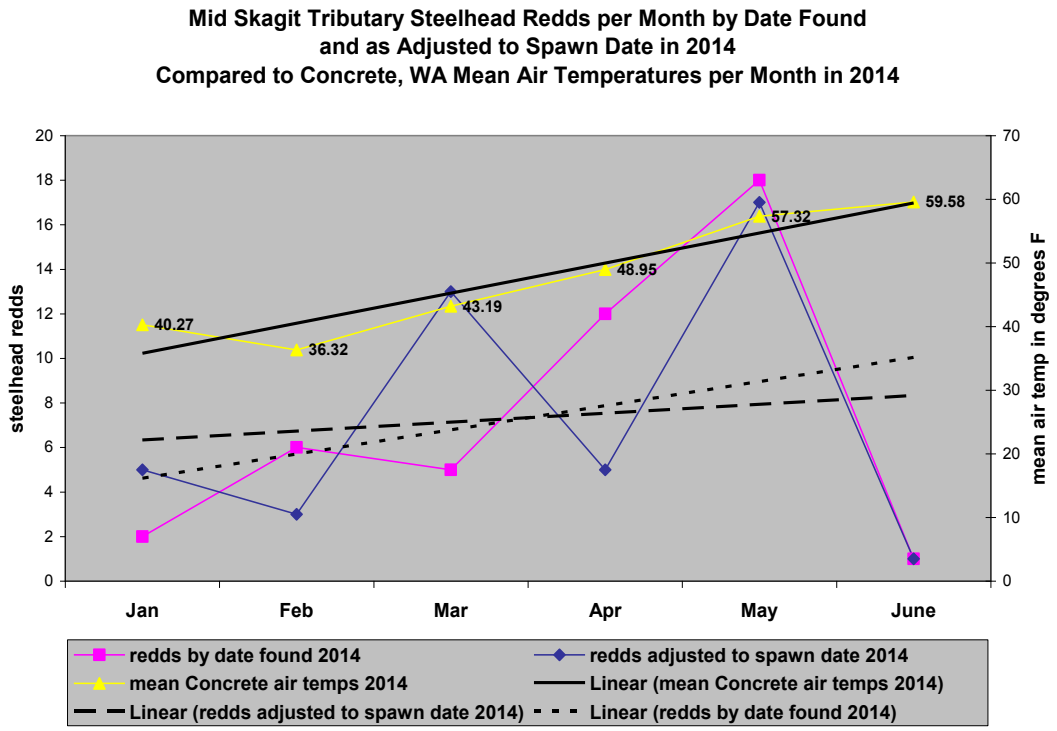
Figure 16.



Pearson's correlation coefficient table. If June is eliminated as the month when only one steelhead redd was found, "r" reverses to + 0.2845, which is also not statistically significant. If February is excluded as the outlier month in the pattern "r" is + 0.9823 and is highly significant, but to exclude February would be to ignore the one month with the greatest steelhead redd count. When the steelhead redd to air temperature correlation is determined after the redds are adjusted to estimated spawning date (Figure 16) for the January to June full spawning period "r" reverses to - 0.7713 and is statistically significant. However, if June is excluded as outside the more typical spawning period "r" is not significant at - 0.6448. Although there is a significant negative correlation of spawning to increased air temperature if redds are adjusted to spawning date and including June, the redds were so limited in June (with air/water temperature increases that limit spawning) that eliminating June is potentially the better evaluation. Given the range of findings, there may be some other relationship that is more primarily driving steelhead spawning than air temperature. Alternatively, the monthly level of temperature to redd date, or to spawning date, comparisons over the 2010-2014 period may not be specific enough to portray the daily temperature variations that could still be a main driver of steelhead spawning.

The steelhead spawning redds adjusted to estimated spawning date at the Mid Skagit tributaries are also compared to mean air temperatures per month at Concrete in 2014 alone (Figure 17). The general trendline for the redds by date found is more similar to that of the mean monthly air temperature trend than when the redd counts are adjusted to estimated spawning date. Nevertheless, the latter trend has a general ascending pattern but the actual spawning occurs in greater peaks and valleys between months. A further evaluation of the relationship of air temperatures to the 2014 steelhead redds as found was made (Figure 18) with a resulting "r"

Figure 17.



of + 0.3230 which is not statistically significant, although if June is excluded (with only one redd found) it results in an "r" of + 0.9060 which is significant. If the 2014 steelhead redds are adjusted to estimated spawning date as compared to mean monthly air temperature (presumably the more appropriate evaluation) it results in an "r" of + 0.1907 which is not significant, and if June is excluded the "r" increases to + 0.7396 but which is still not quite statistically significant (Figure 19).

At the specific tributary level only Finney Creek had enough redds per year in 2010 and 2014 to provide a useful comparison of spawning to air temperature. The redd counts were adjusted to represent the estimated spawning dates in Figure 20 with an apparent increase in spawning as monthly air temperature increased from January through June both years (but spawning only into May). Rather than an even progression spawning occurred in alternating monthly peaks and valleys in 2014 when a particularly cool February with no spawning was followed by a March spawning peak. A second higher spawning peak occurred in May as it warmed after April. In 2010 the air temperatures were more evenly gradual with similarly gradual increases in spawning until a sudden peak in April with little thereafter. During the generally warmer early spawning period of 2010 the peak in mid April was a month earlier than that of mid May in the colder early spawning period of 2014. The Pearson's correlation coefficient for monthly spawning at Finney Creek in 2014 compared to monthly mean air temperature at Concrete resulted in an "r" of + 0.7773 and in 2010 an "r" of + 0.2126. While spawning was positively correlated to air temperatures in the January to May spawning period both years (more so in 2014 than 2010) it was not statistically significant.

The combined comparisons of monthly air temperature correlations to spawning time at the Mid Skagit tributaries are erratic. Without more precise dates when spawning occurs it may limit finding a significant temperature/spawning correlation if there is one (and there apparently is related to initiation and end points). However, stream conditions often deny visibility and the ability to find enough active spawning from which to

Figure 18.

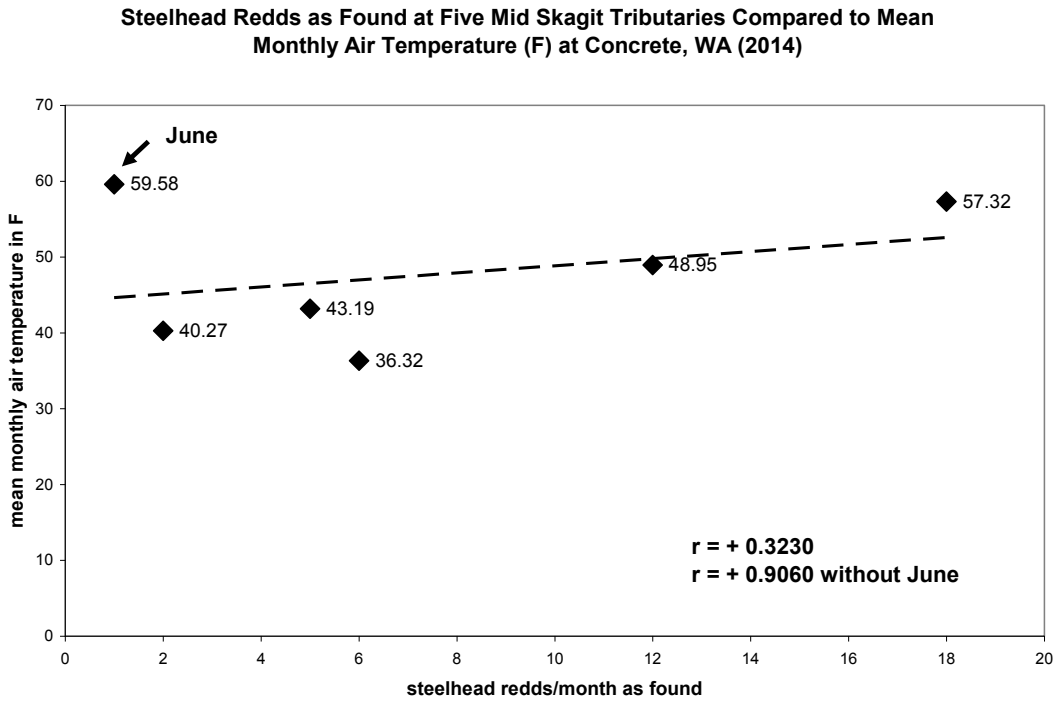


Figure 19.

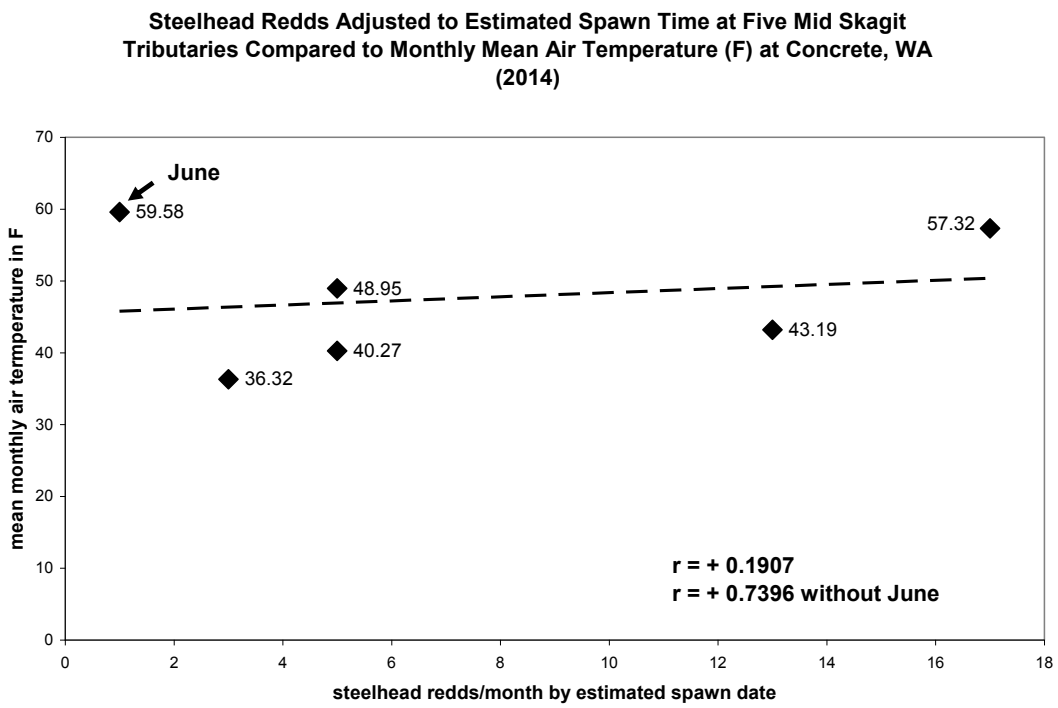
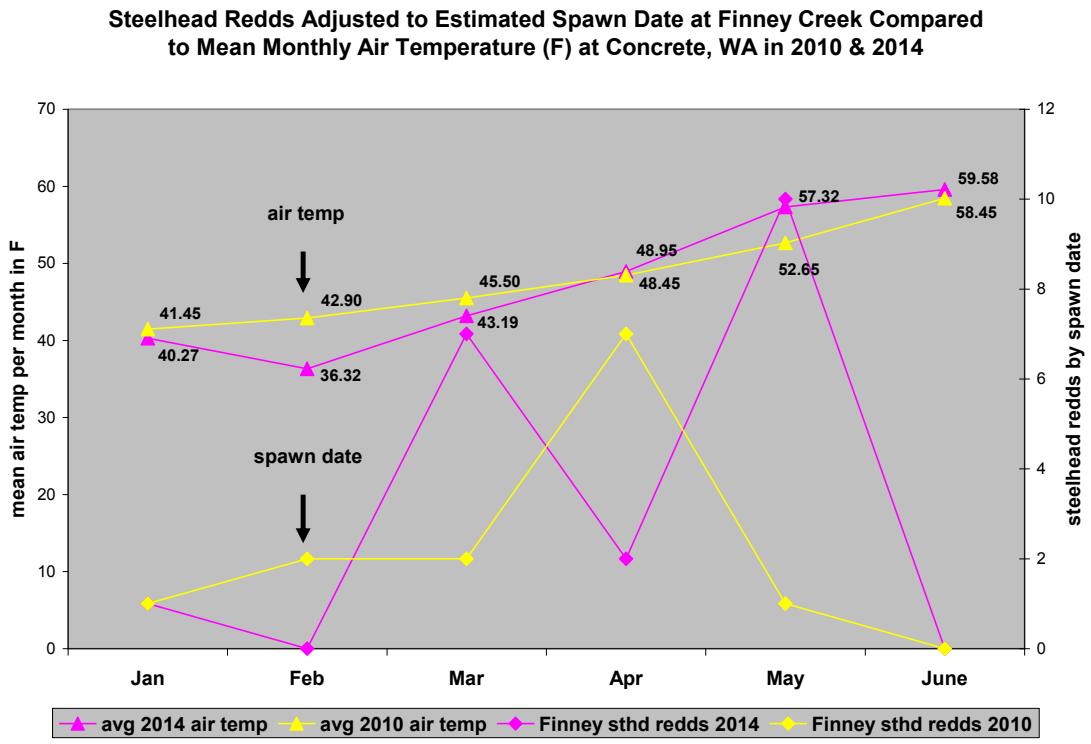


Figure 20.



compare daily temperatures. The Finney Creek shift in peak spawning by 30 days between warmer years and colder years in the early spawning period may well be the most identifiably important temperature relationship. It also concurs with the steelhead spawning survey findings at other Washington rivers (Crawford et al. 1979; Cederholm 1984)) where colder years resulted in later spawning peaks and warmer years in earlier peaks. It also remains that some other factor may be a more consistent driver of steelhead spawning time in the Mid Skagit tributaries, particularly that of intermittent and perennial flows in their selection over time for earlier or later spawning as previously identified.

Precipitation and Streamflow Relationship to Spawning Findings

There are presently no streamflow gages at any of the tributaries surveyed in the Mid Skagit basin, but 1943-48 streamflow records are available for Finney Creek (USGS 1943-48). Streamflow records for 1928-2014 are also available for the North Fork Stillaguamish River (USGS 1928-2014) and have been used by others as a surrogate for Finney Creek (Nichols and Ketcheson 2013). However, Finney Creek streamflows (or those of the North Fork Stillaguamish River) may not necessarily reflect those of the four other Mid Skagit tributary creeks that have shorter lengths, smaller basin sizes, and differing watershed source attributes. Alternatively, monthly precipitation records dating to 1905 are available for Concrete in the Mid Skagit basin (WRCC 2014) that may provide a proxy for streamflow trends, if not the flows themselves, over a long historical period that is more relevant across all five tributaries surveyed. The combination of the 1943-48 streamflow baseline at Finney Creek and mean precipitation per month in the 1909-15 and 1931-2014 time periods at Concrete also provides the opportunity for streamflow considerations related to steelhead spawning based on available comparative trends over time and toward the future.

At the shorter term scale of 2002-14 my rain gage near the mouth of Savage Creek (near Birdsview, Washington) provides the monthly precipitation during the 2010-2014 spawning survey period that is geographically closest to the lower basin areas of the five Mid Skagit tributaries primarily surveyed. The precipitation measures at these two locations from 2010 to 2014 are compared to the steelhead redds by the date found at the Mid Skagit basin tributaries in the same period (Figure 21; Appendix A, Tables 1 and 2 provide the precipitation data per month for Birdsview and Concrete). The precipitation gage near Birdsview is on the south side of the Mid Skagit River near the entry of Savage Creek (RM 45.75) while that of Concrete is on the north side, a short distance up the Baker River (RM 56.5) 10.75 miles (17.3 km) upstream. The five Mid Skagit creeks where the surveys occurred are all on the south side of the Skagit River from O'Toole Creek (RM 43.5) to Finney Creek (RM 47.5) with the Birdsview gage near the middle of the 4 mile length of river that all five tributaries enter. Although the Birdsview precipitation is greater than at Concrete in all months except July and August and may be specifically more accurate for the tributary locations, their pattern of temperatures from month to month are very similar during the steelhead spawning period. As a result, for the purposes of this report the Concrete precipitation data have been used as a surrogate for that of Birdsview because of the longer term history for further comparisons.

The Concrete precipitation is further compared to the redds found at the five Mid Skagit tributaries as adjusted to the estimated steelhead spawning dates (Figure 22) which is the more relevant comparison if the estimated spawning dates more accurately represent the actual spawning time. While it was obvious that a number of redds found were several days to several weeks old, the actual spawning time could only be a best judgment based on amount of algae on the redd, how vague its pit or tailing had become, and the prior periods when there had been spawning in near-by tributaries or otherwise what had seemed the best periods for steelhead entry into these streams.

Figure 21.

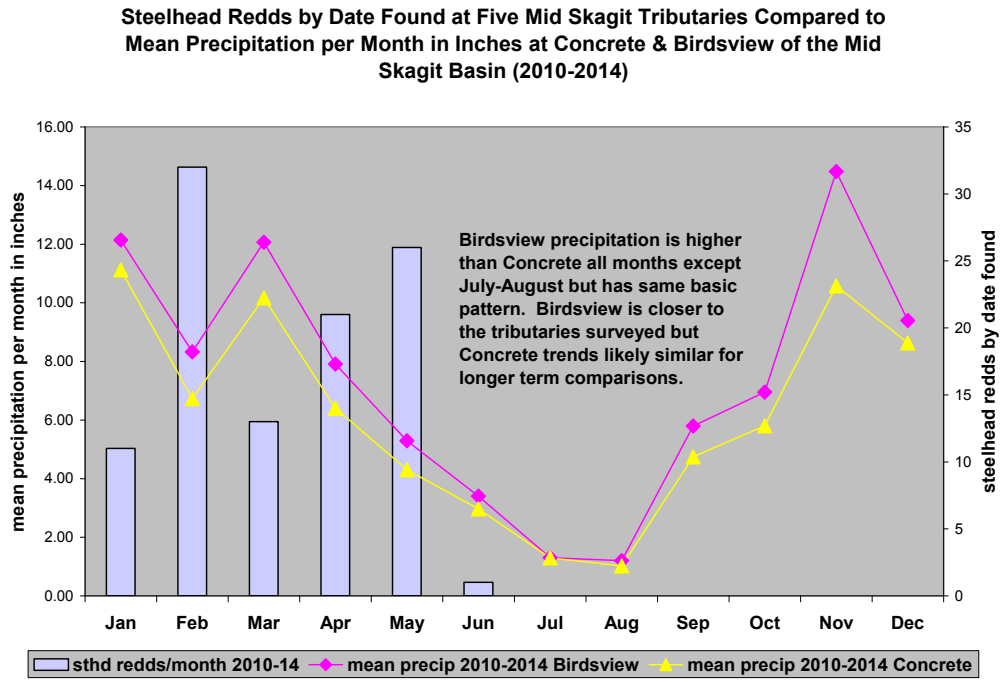


Figure 22.

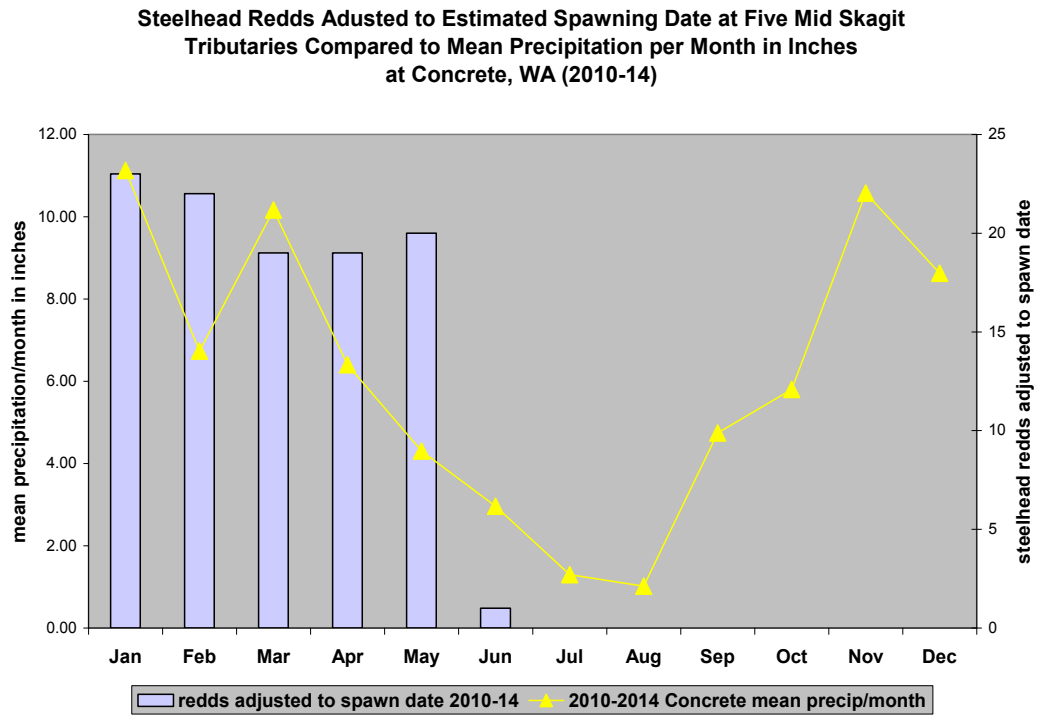
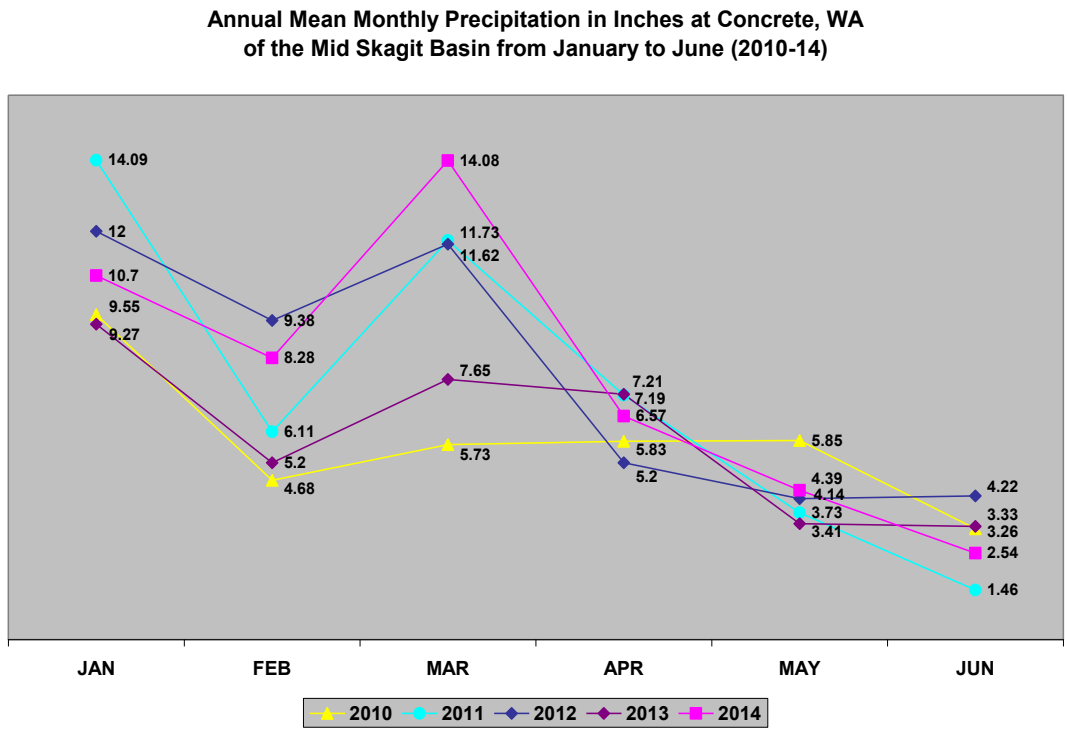


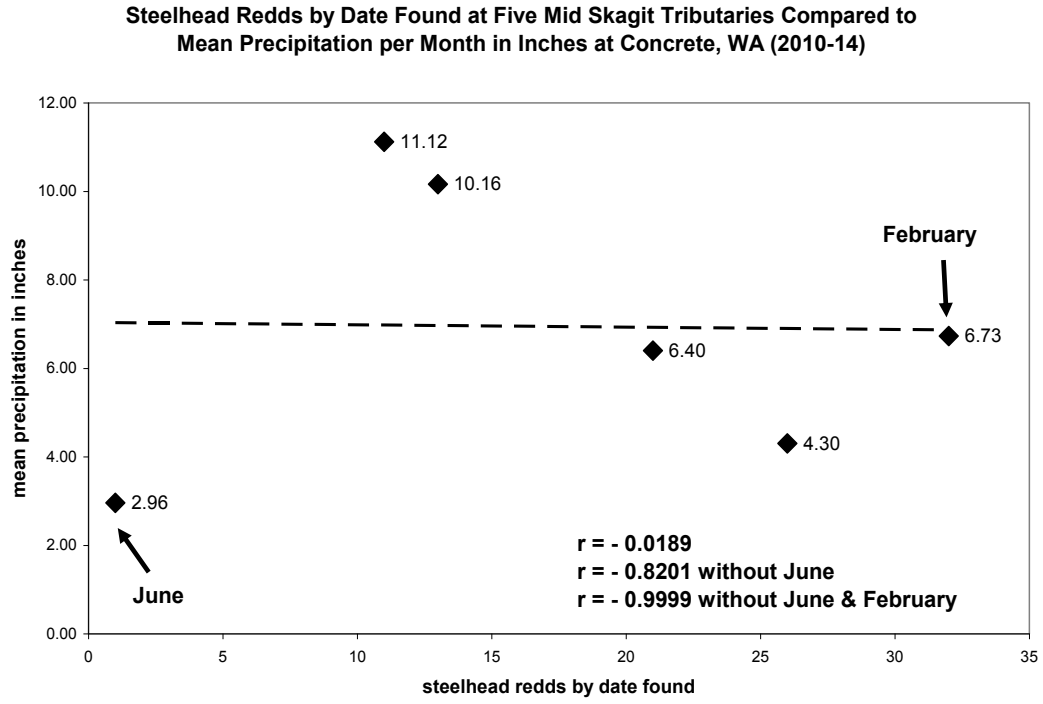
Figure 23.



The mean precipitation per month at Concrete for each year during the complete steelhead spawning period of January to June during the 2010-14 Mid Skagit tributary surveys (Figure 23) had the greatest range in precipitation in March, the smallest ranges in precipitation in April, May, and June, the most precipitation in January and March, and the least precipitation in June.

An evaluation of the relationship of mean monthly precipitation to steelhead redds per month by date found in the full steelhead spawning period from January through June was made with a resulting negative correlation (inverse relationship of precipitation and steelhead redds), or "r", of - 0.0189 (Figure 24). However, this is near zero with little or no correlation. If June is excluded as a month minimally represented in the Mid Skagit tributary spawning findings, the "r" increases to - 0.8201 but it remains a little below what is statistically significant. If February is excluded "r" is - 0.9999 and is highly significant to the point of being for all practical purposes a perfect 1.0. However, as with the temperature considerations, to ignore February would be to ignore the one month with the greatest steelhead redd count. A further evaluation was made of mean monthly precipitation to steelhead redds per month as adjusted to the estimated spawning date in the January through June full spawning period (Figure 25) with a resulting positive correlation (spawning increased with precipitation) and an "r" of + 0.7444 which is below being statistically significant. If June is excluded as the

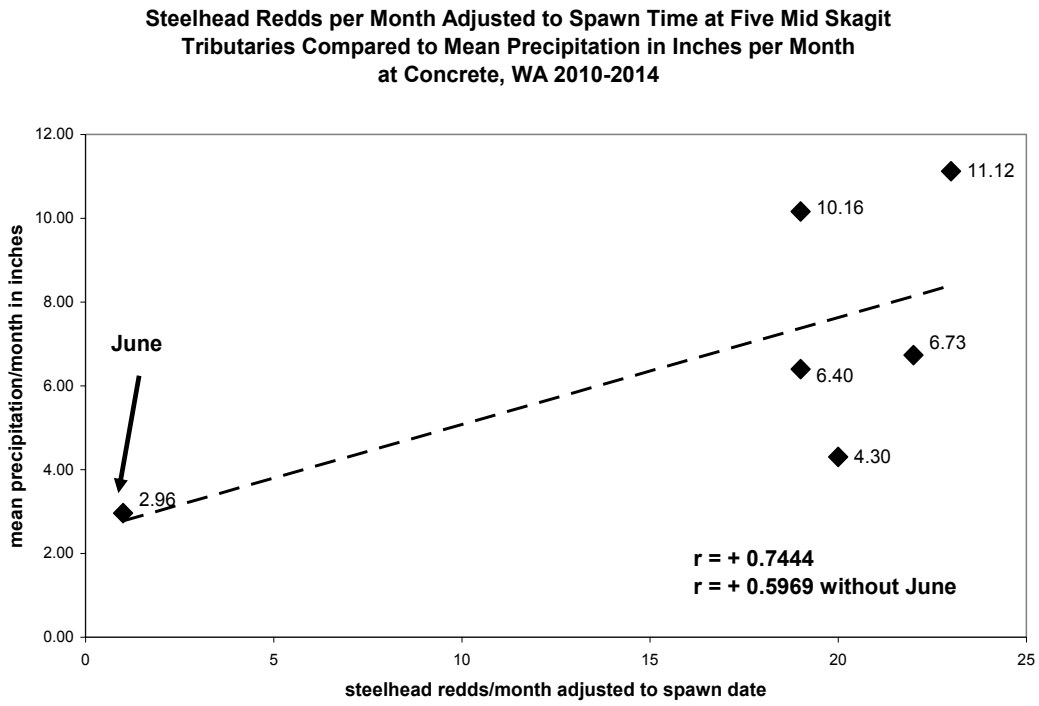
Figure 24.



month least represented in Mid Skagit tributary steelhead spawning "r" decreases to + 0.5969 with even less significance.

Streamflow data from the North Fork Stillaguamish River gage have been used as a surrogate for Finney Creek streamflows (Nichols and Ketcheson 2013). The North Fork Stillaguamish drains the southeast side of Finney Peak. My personal observations over the past 16 years of living near Finney Creek have noted that during high flow event years that Finney often responds more like the streamflows of the North Fork Stillaguamish

Figure 25.



than those for the Skagit or the Sauk rivers from available USGS website data. The mean streamflow per month at the North Fork Stillaguamish from 1943 to 1948 (USGS 1928-2014) can be compared to Finney Creek from 1943 to 1948 (USGS 1943-48) when Finney was gaged, and both of these then compared to North Fork Stillaguamish streamflow during the 2010-14 period when the Mid Skagit tributary spawning surveys occurred (Figure 26). Although the Finney Creek 1943-48 streamflow period has more extreme peaks and valleys than the North Fork Stillaguamish flows in the same period, the patterns of the two are similar regarding how they may influence entry for steelhead spawning and spawning time. The 2010-14 Stillaguamish streamflow pattern (and likely that of Finney Creek) has altered with the former spring peak of May in 1943-48 having shifted to March, two months earlier. The former 1943-48 streamflow valley in March has shifted to February, one month earlier. The historical March valley in spring flow has shifted to a spring peak, a major divergence in pattern that steelhead spawning success must adapt to. The one month of relative stability has been February.

The shift in streamflow patterns can also be compared to precipitation pattern shifts in the same 1943-48 and 2010-14 time periods (Figure 27). As has been established in the prior comparison, 1943-48 mean flows per month for North Fork Stillaguamish & Finney Creek have similar patterns, but it remains that it may not as well reflect the flow patterns of the other Mid Skagit creeks. The precipitation per month at Concrete has greatly increased in January and March with more moderate increases into April and May, but precipitation has not increased in February. Although the precipitation patterns have shifted almost identically to the streamflow patterns in January, February, and March, the 2010-14 streamflow in April has increased at a greater level than the precipitation increase. In the case of Finney Creek and the North Fork Stillaguamish this could be a result of higher elevation snowfall in March that subsequently melts out as much in April as it formerly did with a

Figure 26.

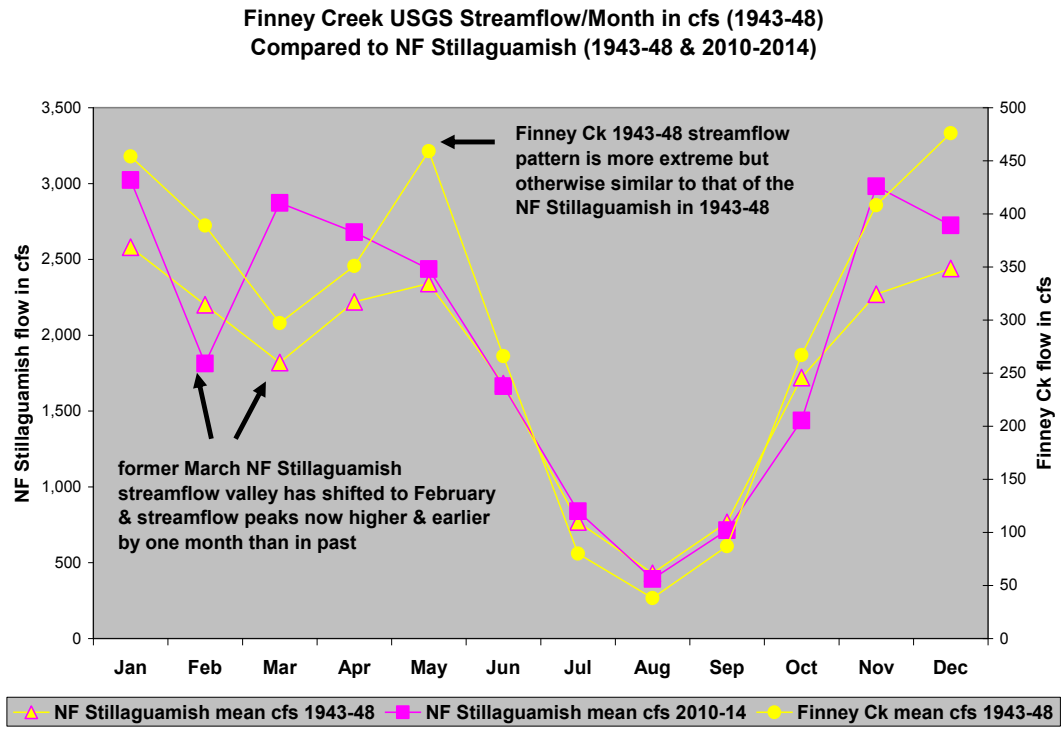
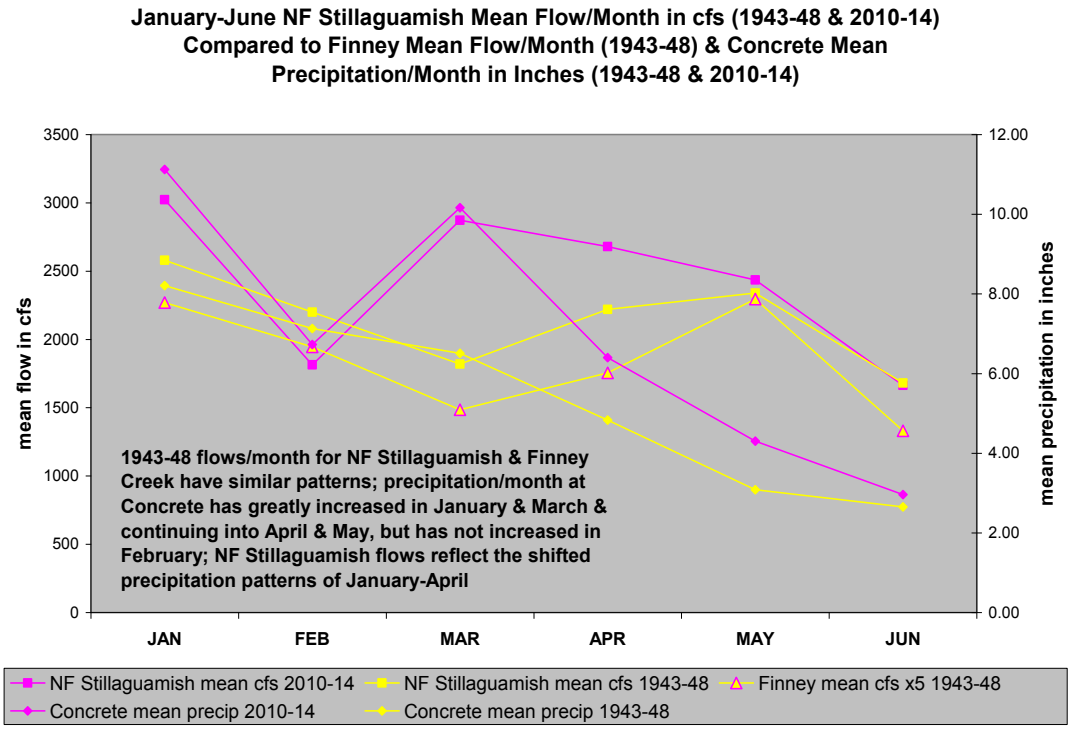


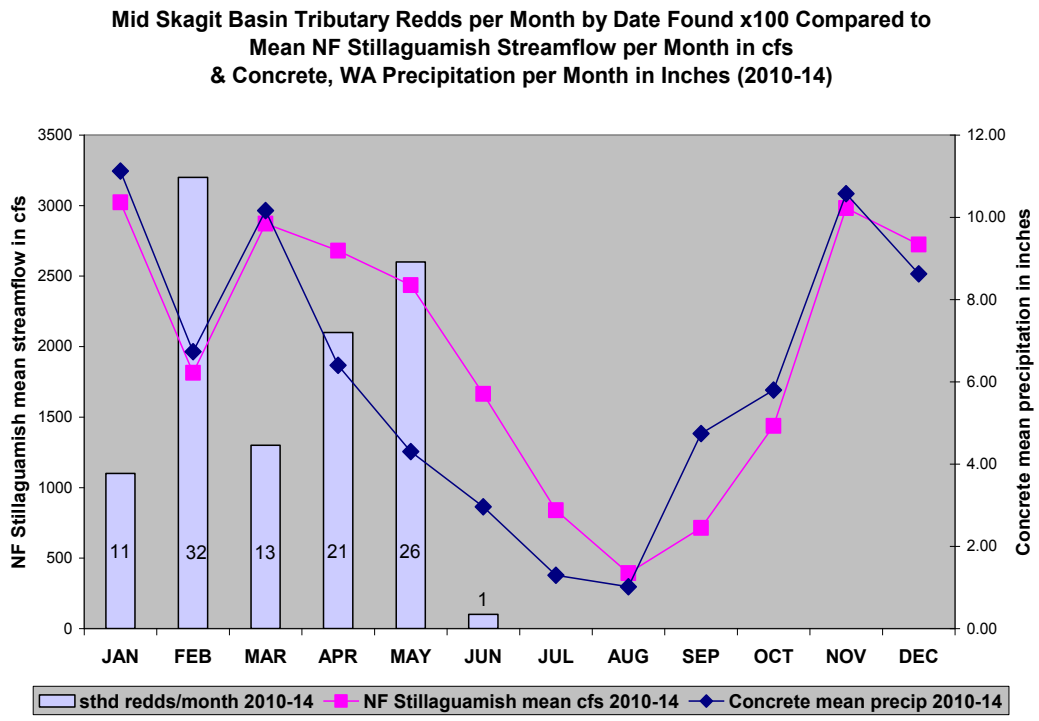
Figure 27.



more singular peak in May. This may, or may not be the case with the other Mid Skagit tributary creeks that are shorter streams with smaller watershed sizes dominated by lower elevation conditions of less snowfall.

The North Fork Stillaguamish mean streamflows per month can be further compared to the mean precipitation per month at Concrete in the 2010-14 time period and to the Mid Skagit tributary redd counts per month (Figure 28). This conveys the convex balloon in NF Stillaguamish streamflow (and likely that of Finney Creek) that now occurs in April, May, and June as compared to the concave pattern of precipitation in the same period at Concrete. The balloon in streamflow, as previously suggested, likely represents increased snowmelt from increasing March precipitation falling as snow at higher elevations. The steeelhead redds found at the Mid Skagit tributaries per month and adjusted to reflect estimated spawning date are portrayed in Figure 29 with resulting differences of spawning time related to streamflow from that of the redd counts Figure 28.

Figure 28.



A comparative evaluation of the relationship of mean monthly streamflow from the North Fork Stillaguamish River to steelhead redds by date found in the January to June full spawning period in the Mid Skagit tributaries was made (Figure 30). It resulted in an "r" of - 0.0391 which is near zero with no correlation of significance. If June with its minimal steelhead spawning is eliminated it results in an "r" - 0.95679 which is highly significant using critical values from the Peaerson's correlation coefficient table. However, if the redds are adjusted to reflect the estimated spawning date as probably the more relevant comparison (Figure 31), "r" reverses to + 0.7836 which is not statistically significant and is less so if June is excluded with an "r" of + 0.6197.

Figure 29.

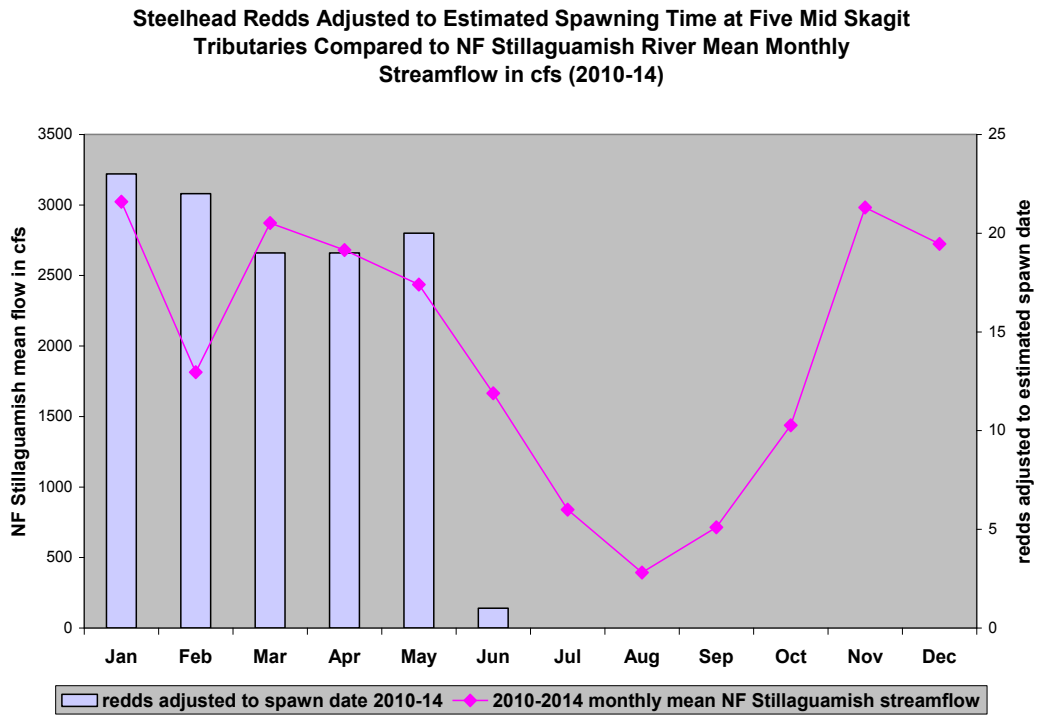


Figure 30.

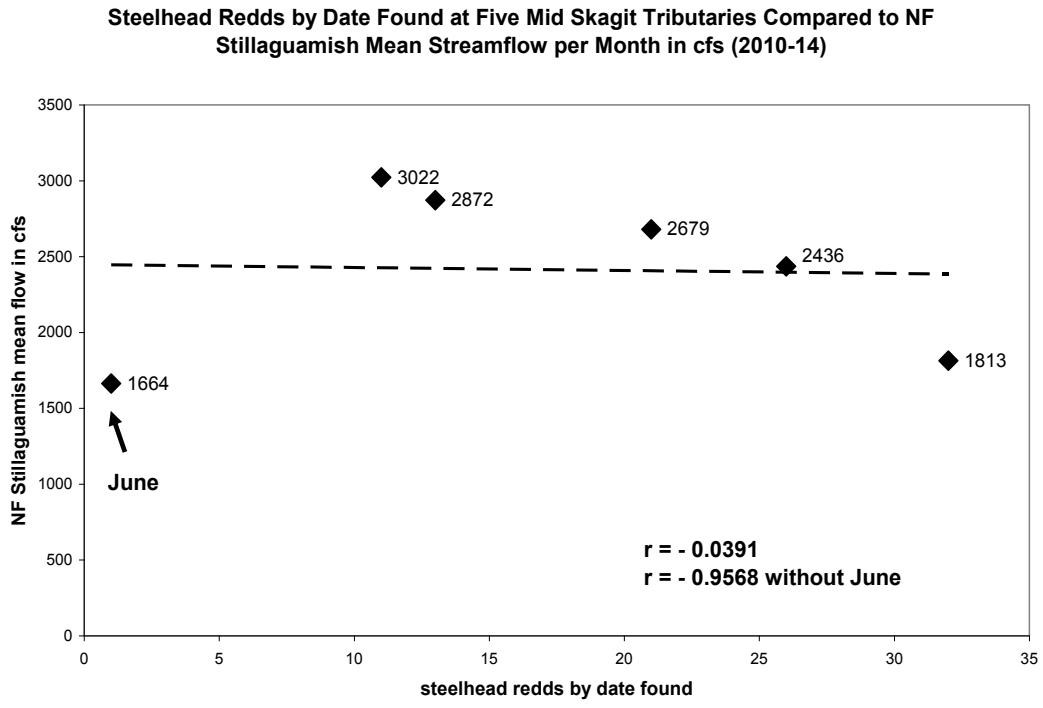
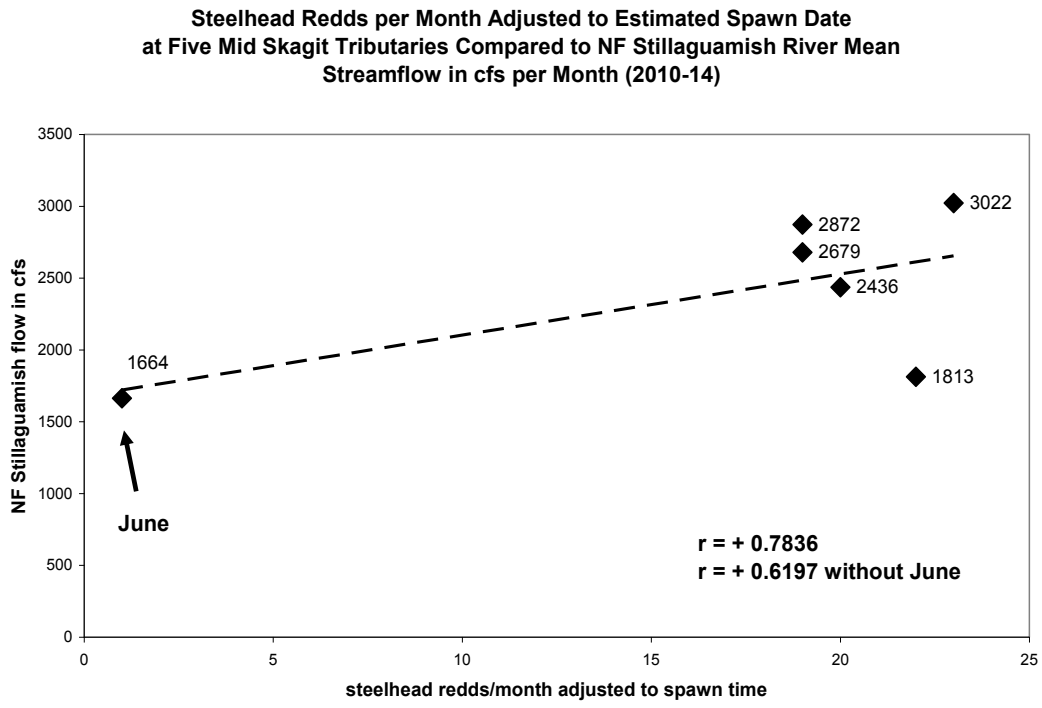


Figure 31.



Intermittent and Perennial Flows

Of particular importance for successful reproduction to the smolt stage is how spring and summer hydrology differences in flow patterns may shape spawn time and fry emergence, particularly the effect of intermittent flows if they regularly occur. Intermittent flows annually occur in the anadromous areas of the mainstems of the following three tributaries regularly surveyed in 2014 (Table 12): Savage Creek, Mill Creek, and Dry Creek. The earliest and latest dates the redds were found is also listed as well as the dates and locations of intermittent flows by tributary if that occurred. At Finney Creek the mainstem remains perennial but side channels used for both spawning and rearing commonly go intermittent. Of the five tributaries regularly surveyed, only O'Toole Creek's entire anadromous length remains perennial. The percentages of spawning that occured in each tributary prior to March 15th (and listed by whether intermittent, parts going intermittent, or perennial) as estimated from redd counts in 2014 and the five year period of 2010-14 are shown in Figures 32 and 33.

Table 12. 2014 Mid Skagit steelhead spawning period differences determined by when redds were found and listed by tributary from earliest to latest, and dates of when stream sections went intermittent if that occurred

Mid Skagit tributary	Time period steelhead redds found	Date & location of intermittency
Savage Ck	January 23-March 15	July 10-13 above pond; Aug 1 below
Mill Ck	April 30	July 10-13 from mouth progressing up
O'Toole Ck	April 7-June 16	Remained perennial
Finney Ck	February 1-May 22	May 30 at numerous side channels
Dry Ck	January 16-May 14	June 24-27 from mouth progressing up

Figure 32.

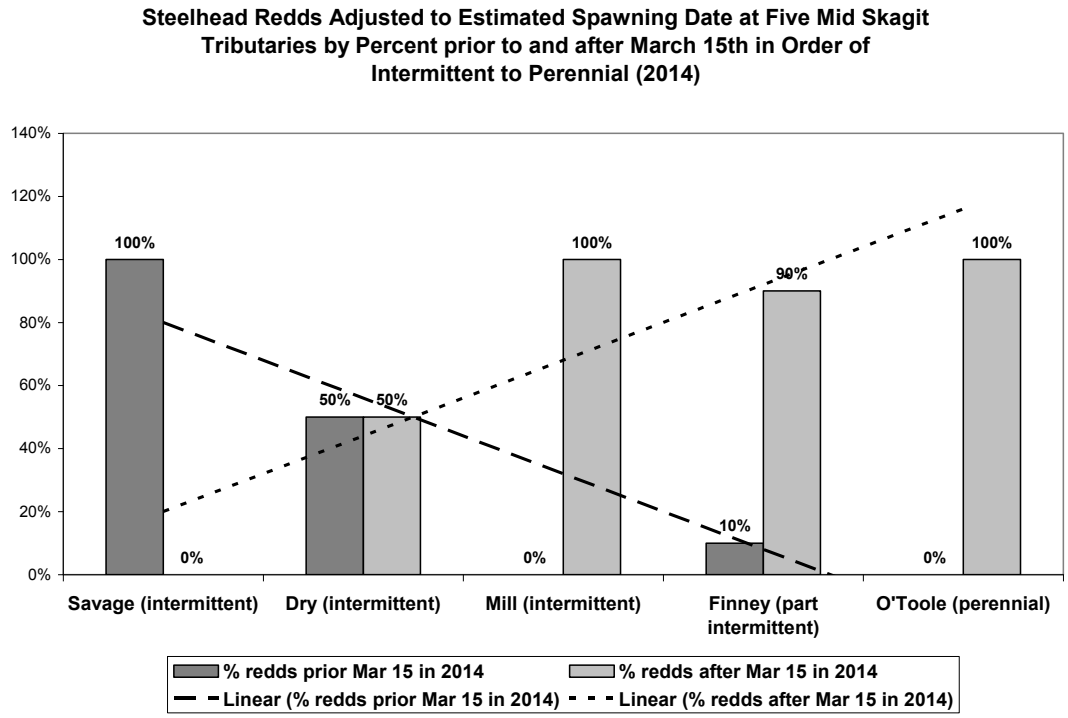
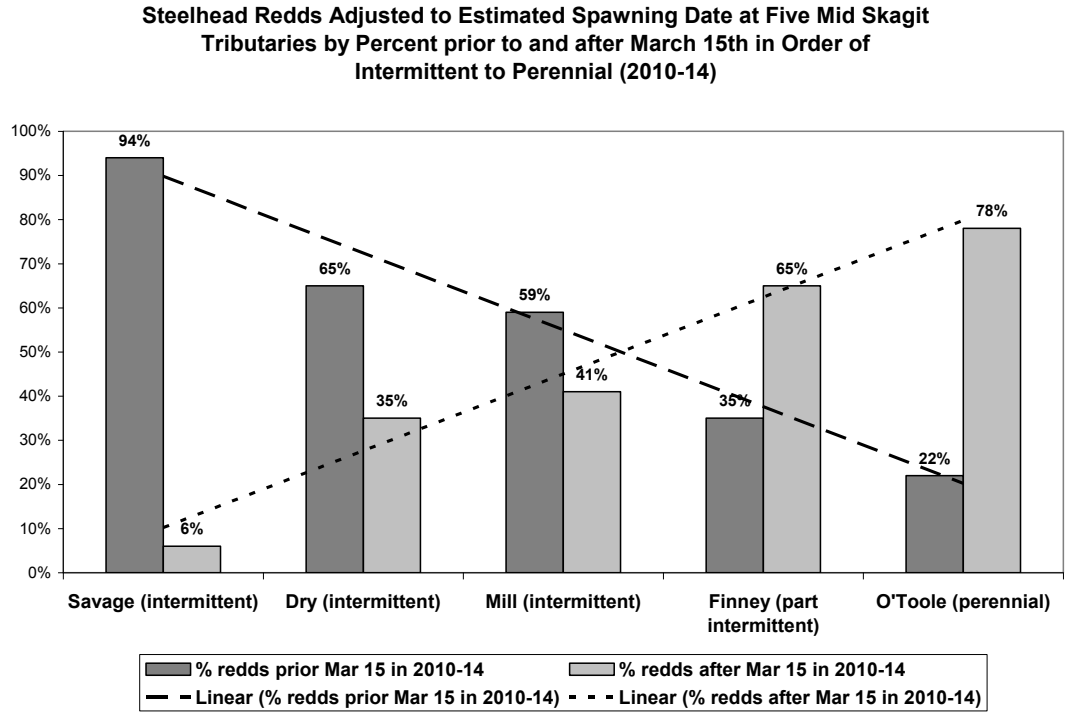


Figure 33.



Although intermittent/perennial flows are but one environmental factor that may shape steelhead spawning time by specific tributary through selective adaptation, the percent of estimated spawning prior to March 15th and thereafter as shown by tributary in 2010-14 (Figure 33) indicates these two hydrology types and the extent of anadromous habitat affected within each tributary, are likely primary drivers of steelhead spawning time. Combining the information from Table 12 and Figure 33 leads to a conclusion that there is a direct relationship between intermittency and percent of steelhead spawning prior to March 15th as indicated by the trendlines at the Mid Skagit tributaries in the five year period of 2010-14. Inversely, the same information leads to a conclusion that spawning primarily after March 15th is related to delay in the area and date of intermittency, and especially to the one stream with perennial flow (O'Toole Creek). At the level of annual variables, as in 2014 (Figure 32), the relationship is not as evident as the more complete data from cumulative years. While intermittency is likely a driving factor of earlier steelhead spawning time, colder early air temperatures in 2014 likely delayed spawning as a factor that can vary more greatly and less predicatively on an annual basis than intermittent or perennial flow patterns (Figure 20).

Specific Differences Found by Tributary Regarding Intermittent/Perennial Flow Patterns and Timing

Finney Creek:

Although Finney Creek's mainstem remains perennial there are numerous side channels in the 3.5 km of the 2014 survey reach that go dry even in lower winter/spring flows and increasingly so throughout the summer period. Also, both main channels and side channels can be suddenly vacated during any high flow event due to the unstable nature of its broad channel (Photo 2 and 3). Although juvenile *O. mykiss* movements to the Skagit River are not restricted from mainstem Finney at any time, if side channels are to be effectively used for reproduction the timing of spawning and emergence must fit with the potential for redd dewatering by late May to mid June, or lethal entrapment of emergent fry results with loss of access to the mainstem for escape due to side channels commonly dewatering first at the shallow outlets and inlets.

Photo 2: Finney Creek's continually shifting channel on April 26, 2010, the distant channel now vacated

Photo 3: A former mainstem channel at Finney Creek about to go dry on May 30, 2014

Dry Creek (of lower Finney Creek):

The lower 70-250 m typically goes subsurface by late June to early July. By June 27th of 2014 the lower 70 m had gone subsurface with disconnection from Finney Creek. By July 10th the lower 240 m were subsurface and by July 13th the lower 340 m. Rechecked on August 28th the lower 375-400 m were subsurface. About 525 m above the mouth the gradient significantly increases in transition from the valley floor to the valley wall until anadromous fish passage is blocked by a 6-6.5 m waterfall 870 m from the mouth. This uppermost anadromous reach likely remains perennial most, if not all, years (Photos 4, 5, and 6).

The potential for effective steelhead reproduction given the intermittency pattern at Dry Creek suggests several things. A little over half of the available anadromous stream length remains perennial. If spawning occurs in the lower 400 m the newly emerged fry need to either migrate downstream or upstream prior to that section going subsurface. To go downstream requires fry inclination to do so and an emergence date prior to late June. To go upstream may be denied by significant drops over log sills and boulders of 10-12 inches (25.4-30.5 cm) that newly emerged fry may be incapable of. Steelhead reproduction success in the lower 400 m likely requires spawning to occur that results in downstream emergent fry migration prior to the end of June. By contrast, steelhead reproduction may successfully occur throughout the usual steelhead spawning period if located in the upper 470 m of the anadromous length that remains perennial. However, this provides limited rearing space during reduced summer flows. Greater reproduction success to the smolt stage would be anticipated if a considerable proportion of the fry emerged early enough to outmigrate to Finney Creek (and/or the Skagit River) prior to loss of that opportunity by late June.

Photo 4: Dry Creek's clear flow enters turbid Finney Creek providing conducive entry, March 14, 2014

Photo 5: Lower Dry Creek having gone subsurface with disconnection from Finney Creek by June 27, 2014

Photo 6: Dry Creek channel still wetted in the 400-500 meters below waterfall barrier, July 10-13, 2014

Mill Creek:

The lower 355 m from the Skagit River entry to the South Skagit Highway commonly goes subsurface by mid

Photo 7: Mill Creek still wetted for 100 m below South Skagit Highway, July 13, 2014

Photo 8: Mill Creek lowermost 300 meters dewatered and disconnected from Skagit River, July 13, 2014

July or early August, except during wetter summers. By July 13th of 2014 Mill Creek's lowermost 250-260 m had gone subsurface disconnecting it from the Skagit River (Photos 7 and 8). In drier summers this subsurface reach can include the lower 400-450 m as occurred by August 28th of 2014. On July 13th the water temperature 90 m above where it went dry was 14.2 C (57.5 F), still healthily cool for rearing.

Successful steelhead reproduction in the lower 250-260 m of Mill Creek depends on spawning that would be sufficiently early for fry to have emerged by early July and either migrate downstream to the Skagit River or upstream to the perennial anadromous reach. The latter is presently limited by a landslide and associated debris about 730 m above Skagit entry preventing upstream passage for fry to a more extensive higher gradient rearing reach above. This presently leaves about 280-480 m for young-of-year rearing for steelhead that spawn in the first 730 m of stream depending on whether summers are drier or wetter. Early outmigration by a significant proportion of the fry would be anticipated to increase productivity to the smolt stage with greater rearing area.

Savage Creek:

This is a more complex watershed that runs through wetlands and ponds (Photos 9, 10, and 11). The lower 1,475 m from the Uppermost Savage Pond outlet to the mouth typically go subsurface by late June to early July with loss of surface connectivity to the Skagit River (personal observations by B. McMillan since 1998). However, when field checked on July 13th of 2014 this prior pattern altered. Despite June of 2014 being slightly drier than normal (Appendix A), and with no July precipitation up to that time, the entire length from Uppermost Savage Pond to the mouth remained wetted with connectivity to the Skagit River. This may have been due to a beaver dam created near the outlet of the upper pond to the ditched section of Savage Creek in the winter of 2013-14 that South Skagit Highway road maintenance left in place rather than removed. The smaller

ponds below the South Skagit Highway go dry by August in all but the wettest summers, but the uppermost pond (Photo 11) remains watered. The uppermost pond has a depth at the deepest point of 13 feet as recently measured in July of 2014 (pers. com. Nora Kammer, Skagit River System Cooperative). Savage Creek from the Uppermost Savage Pond on upstream about 400 m has also gone dry about the same time as Lower Savage Creek disconnecting it from the pond below. The former pattern of going dry remained the same above Uppermost Savage Pond on July 13th. The first 160-185 m above the pond had gone subsurface (Photo 11) and the next 90-100 m would soon do so. These identified portions of Savage Creek that go intermittent above and below the upper pond combine to create a considerable length of stream that is lethal for steelhead fry unless spawning is early enough to result in their migrations to the Skagit River or the upper pond prior to early June.

On July 14th the evening water temperature 450 m above the uppermost pond was 14.4 C (58.0 F), while 135 m below the same pond it was 24.2 C (75.5 F). The evening air temperature was 20-21 C (68-70 F) with a high air temperature at the afternoon peak of 28.3 C (83 F). Numerous coho fry and other unidentified salmonids were sighted at the point below the pond where the 24.2 C temperature was recorded, seemingly healthy and feeding. Salmonid fry were observed throughout the wetted reach 300 to 600 m above the pond but thousands apparently perished in the more than 200 meters that went dry. By the first of August, Savage Creek below the uppermost pond went dry from lack of rainfall after July 13th.

On July 9, 2014, a 24 inch range probable female steelhead kelt was observed in uppermost Savage Pond (pers. com. Nora Kammer and Eric Mickelson, Skagit System Cooperative) during temperature monitoring of the pond. The pond has apparent values for not only juvenile rearing but potential over-summer survival for late spawning steelhead kelts. The last steelhead redd was observed at a fork of upper Savage Creek on March 15th (Appendix C) and may have been created by the female sighted in the pond downstream on July 9th.

Photo 9: Mid Savage Creek during flow conditions conducive to upstream migration, March 7, 2014

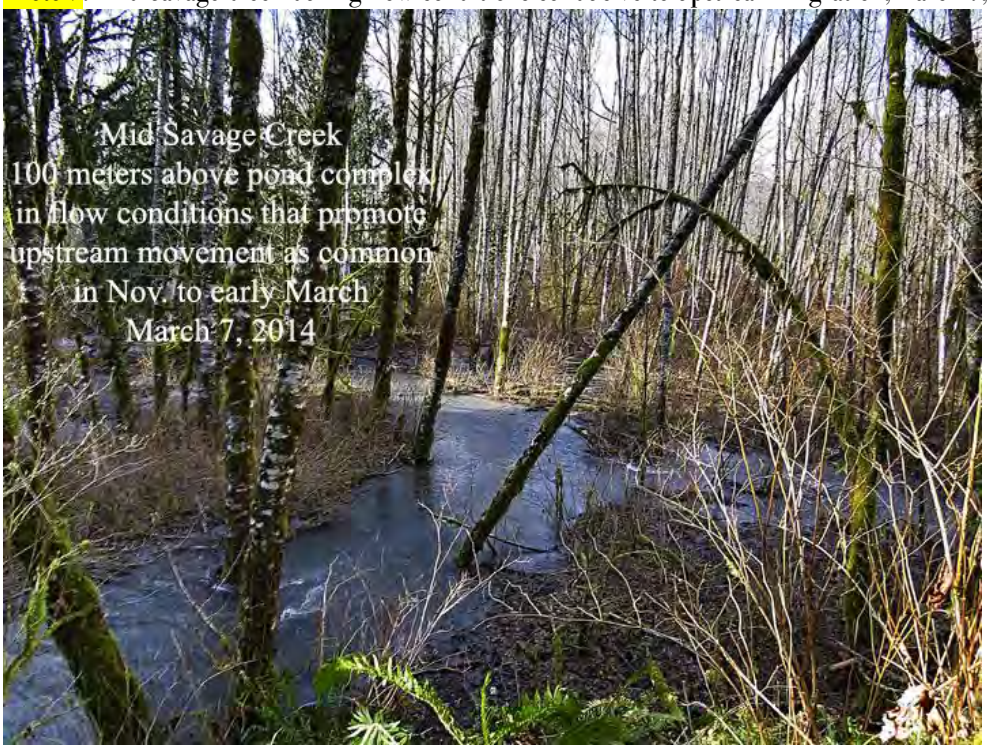
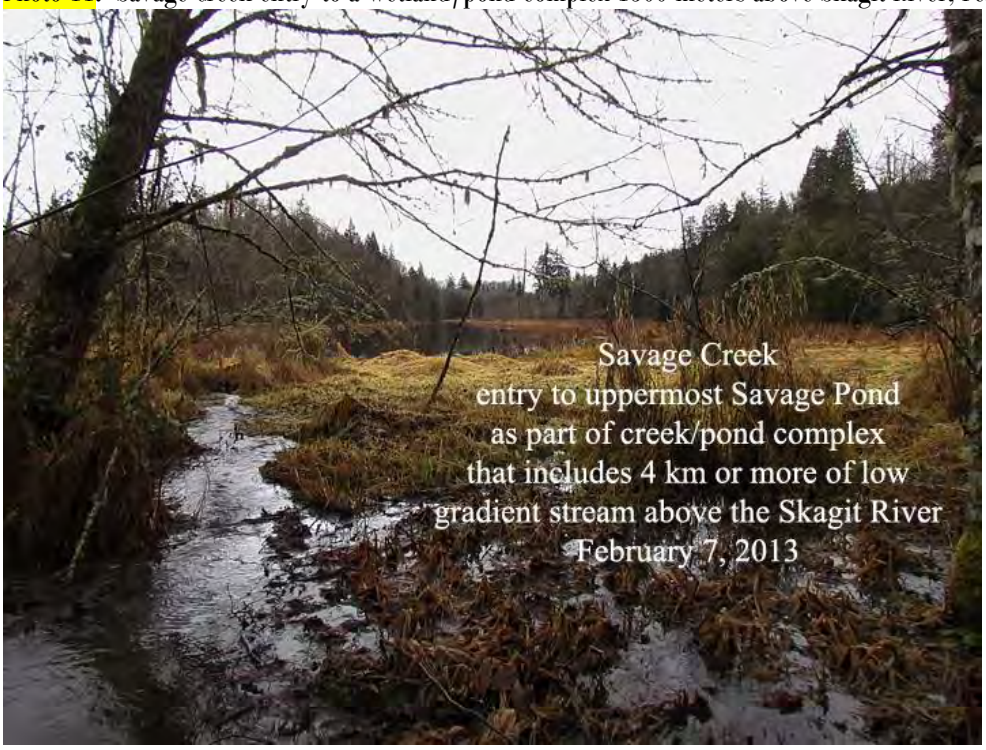


Photo 10: Savage Creek at same point as Photo 10 but looking upstream at dry channel, July 13, 2014

Photo 11: Savage Creek entry to a wetland/pond complex 1500 meters above Skagit River, February 7, 2013



O'Toole Creek:

The entire anadromous length of 620 m to the barrier falls is perennial. As depicted (Photo 12), O'Toole Creek

Photo 12: O'Toole Creek which retains a perennial flow and cold water temperatures, March 14, 2014

has a larger substrate and higher gradient in its lower reaches than the other four streams regularly surveyed. It has a minimal gravel deposition bar at its entry to the Skagit River and throughout the year juveniles have access to the mainstem river with no constraints on steelhead fry movements after spawning. When field checked on August 16, 2014 its water temperature at 3:20 pm was 59 F (15.0 C) with an air temperature of 69.5 F (20.8 C). Both winter and summer it often has the coldest water temperatures measured of the five Mid Skagit tributaries regularly surveyed for steelhead spawning.

O. mykiss Fry Emergence Time and Presence of Other *O. mykiss* Ages

Related to streams being perennial or intermittent, stream checks at the end of the spawning survey season occurred from mid May to mid June to determine when fry emergence was occurring. Photographs were taken using a small underwater camera mounted on a four foot long pole as previously described. The camera was set to take photos automatically at 5-second intervals at varied points under the stream surface to try to determine at what date steelhead fry emergence was occurring prior to going dry and if there was time for fry migration to perennial flow areas within the same stream or to the mainstem the creek was tributary to. The presence of other species of fry was also determined as well as life histories other than fry. The photographs were examined to determine the presence of *O. mykiss* fry and other *O. mykiss* ages present. This entailed enlarging the photographs on a computer monitor to the limits that the resolution of the digital photos allowed from which to

attempt making species distinctions. The underwater camera needed for this was not available until May 12th and may have resulted in missing earliest *O. mykiss* fry emergence. The earliest fry positively determined to be *O. mykiss* were photographed on May 30, 2014 at both Finney Creek and Dry Creek of Finney Creek (Photos 13 and 14). Potential *O. mykiss* fry mixed with coho fry were photographed at lower Dry Creek on May 16th and 21st. Those of May 16th were either large young-of-year (YOY) or very small age 1-plus *O. mykiss* (estimated 40-45 mm), and the photos of May 21st were too low resolution to positively identify as *O. mykiss*. Juvenile salmonids observed in Mid Skagit tributary streams from January 5th to July 10th of 2014 are listed in Table 13 which includes all species and above surface observations.

Table 13. Mid Skagit Basin Tributary Juvenile Salmonid Life Histories Observed by Date in 2014

Creek (section)	Date	Species, life history, & estimated size in mm	Abundance	Method of observation
Savage (lower)	1/5/2014	unknown species; large fry; 35-55mm	50 moving downstream	above surface visual
Savage (lower & mid)	4/19/2014	coho; fry; 20-30mm	dozens	above surface visual
Dry (lower)	5/2/2014	coho; fry; 20-30mm	dozens	above surface visual
Dry (mid)	5/14/2014	O. mykiss; likely 1-plus; 60-100mm	2-3	underwater photos
O'Toole (upper)	5/15/2014	O. mykiss; 1- & 2-plus; 100-175mm	3	underwater photos
Dry Ck (lower)	5/16/2014	O. mykiss; fry or small 1-plus; 40-50mm coho; fry; 25-40 mm	a few scattered dozens	underwater photos
Hatchery (lower)	5/16/2014	O. mykiss; 1- to 2-plus; 100-125mm	2	underwater photos
Dry (lower)	5/21/2014	O. mykiss; fry or small 1-plus; 40-50mm O. mykiss or clarki; 1-plus; 100-125mm coho; fry; 25-40mm	a few scattered 1 dozens	underwater photos
Mill (mid)	5/22/2014	O. mykiss; 1- to 2-plus; 100-150mm coho; fry; 25-35mm	5-6 10-15	underwater photos above surface visual
O'Toole (mid)	5/22/2014	O. mykiss; fry or small 1-plus; 40-50mm O. mykiss; likely 1- 2-plus; 100-150mm	2 5	underwater photos
Dry (lower & mid)	5/30/2014	O. mykiss; fry; 20-30mm coho; fry; 25-50mm	a few scattered hundreds; some moving downstream	underwater photos
Lower Finney (side channel pool going dry)	5/30/2014	O. mykiss; fry; 20-30mm coho; fry & parr; 25-70mm Chinook fry; 30-35mm chum fry; 30-35mm	a few scattered 100-200 10-12 2-4	underwater photos
Dry (lower)	6/6/2014	O. mykiss; fry; 25-35mm O. mykiss; 1- 2-plus; 60-150mm coho; fry; 25-40mm	a few scattered 5-6 many hundreds	underwater photos
Dry (lower)	6/17/2014	O. mykiss; fry; 20-35mm O. mykiss or clarki; 1- 2-plus; 100-175mm coho; fry & parr; 25-70mm	6-10 3 many hundreds	underwater photos
Lower Finney (side channel pool nearly dry) Lower Finney mainstem	6/17/2014	O. mykiss; fry; 20-35mm coho; fry & parr; 25-80mm Chinook fry; 30-40mm coho; parr; 60mm	5-6 100-200 5-6 1	underwater photos
Dry (lower – going dry) Dry (mid) Dry (upper)	6/27/2014	O. mykiss; fry; 20-30mm coho; fry & parr; 25-70mm O. mykiss; fry; 20-30mm O. mykiss; 1- 2-plus; 100-150mm coho; fry & parr; 25-70mm O. mykiss; fry; 20-35mm O. mykiss; 1-plus; 90-125mm coho; fry; 30mm	dozens hundreds dozens 2-3 hundreds few dozen 2-3 2-3	underwater photos
Dry (lower) Dry (mid) Dry (upper)	7/10/2014	O. mykiss; fry; 20-40mm O. mykiss; 1- 2-plus; 80-150mm coho; fry & par; 25-70mm O. mykiss and/or clarki; fry; 20-35mm O. mykiss or clarki; 1- 2-plus; 80-150mm coho; fry; 25-40mm O. mykiss and/or clarki; fry; 20-35mm O. mykiss or clarki; 1- 2-plus	dozens 3-4 many hundreds few hundred 3-4 hundreds many dozens 5-6	underwater photos

O. mykiss of ages 1-plus and probable 2-plus were photographed from May 14th through July 10th at Mill, O'Toole, and Dry creeks of those streams regularly surveyed, and at Hatchery Creek of those infrequently surveyed. The July 10th underwater photographs taken at Dry Creek were the last taken as it was progressively dewatering in an upstream direction leaving a dry stream channel where an estimated several thousand combined juvenile coho, *O. mykiss*, and *O.clarki* perished within the space of 3-4 days. Despite digging down into the gravel at several locations after dewatering no evidence of any fry or parr was found.

Of the five Mid Skagit tributary creeks of survey emphasis, four are known to be subject to intermittent flows in portions of their steelhead spawning areas: Mill, Savage, Dry, and Finney. Dry Creek is the most predictable and extreme of those with intermittent flows, and yet sustains considerable wild steelhead spawning. Each year it begins to go subsurface by latter June to early July with an initial disconnection from its entry to Finney Creek in the lowermost 100 m with a progression of dewatering that continues upstream another 300-400 m, or about half of its 0.85 km anadromous length.

No water temperature data were taken in 2014 with the needed frequency to determine how the dates of the *O. mykiss* fry sightings may relate to their date of egg deposition/fertilization. However, Table 14 provides the ranges of hatch times per water temperature found in the published literature. From that table, steelhead fertilization to fry emergence at 5 C (41 F) would be about 94-101 days (Wales 1941). At 5.5 C (41.9 F) Hardy (2002) indicates a similar period of time if 2-3 weeks is used for hatch-to-emergence. At 10 C (50 F) there is a range of 35-50 days indicated for fertilization to hatch time (Hardy 2002; Shumway et al. 1964; and Wydoski and Whitney 1979) and if the 2-3 week hatch-to-emerge time is used it would indicate 49-71 days. Given the mid January to mid May period of time when steelhead spawning was found at Dry and Finney creeks, a water temperature range of 5-10 C (41-50 F) and subsequent 49-101 days for fertilization to fry emergence provides a reasonably good fit based on the photographic evidence of fry presence in 2014.

Table 14. *O. mykiss* fertilization-to-hatch, hatch-to-emerge, and total emergence times found in literature

Temp	Days to hatch	Days to emerge	Total days to emerge	Reference
2 C (35.6 F)	115	....	....	Quinn 2005
5 C (41 F)	68	....	....	Quinn 2005
8 C (46.4 F)	42	....	....	Quinn 2005
11 C (51.8 F)	28	....	....	Quinn 2005
14 C (57.2 F)	22	....	....	Quinn 2005
5.5 C (41.9 F)	80	....	....	Hardy 2002
10 C (50 F)	31	20	51	Hardy 2002
15 C (59 F)	19	10	29	Hardy 2002
10 C (50 F)	35 *	....	....	Shumway et al. 1964
5 C (41 F)	80	2-3 weeks	94-101	Wales 1941
15 C (59 F)	19	2-3 weeks	33-40	Wales 1941
10 C (50 F)	50	....	somewhat later	Wydoski & Whitney 1979

* Dissolved oxygen considerations from Quinn 2005: decreased O2 delayed hatching at 10 C (50 F) from about 35 days to 40 days in steelhead as cited from Shumway et al. 1964.

Using Table 14 as a guide, the hatchery female steelhead digging a redd with a wild resident *O. mykiss* male on January 16th would result in fry emergence between April 20 to April 27 if the average temperature was 5-5.5 C (Wales 1941; and Hardy 2002). For the wild steelhead sighted on February 19th, fry emergence at that same average temperature would be May 24 to May 31. The possible sighting of *O. mykiss* fry on May 16th, as

occurred at Dry Creek, would be well within the time required from the earlier spawning that was observed. Even earlier emergence is a consideration depending on weather/temperature variables each year, and this could explain the potential *O. mykiss* fry of 40-45 cm, rather than being very small 1-plus aged *O. mykiss*.

Photo 13. *O. mykiss* fry at Dry Creek of Finney Creek, May 30, 2014

Photo 14. *O. mykiss* fry at Finney Creek side channel, May 30, 2014

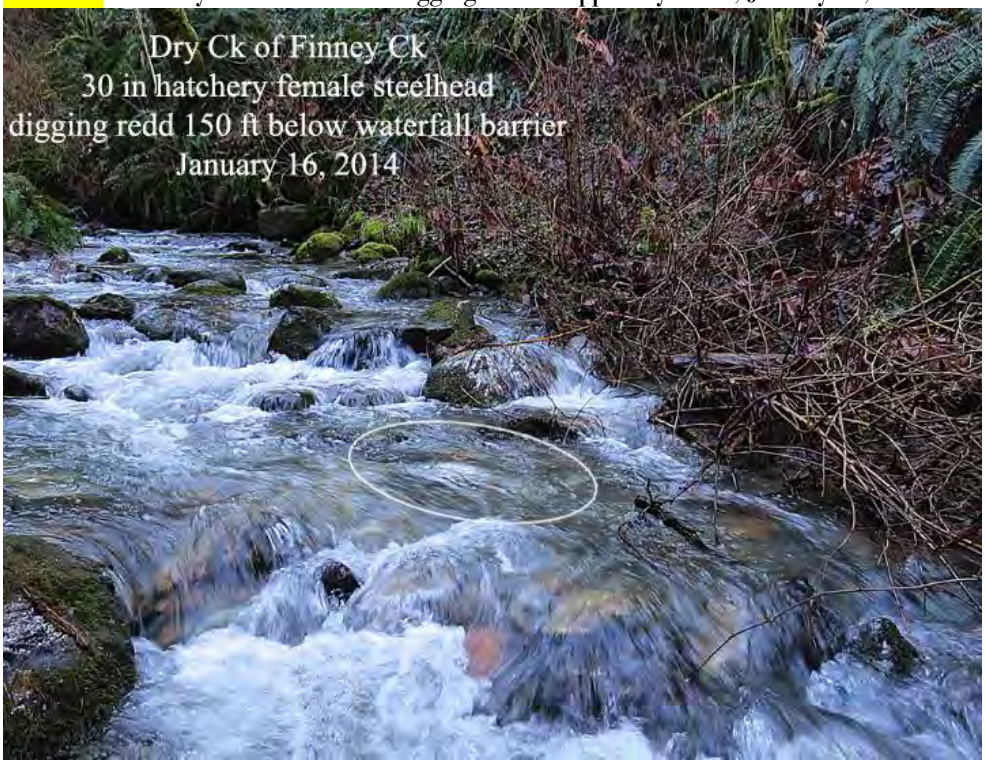
At Savage Creek, numerous coho fry were visually identified without a camera by at least April 19th of 2014. At Dry Creek, many coho salmon fry were observed by May 2nd of 2014. On January 5th of 2014 a school of about 50 juvenile salmonids of an estimated 35-55 mm in length were observed moving downstream at Savage Creek below the upper two ponds about 830 yds (0.76 km) from its entry to the Skagit River. Their size was seemingly too large to be the out-migrating fry of pink salmon that spawned in considerable numbers the previous fall in Savage Creek, and seemingly too small and too early to be coho smolts leaving the ponds. The schooled downstream movement did not seem a likely trait of *O. mykiss* or *O.clarki* parr either. A downstream movement of similar sized salmonids was observed the previous year about the same time at Savage Creek. It was considered that it may be characteristic of one of the salmonid species that uses the ponds for part of its life history and then moves into the Skagit at the peak of winter. There is also a large pond midway downstream to the Skagit River. Perhaps the fry migrate between the ponds to take advantage of some advantageous condition of one over the other. Alternatively, there may have been a prior migration of the same juvenile salmonids from the Skagit River that moved upstream into the creek and ponds for warmer and more stable conditions in the fall than provided by the mainstem river followed by a winter outmigration back again. For whatever reason, it provides an example of the differences individual tributary characteristics can have on salmonids in apparent deviations from what are considered more typical life history patterns.

Discussion

Wild, Hatchery, and Resident *O. mykiss* Spawning Mix in Mid Skagit Tributaries

At the five tributaries of the Mid Skagit basin regularly surveyed in 2014 steelhead spawning began by at least January 16th. At that date a hatchery female steelhead (missing adipose fin) of an estimated 30 inches (76.2 cm)

Photo 15. Hatchery female steelhead digging redd at upper Dry Creek, January 16, 2014



was paired with a wild male resident *O. mykiss* of an estimated 15 inches (38.1 cm). Of particular significance, this spawning activity was observed less than 50 m below the uppermost limit of anadromous migration determined by a 4-5 m waterfall in a tributary of a tributary of the Mid Skagit basin (Photo 15). This indicates there is likely no accessible area within the tributaries of the Mid Skagit basin where hatchery steelhead have not penetrated through straying and where feral spawning has taken place that includes with wild steelhead and/or wild resident *O. mykiss* males. The resident male life history, and/or mature male parr, of *O. mykiss* are an important part of the overall spawning population of a number of steelhead populations throughout their geographic range (Needham and Taft 1934; Savviatova et al. 1973; Seamons et al. 2004; McMillan et al. 2007; Christie et al. 2011).

The first wild steelhead (with adipose fin) was observed on February 19th at upper Dry Creek just 25 m below the barrier falls and within 25 m of where the hatchery female had created its redd a month earlier. Although redd digging was not occurring, and spawning was potentially completed, the wild female (estimated 23 inches, 58.4 cm) was still being vigorously attended by a male steelhead (estimated 24 inches, 61 cm) of undetermined origin (adipose presence could not be determined) in apparent competition with a smaller male. The smaller male (estimated 17 inches, 43.2 cm) was likely a sea-run cutthroat found mated in active spawning with a female sea-run cutthroat (estimated 15 inches, 38.1 cm) near the same location the following day. Although it could not be determined if the wild male sea-run cutthroat had spawned with the wild female steelhead, or if it was present primarily to feed on eggs, it is well documented that hybridization between steelhead and cutthroat occurs in similarly small streams (Taylor 1997; Campton and Utter 1985).

What became evident in the 2013/14 spawning surveys regarding *O. mykiss* is that the spawning grounds of even very small tributaries of the Mid Skagit basin are complex places that include feral spawning hatchery steelhead, hatchery/wild *O. mykiss* spawning interactions at multiple life history levels, and that there is not only probable natural hybridization between steelhead and sea-run cutthroat, but that it may also include wild sea-run cutthroat hybridization with hatchery steelhead. Although the lattermost case was not observed, the spawning presence of time and place by both closely coincided.

It is clear from the Mid Skagit tributary surveys that significant amounts of steelhead spawning occur at or prior to March 15th, but this was less so in 2014 (27%) than for the cumulative 2010-2014 period (49%). Past survey protocols commonly used have been unable to account for this early steelhead spawning due to rarely, if ever, performing surveys on these streams prior to March, or more commonly March 15th. The recent exception to this has been the initiation of February surveys in the upper anadromous section of Finney Creek to determine what is thought to be largely summer steelhead spawning there (pers. com. Brett Barkdull of WDFW). Regarding how much of the early spawning is by hatchery steelhead or wild is limited to making careful observations of active steelhead spawning and resident *O. mykiss* life history mixes. In the 2014 surveys, five incidences of female steelhead associated with spawning redds were encountered with observations and photographs made between January 16th and May 12th (Table 8). The observed spawning participants were composed of 10 anadromous *O. mykiss* life history steelhead (76.9%), two resident life history *O. mykiss* (15.4%), and one sea-run cutthroat (7.8%). Their species, life history, sex, and origin were: 3 wild female anadromous *O. mykiss* (23.0%), 2 wild male anadromous *O. mykiss* (15.4%), 2 hatchery female anadromous *O. mykiss* (15.4%), 3 male anadromous *O. mykiss* of unknown origin (23.0%), 2 wild male resident *O. mykiss* (15.4%), and 1 wild male anadromous *O.clarki* (7.8%). Of the 7 steelhead of known origin, 5 were wild (71.4%) and 2 hatchery (28.6%). Of the 10 fish with steelhead life history, 30% were wild females, 20% wild males, 20% hatchery females, and 30% undetermined origin males. Of the seven steelhead with known origin,

five were wild (71.4%) and two were hatchery (28.6%). If this is applied to the three unknown origin steelhead males it would represent two that were wild and one hatchery. Of the 10 steelhead, it was a 50/50 ratio of females/males.

In 2014 a total of 44 steelhead redds was found in the five Mid Skagit basin tributaries regularly surveyed (Table 4) with another 5 redds found in the four tributaries intermittently surveyed (Table 5). If the fish related to those 44 redds of the regularly surveyed streams in 2014 were similarly occupied as those found in the 5 active spawning participant findings, it would mean 2.6 fish per redd with a total of 114 fish. Of those 114 fish, 88 would be of steelhead life history. Of the 88 steelhead of which the actual redd construction was related, there would be 44 females and 44 males. Of the 26 unknown origin male steelhead 19 would be wild and 7 hatchery. The resulting composition would be 26 wild female steelhead, 18 hatchery female steelhead, 37 wild male steelhead, 7 hatchery male steelhead, 17 wild male resident *O. mykiss*, and 9 wild male sea-run cutthroat.

Due to the small sample size to draw from, the extension of the above breakdown to the number of redds found can only be considered a rough estimate. For instance, one of the unknown origin male steelhead sighted was an estimated 46-51 cm in length that could have equally been a resident *O. mykiss*. It could also be that the unknown origin males were either all wild or all hatchery. However, it does provide an accurate representation that the Mid Skagit tributary streams are complex spawning grounds from mid January to early June regarding wild and hatchery steelhead, their resident *O. mykiss* life history, and their interactions with sea-run cutthroat. This complexity has gone undocumented as a result of the abbreviated temporal window previously used for Puget Sound steelhead spawning surveys that has particularly excluded the ability to determine the level of feral hatchery steelhead spawning that occurs compared to wild and the life history mix that can result in hatchery/wild *O. mykiss* spawning interactions.

Considerations of How Well the Observed Active Spawners Represent the *O. mykiss* Spawning Populations

Because the active steelhead spawner observations were limited to 7 sightings (Table 8) over the five years of the 2010-14 Mid Skagit tributary surveys out of a total of 104 spawning redds found (Table 6), and 5 active sightings in 2014 (Table 8) of 44 spawning redds found (Table 3), it leads to a discussion of how well 7-11% of the spawning activity evidence represents the *O. mykiss* spawning that occurred in these two periods.

It is possible that wild adult steelhead confined to small tributary environments during spawning are particularly elusive and difficult to initially observe and even more difficult to further observe once initially sighted. As but one example, on January 19, 2011 a hatchery steelhead spawning pair was observed (and photographed) in the South Skagit Highway ditched section of Savage Creek at evening of a cloudy day. The two hatchery steelhead, a female and a male, allowed close observation despite the open roadway with my visible presence. A second male steelhead with red gills and sides immediately fled downstream to a culvert (or perhaps even beyond) before it could be determined if there was an adipose fin or not (wild or hatchery origin) and before a photo could be taken. The very different reactions of the one fish to the other two suggested the potential that the fleeing male may have been wild as a result of inherent streambred selection for caution. On return to Savage Creek in the morning of the next day, the hatchery female steelhead was still present with the redd greatly enlarged, but with no remaining evidence of the hatchery male steelhead. However, downstream a male steelhead of more vivid red gill and side coloration than either of the males sighted the previous day was briefly sighted before it fled downstream. A photograph was attempted but with results too blurred to make any determinations. Again the hatchery origin female remained in close proximity without fleeing.

Of 16 steelhead Mid Skagit tributary steelhead observed, including the previously described female observed twice in two days with differing mates (total of 17 sightings to evaluate), 67% of the wild fled when I was sighted, 33% of the wild did not, 0% of the hatchery fled, 100% of the hatchery did not, 67% of the undetermined origin fled, and 33% of the unknown origin did not (Table 15). The known wild steelhead most often fled and none of the hatchery steelhead fled. Most of the unknown origin steelhead fled suggesting more were wild than hatchery, and the unknowns that did not flee were somewhat more likely to be hatchery.

Table 15.

Stream	date	wild flee	wild remain	hatchery flee	hatchery remain	unknown flee	unknown remain
Finney	3/5/2010	1				1	
Savage	1/19/2011				2	1	
Savage	1/20/2011				1	1	
Dry	1/16/2014				1		
Dry	2/19/2014		1*			1	
Dry	3/12/2014				1		1
Finney	3/28/2014	1	1				1
Dry	5/12-2014	2					
Totals		**4 (67%)**	**2 (33%)**	**0%**	**5 (100%)**	**4 (67%)**	**2 (33%)**

* This wild female did not flee as rapidly as its unknown origin mate. Both were in a white water pocket partially shrouded by bubbles. It is possible the female did not actually see me until I moved quite close and then fled. Nevertheless, its mate fled more quickly and this one is counted as having remained.

It is known that wild steelhead selected for spawning and thereafter reared in a hatchery environment result in domestication even within the first generation (Christie et al. 2012a) and that this domestication in hatcheries also occurs in Atlantic salmon (Debesa and Hutchings 2014). The latter have a similar life history to steelhead and an increased vulnerability to predation was found (implying less caution). Domestication via hatchery rearing also occurs rapidly in other fish species such as found in Atlantic cod (Mayer et al. 2011). Not only does domestication occur in the hatchery population on release into the wild, but it is also conveyed to the supplemented wild populations they reside and interact with and with resulting reduced productivity (Reisenbichler and Rubin 1999; Reisenbichler et al. 2004). This can persist even after cessation of hatchery stocking (Araki et al. 2009). How long it takes to be selected out apparently remains little known.

The combined observations of wild and hatchery steelhead reactions to being observed were not entirely conclusive due to including six steelhead of unknown origin, but they favored the probability that wild origin steelhead are more inclined to flee when observed than hatchery steelhead. The reason for these observed differences to human proximity (or that of a large animal) of steelhead in the spawning tributaries could be a result of retained domestication from juvenile hatchery pond rearing in the case of the hatchery steelhead. If this is the case, and significant numbers of wild steelhead flee prior to being observed by the surveyor, the active steelhead spawning sightings would tend to favor hatchery over wild. However, except for Finney Creek, the streams surveyed are very small which greatly favors sighting steelhead presence. Also, due to prior histories of timber harvest, deep pools and cover provided by large woody debris are less common than was likely the historical case for the Mid Skagit tributaries surveyed. This results in fewer places for steelhead to effectively hide in these small streams.

What was conclusively evident was that by increasing the survey frequency in 2014 during the early part of the survey season that is most affected by greater precipitation and streamflows (particularly common in January

and early March), the sighting of active spawning steelhead increased from that of the previous four years. The increased survey frequency at least partly mitigated for the tendency of wild steelhead to potentially flee and evade being sighted more frequently than hatchery steelhead.

Regarding how the steelhead spawning redds found may represent the actual number of female spawners, there are still other considerations. On May 12, 2014 at Dry Creek a wild steelhead pair fled from the pool they were originally in with no redd in that location at the time (Appendix C, in Table 1; and Appendix F, in Table 2). That same day 3 prominent steelhead redds were found in the 100 m downstream of these two fish and 4 more less easily distinguished possible small steelhead redds were dispersed among white water pockets 300-400 m upstream. Of the latter, it was concluded to interpret these apparent diggings as but one extended steelhead redd. All of this spawning activity had occurred since the prior survey of Dry Creek on May 6th, and all redds were considered very fresh. Subsequently on May 13th another survey was made at Dry Creek to determine if the two wild steelhead were still present, or if there was yet another fresh redd. Although there was no finding of the two steelhead, what appeared to be yet another fresh redd was found at the location they had initially fled the previous day. All in all, this was determined to be 5 fresh redds in the same time period as the potential spawning with only two steelhead observed. It remained an unresolved question of whether one wild female may have built 5 redds over some 600-700 m of Dry Creek (of which one was actually a dispersal of 4 separate spawning pits) or if there were yet other females that had entered and spawned unobserved a day or two previous to the May 12th survey. One of the large redds downstream of where the pair was sighted had been constructed at a point where the gravel of the final digging encountered a layer of hardpan clay about 10 inches down. Was that redd subsequently abandoned with further spawning redds at other locations? The wild female sighted (and photographed) was an estimated 26-27 inches (66.0-68.6 cm) in length and appeared not to be completely spawned, if spawned at all. If a number of redds had been built with eggs deposited, a female steelhead that did so would commonly appear thin of body and noticeably egg depleted. However, some female steelhead have been examined (pers. observation) that remain quite thick of body and are not easily distinguished as having spawned. Therefore if this particular female had spawned fully, partially, or not at all could not be conclusively determined. It remains that steelhead spawning in small tributaries may include female steelhead making multiple redds as the most favorable reproductive strategy.

Wild/Hatchery Findings and Genetics Considerations

Steelhead genetics research on the Washington Coast has found significant levels of wild/hatchery hybridization with resulting declines in wild steelhead productivity despite what was thought to be isolative hatchery spawn timing earlier than for wild steelhead (Seamons et al. 2012). Forks Creek, where this research took place, is a low elevation, rain and snowmelt fed tributary of the Willapa River that is not unlike a number of similarly low elevation tributary streams of Puget Sound including the Mid Skagit basin. The genetics findings at Forks Creek are entirely consistent with the 2010-2014 spawning survey findings of the Mid Skagit basin tributaries. The results of the Forks Creek research bear quoting in light of the Mid Skagit spawn survey findings:

"We tested the efficacy of the strategy of segregation by divergent life history in a steelhead trout, Oncorhynchus mykiss, system, where hatchery fish were selected to spawn months earlier than the indigenous wild population. The proportion of wild ancestry smolts and adults declined by 10–20% over the three generations since the hatchery program began. Up to 80% of the naturally produced steelhead in any given year were hatchery/wild hybrids ... Divergent life history failed to prevent interbreeding when physical isolation was ineffective, an inadequacy that is likely to prevail in many other situations."

From the cumulative findings of the active steelhead spawning redds observed on the Mid Skagit tributaries from 2010 to 2014 (Table 16): of 16 total steelhead observed, 6 were wild, 4 hatchery, and 6 of unknown origin.

Table 16. Life history, sex, and origin of live *O. mykiss* observed on redds occupied by female steelhead by tributary in the cumulative surveys of the Mid Skagit basin in 2010-2014 and in 2014 alone

2010-11 data used
2014 data used
2010-14 combined data used

Tributary	Date	Wild sthd ♀	Wild sthd ♂	Hat sthd ♀	Hat sthd ♂	? sthd ♂	**Wild resident *O. mykiss* ♂**
Finney Ck	3/4/2010	1				1	
Savage Ck	1/19/2011			1	1	2	
Dry Ck	1/16/2014			1			1
Dry Ck	2/19/2014	1				1	
Dry Ck	3/12/2014			1		1	1
Finney Ck	3/28/2014	1	1			1	
Dry Ck	5/12/2014	1	1				
2014 Total	**known origin sthd only** **known sthd with resident**	**5 wild = 71%** **7 wild = 78%**		**2 hatchery = 29%** **2 hatchery = 22%**		**3** **3**	**2** **2 res wild**
2010-14 Total	**known origin sthd only** **known sthd with resident**	**6 wild = 60%** **8 wild = 67%**		**4 hatchery = 40%** **4 hatchery = 33%**		**6** **6**	**2** **2 res wild**

Those of known origin were 60% wild and 40% hatchery. If resident males are included it was 67% wild and 33% hatchery as the *O. mykiss* population spawning mix. From the active spawning evidence of 2014 alone the adult steelhead spawning mix was 71% wild to 29% hatchery. If the resident males are included it was 78%

Table 17. Steelhead/Rainbow by Wild, Hatchery, or Unknown Origin of Spawning Mix Prior to March 15th and After at Five Mid Skagit Tributaries in 2010-14 and 2014 alone.

in 2014 with resident O. mykiss included
in 2014 without resident O. mykiss included
in 2010-14 with resident O. mykiss included
in 2010-14 without resident O. mykiss included

	Wild	**Hatchery**	**?**	**% Wild**	**% Hatchery**	**% ?**	**% Wild without ?**	**% Hatchery without ?**
Prior March 15th (2014)	3	2	2	42.86%	28.57%	28.57%	60%	40%
After March 15th (2014)	4	0	1	80%	0%	20%	100%	0%
Prior March 15th (2014)	1	2	2	20%	40%	40%	33%	67%
After March 15th (2014)	4	0	1	80%	0%	20%	100%	0%
Prior March 15th (2010-14)	4	4	5	30.75%	30.75%	38.50%	50%	50%
After March 15th (2010-14)	4	0	1	80%	0%	20%	100%	0%
Prior March 15th (2010-14)	2	4	5	18.18%	36.36%	45.45%	33%	67%
After March 15th (2010-14)	4	0	1	80%	0%	20%	100%	0%

wild and 22% hatchery as the *O. mykiss* spawning population mix. The resulting range was from 60%-78% wild *O. mykiss* and 22%-40% hatchery at the five Mid Skagit tributaries regularly surveyed over the five year period of 2010-14 based on the active spawning evidence.

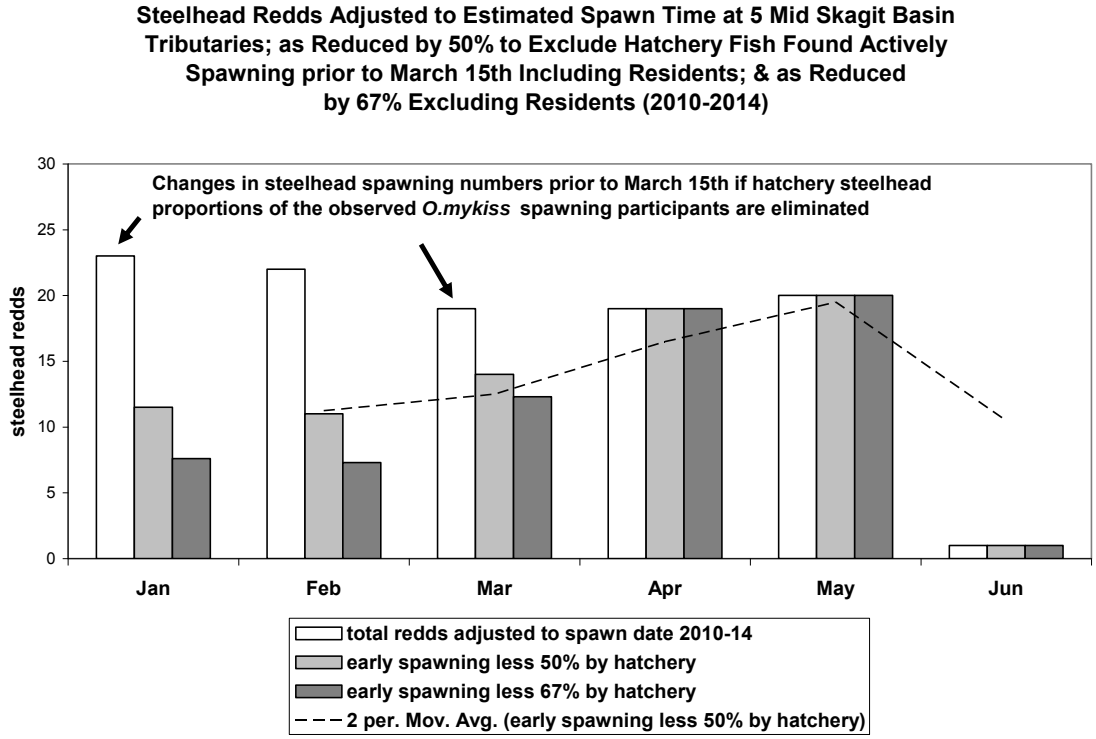
The observed active *O. mykiss* spawning at the five Mid Skagit tributaries that occurred prior to March 15th and after March 15th in 2014 (Table 17) indicates that if the resident life history is included in the spawning mix the known origin participants were 60% wild and 40% hatchery prior to March 15th, and 100% wild and 0% hatchery after March 15th. If the resident life history is excluded it was 33% wild and 67% hatchery prior to March 15th, and still 100% wild and 0% hatchery after March 15th. Over the full five year period of 2010-14 if the resident life history is included in the spawning mix the known origin participants were 50% wild and 50% hatchery prior to March 15th, and 100% wild and 0% hatchery after March 15th. If the resident life history is excluded it was 33% wild and 67% hatchery prior to March 15th, and still 100% wild and 0% hatchery after March 15th. The range of mixes considered prior to March 15th was 33%-60% wild and 40%-67% hatchery. It remains that the spawning participants of unknown origin ranged from 20%-45% of the total spawning mixes and which could alter these outcomes. However, there was little reason to believe that the steelhead of unknown origin were a significantly different mix of wild and hatchery. Judgment calls could have been made in three instances among the six unknowns, one leaning toward hatchery and two leaning toward wild, but rather than try to internally debate it further in each instance these fish were classified as unknowns. In the case of the remaining three unknowns they were simply that.

The percentage of steelhead redds found on or prior to March 15th represent the time period when wild/hatchery spawning interactions between Chambers Creek origin hatchery steelhead and wild steelhead would be more anticipated to occur than after March 15th as a result of more than 50 years of Chambers Creek steelhead selection for early spawning (Crawford 1979). Active hatchery steelhead spawning observations were indeed found wholly within the earlier time period. However, it remains that hatchery steelhead kelts were sampled in the Skagit basin throughout the month of March as well as April between 2008 and 2012 as part of a larger steelhead study (Pflug et al. 2013). Six males of unknown origin were found among the spawning mix in the 2010-14 Mid Skagit tributary surveys of which one was after March 15th and which was of a smaller size that is common for Chambers Creek origin hatchery steelhead. The limitation in active steelhead sightings to draw from in the Mid Skagit tributary surveys may well have otherwise missed documenting hatchery steelhead spawning presence from mid March through April.

If the hatchery percentages of the observed spawning *O. mykiss* spawning mixes are eliminated from the early January to March 15th spawning period, the spawning time that represents that of wild steelhead can be better identified as found in the Mid Skagit basin tributaries over the past five years (Figure 35). The range of hatchery spawning as observed among the active spawning participants prior to March 15th was 50%-67% depending on whether the wild male resident *O. mykiss* were included as part of the spawning population or not (as they should be but which often remain excluded from consideration). This significantly alters the pattern of the monthly steelhead spawning from that which did not take the hatchery component into account. The graphed data then come to better reflect a curve that is top heavy at the May end (the trendline represents the 2% moving average for 50% hatchery reduction level). Although it is tempting to conclude that this is the truer wild steelhead spawning pattern at the Mid Skagit basin tributaries, it does not take into account the probable necessities for a spawning curve that is top heavy toward the earlier time period, rather than the later, for the three tributary streams of the five regularly surveyed that have intermittent flows. Conversely, a pattern that is even more skewed toward the latter period may well be the actual spawning curve that better fits those streams with perennial flows. What Figure 34 can't further depict is the amount of early (or later) steelhead spawning

that includes wild/hatchery hybrid participants and what the overall drain on early wild steelhead spawning productivity has been due to wild/hatchery interactions at all combined levels. It also does not depict what the effects of decades of focused harvest on early return wild steelhead has been as by-catch that targets the hatchery returns at what have been 80%-95% harvest rates set by WDFW and Western Washington Treaty

Figure 35.



Tribes (SASSI 1994; McHenry et al. 1996). It is particularly likely that wild steelhead productivity in those tributary streams of the Skagit River basin that have portions of their mainstems and/or side channels used for spawning that go intermittent have been particularly affected by interactions with hatchery steelhead that apparently target these same spawning areas. It is necessary for early spawning to occur if these streams are to be fully productive for wild steelhead. This will loom even larger in importance given future considerations related to climate change.

The steelhead spawning in Mid Skagit tributaries includes both wild and hatchery steelhead that have overlapping periods of spawning with significant opportunity for hybridization to occur, as would be anticipated from the Forks Creek wild/hatchery steelhead genetic findings (Seamons et al. 2012). The finding of wild resident male *O. mykiss* as part of the spawning mix indicates that they further increase the opportunity for the overall wild and hatchery *O. mykiss* populations to hybridize. The mature male parr life history form of *O. mykiss* was considered to contribute 39% to overall wild steelhead production at Snow Creek of Puget Sound (Seamons et al. 2004). Potential mature male parr contributors to the steelhead spawning mix are fish too small to be have been noticed during the Mid Skagit basin tributary surveys, but the percentages indicated in the literature suggest their probable presence. At Hood River the importance of wild male resident contribution to the steelhead population was described by Christie et al. 2011:

Page 1263: *"... while 20% of steelhead genes come from wild residents. A further 23% of anadromous steelhead genes come from matings between two resident parents. If these matings mirror the proportion of matings between residualized hatchery fish and anadromous partners, then closer to 40% of all steelhead genes come from wild trout each generation."*

Further Genetic Considerations

Through direct observations of active steelhead spawning during the Mid Skagit basin tributary surveys it has been clearly evident that significant spawning interactions are occurring between wild and hatchery *O. mykiss*. The observed spawning interactions also indicate that gene flow between the wild and hatchery populations of steelhead and the inclusive resident life history of *O. mykiss* are likely occurring at similar levels to the identified spawning participants. Over the full steelhead spawning period the spawning mix was 71% wild to 29% hatchery in 2014, and 60% wild to 40% hatchery in the longer 2010-2014 period. It was 78% wild and 22% hatchery in the case of a mixed steelhead/*O. mykiss* spawning population in 2014, and 67% wild and 33% hatchery in the cumulative 2010-2014 period. In 2008, hatchery steelhead smolt plant numbers were significantly reduced by over 50% (Pflug et al. 2013) with reduced numbers of returning adult hatchery steelhead potentially occurring from 2010 onward. Therefore, the 2010-2014 Mid Skagit basin tributary surveys did not capture what may have been an even higher former level of hatchery steelhead on these spawning grounds. The wild/hatchery spawning interactions observed were all between mid January and mid March. Therefore the earlier return component of the wild steelhead population would be anticipated to have been affected by the greatest gene flow from hatchery steelhead with resulting productivity loss as indicated at Forks Creek on the southwest Washington Coast by Seamons et al. (2011). The only real question about gene flow is at what level it survives to be measured by the present analytical tools and collection methodologies used, and at what hidden level this may occur in eggs, alevins, and very early fry most recently emerged that remains little known. Furthermore, how well are the predominant early spawning areas being sampled from which to best document these wild/hatchery interactions that apparently are most commonly occurring in tributary streams that have some level of intermittency?

Regarding whatever future steelhead genetic work may occur in the Skagit basin regarding a determination of wild/hatchery hybridization, or that of feral hatchery/hatchery spawning, the spawning period when this is most likely to occur as found in the Mid Skagit tributary spawning surveys is from January through March with anticipated fry emergence that could be from late April to mid June. Due to the greatly reduced survival of hatchery/hatchery feral spawning found in numerous steelhead studies, and the reduced survival of wild/hatchery hybrids, it would be anticipated that greater loss of these rearing *O. mykiss* of purely hatchery or wild/hatchery origin would especially occur during their earliest life history stages on exposure to natural selection. The least fit would be anticipated to be most abundant shortly after emergence (or before emergence) with increasing diminishment throughout the rearing period with the more fit being the latter survivors that are much reduced in numbers. Sampling juvenile *O. mykiss* for genetic determinations in the tributaries of the Mid Skagit basin should, therefore, occur as close to emergence time as possible in order to most effectively detect whatever hatchery heritage is present. This time period, depending on annual climate variations, should be from late April to mid June. Any later and it would be anticipated that the hatchery genetic signal (no matter what genetic analytical method is used) in a tributary population of steelhead that may have occurred during natural spawning would have been diminished as a result of natural selection that would favor wild heritage survival and with any hatchery heritage genetic signal increasingly diminishing over the extent of rearing time.

In the case of the Skagit basin, if Chambers Creek origin hatchery steelhead continue to be curtailed from 2014 onward for at least 12 years, as a recent lawsuit settlement agreement has indicated, the last two-salt life history return of this hatchery stock would be the spawning year of 2015 from the 2013 smolt plants, and continuing into the spawning year of 2016 if some level of three-salt hatchery returns occurs. However, it remains that some level of hatchery introgression into the Mid Skagit tributary *O. mykiss* populations may continue with a genetic signal thereafter for an unknown period through what has been termed the "carry over effect" (Araki et al. 2009). It also remains to be determined if some other hatchery steelhead program may occur from which these considerations for monitoring the Mid Skagit tributary steelhead populations related to potential hatchery effects may remain valid.

The baseline of information on steelhead/*O. mykiss* spawning that has now been collected at Mid Skagit tributaries throughout the breadth of their spawning period can provide a basis to guide juvenile collections for genetic analysis, as well as that of providing a guide for when to initiate future steelhead spawning surveys in a way that can capture the full breadth of spawning by *O. mykiss* that occurs.

Evidence of Skagit Basin Tributary Steelhead Spawning and Genetic Diversity about 35 Years Ago

Of background interest, a study of the genetic structure of wild steelhead throughout the Skagit basin was initiated in 1979 through electrophoretic analysis of tissue proteins from age 0+ juveniles taken at 57 sample sites (Phillips et al. 1981a). Intended to be a three year study, it was abandoned after the first year with no follow up. While no significant differences were found between Skagit and Sauk River steelhead, the Cascade River steelhead were found significantly different. However, the greatest level of gene frequency differences with the greatest variability was found between individual tributary creek samples of the Skagit basin and between the general geographic areas these tributaries are within. Significant portions of the only known remaining copy of this study are missing leaving gaps in what can be understood, but the primary finding of this within-basin genetic differentiation was acknowledged by Phelps et al. (1994). Finney and O'Toole creeks of the Mid Skagit basin were among the tributary streams sampled and genetically evaluated in what remains of that 1981 report. The Phillips et al. (1981a) steelhead genetic study of the Skagit basin was in the same period of time when the tributary creeks of the Skagit basin were supporting 65-80% of all the steelhead spawning (Phillips et al. 1981b) as found by spawning surveys conducted in the Skagit basin from 1978 to 1981. Despite their relatively small size, Skagit tributary creeks have a large presence in its steelhead history. These historical reports on Skagit steelhead tributary findings provide an historical baseline for further comparisons today and as an aid to recovery planning.

Reasons for Steelhead Spawning Time Differences

Water temperature and a combination of precipitation and streamflow levels have been identified as contributive factors controlling steelhead spawning time (Briggs 1953; Shapovalov and Taft 1954; Crawford et al. 1979; Cederholm 1984). Earliest spawning migrations typically occur for salmon and steelhead destined for uppermost watershed locations at both the larger watershed scale and that of smaller tributaries, and differences in both streamflow and temperatures further result in differing general entry times for spawning (Briggs 1953). Streamflow patterns also predictably determine spawning time differences of steelhead in tributaries as compared to mainstem locations which Oregon spawning surveys are planned around (Susac and Jacobs 1999). Intermittent streams have further controls on time of spawning related to successful *O. mykiss* emergence and non-lethal rearing opportunities that fry-to-parr survival ultimately depend on in migrations from drying natal streams to perennial ones for rearing (Everest 1973; Erman and Hawthorne 1976; Boughton et al. 2009). All of

these factors are relevant to steelhead/*O. mykiss* spawning found in Mid Skagit basin tributaries. It is informative to examine the comparative literature regarding steelhead/*O. mykiss* spawning elsewhere and how it may more broadly relate to the Skagit basin in the past and into the future.

Temperature and Precipitation/Streamflow

Cederholm (1984) indicated that a combination of water temperatures and streamflows were the likely drivers of steelhead spawning time differences he found in differing years at the Clearwater River and its tributaries of the Queets basin on the Northwest Washington coast. In seven years of spawning surveys he found a 39 day difference in annual peak spawning dates of wild steelhead prior to hatchery introductions into the Queets basin. The primary correlation in this shifting spawning time peak was thought to be water temperature differences with the earliest peak spawning being in the year when water temperature reached 7 C on or before March 16th but which did not occur in the latest year until April 10th. The 7 C water temperature was the midpoint recommended water temperature for steelhead spawning as determined by Reiser and Bjornn (1979). The 25 day difference they documented in achieving the 7 C water temperature was considered by Cederholm to be relatively comparable to the 39 day differences found in peak steelhead spawning at the Clearwater River and its tributaries surveyed. By contrast, entry time of steelhead did not alter as determined by the lower Queets River tribal steelhead fishery. Therefore the differences in peak spawning dates were likely determined by annually differing environmental factors that occurred after initial Queets River entry, especially water temperature and at a more general long-term scale by streamflows. He also found that tributary spawning time varied widely between streams and on the whole tributary spawning peaked earlier than in the mainstem. Tributary spawning began in January some years and as late as June, virtually identical to that found in the Mid Skagit basin tributaries. Cederholm also indicated that spring steelhead spawning is a disadvantage for some juvenile steelhead due to emerging from the gravel in mid- to late summer (June to August). As a result, many later spawning steelhead are of small size going into their first winter and must spend two or more winters in freshwater with related added mortality prior to smolting. Given this consideration, early spawning as found in Savage, Dry, Finney, and some years Mill Creek in the Mid Skagit basin could result in greater juvenile growth going into their first winter and subsequent higher overall survival; late spawning could result in reduced juvenile growth going into the first winter and reduced survival. This would, however, be balanced by high streamflow peaks in the earlier spawning period and more stable streamflows in the later spawning period that may otherwise select for survival depending on the year and individual stream.

At the Kalama River there were two back-to-back years of significantly different temperature and flow conditions that affected steelhead spawning (Crawford et al. 1979). The 1976-77 winter was one of drought and cold average temperatures while 1977-78 was a winter with a 100-year flood and remained warm and rainy throughout. Steelhead began spawning 37 days earlier in 1977-78 with a resulting two month earlier spawning peak (mid January opposed to mid March) than in 1976-77.

In the detailed studies at Waddell Creek on the California Coast, steelhead waited off the mouth of the creek for spawning migrations upstream until the opening of blocking sand bars occurred with the first fall storms (Shapovalov and Taft 1954). The initial entry of steelhead with earliest storms was comparatively small to that of subsequent entries with each storm that followed until the end of the spawning entry season. The complete breadth of entry as trapped at the Waddell Creek weir was from October 28th through July 21st, but 96 percent of all the steelhead were counted during the 22 weeks from December 3rd to May 5th. Of all fish trapped during the nine years of study (1934-1942), 39 percent of the fish were taken from March 1st onward (61 percent prior to that). Steelhead upstream migration for spawning was dependent on seasonal variations in weather and water

conditions with a strong relationship to streamflow. Migration typically ceased at peak flood flows, but could occur on both rising and falling levels. Climatic conditions were thought to be a factor as was water turbidity and sexual ripeness. It was found that there were two peaks of upstream movement, one in the week ending January 6th and the other for the week ending March 17th.

In the case of the Mid Skagit basin tributaries, both temperature and streamflow appear to have a relationship to spawning entry and time similar to that described at both Waddell Creek and at tributaries of the Clearwater River.

Precipitation/Streamflow Relationships to Spawning Entry

Outside the Mid Skagit basin, the Waddell Creek example of steelhead spawning migrations dependent on storm events and high streamflows (Shapovalov and Taft 1954) is comparable to steelhead spawning entry limitations at the Mid Skagit tributaries. Of the five tributary creeks regularly surveyed, three have gravel deposition bars that have built up at their mouths (Finney, Dry, and Savage creeks) that can restrict anadromous fish entry to periods of higher streamflow in the tributary itself, and/or higher streamflows in the Skagit River or the mainstem the tributary enters. In the case of Dry Creek, its deposition bar is at entry to Finney Creek (Photo 4), but Savage and Finney Creek deposition bars are at entry to the Mid Skagit River (Savage Creek entry Photo 16). This is not unlike the sandbars that must be breached by periodic Pacific storms for entry to Waddell Creek (California Coast) throughout the spawning return period. At two of these Mid Skagit tributaries in 2014, Dry and Savage creeks, 50-100% of steelhead redds found were prior to March 15th (Figure 2). In the cumulative period of 2010-2014 it was 65-94% of the steelhead redds found prior to that date in the same two tributaries (Figure 4). Like at Waddell Creek, steelhead spawning entry prior to early to mid March was dominant at two creeks where spawning entry is controlled by flow, in this case gravel bars at their mouths rather than sand bars.

As an observed example of streamflow effects related to spawning entry (Photo 16): on the evening of January 29, 2014, after lack of rainfall since January 16th, there was 0.85 inch rainfall measured in my gage near the mouth of Savage Creek near Birdsview (Appendix F, Table 2). At the Concrete gage it was 0.18 inch rainfall on January 29th, likely occurring in very early morning, and 0.40 inch on January 30th likely from the previous day with a cumulative total of 0.58 inch probably occurring on January 29th if the Concrete gage was emptied at 8:00-9:00 am each day. As is the common pattern, there was less rainfall at Concrete than at my Birdsview area gage. Although Savage Creek did not appreciably rise in flow, a steelhead (or less likely by that date a coho) twice attempted entry over the shallow bar from the Skagit River. Its splashing was sighted from 100 m upstream. Despite the vigorous efforts it failed to enter and dropped back into the main river, potentially entering later with subsequent continued precipitation and rise in flow. Rain continued for another two days. On spawning surveys of Dry and Finney creeks on February 2nd two inactive redds were found that were likely made after successful entry with the rise in flows due to the initiation of rainfall on January 29th. However, no corresponding redd was found at Savage Creek on January 30th or on February 16th and 18th in the creek sections surveyed. On February 20th two inactive redds were found at Savage Creek, but they were estimated as built within the week not 2-3 weeks previous. This was likely related to 4.4 inches of rainfall measured at my Birdsview gage between February 15th and 19th and 5.27 inches as measured at the Concrete gage between February 10th and 20th rather than the prior rainfall in late January. Steelhead angling remained open on the Skagit River through January 31st with hatchery steelhead legal to harvest. Potentially it was a hatchery steelhead sighted attempting entry to Savage on January 29th that was subsequently harvested, or perhaps with denial of entry on that date the steelhead (or coho) spawned in the mainstem Skagit or nearby Grandy Creek

directly across the Skagit River. Alternatively it could have entered and spawned in Savage Creek in one of the anadromous sections of the creek that was not surveyed on January 30th and subsequent surveys missed it due to significant rainfall occurring during the February 10-20th time period that erased evidence of any redd. It remains that Photo 16 well depicts the necessity for sufficient streamflows required at some Mid Skagit tributaries for steelhead spawning entry to occur.

Photo 16: Savage Creek Deposition Bar at Entry to the Mid Skagit River

Although the Finney Creek deposition bar at entry to the Skagit River is an obstacle at lower October through May flows of typical anadromous fish entry, it more commonly remains navigable for spawning entry due to its larger size and greater overall flow. Both early and late steelhead spawning occur at Finney Creek with 10-38% (average 35%) prior to March 15th (Figures 4, 5, and 6).

From January to June there is generally declining precipitation except for a precipitation spike in March as the average trend in the 2010-2014 Mid Skagit tributary survey period (Figures 21 and 22; and Appendix A, Tables 1 and 2). The steelhead entry and spawning at Savage and Dry creeks are likely driven in part by greater precipitation prior to April. Although February precipitation is about the same as April, January's precipitation can include considerable snow which sustains February flows as it begins to melt in these smaller tributaries of relatively short length dominated by lower rather than higher elevations (Figure 17). Passage over obstructing deposition bars at their stream mouths is likely more favorable for steelhead prior to April if precipitation amount is a proxy for streamflow at these two tributaries. Because of so little of their drainage being at higher elevation they are rain and snowmelt driven with relatively immediate response to precipitation except during generally short periods of snowfall of 1-2 weeks. Although the streamflow data from the North Fork Stillaguamish River may well be a surrogate for the streamflow pattern at Finney Creek (Figures 26) that is more independent of precipitation patterns from March through May (Figure 28), this is less likely at Savage and Dry creeks. Finney Creek's more extensive length at higher elevations prior to meeting the Skagit Valley

floor likely results in more delay of snowmelt that has accumulated (Table 18). Snow accumulation from 760-1070 m is considered transitory with rain-on-snow storms from October to February resulting in most of the peak flows, while the uppermost 479 m to its 1,549 m source at Finney Peak is apparently longer term snowpack (Nichols and Ketcheson 2013). Although other Mid Skagit basin tributaries drain elevations as high as the actual stream channel source of Finney Creek (as determined from Google Earth measures), their elevations that are above 500 m (1,640 ft) are comparatively short stream lengths, while upper mainstem Finney has 6.0 mi (9.66 km) that are above 500 m, plus another 4.48 mi (7.2 km) at two of its larger headwater tributaries. The two Mid Skagit tributaries regularly surveyed with the least lineal lengths of their drainages above 500 m are Dry and Savage creeks, also the streams with earliest spawning and greatest mainstem lengths that go intermittent the earliest.

Table 18. Stream Lineal Lengths, Drainage Areas (if available), and Source/Mouth Elevations for the Five Mid Skagit Basin Tributaries Regularly Surveyed and Rarely Surveyed *

Rarely surveyed
Least stream lengths above 500 m elevation of Mid Skagit tributaries regularly surveyed

Stream	Length miles miles (km)	Area mi2 (km2)	Source elevation feet (m)	Mouth elevation feet (m)	Stream length above 500 m in miles (km)	Reference
Savage	2.1 (3.4 km) 3.86 (6.2 km)	....	.... 2,715 (828 m)	.... 113 (34.4 m)	0.35 (0.56 km)	Williams et al. 1975 Google Earth measures
Mill	4.6 (7.4 km) 4.7 (7.6 km)	....	.... 3,300 (1,006 m)	.... 112 (34.1 m)	.... 2.58 (4.15 km)	Williams et al. 1975 Google Earth measures
O'Toole	4.0 (6.4 km) 3.5 or 5.6 (5.6 or 9.0 km)	....	.... 2,500 or 3,800 (762 or 1,158 m)	.... 111 (33.8 m)	.... 2.0 or 3.98 (3.2 or 6.4 km)	Williams et al. 1975 Google Earth mearsues
Finney	23.98 (38.6 km) 23.8 (38.3 km)	54 (140 km2)	5,082 (1,549 m) 3,560 (1,085 m)	134.5 (41 m) 125 (38.1 m)	.... 6.0 (9.65 km)	Nichols & Ketcheson 2013 Google Earth measures
Dry	2.1 (3.4 km) 2.4 (3.9 km)	....	.... (604 or 790 m)	.... 167 (50.9 m)	.... 0.15 or 0.43 (0.24 or 0.69 km)	Williams et al. 1975 Google Earth measures
Cumberland	5.4 (8.7 km) 4.1 or 5.0 (6.6 or 8.0 km)	....	.... 2,730 or 2,900 (832 or 884 m)	.... 91 (27.7 m)	....	Williams et al. 1975 Google Earth measures
Grandy	7.6 (12.23 km) .... 7.2 or 8.4 (11.6 or 13.5 km)	.... 19.7 (51 km2)	.... 1,000 or 4,000 (305 or 1,219 m)	.... 113 (34.4 m)	....	Williams et al. 1975 Ames & Bucknell 1981 Google Earth measures
Hatchery	3.4 (5.5 km) 3.3 (5.3 km)	....	.... 3,000 (914 m)	.... 236 (71.9 m)	....	Williams et al. 1975 Google Earth measures
Quartz	3.5 (5.6 km) 3.1 (5.0 km)	....	.... 3,182 (970 m)	.... 234 (71.3 m)	....	Williams et al. 1975 Googel Earth measures

* Google Earth measures determined were to stream channel ends that could be followed, and source elevations were similarly so and not to the height of the surrounding mountains they may drain.

In the coastal Oregon steelhead spawning surveys it was found that steelhead spawning in tributaries coincided with freshet conditions and that as a result the surveys focused on mainstem rivers during low flow periods and later in the spawning season (Susac and Jacobs 1999). Precipitation in the Mid Skagit basin is greater from January through March than thereafter (Appendix A, Tables 1 and 2) and it would be anticipated that steelhead spawning in the tributary creeks are sometimes driven by this greater precipitation period, particularly in those streams where entry may be otherwise deterred by gravel deposition at their mouths as previously described. The two Mid Skagit tributaries regularly surveyed that have deeper channels at their mouths without a deposition bar to overcome for anadromous fish entry from October through May are O'Toole and Mill creeks.

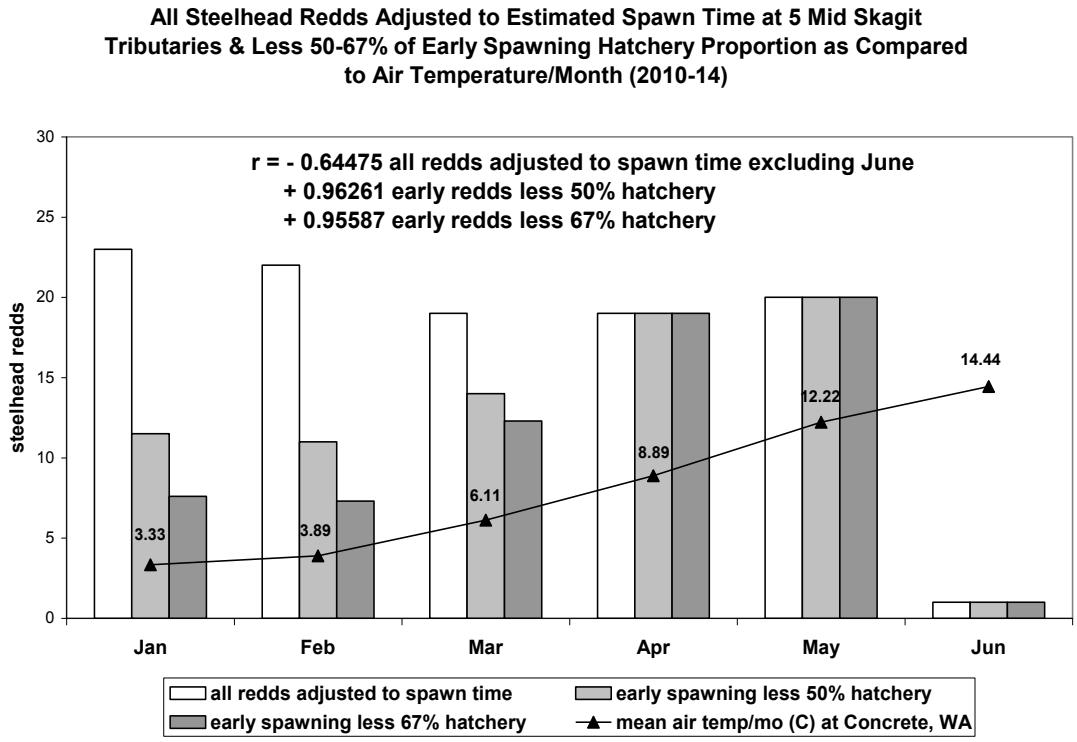
O'Toole Creek steelhead spawning is mostly later in the season (78%) and Mill Creek has both early (59%) and later (41%) spawning by steelhead (Figure 4).

A pattern of earlier entry for steelhead and salmon destined for upper watershed spawning destinations has also long been noted to occur (Briggs 1953), and that this can even occur at the smaller tributary scale as found at Prairie Creek on the California coast. At Prairie Creek earliest spawning more densely occurred in the upper watershed portion and progressively shifted down the watershed through the steelhead spawning period. At the larger Skagit basin level, one would anticipate that uppermost watershed areas would particularly depend on earlier entry time to reach those more distant spawning destination locations. However, this may not necessarily mean earlier spawning than elsewhere in the basin. It was also determined that while both flows and temperatures determined spawning migrations that it was difficult to isolate one from the other:

Page 13: *"In the California north coastal region the stream rises in the winter time almost always seem to be accompanied by sharp temperature increases ... This fact makes it difficult to separate the effects of these two environmental factors."*

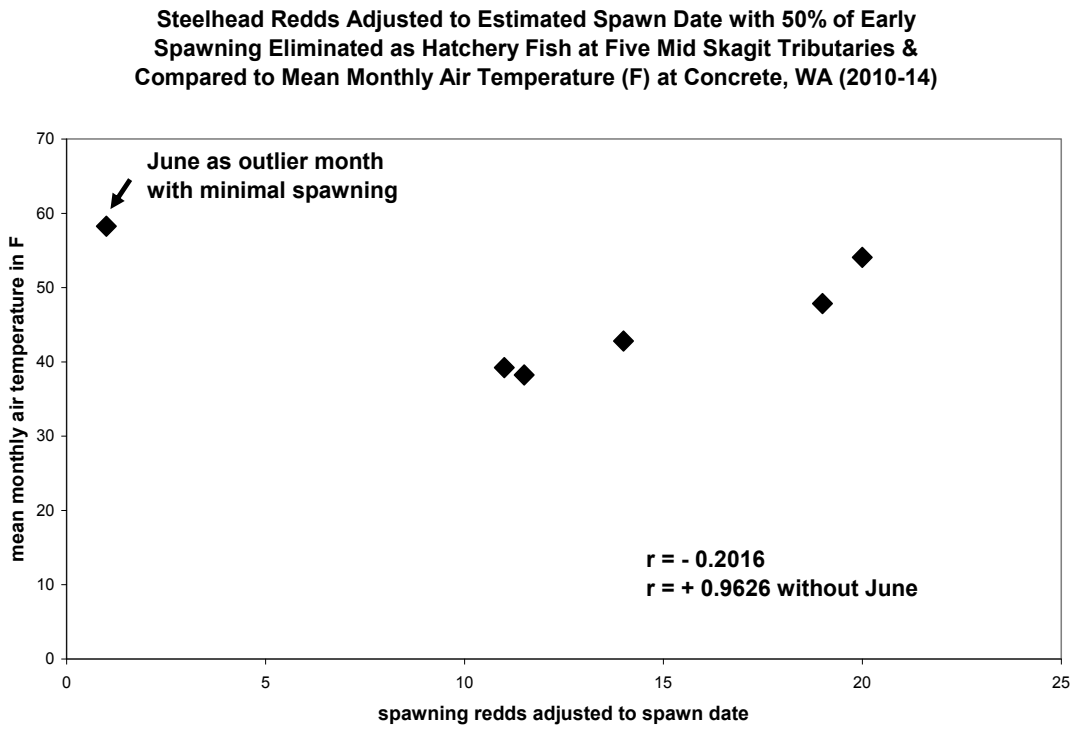
Coinciding environmental variables may also have been a reason for the inability to find significant correlations between flows, precipitation, and temperatures in the Mid Skagit basin tributaries. Furthermore, the hatchery steelhead spawning time may have a somewhat different driver (narrower period of primary spawning time for instance that is determined through hatchery selection) that predominates compared to the generally broader distribution of spawning time for wild steelhead as depicted when hatchery steelhead were eliminated from the spawning mixes in Figure 35. The data that included hatchery steelhead from which correlations were determined between spawning time and air temperature, precipitation, and streamflow may have been one factor

Figure 36.



that confounded the ability to find significant correlations. However, on eliminating 50-67% of the early spawning between January and March 15th to represent the actual wild spawning mix (including residents along with steelhead) found at the Mid Skagit tributaries by eliminating the proportion found to be hatchery steelhead on the active redds, it remained that streamflow and precipitation did not have any more significant correlations

Figure 37.



than previously done. Air temperature, as a surrogate for stream temperatures was another matter and was found to have a much stronger comparative pattern with wild steelhead spawning (Figure 36) and resulting correlation (Figure 37) than previously found when the potential proportion of hatchery steelhead in the overall population was not excluded (Figures 15, and 16). A highly significant Pearson's correlation "r" of + 0.9626 was found (at 50% reduction of early spawning by hatchery fish) if June is eliminated as the outlier month when minimal steelhead spawning occurs in the Mid Skagit tributaries regularly surveyed. June may result in air/water temperatures at low elevation streams commonly beyond the maximums for steelhead indicated by Bell (1973) and Bovee (1978) of 9.4-13 C (48.9-55.4 F).

C. Intermittent and Perennial Streamflows

Everest (1973) found that the high summer steelhead productivity in the Rogue River basin was dependent on intensive spawning use of small tributaries with watershed basin areas of less than 25 square miles and winter streamflows of less than 50 cfs. Most of these streams became intermittent in summer, as early as mid June, and yet supported large steelhead spawning populations in winter while going completely dry in summer. As a result, most fry had to migrate from these streams to larger tributaries or the mainstem soon after emergence. As but one example, Kane Creek was intensively studied and supported more than 2,000 spawning adults despite being dry from August through October. Peak spawning in the 1979-71 water year occurred from late

January through mid February shortly after a peak maximum flow event on January 18, 1971. Peak fry outmigration occurred in May.

It is apparent from the Rogue River example that intermittent tributary streams are not only used by steelhead for spawning, but that they can support very large numbers of spawning steelhead per size of watershed. In the case of the Mid Skagit basin tributaries, the one stream that is of smallest estimated winter streamflow, and with a greater percent of its anadromous length going dry every summer (about 50%), is Dry Creek. Yet, 14 steelhead redds per kilometer were found at Dry Creek in 2014, which was about 2-10 times greater density of steelhead redds found than at any of the other four tributaries (Table 4). Emergence of *O. mykiss* fry was found in Dry Creek by mid to latter May, with probable emergence even earlier. This was sufficiently early to provide downstream migration to Finney Creek, and/or the Skagit River prior to its lower portion going subsurface likely several days prior to its being photographed on June 27th (Photo 5). As at the Rogue tributaries, steelhead spawning began in latter January (hatchery female steelhead and wild resident male) and February (wild female steelhead, undetermined male steelhead, and sea-run cutthroat male) in 2014. In 1978-1981 it was found that 65-80% of Skagit basin steelhead spawning occurred in the tributary creeks rather than the mainstems (Phillips et al. 1981b). However, it was thought that while the majority of the spawning occurred in the tributaries, most of the rearing to result in the adult returns must occur in the mainstems which even at that time were thought to be below carrying capacity and could accommodate still more. Although intermittency was not considered on the Skagit 35 years ago, the movement of juveniles from the tributaries to the mainstems was otherwise of the same pattern as on the Rogue.

Of the five Mid Skagit basin tributaries regularly surveyed in 2014, only O'Toole Creek remained completely perennial throughout the summer period (Table 12; and Photo 12). Significant portions of all the others went intermittent at varied times from May 30th to August 1st. In the case of Finney Creek, the largest of the streams surveyed, its mainstem remained perennial but numerous significant side channels where *O. mykiss* spawn and/or rear began to go intermittent by May 30th. There were known losses of large numbers of mixed salmonid fry and some parr that included *O. mykiss* photographed in late May as these side channels approached complete dewatering (Photo 14). The lowermost tributary of Finney Creek, Dry Creek, went intermittent in its lower 70 m by June 24-27 and progressed upstream as previously described leaving only the upper 400-500 m wetted from mid July onward. Nevertheless, it supported the highest level of steelhead spawning found at 14 redds/km, nearly double the next highest steelhead spawning in any of the other four tributaries regularly surveyed (Table 4). Dry Creek also has the most confined and stable channel of the five streams regularly surveyed, and while its spawning gravel has considerable fine sediment, it is much less so than the gravel of Finney Creek from visual estimates.

In the case of lower Savage and Mill creeks, both have had significant depositions of gravel related to landslides and/or bank erosion further upstream. These gravel depositions are likely related to their logging land use histories and aggravated by major flood events in the Skagit basin that have increased from eight of over 90,000 cfs in the 30 year period of 1948-1977 to fourteen in the 30 year period of 1978-2007, nearly double the flood event frequency of over 90,000 cfs from the earlier period (Appendix D). Weather pattern shifts related to climate change are likely contributing to this and shifts toward increasing changes in flow patterns are predicted to particularly occur in the northern Pacific Northwest (Wade et al. 2013). Despite the present conditions, that may or may not have been the case regarding the prior hydrology and geomorphology histories of these two tributaries, they are annually used for spawning and seasonal rearing by steelhead and other salmonids. They were even more prevalently used by steelhead about 35 years ago (Table 19; and Phillips et al. 1981b). At the time of the 1978-1981 spawning surveys there was no data provided if the streams included at the time were a

mix of perennial and intermittent or not. Presumably portions of the lengths of some were intermittent, as is the case today, but that can't be determined from the information provided. Of the 26 Skagit River tributary creeks surveyed at that time, Finney, Mill, and O'Toole were included for some or all years and steelhead spawning use in the differing eras can be compared (Table 19). Steelhead spawning use has significantly declined in these three Mid Skagit basin tributary creeks since that earlier period based on the 2014 survey findings and is now 35-78% of that in the past. Yet, the wild steelhead preliminary escapement estimate for 2014 is higher than any of the years in the 1978-1981 period (Table 20). The average escapement of 5,670 in that former time is less than 63% of the 2014 preliminary estimate of over 9,000 wild steelhead. Presumably if the tributaries were at former productivity levels present Skagit wild steelhead numbers would be considerably greater.

Table 19. Steelhead redds/km in three Mid Skagit tributaries in 1978-1981 compared to 2014

Stream	redds/km 1978-1981	redds/km 2014	present % of former spawning
Finney Ck	11.9	5.7	48%
Mill Ck	5.0-6.8	2.4	35-48%
O'Toole Ck	10.3-22.2	8.0	36-78%

Table 20. Skagit basin wild steelhead spawning escapements 1978-1981 and 2014

Year	Wild steelhead escapement	Reference
1978	7294	Phillips et al. 1981b
1979	3943	Phillips et al. 1981b
1980	6009	Phillips et al. 1981b
1981	5435	Phillips et al. 1981b
2014	over 9000, as preliminary estimate still to be finalized	per. comm. Brett Barkdull, WDFW, Nov. 6, 2014

Intermittent streams will increasingly be a part of the Northwest future if climate change progresses with continued warming at latitudes north of 45°N (Boughton et al. 2009). *O. mykiss* have adapted to this successfully and productively through much of their southern range and presumably a similar adaptation can transition northward as streams increasingly become intermittent over time. In fact, intermittent streams may even provide the most preferred spawning habitat due to having greater gravel accumulations (Everest 1973; Erman and Hawthorne 1976; Boughton et al. 2009) as occurs at Mill and Savage creeks of the Mid Skagit basin as a result of the probable mix of logging, landslides, increased flood events, and climate change. However, this adaptation and high level of potential productivity from intermittent streams will have to include early enough spawning for *O. mykiss* fry to get out of the gravel and migrate to perennial streams or perennial stream sections within the same streams for continued rearing.

There is a further consideration regarding intermittency and the use of such streams for successful wild steelhead reproduction. Although it was previously indicated that after significant portions had gone subsurface at Dry Creek with the assumption that potentially thousands of fry had perished by not outmigrating earlier, in the case of juvenile Atlantic salmon it has been found that juveniles, both fry and even parr size, can effectively penetrate the hyporheic flow of streams at least 60 cm (24 in) in both vertical and horizontal directions and may potentially include even more extensive movements (Heggenes et al. 2013). It was indicated that hatchery heritage fry may not be equally successful at doing so. At the level of benthic invertebrates, the hyporheic flow of rivers has been found to sustain connected communities 10 m (33 ft) deep and 2 km (1.24 mi) distant from the river channel within its more extensive floodplain (Stanford and Ward 1988). In the case of the Atlantic salmon fry, it indicated that finer sized substrates limited their movements more than larger sized substrates.

Dry Creek has considerable fine sediment in the gravel which may more restrict access to the hyporheic flow that otherwise likely includes both it and Finney Creek as part of an interactive floodplain. At both Dry Creek and Savage Creek, once they began to go subsurface digging down about 30 cm (12 in) did not reveal evidence of fry or parr, alive or dead, nor did the surface of the recently dewatered areas. However, the question remains: could they have been deeper, even a lot deeper? It remains for further consideration. Nevertheless, steelhead spawning time in the three tributaries that go intermittent in the Mid Skagit basin was earlier than the one regularly surveyed that remains perennial with apparent selection for earlier spawning by steelhead in the intermittent streams and likely earlier emergence as an adaptive advantage.

At Sagehen Creek in California, Erman and Hawthorne (1976) found that 39-47% of a rainbow trout population used an intermittent mountain stream to spawn despite the nearby presence of perennial stream habitat. On subsequent emergence the fry moved downstream to Sagehen Creek before the tributary dried up during a dry year (Erman and Leidy 1975). In a wetter year fry also moved downstream even though the streamflow remained permanent but many also remained as almost the only fish occupants of the stream. For whatever reasons that may not always be immediately identified, the intermittent tributary to Sagehen Creek example in California demonstrates the considerable attraction such streams have for *O. mykiss* spawning.

At the Arroyo Seco River, tributary of the Salinas River basin in central California, it was found that there was a spatial and temporal segregation of winter spawning habitat from over summering habitat as used by resident and anadromous *O. mykiss* (Boughton et al. 2009). The eastern side of the watershed was drier, the streams intermittent, spawning gravel aggregations greater, and spawning use was predominant; the western side of the watershed had more rainfall, cooler summer air temperatures, cooler streams with perennial flow, and resulting greater rearing use. It was considered that the fitness of the young-of-year hatching from the intermittent streams of the eastside depended on their ability to access the perennial westside tributaries for summer rearing before being lost to predation, warm temperatures, and intermittency. Of particular relevance to the Mid Skagit basin tributary creeks (Boughton et al. 2009):

Page 102: *"... suitably sized spawning gravels tended to occur in intermittent tributaries ... Significantly, some of the earliest-drying parts of the intermittent tributaries occurred just above their confluences, where they emerged from steep side canyons onto the unconstrained floodplain of the mainstem. This pattern cut off the possibility of emigration from intermittent creeks early in the seasonal drying process. This sort of bottom-up drying pattern might have greater mortality impacts than a top–down pattern, as the fish would retain a greater number of dispersal options for a longer time in the top–down pattern."*

Of further significance for recovery of ESA listed Puget Sound steelhead that includes the Mid Skagit basin:

Page 102: *"In many parts of their range, O. mykiss inhabit snow-fed mountain streams that more effectively store water for summer discharge than the rain-fed system observed in our study. However, many of these are expected to convert to rain-fed systems due to climate change. Under a given amount of annual precipitation, such conversion will produce larger peak flows in winter and lower minimum flows in summer."*

Page 92: "*In parts of North America, 59% of total stream length appears to be either intermittent or ephemeral (Nadeau & Rains 2007), and occurrence of intermittency may expand in the future as climate trends convert snowfed stream systems into rain-fed systems with reduced natural water storage and lower minimum flows. Such conversions are already in progress (Mote et al. 2005; Regonda et al. 2005; Hodgkins & Dudley 2006;*

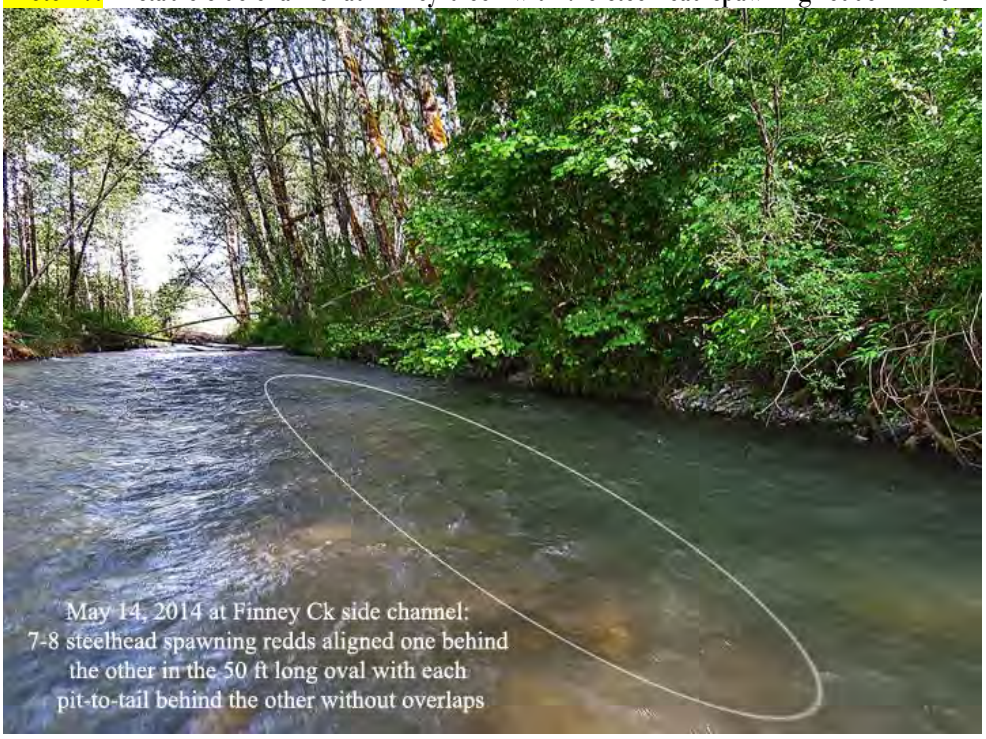
Knowles et al. 2006), and are expected to affect most of the European, Asian and American continents north of 45°N ...”

A major question for the Mid Skagit basin tributary streams is what has happened to the formerly greater steelhead spawning use found 35 years ago? It is apparent that an increasing shift toward intermittency may not be a limitation on steelhead productivity, but may actually increase the amount of spawning gravel available. If steelhead can’t make effective use of these intermittent streams now, the future will likely only become worse until the present limitations in their steelhead productivity are effectively analyzed and rectified through fishery management changes and/or addressing other habitat constraints. This is particularly critical given that Skagit basin steelhead (and all those of Puget Sound) are ESA listed as Threatened with legal obligations intended for their recovery rather than perpetuating a continued slide toward further depletion. Given that wild steelhead escapements were actually higher in 2014 than in the period of 1978-1981, it is apparent that resolving the present limitations for tributary steelhead productivity in the Skagit basin would likely lead to considerable progress toward wild steelhead recovery.

More Heavily Used Mid Skagit Tributary Spawning Area Characteristics

The one Mid Skagit tributary with proportionally greatest steelhead spawning use in 2014 was Dry Creek with about 14 redds per km (Table 4). Although Finney Creek overall had very dispersed steelhead spawning (less than 6 redds per km), there is a side channel below a logjam of about 150 m in length where 7-8 redds were found in a 40-50 foot (12-15 m) line (Appendix C, in Table 1) in a deep riffle with faster current speed than where most steelhead redds are found. These 7-8 redds were all a result of spawning that occurred in a relatively short period as found May 14, 2014 and photographed at a lower flow two days later (Photo 17). If this section was expanded to a length of 1 km it would result in 46 redds per km at 7 redds found, or 53 redds

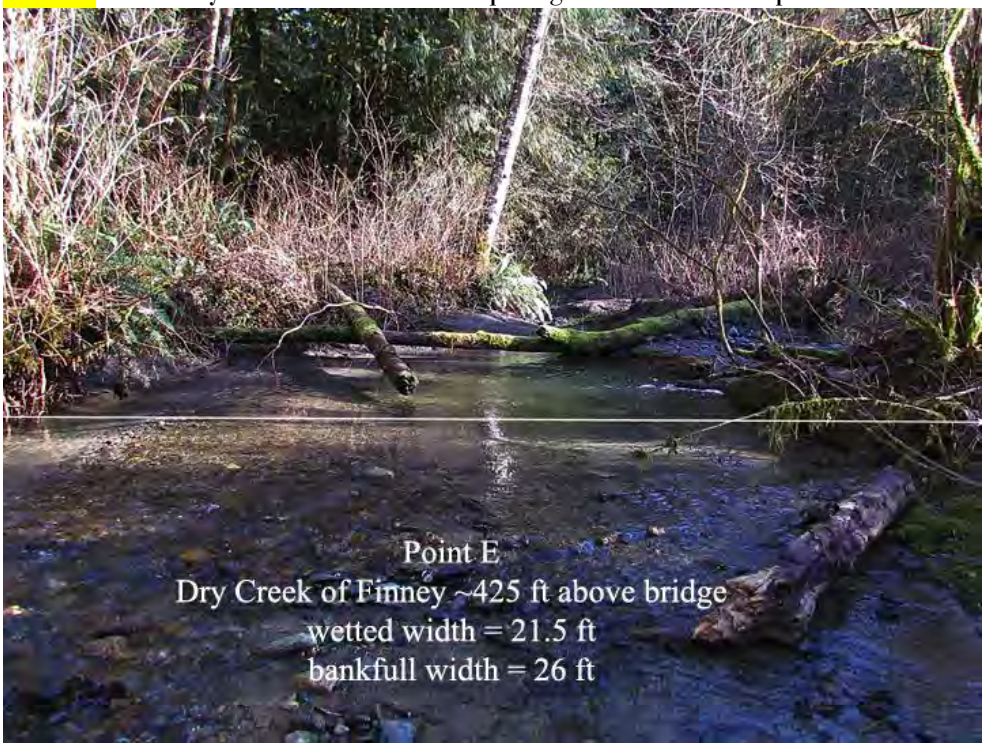
Photo 17. A stable side channel at Finney Creek with 7-8 steelhead spawning redds in line



per km at 8 redds found if the majority of Finney Creek was similarly conformed. If this is further expanded to the approximate 10 km length of Finney Creek where winter steelhead spawning primarily occurs, it would result in 460-530 winter steelhead redds in the primary spawning area that may have once included many similar reaches as this 150 yard reach prior to the past 50 year logging history. This excludes whatever other redds may have occurred in this side channel due to the inability to effectively survey it during much of the earlier spawning season in 2014 due to high and/or discolored flows.

Dry Creek is a tributary of lower Finney Creek. Although it is of intermittent flow, it is the one tributary in the anadromous length of Finney basin that continues to have a considerable portion of its 800 m of anadromous length that is forested with conifer trees of larger second growth size. Perhaps as a result of this its channel is well contained (Photos 6 and 18). During the January through May spawning period the wetted width and bankfull width do not greatly differ (Table 21). This contrasts with Finney Creek that commonly has a very broad channel with great differences between wetted and bankfull widths during the steelhead spawning season that includes significant channel shifts during the higher flow events (Photos 2 and 3). Over the past five years of spawning surveys, the most contained and stable channel of Finney Creek in the lower anadromous reach is the side channel below the logjam that has been described. Although this side channel has been enlarging, it still remains well contained with little difference between wetted and bankfull widths during the steelhead spawning period. The steelhead use in this side channel as evidenced by redds has increased since the initial

Photo 18. Lower Dry Creek forested section depicting one of five channel points measured February 15, 2013



formation of this side channel shortly prior to, or near the same time, as the first 2009-2010 period of the initial year of the surveys.

One readily identified commonality between these two areas of Finney Creek's lower basin is their well contained channels during the steelhead spawning period as determined by the relatively small difference

between wetted and bankfull widths. The one other stream of the five Mid Skagit tributaries regularly surveyed that has a similarly well contained channel throughout its anadromous length is O'Toole Creek with 8 redds per kim, the second highest behind Dry Creek.

Table 21. Lower Dry Creek channel measures taken at five points on February 15, 2013

Dry Ck channel point of measure	Location	wetted width	bankfull width
A	34 ft below the Finney logging road bridge	12-13 ft	19-20 ft
B	8 ft above the Finney logging road bridge	11 ft	14 ft
C	90-100 ft above the Finney logging road bridge	9.5 ft	25 ft
D	~275 ft above the Finney logging road bridge	5.5 ft	38 ft
E	~425 ft above the Finney logging road bridge	21.5 ft	26 ft

Regarding streamflows, although no measuring gages occur at either stream, it has been apparent during the surveys that Dry Creek does not react as significantly as Finney Creek to rainfall, that it clears quickly after peak flows (unlike Finney), and that peak flows quickly subside (unlike Finney). The Finney Creek side channel, however, remains wetted longer into the summer period than Dry Creek, and may remain wetted throughout (although it has not been field checked in July and August). This alone would not make later steelhead spawning a reproductive disadvantage in the way it may be at Dry Creek. Regarding this, the 2014 finding of six steelhead redds in the first 12 days of May at Dry Creek, of which five were likely constructed in that period (Table 3; and Appendix C in Table 1), was unexpected given the late June period when it goes intermittent with disconnection from Finney Creek. Furthermore, all but one of these redds was in the stream section that went subsurface June 27th to July 13th in 2014. Spawning at that late date may be at great risk for reproductive success, yet it occurred. Apparently enough years occur when emergent fry can move downstream or upstream to sustain the significant evidence of spawning in May prior to mid month. It has to be a reproductive strategy that is at the thin edge of adaptation to Dry Creek, but which would be anticipated to be an entirely reliable strategy at the one Finney Creek side channel. Another possibility is that Dry Creek's stable channel may result in attraction of straying Finney Creek steelhead searching for more stable spawning sites than are provided by the commonly shifting channels at Finney Creek and associated potential risk through even lower reproductive success they are trying to avoid.

Although sediment levels in the gravel spawning areas were not measured at either Finney or Dry creeks, sediment appears to be particularly high at Finney Creek. However, sediment in the gravel at Dry Creek is not insignificant and may be finer and more compacted than at Finney.

O'Toole Creek, with the second highest steelhead spawning redd density per km, has a relatively confined channel and stable riparian area, in this case of older deciduous trees. Although a great difference between wetted and bankfull widths is not apparent, it is subject to high velocity peak flows due to the majority of the watershed being high gradient and in immediate proximity to the short, lower gradient anadromous area available. Nevertheless, it appears to have the least sediment in the gravel of the five Mid Skagit tributaries regularly surveyed. The gravel, however, in the areas that the steelhead primarily use for spawning is commonly limited to patches at stream edges and behind boulder pockets due to its higher gradient channel and common presence of boulders and large cobble. Yet, pink salmon numbering in hundreds in stronger return years find sufficient gravel to spawn without apparent over crowding (Appendix C, in Tables 1, 3, and 5), and Chinook salmon can number in the dozens (Appendix C, in Table 2). As indicated previously, it is the only

stream of the five regularly surveyed that throughout its anadromous length is perennial inclusive of the channel splits, what few there are. As with Dry Creek and the one side channel at Finney Creek, the one most apparent commonality is a confined channel. In size of channel and streamflow volume, it is considerably larger than Dry Creek with a channel width likely 2-4 times greater depending on area, but which has not been measured.

Of the Mid Skagit tributary streams regularly surveyed, it is Dry Creek that particularly stands out for the amount of steelhead spawning it sustains. Of considerable concern is the potential threat of what the loss of the older second growth forest, much of which is western red cedar, along its lower reaches might result in for steelhead with its potential loss and for lower Finney basin overall if Dry Creek's present use for steelhead spawning were to diminish. There is no stream area in lower Finney Creek that has a similarly retained forested section. The only section with a similarly confined channel is the 150 m side channel of Finney Creek in which its present stability is likely a result of a logjam that has built above it. Unfortunately, this side channel is likely a temporary feature as evidenced by its trend toward enlargement and inevitable movement of the protective logjam due to the stream channel instability surrounding it both upstream and down.

Future Spawning Related to Monthly Precipitation, Temperature and Streamflow Based on Historical Evidence

The over 100 year weather records from a fish collection station on the lower Baker River of the Mid Skagit basin near Concrete, WA provide the opportunity to make comparisons of mean monthly precipitation (Table 22) and air temperatures (Table 23) from 1909 to the present (a gap in data from 1916 to 1930). If broken into three 25 year periods from 1931 to 2005, a 7 year period from 1909 to 1915, and a 9 year period from 2006 to 2014 changes in precipitation and temperature can be determined as being positive (increasing), negative (decreasing), or neutral (little changed or an undetermined) trends over time. This can be estimated by subtracting the lowest reading from the highest each month for each period of time and if these readings are primarily progressing over time in an increasing or decreasing manner across the years of record. This results in a plus, minus, or erratic (essentially neutral) range of differences in readings across years for each month.

Table 22.
Mean Monthly Precipitation (inches) at Concrete, WA of Mid Skagit Basin over Five Periods (1909 to 2014); the Range of Monthly Differences and if Mostly Positive, Negative, or Neutral; and the Precipitation Trend

Positive monthly mean precipitation increasing over time
Negative monthly mean precipitation decreasing over time
Neutral monthly mean precipitation remaining little changed or of undetermined trend over time

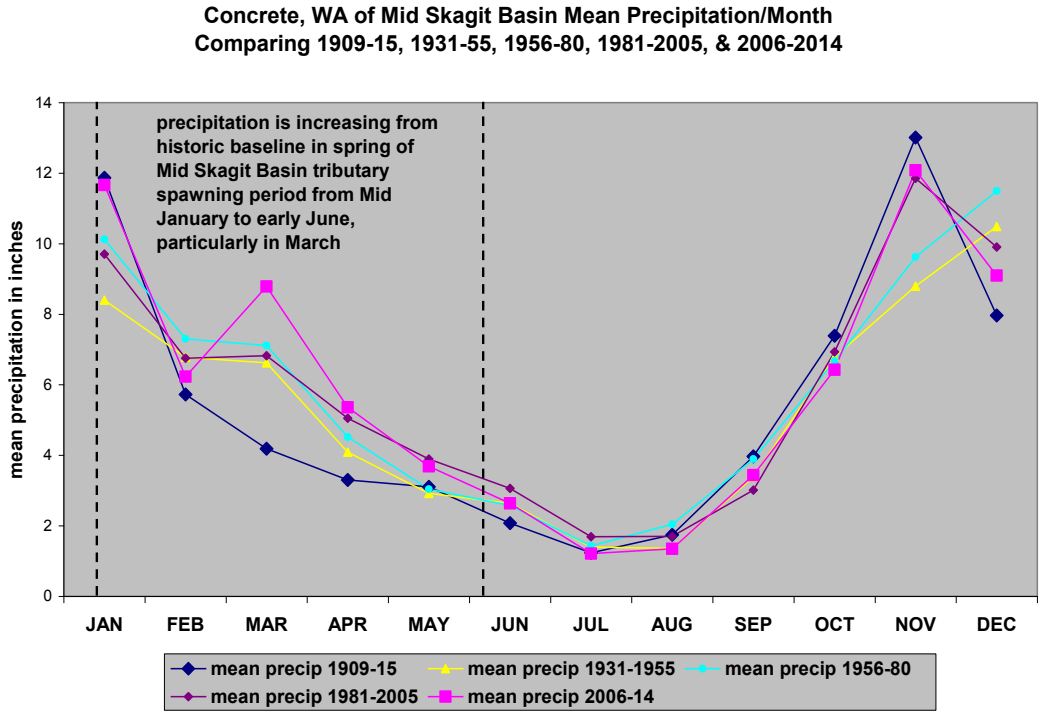
Time Period	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Mean
1909-15	11.87*	5.72	4.18	3.30	3.10	2.08	1.23	1.75	3.97	7.39	13.01*	7.96	65.57
1931-55	8.40	6.78	6.62	4.09	2.92	2.63	1.39	1.36	3.39	6.79	8.80	10.49	63.66
1956-80	10.12	7.30	7.11	4.52	3.04	2.57	1.43	2.04	3.89	6.67	9.62	11.49	69.83
1981-2005	9.70	6.75	6.82	5.05	3.89	3.06	1.69	1.70	3.01	6.93	11.85	9.91	70.37
2006-14	11.66	6.23	8.79	5.36	3.69	2.64	1.21	1.35	3.44	6.43	12.08	9.10	71.97
Range Difference	±3.47 +3.26	±1.58	+4.61	+2.06	+0.97	±0.98	±0.48	±0.69	±0.96	-0.96	±4.21 +3.28	±3.53	+8.37
Trend	neutral higher	neutral	higher	higher	higher	neutral	neutral	neutral	neutral	lower	neutral higher	neutral	higher

* Excluding the 7-year period of 1909-15 for January and November results in a progressive increase in precipitation over time, but if that 7-year period is included it is a more neutral pattern of precipitation over time. The 7-year period may be too short to provide as good indication as the three 25-year periods of time from 1931 to 2005.

In the case of precipitation (Table 22 and Figure 37) five months of the year (January, March, April, May, and November show a generally increasing trend over time as does the annual mean. In the cases of January and November of the 7-year 1909-1915 period, the precipitation amount was as high or higher than in the most recent 2006-2014 period, but excluding those earliest 7 years of data the trend is more definitely increasing. It is unknown if the 7-year period of 1909-1915 was reflective of precipitation over the longer 25 year span that would have gone back another 18 years if it had been available. Nevertheless, the annual mean precipitation data indicates it is indeed increasing in annual total amount over time. The Mid Skagit basin is apparently getting wetter and especially so in the steelhead spawning period found in the Mid Skagit tributaries of January through May as the primary spawning months, the exception being February in which precipitation is remaining quite stable. The one month in which precipitation is increasing the most is March (an increase of 4.61 inches at this time from that of 1909-1915) followed by April (increase of 2.06 inches) and May (increase of 0.97 inch). January precipitation is either increasing considerably or remaining neutral, dependent on whether the 1909-1915 data are included or not.

These are the precipitation changes that steelhead are presently adapting to and will continue to adapt to as climate change progresses in its effects on the Mid Skagit Basin if the past 100 year trend continues: generally increasing precipitation during their spawning period, especially in March, and with February the one month with the least change. February would be anticipated to provide steelhead spawning conditions most similar to what shaped their spawning time in the past 100 years regarding precipitation. March, on the other hand, would be the month with the most extreme shift in steelhead spawning conditions from those that shaped their spawning time in the past 100 years regarding precipitation. Precipitation in tributary streams whose drainage areas are dominated by low elevations would be a particularly anticipated driver of streamflows, but this may not be as much the case with tributaries dominated more by high elevations drainage areas that accumulate as snowfall that comes out at a later date as melt water.

Figure 37.



In the case of air temperatures (Table 23 and Figure 38) six months of the year (March, April, May, June, September, and December) show a generally decreasing trend over time as does the annual mean. In the cases of October, December, and the annual mean of the 7-year 1909-1915 period, the temperatures were slightly colder than in the most recent 2006-2014 period, but excluding those earliest 7 years of data the trend is more

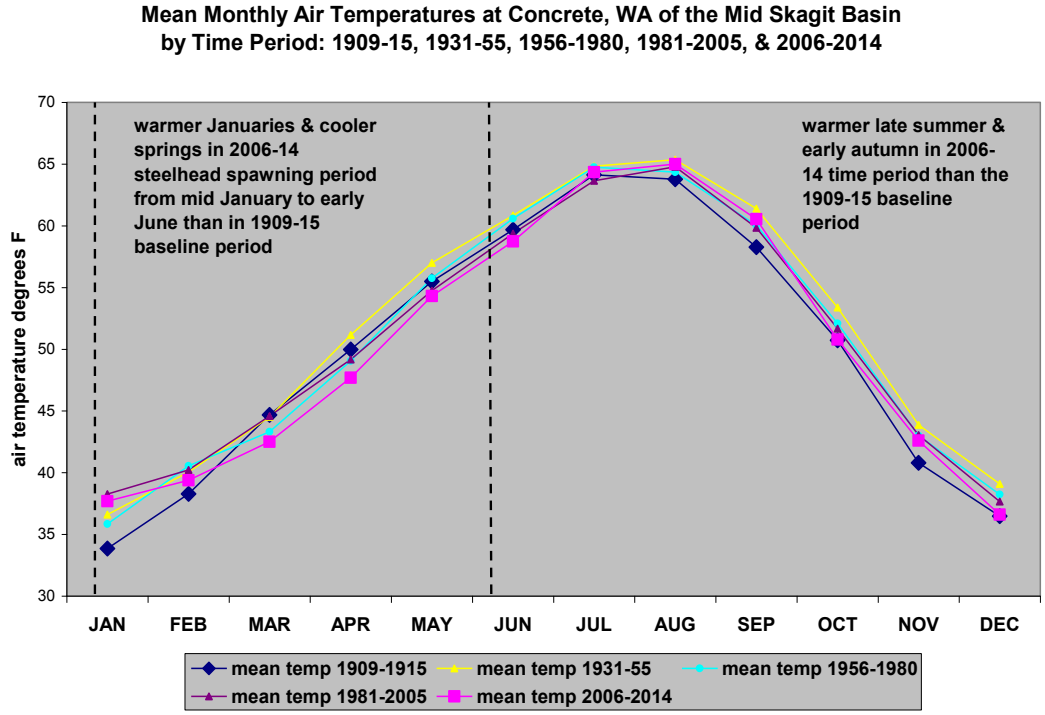
Table 23.
Mean Monthly Air Temperature (F) at Concrete, WA of Mid Skagit Basin over Five Periods (1909 to 2014); the Range of Monthly Differences and if Mostly Positive, Negative, or Neutral; and the Temperature Trend

Positive monthly mean temperatures increasing over time
Negative monthly mean temperatures decreasing over time
Neutral monthly mean temperatures remaining little changed or of undetermined trend over time

Time Period	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Mean
1909-15	33.85	38.28	44.69	49.97	55.49	59.69	64.13	63.77	58.27	50.72*	40.80	36.48*	49.68*
1931-55	36.60	40.06	44.50	51.15	57.00	60.83	64.82	65.35	61.39	53.38	43.87	39.09	51.50
1956-80	35.85	40.56	43.31	49.06	55.75	60.58	64.76	64.35	60.04	52.09	43.00	38.24	50.63
1981-2005	38.26	40.23	44.59	49.16	54.74	59.37	63.65	64.78	59.84	51.67	43.04	37.65	50.58
2006-14	37.69	39.38	42.50	47.69	54.31	58.74	64.34	65.00	60.54	50.78	42.60	36.60	50.02
Range Difference	+4.41	±2.28	-2.19	-3.46	-2.69	-2.09	±1.17	±1.58	±3.12	±2.66 -2.6	±3.07	±2.61 -2.49	±1.82 -1.48
Trend	**higher**	**neutral**	**lower**	**lower**	**lower**	**lower**	**neutral**	**neutral**	**neutral**	**neutral lower**	**neutral**	**neutral lower**	**neutral lower**

* Excluding the 7-year period of 1909-15 for October, December, and the Annual Mean results in a progressive increase in air temperature over time in each of those columns, but if that 7-year period is included it is a more neutral pattern of precipitation over time. The 7-year period may be too short to provide as good indication as the three 25-year periods of time from 1931 to 2005.

Figure 38.



definitely decreasing. It is unknown if the 7-year period of 1909-1915 was reflective of temperatures over the longer 25 year span that would have gone back another 18 years if it had been available. Because the annual mean temperature data is in some question without a clear trend it can't be determined if there is an actual annual change over time. However, what is apparent is that in the full period of steelhead spawning of January to June found in the Mid Skagit tributaries that March (- 2.19 F), April (- 3.46 F), May (- 2.69 F), and June (- 2.09 F) are all getting cooler. Only January is warming, but very much so with a 4.41 F (2.45 C) increase in overall range, or 3.84 F (2.13 C) increase from 1909-15 period to 2006-14. February air temperatures, as with precipitation, are a relatively neutral trend.

These are the air temperature changes that steelhead are presently adapting to and will continue to adapt to as climate change progresses in its effects on the Mid Skagit Basin if the past 100 year trend continues: generally decreasing temperatures during their spawning period, especially in April (- 3.46 F, or - 1.92 C, as the overall temperature change range; - 2.28 F, or - 1.26 C, as the change between 1909-15 and 2006-14) and May (- 2.69, or - 1.50 C F, as the overall temperature change range; - 1.18 F, or - 0.66 C, as the change between 1909-15 and 2006-14), and with February the one month with the least change remaining relatively temperature-neutral. February would be anticipated to provide steelhead spawning conditions most similar to what shaped their spawning time in the past 100 years regarding temperatures. April and May, on the other hand, would be the months with the most extreme shifts in steelhead spawning conditions from those that shaped their spawning time in the past 100 years regarding temperatures that are lower. January, however, is the single month with the greatest temperature shift during the steelhead spawning period in its anomalous increase of 4.41 F (2.45 C) in the overall range, or 3.84 F (2.13 C) increase between 1909-15 and 2006-14. This is a January air temperature shift that would be anticipated to more regularly result in water temperatures that initiate steelhead spawning (3.9-4.0 C, or 39.02-39.20 F) as determined from Bell (1972) and Bovee (1978). The January warming would also be anticipated to result in less snowfall, particularly accumulations of snowpack at higher elevations at this winter date. Cooling in March and especially April, on the other hand, would increase the potential for snow and potentially result in an increasing snowpack at these late dates at higher elevations rather than what may have formerly been snowpack melt conditions. This will result in shifts in snowmelt accumulations at higher elevations in the Mid Skagit basin with stream hydrology shifts that steelhead spawning time is partially shaped by and will continue so into the future if the temperature trends remain on a similar path.

The 86 year streamflow records from the USGS gage between Arlington and Oso, WA on the North Fork Stillaguamish River provide the opportunity to make comparisons of mean monthly streamflows (in cfs) from 1928 to the present (Table 24 and Figure 39). If broken into three 25 year periods from 1928 to 2003 and a 12 year period from 2003 to 2014 changes in streamflow can be determined as being positive (increasing), negative (decreasing), or neutral (little changed or an undetermined) trends over time. As with precipitation and temperature, this can be estimated by subtracting the lowest reading from the highest each month for each period of time and if these readings are primarily progressing over time in an increasing or decreasing manner across the years of record. This results in a plus, minus, or erratic (essentially neutral) range of differences in readings across years for each month.

In the case of North Fork Stillaguamish River streamflow as a surrogate for that of Finney Creek and likely some other tributaries in the Mid Skagit basin (Table 24), four months of the year (January, March, April, and November) have a generally increasing trend over time. Although February has an erratic neutral trend over

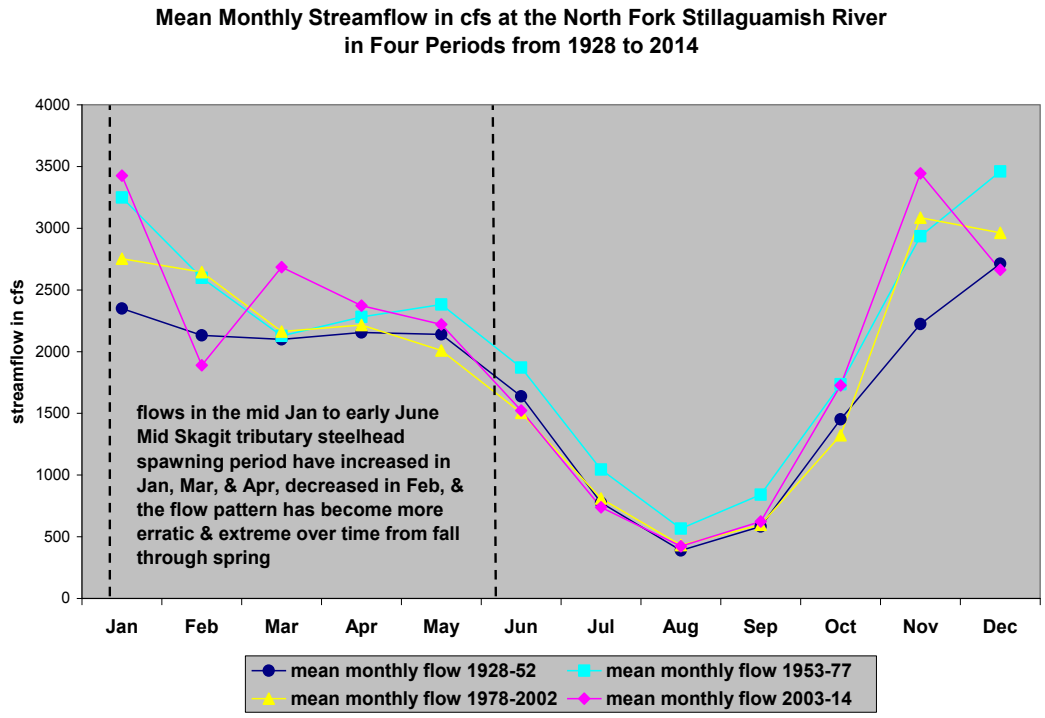
time, the most recent period of 2003-2014 has sharply declined in streamflow. During the primary Mid Skagit tributary steelhead spawning period of January through May, January has the greatest shift in streamflow with an increase of 1,077 cfs from that of 1928-52, although this trend is not as steadily progressing as that of March (587 cfs increase) and April (218 cfs increase). As with January, November has had a large shift to increased flow. Overall, the once relatively even curves of streamflow in the 1928-52 period have become both erratic and extreme in the fall through spring period.

Table 24.
Mean Monthly Streamflow (cfs) at North Fork Stillaguamish River during Four Periods from 1928 to 2014; the Range of Monthly Differences and if Mostly Positive, Negative, or Neutral; and the Streamflow Trend

Positive monthly mean streamflows increasing over time
Negative monthly mean streamflowss decreasing over time
Neutral monthly mean streamflows remaining little changed or of undetermined trend over time

Time Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean
mean monthly flow 1928-52	2348	2132	2098	2154	2139	1637	775	389	583	1451	2223	2712	1720
mean monthly flow 1953-77	3249	2597	2127	2281	2382	1870	1045	566	840	1735	2934	3460	2090
mean monthly flow 1978-2002	2753	2644	2162	2216	2009	1504	809	431	596	1321	3085	2962	1875
mean monthly flow 2003-14	3425	1889	2685	2372	2220	1522	738	423	622	1726	3444	2663	1978
Range Difference	+1077	±755	+587	+218	±373	±366	±307	±177	±257	±414	+1221	±797	±370
Trend	**higher**	**neutral**	**higher**	**higher**	**neutral**	**neutral**	**neutral**	**neutral**	**neutral**	**neutral**	**higher**	**neutral**	**neutral**

Figure 39.



In the case of streamflow there are anthropogenic changes at the environmental level, such as widespread timber harvest, that may be more intensive in one period of time than another with a significant influence on how precipitation and air temperature affect streamflow in the North Fork Stillaguamish basin (and potentially differing considerably in the Mid Skagit basin by specific tributary). Although Figures 37 and 39 indicate that precipitation and streamflow patterns over the past 85-100 years have been generally similar during relatively comparable time periods, a more detailed analysis of this in the examination of timber harvest records may indicate a significant relationship that is not immediately apparent from the data used in the previous tables and figures.

Whatever the origins of streamflow shifts may be steelhead are adapting and will continue to adapt to these changes with spawn timing as climate change progresses, and which they have well enough adapted to in past climate shifts. Although this is a matter of magnitude of what the future may hold, at this point in time it would appear that through the present century Mid Skagit basin steelhead will not encounter stream characteristics that they have not successfully adapted to in the past 10,000-15,000 years after the Cordilleran ice sheet retreated from Puget Sound and steelhead again colonized the streams. What Mid Skagit tributary spawning wild steelhead did not encounter during past periods of climatic change were hatchery steelhead with reduced productivity levels that now inhabit their spawning grounds during significantly overlapping spawning periods. In the case of streamflows, the trend is toward more erratic monthly patterns with greater flow during the initiation of steelhead spawning in January, less flow in February, and increased flow in March and April for those tributary streams that may have similar monthly streamflow characteristics to the North Fork Stillaguamish River.

Steelhead Spawning, Streamflow, Precipitation, and Air Temperature at the Individual Tributary Level of Finney Creek

At the individual tributary level, Finney Creek is the largest of the five Mid Skagit tributaries that were regularly surveyed in the 2010-14 five year period. It is also the stream that drains the greatest amount of higher elevation areas in its watershed and with an historic streamflow record available from 1943 to 1948 (when it had a gaging station). Its streamflows have been found to be similar in monthly pattern to the North Fork Stillaguamish streamflows historically (Figure 26) and is thought to be similarly so today (Nichols and Ketcheson 2013). As a result Finney Creek provides time shots of the changes in streamflow patterns that have occurred between 1943-48 and 2010-14 as compared to the total number of steelhead redds counted at Finney Creek and adjusted to estimated spawning date from 2010 to 2014 (Figure 40). This further portrays the shifting streamflow trends that are particularly occurring in the steelhead spawning period of mid January to May at Finney Creek (and rarely to early June as found overall in the Mid Skagit tributaries). As previously indicated, the one month in the steelhead spawning period with flows that have remained more stable over time has been February from the streamflow data available that is at least in part representative of Mid Skagit tributaries.

Because there is no prior baseline of early spawning surveys from January to early March for comparison, what these streamflow shifts may have resulted in relative to steelhead spawning can't be determined. However, there is now such a baseline from which to make future comparisons as streamflows (and precipitation and temperatures) continue to shift over the coming years as will likely occur with continued climate change. The trend is for increasing streamflows during three (January, March, and April) of the four most important months

Figure 40.

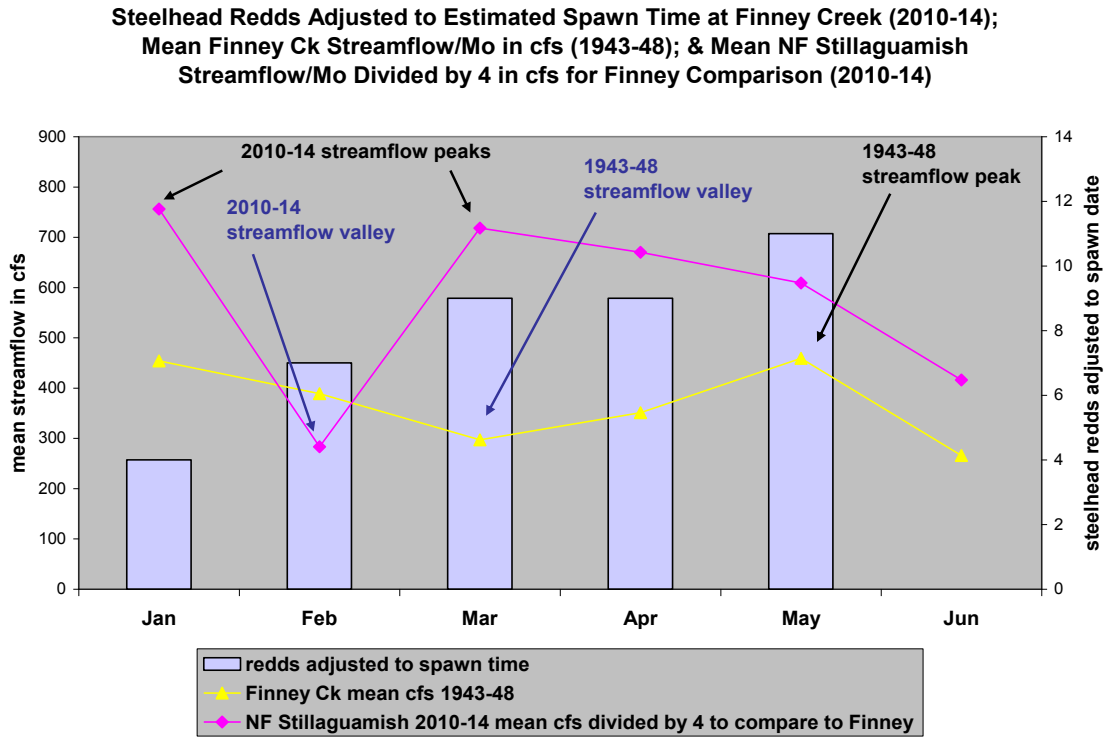
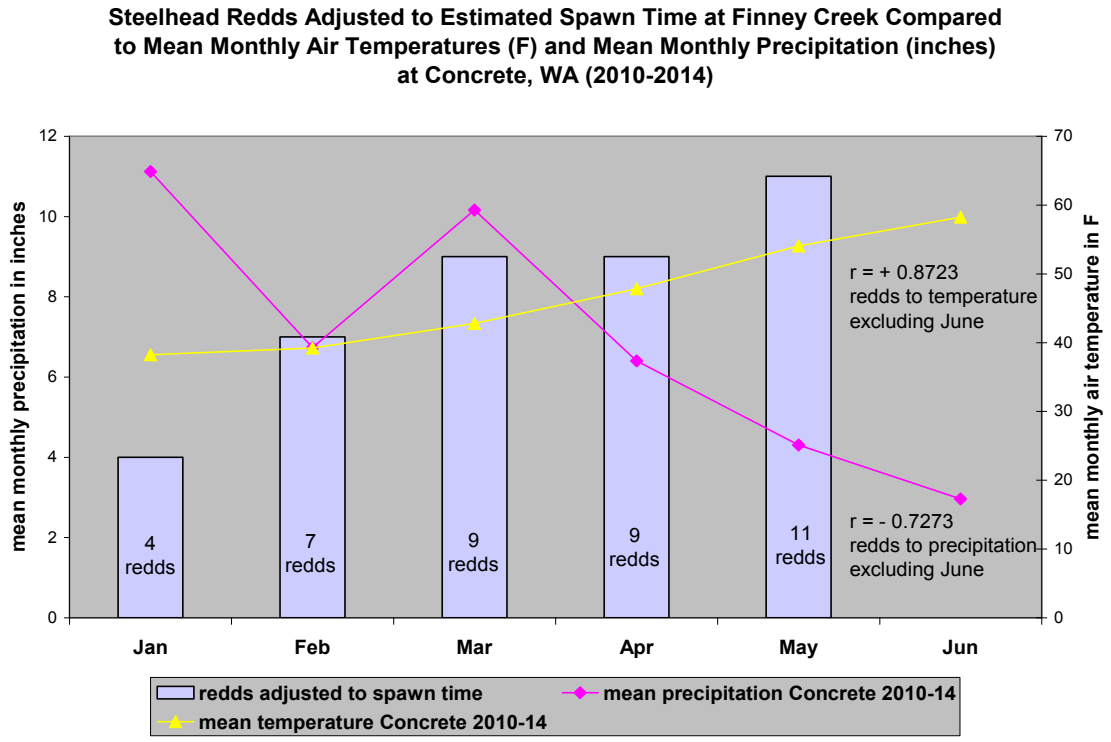


Figure 41.



for steelhead spawning (January, February, March, April, and May). The one month with the least streamflow change that may be particularly important for steelhead spawning adaptation through otherwise increasing streamflows is February if Finney Creek is a good representation for Mid Skagit basin tributaries. As previously determined, Finney Creek has perennial mainstem flow and important side channels used for spawning and/or rearing that have intermittent flow characteristics with resulting steelhead spawning that occurs both early and late (Figures 32 and 33) and does represent to some degree an intermediary stream in this regard. The potential relationship of streamflows to steelhead spawning at Finney Creek, however, is not a statistically significant correlation with a Pearson's "r" of - 0.2080 when excluding June or + 0.4385 when including June (when no redds were found). The actual relationship of streamflows to spawning likely requires more specific spawning dates than estimates of redd dates can provide because streamflows can significantly alter within one or two days of each other at Mid Skagit tributaries when significant precipitation occurs or ceases.

Furthermore, any specific flow may be of less relevance than any sudden rise in streamflow with precipitation followed by a decline when it subsides. This is when actual spawning entry has been observed to most often occur, not only at the Mid Skagit tributaries but elsewhere (Susac and Jacobs 1999).

Regarding precipitation and air temperature means per month at Concrete, Washington during the five year survey period at Finney Creek (Figure 41), there has been a positive correlation ("r" = + 0.8723) of steelhead spawning to air temperature if June is excluded as the outlier month when minimal steelhead spawning has been found in the Mid Skagit tributaries, and with no June evidence found at Finney Creek (although some likely occurs some years when cooler June air/water temeratures may occur). This is a significant correlation of increased spawning with increasing air temperature through May. Regarding precipitation, there has been a negative correlation to steelhead spawning ("r" = - 0.7273) as spawning has tended to be less with increased precipitation, but it is not a significant correlation. The month most out of alignment in the precipitation to spawning pattern has been March with its trend for increasing precipitation.

In the case of the precipitation to streamflow relationship, the choices between negative or positive anthropogenic changes related to the future of the Mid Skagit basin tributary streams may as well determine the adaptive future for steelhead as climate change itself, at least in this century. Anthropogenic change is not only related to habitat. The reproductive success for steelhead will be at least equally determined by decisions made regarding hatchery plants, commercial/sport/subsistence fisheries, and effective recovery of the range of historic life histories that formerly allowed *O. mykiss* to be such a productive species in the Skagit basin and which will determine their ability to reproductively adapt to future change or not across the full spectrum of temperatures, precipitation, and streamflows. Understanding the inherent range of characteristics of *O. mykiss* reproduction that have made them successful will only be determined by a future that includes effective monitoring of the amount, timing, and reproductive strategy shifts of combined anadrous/resident spawning in the vital tributary creeks of the larger basin where 65%-80% of former steelhead spawning occurred. This will also have to include the more obviously understood management of habitat, but preserving the necessary attributes of broad fish life histories needed to sustain themselves through continued change may well more quickly determine their fate (one way or the other) beyond that of habitat alone.

Among the more necessary attributes for reproductive success suggested by the Mid Skagit basin tributary surveys are: run timing; spawn timing; emergence timing; juvenile directional traits displayed shortly after emergence; and presence of resident males to insure fertilization that includes increased life history diversity. There are, of course, further determinations that can include female body size (that can determine redd depth),

female fecundity (not necessarily related to body size), diverse juvenile life histories with differing ages and migrational characteristics, and etc., but which were largely outside the ability of the spawning surveys to determine, and yet need to be determined. Many diverse characteristics thought to be inherited have thus far not been effectively identified through use of analytical genetic technology presently available. As a result identifying diverse life history characteristics in the field are necessary to identify those that evade lab detection. Unfortunately, lab identifications rather than field identifications have often become the primary means on which recovery decisions are based for steelhead. This includes common disregard for history (often depicting life history traits) to fill in biological puzzle parts needed on which to base recoveries sometimes available that date back a century or more.

Conclusion Essentials

The past five years of Mid Skagit basin surveys at five tributaries regularly surveyed for spawning steelhead, salmon, and cutthroat trout found the following:

- confirming old historical records steelhead spawning entry and spawning began in January, not March 15th as has been described in Puget Sound steelhead management documents in more recent history
- 104 steelhead redds were counted in the cumulative 2010-14 period; 49% of the redds were prior to March 15th; when redds were adjusted to estimated spawn time 53% were prior to March 15th
- coho salmon and steelhead have slight overlapping spawning times some years but typically minimal; sea-run cutthroat trout (and resident *O.clarki*) have significant spawning time overlaps with steelhead
- the tributary spawning populations include resident and anadromous *O. mykiss* life histories as well as probable sea-run and perhaps resident *O.clarkii*, with the resident proportions being males
- hatchery steelhead were included in the *O. mykiss* spawning population mix that includes mating with both resident and anadromous life histories and probably wild sea-run and resident *O.clarkii* males
- the proportion of hatchery steelhead actively spawning in the mid January to early June spawning period was a range of 29%-40%; if the wild male resident life history was included in the spawning mix the range was 22%-33% hatchery depending on if 2014 alone or that of 2010-14 cumulatively
- both wild and hatchery origin steelhead were found spawning in the early spawning period of mid January to mid March
- the proportion of hatchery steelhead actively spawning in the mid January to mid March spawning period was 67%; if the wild male resident life history was included in the spawning mix it was a range of 40%-50% hatchery depending on if 2014 alone or that of 2010-14 cumulatively
- although no hatchery steelhead were found spawning after March 15th the unknown origin steelhead after that date were 20% of the total steelhead then observed
- the spawning time of steelhead was found to differ by specific tributary with over 50% of the spawning occurring prior to March 15th at three of the tributaries regularly surveyed and with less than 50% at two
- potential reasons for differences in steelhead spawning time were examined and included differences in air/water temperature, precipitation, streamflow, and intermittent or perennial hydrology from data available with weather records dating to 1909 through the present and streamflows to 1928
- mean monthly air temperature, precipitation, and streamflow were compared to steelhead redd counts (and as adjusted to estimated spawning date) and then evaluated for Pearson's correlation coefficient "r" to determine if there was a significant relationship or not; although both water temperature and streamflow variables have been described by others as important factors in steelhead spawning time the correlations found generally proved to be erratic and not dependably significant; lack of the exact date of most spawnings and the need to use surrogate air temperature data for stream temperatures, and to use

precipitation and North Fork Stillaguamish River streamflow data as a substitute for missing stramflow data at each tributary surveyed may have confounded the ability to demonstrate statistically significant correlations to spawning time

- at the cumulative level of all five tributaries a highly significant correlation was found between average monthly air temperature and steelhead redds per month when adjusted to spawning date if 50-67% of the redds during the early spawning period were eliminated to better reflect wild steelhead spawning
- what water temperature data were taken indicated that steelhead spawning in warmer streams was skewed earlier and in colder streams skewed later; at one tributary with significant spawners in 2010 and 2014 the warmer year (2010) had a month earlier spawning peak than the colder year (2014)
- whether a tributary's hydrology was intermittent or perennial was found to be a particularly probable driver of steelhead spawning time differences regarding whether most was prior to March 15th or thereafter; this was hypothesized to be due to the need for spawning to be early enough for significant numbers of emergent steelhead fry to move either downstream to perennial waters prior to late June to early July when intermittent flows began to disconnect these tributaries from larger downstream water bodies (or upstream if that option was available)
- although intermittency is predicted to increase in northward expansion and is sometimes perceived as a great limitation on steelhead reproductive success, there are examples of great steelhead productivity that occurs in intermittent streams and where gravel accumulations may actually provide better spawning habitat if steelhead life histories have effectively adapted with early spawning and emergence
- steelhead fry emergence was first confirmed by late May at an intermittent tributary and another with side channels going intermittent as found in underwater photographs; steelhead fry in the photographs were likely present dating to at least mid May that could not be clearly identified; photographs earlier than early May did not occur that might have captured even April emergence
- shifts in the monthly pattern of air temperatures and precipitation since 1909 were examined as were streamflows dating to 1928; shifts are occurring that are particularly affecting the steelhead spawning period of January to May; the trends are toward warmer Januaries and neutral Februaries but cooler the other three months; more precipitation occurs each of the months but February; and greater streamflows occur except February and May; a former spring streamflow peak in May has shifted two months ahead to March; steelhead spawning must adapt to these climate changes; the one month with least change is February and may be an important point of stability
- regarding future genetic studies that may occur, it will be important to recognize the early period of time when steelhead fry emergence occurs and that the most likely time period for the hatchery signal to show up prior to significant depletion through natural selection would be fry sampling from May to mid June prior to probable high loss of hatchery and hybrid fry whose life histories may well exclude effective movements from intermittent streams, or stream sections, and vulnerability to predation or other factors that may commonly limit hatchery related characteristics to survive as well as wild
- of the five Mid Skagit tributaries regularly surveyed the one stream attribute identified that resulted in more intensive steelhead spawning use was a well contained channel with least difference between wetted and bankfull widths during the steelhead spawning period
- the Mid Skagit tributary surveys provide a baseline for the full period of steelhead spawning that has otherwise been lacking from which to monitor wild steelhead escapements, the hatchery component of the escapements, and how the steelhead spawning is variable in time and quantity by individual tributaries that have similarly variable environmental conditions that need to be understood and managed for in recovery planning

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Appendices
(A-G)

Appendix A.

Table 1.
Annual precipitation in inches near the mouth of Savage Creek and Birdsview, WA on the Mid Skagit River (2001-2014) with months of heaviest mean precipitation in light gray

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Jan		14.750	14.925	10.600	7.875	23.100	10.650	7.300	16.625	10.150	11.700	13.925	10.775	14.150	**12.810**
Feb		10.350	4.675	4.375	2.625	6.500	7.575	8.100	2.770	5.025	7.825	10.650	7.500	10.625	**6.815**
Mar		10.040	17.200	6.825	9.300	4.425	11.325	9.075	9.475	6.750	13.175	14.425	8.550	17.415	**10.614**
Apr		7.420	5.895	1.375	7.450	5.575	4.695	4.325	5.600	6.575	8.350	8.825	8.710	7.075	**6.298**
May		4.220	3.500	4.350	4.700	3.050	1.500	3.175	6.675	6.000	5.425	4.325	4.135	6.575	**4.433**
Jun		4.430	1.400	3.000	3.225	2.900	3.700	2.775	0.950	4.000	1.440	5.275	3.450	2.825	**3.028**
Jul		1.680	0.000	0.550	1.875	2.025	2.125	1.415	0.500	0.300	1.825	2.175	0.200	2.000	**1.282**
Aug		1.080	0.450	8.450	1.575	0.200	1.750	4.450	1.175	1.725	0.550	0.000	2.525	1.692	**1.994**
Sep		3.060	2.100	9.820	3.525	1.575	4.275	1.250	4.950	7.175	3.400	0.450	12.150		**4.478**
Oct	11.300	1.980	17.500	5.975	9.135	2.675	8.000	5.750	14.950	5.300	7.725	11.675	3.100		**8.082**
Nov	14.750	8.960	16.600	13.525	10.475	23.275	7.475	13.575	21.150	11.050	16.150	15.400	15.310		**14.438**
Dec	16.900	14.800	9.000	11.425	11.550	11.825	17.575	9.700	4.835	13.850	6.300	11.585	5.825		**11.167**
Total		**82.770**	**93.245**	**80.270**	**73.310**	**87.125**	**80.645**	**70.890**	**89.655**	**77.900**	**83.865**	**98.710**	**82.230**		**85.415**

Table 2.
Annual precipitation in inches at the lower Baker River near Concrete, WA on the Mid Skagit River (2001-2014) with months of heaviest mean precipitation in light gray

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Jan		11.820	11.730	9.530	6.610	20.180	7.990	6.350	14.850	9.550	14.090	12.000	9.270	10.700	11.128
Feb		8.440	3.740	3.650	1.900	7.140	5.860	7.380	2.030	4.680	6.110	9.380	5.200	8.280	5.676
Mar		7.840	13.940	6.610	7.230	4.080	9.750	7.290	7.140	5.730	11.730	11.620	7.650	14.080	8.822
Apr		7.030	5.400	0.930	5.890	4.690	3.820	3.410	4.340	5.830	7.190	5.200	7.210	6.570	5.193
May		3.210	3.850	3.600	3.590	2.510	1.620	2.880	4.670	5.850	3.730	4.140	3.410	4.390	3.650
Jun		3.700	0.930	2.370	3.130	2.370	3.110	2.370	1.090	3.260	1.460	4.220	3.330	2.540	2.606
Jul		1.110	0.080	0.710	1.630	1.940	1.590	0.910	0.000	0.200	1.910	2.180	0.060	2.130	1.112
Aug		1.120	0.550	6.680	0.970	0.220	1.490	3.970	1.360	0.580	0.210	0.010	2.250	2.040	1.650
Sep		1.900	1.550	8.760	3.440	1.660	2.290	1.460	3.110	7.380	2.180	0.330	9.080		3.595
Oct	10.080	1.360	15.220	5.010	6.840	2.600	8.040	4.040	13.530	4.740	5.500	9.880	3.080		6.917
Nov	10.930	6.940	14.170	11.040	9.380	19.650	6.280	11.910	16.510	9.800	12.590	11.250	8.650		11.469
Dec	13.170	10.610	7.870	9.730	8.250	11.090	13.230	9.630	4.330	11.310	4.330	12.010	6.850		9.416
Total		**65.080**	**79.030**	**68.620**	**58.860**	**78.130**	**65.070**	**61.600**	**72.960**	**68.910**	**71.030**	**82.220**	**66.040**		**69.796**

Appendix B.

Table 1. Skagit River Tributary Steelhead Egg Taking Operations 1914-1920 [tributary spawning steelhead averaged 2,855 eggs/female as found at Green River by Pautzke and Meigs (1941) and was used to estimate Skagit River tributary females from eggs taken]

Stream	Year	steelhead eggs	# females
Day Ck	1914	194,000	68
	1915	263,000	92
	1916	286,000	100
	1917	n/a	n/a
	1918	82,000	29
Grandy Ck	1913	2,679,000	938
	1914	829,000	290
	1915	1,800,000	630
	1916	3,212,000	1,125
	1917	290,000	102
	1918	3,043,000	1,066
	1919	226,400	79
	1920	255,000	89
Illabot Ck	1913	347,500	122
	1914	187,755	101
	1915	60,000	21
	1916	272,000	95
	1917	n/a	n/a
	1917-18	451,500	158

Appendix C.

Table 1. Mid Skagit Basin Spawning Survey Counts from October 3, 2013 to June 16, 2014 Made Regularly at Five Primary Index Streams: Savage, Mill, O'Toole, Finney, and Dry (of Finney) Creeks; and Rarely at Four other Streams: Quartz (of Finney), Hatchery (of Finney), Cumberland, and Grandy Creeks

Savage Creek redd counts							Savage Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7	25						206					
Oct 8-15	140			9			56			1		
Oct 16-23							46					
Oct 24-31												
Nov 1-7												
Nov 8-15				6						2		
Nov 16-23												
Nov 24-30				27						23		
Dec 1-7				24						20		
Dec 8-15												
Dec 16-23												
Dec 24-31			1	41		2			1	35		
Jan 1-7				14		1				17		
Jan 8-15				30						65		
Jan 16-23				32	1					16		
Jan 24-31				1		1				1		
Feb 1-7												
Feb 8-15												
Feb 16-23					2	1						
Feb 24-29												
Mar 1-7												
Mar 8-15					2	1						
Mar 16-23						1						
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**165**		**1**	**184**	**5**	**7**	**308**		**1**	**180**		

Notes:

The pink salmon minimum escapement should be based on the redd count of Oct. 8-15 plus the live counts of Oct. 1-7 and Oct. 16-23. But actual escapement was likely greater due to likely missing earliest spawning in latter Sep.

On Jan. 23rd, the steelhead redd found was large and likely built between Jan. 4-14.

On Feb. 19th, the 2 probable steelhead redds found were likely built within the week; the cutthroat redd within 1-2 weeks all in Mainstem above WF Savage.

On Mar. 12th, one steelhead redd found near the mouth of Savage Ck., and on Mar. 15th another probable steelhead redd was found at WF Savage inside upper end of logging road culvert – the first probable steelhead redd ever found in WF Savage.

Mill Creek redd counts							Mill Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7	124	1					219	2	1			
Oct 8-15							416					
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23				1						3		
Nov 24-30												
Dec 1-7				6						5		
Dec 8-15												
Dec 16-23												
Dec 24-31				15						5		
Jan 1-7				17						8		
Jan 8-15				14						19		
Jan 16-23												
Jan 24-31				6						3		
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30					2							
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**124**	**1**		**59**	**2**		**635**	**2**	**1**	**43**		

Notes:

The pink live and carcass counts were considered most accurate count, but a number of carcasses likely missed due to higher flows washing them out.

Coho escapement should be based on redds.

On April 30th, 2 redds were found both about 200 yds above S.Skagit Hwy; one about 2 wks old & other 3-7 days; first could have been cutthroat but date seemed more likely steelhead.

O'Toole Creek redd counts							O'Toole Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7	149						251					
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7					2	1						
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7					1							
May 8-15												1
May 16-23					1							
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23					1							
Total:	**149**				**5**	**1**	**251**					1

Notes:

Pink escapement should be based on the redd count of Oct. 1-7 plus the live count.

On April 7th, steelhead redd 3.5'x4' & 1-2 weeks old; sea-run cutthroat or resident rainbow redd was 16"x20" in quite large gravel & deep pit & about 1 week old.

On April 22nd, a WDFW steelhead flag marked 4-14-2014 had been considered on April 7th but not marked, it has been added to that survey; it would have been at least 1-2 weeks old at the earlier date.

On May 7th, a steelhead redd in a mid channel pocket was considered & then confirmed as one on May 11th; 2 other WDFW ribbons indicated redds that were highly questionable & unless active I could not count them.

On May 15th, a 15-18" male sea-run cutthroat in dark spawn colors was photographed with underwater camera in pool below falls pool.

On May 22nd, a small 1.5'x2.5' redd was found 200 yds above logjam, either small steelhead or large resident.

On June 16th, a steelhead redd of 1-2 weeks old was found about 80' below the barrier falls in mid-channel 4' x 10' around boulders.

Finney Creek redd counts							Finney Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7					1							
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31					1						3	
Apr 1-7												
Apr 8-15					8							
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15					7							
May 16-23					3							
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:					**20**						**3**	

Notes:

On Feb. 1st, the inactive steelhead redd found was likely constructed Jan. 28-30 shortly after rainfall brought creek up for entry.

On Mar. 28th, an active steelhead redd had at least a 32" female and 32-33" male on it and 18-20" resident or jack steelhead; there may have been another male steelhead and resident as well; visibility was limited by slight discoloration of water -- hatchery or wild origin could not be determined but sizes of main 2 suggested wild.

On April 14th, 8 inactive steelhead redds were found, 1 about a month old, 2 were about 3-4 weeks old, 2 were about 2-3 weeks old, 1 was about a week old, and 1 was just 1-3 days old.

On May 14th, 7-8 steelhead redds found in a long 45-50' line in side channel below logjam; 7 were counted as redds; 6 were likely made within the week and 1 maybe within 2 weeks.

On May 16th, 2 possible redds were found, one 200' below smolt trap site and one 100' below the logjam side channel; the redds were confirmed as such on May 30th.

On May 22nd, a new steelhead redd was found built within a few days below the logging road gate 3/8 mile.

Dry Creek (of Finney Creek) redd counts							Dry Creek Creek live and/or carcass counts					
date	pink	chinook	chum	coho	steelhead	cutthroat	pink	chinook	chum	coho	steelhead	cutthroat
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7	47						31					
Nov 8-15												
Nov 16-23				5						8		
Nov 24-30												
Dec 1-7				1						1		
Dec 8-15												
Dec 16-23												
Dec 24-31				8		2				2		
Jan 1-7				7						5		
Jan 8-15				6						16		
Jan 16-23				8	1					17	1	
Jan 24-31												
Feb 1-7					2							
Feb 8-15												
Feb 16-23					1	2					2	2
Feb 24-29												
Mar 1-7												
Mar 8-15					2						2	
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7					1	2						
May 8-15					5						2	
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												

Total:	47			35	12	6	31			49	5	2

Notes:

Pink and coho escapements should be based on redd counts.

On Jan 16th, the steelhead redd found was actively occupied by a hatchery female & resident male about 100' below the barrier falls.

On Feb 2nd, the steelhead redds found were likely made with rainfall entry on Jan 28-29.

On Feb 19th, the steelhead redd had a wild female on it but not actively digging; a male steelhead was actively chasing a resident rainbow or sea-run cutthroat male continuously away; in the same location as the Feb 19th steelhead sightings, on Feb 20th a pair of sea-run cutthroat were actively spawning with the male potentially the same as sighted with the steelhead the previous day.

On Mar 12th, the 2 steelhead redds found included one with a hatchery female, a probable wild male, and a 14" male resident rainbow just completing active spawning; they then migrated downstream – the female leaving the creek. It is possible that there was another active redd. A steelhead fled off it, but it is possible that it was the lingering male that had not fully gone out yet with the female. The potentially active redd was not counted..

On May 2nd, a steelhead redd of 3.5x3.5 ft of 3-7 days old was found and 2 smaller redds of 1.5'x1.5' each likely cutthroat or resident rainbow 1-2 weeks old.

On May 12th, 3 new inactive steelhead redds were found and 1 wild male and 1 wild female steelhead upstream of the redds. 4 more possible pocket redds were found that if so were likely created by one steelhead and were counted as one redd.

On May 14th, a possible steelhead redd was found at the log sill plunge pool where 2 live steelhead were sighted on the 12th. The redd confirmed on May 30th.

Quartz Creek (of Finney Creek) redd counts							Quartz Creek live and/or carcass counts					
date	pink	chinook	chum	coho	steelhead	cutthroat	pink	chinook	chum	coho	steelhead	cutthroat
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												

May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:												

Notes:

On May 16th, no evidence of steelhead spawning was found in the 200 yds surveyed above the Finney Ck Logging Rd bridge. The gravel was heavily sedimented with black colored sand and the gravel otherwise small quartz pebbles. The creek channel conformation above the bridge was otherwise good but of poor quality below the bridge as surveyed in past.

Hatchery Creek (of Finney Creek) redd counts							**Hatchery Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23					2?							
May 24-31												
Jun 1-7												

Jun 8-15												
Jun 16-23												
Total:					2?							

Notes:

On May 16th, the 2 possible steelhead redds found were old and likely built 4-6 weeks earlier; 1 was 2.5'x3' and the other 2.5'x4' and potentially built by same fish if actual redds.

Cumberland Creek redd counts							**Cumberland Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7					2							
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:					**2**							

Notes:

On May 2nd, a probable steelhead redd of smaller size at 2.5'x3.5' was 2-3 wks old; a larger 6'x6' definite steelhead redd of same age was at same location as a WDFW steelhead redd ribbon dated 5-18-2012. This was at the end of the WDFW survey point.

Grandy Creek redd counts							Grandy Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23					1							
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:					**1**							

Notes:

On Feb. 20th, the steelhead redd found was built within 7 days or less.

Table 2. Mid Skagit Basin Spawning Survey Counts from October 19, 2012 to April 20, 2013 Made Regularly at Five Primary Index Streams: Savage, Mill, Finney, and Dry (of Finney) Creeks; and Rarely at Four other Streams: O'Toole, Hatchery (of Finney), Pressentin, and Grandy Creeks

Savage Creek redd counts							Savage Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31										2		
Nov 1-7												
Nov 8-15				6						2		
Nov 16-23				3						10		
Nov 24-30				35					2	63		
Dec 1-7				24						80		1
Dec 8-15												
Dec 16-23				7						15		
Dec 24-31												
Jan 1-7				1		6				1		
Jan 8-15				12						6		
Jan 16-23												
Jan 24-31												
Feb 1-7				14	1	10				2		
Feb 8-15					4	10				1		
Feb 16-23					2	1						
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15					1							
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:				**102**	**8**	**27**			**2**	**182**		**1**

Notes:

14 older coho redds of 1-3 weeks old were found Feb. 5-8 & 1 new redd all in WF & uppermost Savage; the coho carcasses for same period were very old.

The steelhead redds found Feb. 5-8 all week to 10 days old.

The 2 steelhead redds of Feb. 23rd estimated 10-12 days old; the cutthroat redd was estimated at 7-10 days old; 2 small resident sized redds were also found that are not included.

The probable steelhead redd of April 14th was only 1-3 days old.

Mill Creek redd counts							Mill Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23		6	1					8	2			
Oct 24-31												
Nov 1-7												
Nov 8-15			9	6					10	4		
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7				5								
Jan 8-15												
Jan 16-23												
Jan 24-31			1	1	4							
Feb 1-7												
Feb 8-15												
Feb 16-23					1							
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31					4							
Apr 1-7												
Apr 8-15					1							
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:		**6**	**11**	**12**	**10**			**8**	**12**	**4**		

Notes:

Of the 4 steelhead redds found on Jan. 31st there were 3 below the bridge that were all built within 24 hr to a few days; the 4th was 300 yds above the bridge in a side channel where coho spawn but its newness & large size suggested steelhead redd.

The redd of Feb. 21st was estimated at less than 2 weeks old; size was marginal between cutthroat & steelhead but lower section of creek suggested latter.

Of the 4 steelhead redds on Mar. 27-28, 1 was less than a week old, the other 3 redds appeared to be about 2 weeks old.

The steelhead redd of Apr 13th was likely at least a week old.

O'Toole Creek redd counts							O'Toole Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23		21	6					16	10			
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23					1							
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:		**21**	**6**		**1**			**16**	**10**			

Notes:

The steelhead redd found Feb. 21st was not there Feb. 1st & constructed between those dates; it was located 15' above mouth at Skagit.

Finney Creek redd counts							Finney Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												

Oct 24-31		17	2					7	3			
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7					1							
Feb 8-15				1	6							
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:		**17**	**2**	**1**	**7**			**7**	**3**			

Notes:

The redd of Feb. 2 was likely ~3 weeks old and large with deep pit in channel below logjam

The redd of Feb. 12 was likely built 5-10 days earlier & was 12' long by 5-6' wide not far above logging gate

Feb. 14th one redd was considered coho and 2-3 weeks old and 4' long by 2' wide and had algae on it; one redd was likely steelhead of 2-4 days old and 4' long by 2' wide; another likely steelhead redd was similarly fresh & 6' long by 4' wide

Feb. 15th one redd was 2-3 weeks old and 6' long by 5' wide, one was 2-3 weeks old and 4' x 4', and one was 2-4 days old and 8' long by 4' wide

Dry Creek (of Finney Creek) redd counts							**Dry Creek Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												

Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15				2	5	2						
Feb 16-23												
Feb 24-29						1						
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:				**2**	**5**	**3**						

Notes:

Of the 5 steelhead redds on Feb. 14th, 2 were probable built within 10 days; 3 were somewhat harder to determine due to being 3-4 weeks old.

Hatchery Creek (of Finney Creek) redd counts							**Hatchery Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												

Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15					1							
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:					**1**							

Notes:

The redd found Feb. 15th was considered to be 10-14 days old & size of 4 x 4.5 ft was maginal with cutthroat but redd depth suggested steelhead.

Grandy Creek redd counts							**Grandy Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15				2	5	2						

Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:				**2**	**5**	**2**						

Notes:

Grandy steelhead redds of Feb. 11 looked 10-12 days old; coho redds looked a month old or more.

Pressentin Creek redd counts							**Pressentin Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31		1	11						19			
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												

Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:		**1**	**11**						**19**			

Table 3. Mid Skagit Basin Spawning Survey Counts from October 14, 2011 to May 13, 2012 Made Regularly at Four Primary Index Streams: Savage, Mill, O'Toole, and Finney Creeks.

Savage Creek redd counts							**Savage Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30				60						112		1
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7				16						15		1
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7						1						
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												

May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:				**76**		**1**				**127**		**2**

Mill Creek redd counts							**Mill Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23	41	3					48	3				48
Oct 24-31	4						4					4
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23				14		2						
Dec 24-31												
Jan 1-7				16						8		
Jan 8-15				4						1		
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23				1	1							
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**45**	**3**		**35**	**1**	**2**	**52**	**3**		**9**		

Notes:

The salmon redds on Dec. 21st were first considered even mix of coho & chum but 2014 evidence suggests all coho; the cutthroat redds were smaller.

One large interconnected redd was considered a potential chum at time but 2014 suggests probable coho and counted such.

One inactive redd on Feb 20th had partial algae & considered coho due to age & smaller size; sthd redd large & week or less old.

O'Toole Creek redd counts							O'Toole Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15	147						219					
Oct 16-23	24		4				55		8			
Oct 24-31												
Nov 1-7	3		2				3		4			
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**174**		**6**				**277**		**12**			

Finney Creek redd counts							Finney Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												

Oct 8-15												
Oct 16-23												
Oct 24-31	394	4					749	7				
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**394**	4					**749**	**7**				

Table 4. Mid Skagit Basin Spawning Survey Counts from November 20, 2010 to May 10, 2011 Made Regularly at Three Primary Index Streams: Savage, Mill, and Finney Creeks; and Rarely at Four other Streams: O'Toole, Quartz (of Finney), Hatchery (of Finney), and Grandy Creeks

Savage Creek redd counts							**Savage Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												

Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15				39						84		1
Dec 16-23												
Dec 24-31				2						1		
Jan 1-7												
Jan 8-15				13						10		
Jan 16-23				9	2					7	4	
Jan 24-31					1	1						
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:				**63**	**3**	**1**				**102**	**4**	**1**

Notes:

On the one active steelhead redd in Savage Ditch on Jan 19th there was a hatchery female; 2 males were downstream, 1 hatchery & 1 unknown that fled; next day the redd was greatly enlarged & hatchery female remained; a nearby red-flanked male fled -- possible coho but spots suggested steelhead

Steelhead redd found Jan 31 likely 7-9 days old

Mill Creek redd counts							**Mill Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												

Dec 8-15												
Dec 16-23			3	7								
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31					2							
Feb 1-7												
Feb 8-15												
Feb 16-23					2							
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30					1							
May 1-7					1							
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:			**3**	**7**	**6**							

Notes:

The 2 redds found Jan 31st appeared to be 1-2 weeks old & would coincide with when steelhead spawned in Savage Ck.

The 2 redds found Feb 18 were large sized & built within the week; large stream channel changes due to flood on Jan 17th.

A fresh steelhead redd was intially found April 30 maybe built within a day or 2; a new redd just above & overlapping was found May 8th but was not there on May 7th -- apparently 2 different steelhead.

Table 5. Mid Skagit Basin Spawning Survey Counts from October 19, 2009 to May 13, 2010 Made Regularly at Four Primary Index Streams: Savage, Mill, O'Toole, and Finney Creeks; and Rarely at Three other Streams: Hatchery (of Finney), Cumberland, and Grandy Creeks

Savage Creek redd counts							**Savage Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31	23						33			2		
Nov 1-7												
Nov 8-15			2	5						15		
Nov 16-23			3	3					6	2		

Nov 24-30				38						36		
Dec 1-7				20						9		
Dec 8-15												
Dec 16-23				20						38		
Dec 24-31												
Jan 1-7												
Jan 8-15				2								
Jan 16-23				6								
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23						1						
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30						3						
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**23**		**5**	**94**		**4**	**33**		**6**	**102**		

Mill Creek redd counts							**Mill Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23	43		1				124		4			
Oct 24-31	39	2		1			110	2		1		
Nov 1-7												
Nov 8-15				4			2					
Nov 16-23			1							1		
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												

Jan 16-23				2								
Jan 24-31												
Feb 1-7				1								
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15					3							
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**82**	**2**	**2**	**8**	**3**		**236**	**2**	**4**	**2**		

Notes:

Older redd found on Feb 4 likely that of coho; creek running 42 F at 2:30 pm.

On May 13th a small but deep probable steelhead redd of 2' x 1.5' was found about 2-3 weeks old; another probable steelhead redd of about 3' x 2' was found about a month old; & another 4' x 3' with 2 pits and was about a month old.

O'Toole Creek redd counts							**O'Toole Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**bull trt**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**bull trt**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31	60		2			1	221		8			
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7					1							
Feb 8-15												

Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15					2							
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**60**		**2**		**3**	**1**	**221**		**8**			

Notes:

A potential bull trout redd was found Oct. 28th at the tail of pool below the 1st falls; no salmon redds have been found that high up since or before.

A large probable steelhead redd on Feb. 3rd near entry to Skagit no more than week old; warm winter related to El Nino and O'Toole water temp 42F.

A steelhead redd was found downstream of the S. Skagit Hwy bridge with a ribbon marked the day before (5-12-2010) & estimated to be about a week old & was 3' x 2' with a deep single pit; a steelhead redd of similar size about 3 weeks old was found 150 yds below the bridge.

Finney Creek redd counts							**Finney Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7					1							
Feb 8-15												
Feb 16-23												
Feb 24-29												

Mar 1-7				2	3						1+1?	
Mar 8-15					1							
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15					3							
Apr 16-23					1							
Apr 24-30					2							
May 1-7												
May 8-15												
May 16-23					2							
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:												

Notes:

Large redd found Feb 6th probable steelhead 100' above logging gate; sampled for steelhead but only 10" wild steelhead nearing smolt stage caught; water temp was 44 F at 1:30 pm; mild year.

Active steelhead redd on Mar 4th near mouth of creek above Hatchery Ck; large probable wild female on it; the mate fled with wake & unknown steelhead or resident male; 10 days later expanded to vacated 2 redds.

Cumberland Creek redd counts							**Cumberland Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												

Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Jun 24-30												
Jul 1-7					3							
Total:					**3**							

Notes:

While sampling Cumberland Ck on June 25th a steelhead redd marked on April 19th was still visible; 2 other unmarked redds were found further upstream another 450 yds, both very large and 4-5 weeks old & probably steelhead.

Grandy Creek redd counts							**Grandy Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15					1	1						
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												

Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:					**1**	**1**						

Notes:

On Feb 8th a probable steelhead redd found midway between Cape Horn Rd bridge and mouth; water temp was 44 F at 2:30 pm.

Appendix D.

Skagit River Peak Flows as Measured at USGS Gage 12194000 Near Concrete, WA (1948-2007)

Floods over 90,000 cfs

Floods over 140,000 cfs

water year	date	gage height (feet)	stream flow (cfs)	water year	date	gage height (feet)	stream flow (cfs)
1948	Oct. 19, 1947	32.99	95,200[6]	1978	Dec. 02, 1977	29.27	70,300[6]
1949	May 13, 1949	26.97	55,700[6]	1979	Nov. 08, 1978	25.19	46,000[6]
1950	Nov. 27, 1949	40.80	154,000[6]	1980	Dec. 18, 1979	38.57	135,800[6]
1951	Feb. 10, 1951	38.99	139,000[6]	1981	Dec. 26, 1980	40.19	148,700[6]
1952	Jun. 05, 1952	24.80	43,500[6]	1982	Jun. 21, 1982	26.20	51,700[6]
1953	Feb. 01, 1953	28.61	66,000[6]	1983	Dec. 04, 1982	33.82	101,000[6]
1954	Oct. 31, 1953	27.39	58,000[6]	1984	Jan. 05, 1984	34.94	109,000[6]
1955	Jun. 11, 1955	27.10	56,300[6]	1985	Jun. 07, 1985	25.20	46,100[6]
1956	Nov. 03, 1955	34.48	106,000[6]	1986	Jan. 19, 1986	32.75	93,400[6]
1957	Oct. 20, 1956	27.84	61,000[6]	1987	Nov. 24, 1986	31.30	83,500[6]
1958	Jan. 17, 1958	24.38	41,400[6]	1988	Nov. 24, 1987	23.96	39,600[6]
1959	Apr. 30, 1959	32.36	90,700[6]	1989	Oct. 16, 1988	29.86	74,100[6]
1960	Nov. 23, 1959	32.17	89,300[6]	1990	Dec. 04, 1989	36.39	119,000[6]
1961	Jan. 16, 1961	30.61	79,000[6]	1991	Nov. 10, 1990	40.20	149,000[6]
1962	Jan. 03, 1962	26.82	56,000[6]	1992	Apr. 29, 1992	26.46	53,300[6]
1963	Nov. 20, 1962	35.73	114,000[6]	1993	May 13, 1993	23.95	39,300[6]
1964	Oct. 22, 1963	29.80	73,800[6]	1994	Mar. 03, 1994	23.39	36,500[6]
1965	Dec. 01, 1964	26.20	52,600[6]	1995	Dec. 20, 1994	27.55	59,800[6]
1966	May 06, 1966	23.43	36,800[6]	1996	Nov. 29, 1995	41.57	160,000[6]
1967	Jun. 21, 1967	29.59	72,300[6]	1997	Jul. 09, 1997	32.46	91,400[6]
1968	Oct. 28, 1967	31.41	84,200[6]	1998	Oct. 05, 1997	30.26	76,700[6]
1969	Jan. 05, 1969	25.82	49,500[6]	1999	Dec. 13, 1998	27.81	61,400[6]
1970	Nov. 04, 1969	23.77	38,400[6]	2000	Nov. 12, 1999	34.15	103,000[6]
1971	Jan. 31, 1971	27.90	62,200[6]	2001	Oct. 20, 2000	22.19	30,900[6]
1972	Jul. 13, 1972	32.54	91,900[6]	2002	Jan. 08, 2002	33.06	94,300[6]
1973	Dec. 26, 1972	25.83	49,500[6]	2003	Jan. 26, 2003	28.60	65,500[6]
1974	Jan. 16, 1974	30.75	79,900[6]	2004	Oct. 21, 2003	42.21	166,000[6]
1975	Dec. 21, 1974	27.16	57,500[6]	2005	Dec. 11, 2004	33.78	99,400[6]
1976	Dec. 04, 1975	36.88	122,000[6]	2006	Jan. 10, 2006	27.01	56,300[6]
1977	Jan. 18, 1977	27.31	58,400[6]	2007	Nov. 06, 2006	39.79	145,000[6]

Appendix E.

Skagit River winter steelhead harvests from 1961-62 to 1965-66 and 1974-75 (Phillips et al. 1981b)

Year	total harvest	% wild	wild harvest	hatchery harvest
1961-62	11782	100%	11782	0
1962-63	13638	86%	11729	1910
1963-64	22216	83%	18439	3777
1964-65	13324	81%	10792	2532
1965-66	16699	68%	11355	5344
1974-75	21731	70%	15212	6518

Appendix F.

Table 1.
Weather at Concrete, WA and Steelhead Redds Found by Day and Estimated Period When the Spawning Occurred in 2011 at Four Mid Skagit Basin Tributary Streams and When Active Spawning was Observed

Period of time when conditions likely stimulated steelhead spawning shaded gray Some of more relevant considerations in **bold**

Day	High	Low	Concrete	NF Stilly flow	Sthd redds	Sthd redds	Sthd redds	Sthd redds	Notes
	(°F)	(°F)	precip (inch)	(cfs)	Savage	Mill	O'Toole	Finney	
1-Jan-11	35.1	21.9	0	2,190					
2-Jan-11	37	24.1	0	2,080					
3-Jan-11	39	24.1	0	1,980					
4-Jan-11	39.9	25	0	1,910					
5-Jan-11	35.1	27	0.03	1,940					
6-Jan-11	37	34	**0.78**	**3,740**	0				only coho spawning found near Savage mouth
7-Jan-11	39.9	35.1	**0.98**	**7,090**					
8-Jan-11	43	35.1	**0.51**	**4,960**					
9-Jan-11	39.9	32	0.1	3,430	0				only coho spawning found upper Savage
10-Jan-11	37.9	28.9	0	2,810					
11-Jan-11	37	28.9	0	2,480					
12-Jan-11	36	30	**0.81**	2,650					
13-Jan-11	36	32	**0.76**	**6,870**					
14-Jan-11	39.9	35.1	**0.69**	**13,000**					
15-Jan-11	43	37.9	**0.62**	**7,810**					
16-Jan-11	43	39	**1.68**	**16,100**					
17-Jan-11	**50**	42.1	**2.83**	**20,400**					Skagit flow peaks **75,000cfs** making ease of entry to creeks; south side Skagit creeks very high
18-Jan-11	**46**	39	**0.72**	**6,710**					**14 days prior Jan 31**
19-Jan-11	39.9	36	0.08	3,680	1 active 2 inactive	0			Savage 42F, Mill 39F, Skagit 40F -- Mill Ck too high to wade upstream bridge
20-Jan-11	42.1	33.1	0	2,780	0				live male steelhead red sides of unknown origin at Savage; hatchery female still present with redd much enlarged
21-Jan-11	37	33.1	**0.97**	**4,590**	0				too high to survey ditch well; only redds thought to be coho in mid section above pond
22-Jan-11	**43**	36	**0.88**	**4,180**	0	0			only a coho carcass found below ditched section Savage
23-Jan-11	**45**	37.9	0.17	2,790					
24-Jan-11	**46.9**	39	0.32	2,700					
25-Jan-11	44.1	41	0.52	3,050					**7 days prior Jan 31**
26-Jan-11	48	41	0	2,370					
27-Jan-11	50	36	0	2,080					
28-Jan-11	46	35.1	0	2,030					
29-Jan-11	42.1	35.1	0.27	3,820					
30-Jan-11	46	33.1	0.37	3,330					
31-Jan-11	43	28.9	0	2,250	1 inactive	2 inactive			redd built after Jan 22 at Savage; 2 redds 7-14 days old at Mill & Jan 20 or Jan 23-24 thought most conducive conditions
1-Feb-11	39.9	27	0	1,850			0		
2-Feb-11	39.9	27	0	1,620					
3-Feb-11	44.1	28	0.03	1,510					
4-Feb-11	42.1	37.9	0.98	2,830					
5-Feb-11	46.9	39.9	0.54	2,610					
6-Feb-11	48	39.9	0.07	2,060					
7-Feb-11	46	39	0.49	3,300					
8-Feb-11	43	35.1	0.23	2,460					
9-Feb-11	46.9	28	0	1,920					
10-Feb-11	46	28	0	1,650					

11-Feb-11	48.9	28.9	0	1,500					
12-Feb-11	42.1	35.1	0.04	1,570					
13-Feb-11	**48.9**	39	**0.58**	**2,400**					
14-Feb-11	**50**	39	**0.17**	**2,230**					
15-Feb-11	**46.9**	37.9	**0.47**	**2,740**					**2.3" rain Birdisview Feb 13-15**
16-Feb-11	44.1	36	0.11	2,040					
17-Feb-11	46	32	0.15	1,760					
18-Feb-11	42.1	32	0.25	1,560	0	2 inactive			redds built within the week or past few days
19-Feb-11	46.9	28.9	0	1,390					
20-Feb-11	48	27	0	1,260					
21-Feb-11	44.1	27	0	1,190				0	
22-Feb-11	39.9	30.9	0.32	1,190					
23-Feb-11	41	28.9	0.4	1,130					
24-Feb-11	32	24.1	0.36	1,040					
25-Feb-11	34	16	0.12	934					
26-Feb-11	33.1	16	0	885					
27-Feb-11	28	19	0.32	906					
28-Feb-11	35.1	27	0.48	979					
1-Mar-11	36	32	0.23	919					
2-Mar-11	37.9	32	0.21	1,030					
3-Mar-11	48.9	34	0.22	1,150					
4-Mar-11	42.1	30.9	0.39	1,070					
5-Mar-11	37.9	30.9	0.51	1,370					
6-Mar-11	46.9	35.1	0.09	1,320					
7-Mar-11	46.9	30.9	0.03	1,160					
8-Mar-11	48	33.1	0.03	1,080					
9-Mar-11	42.1	33.1	**0.46**	1,440	0				only a possible cutthroat redd sighted; still snow on ground
10-Mar-11	42.1	37	**0.59**	**3,320**	0	0			
11-Mar-11	45	37	**0.53**	**3,450**					
12-Mar-11	45	37	**0.23**	**2,390**					
13-Mar-11	42.1	37	**0.19**	**2,620**					
14-Mar-11	44.1	37.9	**0.96**	**4,970**					**Skagit flow up to 20,000 cfs**
15-Mar-11	45	39.9	**0.26**	**3,990**					
16-Mar-11	44.1	39.9	**0.87**	**4,620**					
17-Mar-11	41	33.1	**1.18**	**3,460**					
18-Mar-11	48.9	33.1	0.03	2,580	0	0			despite Skagit being up to 20,000 on Mar 14 no new spawning entry found
19-Mar-11	53.1	34	0.28	2,220					
20-Mar-11	54	32	0	1,910					
21-Mar-11	55.9	32	0.12	1,730					
22-Mar-11	52	39	0.34	1,990					
23-Mar-11	53.1	32	0	1,670					
24-Mar-11	61	32	0	1,510					
25-Mar-11	64	32	0.06	1,500				0	
26-Mar-11	55	37	0.14	1,480					
27-Mar-11	57	36	0.18	1,450					
28-Mar-11	55	39.9	0.12	1,510					
29-Mar-11	53.1	39.9	0.18	1,700					
30-Mar-11	48.9	39.9	**0.92**	**8,460**					
31-Mar-11	44.1	39.9	**2.38**	**16,200**					**Skagit up to 33,500 cfs**
1-Apr-11	53.1	42.1	**0.24**	**6,840**					
2-Apr-11	44.1	39.9	**1.03**	**5,990**					
3-Apr-11	46.9	39	**0.25**	**4,030**					
4-Apr-11	48.9	36	**0.22**	**3,700**					
5-Apr-11	39.9	35.1	**1.04**	**4,150**					
6-Apr-11	44.1	37	**0.48**	**3,710**					Finney creek remaining high and dirty
7-Apr-11	46	33.1	0.1	2,860				0	too discolored to see much
8-Apr-11	53.1	33.1	0.01	2,340				0	better color with 12-14" visibility
9-Apr-11	55.9	33.1	0	2,100					
10-Apr-11	52	39.9	0.02	2,070					
11-Apr-11	46	39.9	**0.98**	**3,510**					Finney very dirty and high
12-Apr-11	48	37	**0.25**	**2,740**					
13-Apr-11	57.9	37	0	2,260					
14-Apr-11	54	37.9	0.18	2,130					
15-Apr-11	46.9	36	**0.47**	2,240					

16-Apr-11	46.9	35.1	0.22	2,410					Finney still too discolored to survey
17-Apr-11	48.9	35.1	0.12	2,300				0	above Rexall Ck relatively clear
18-Apr-11	52	32	0.03	1,960					
19-Apr-11	52	33.1	0.26	1,770					
20-Apr-11	52	33.1	0.07	1,610					
21-Apr-11	53.1	34	0.05	1,580	0	0		0	
22-Apr-11	46.9	35.1	0.18	1,490					
23-Apr-11	61	35.1	0	1,430					
24-Apr-11	70	36	0	1,440				0	
25-Apr-11	57	37.9	0.03	1,660				0	
26-Apr-11	**50**	39.9	**0.29**	**2,140**					
27-Apr-11	**57.9**	39.9	**0.21**	**1,980**				0	
28-Apr-11	**52**	37.9	**0.36**	**2,150**					**Birdsview gage had 0.625" rain in 36 hours**
29-Apr-11	50	36	0.07	**1,930**					
30-Apr-11	55.9	37.9	0.03	1,740	0	1 inactive			very fresh redd made that day or day before
1-May-11	55.9	36	0	1,620				0	
2-May-11	66	35.1	0	1,890					
3-May-11	48.9	42.1	0.32	2,670					
4-May-11	51.1	39	0.06	2,220					
5-May-11	**66**	37.9	0.08	2,120					
6-May-11	**54**	45	**0.15**	2,270					
7-May-11	**54**	45	**0.26**	**2,970**	0	0			**at Birdsview gage there was 0.60" rain;** Mill Ck high
8-May-11	51.1	44.1	**0.14**	**2,950**	0	1 inactive			right in front & beside redd of April 30th & not there previous day
9-May-11	**55.9**	44.1	0	2,320					
10-May-11	**57.9**	45	0	2,080	0	enlarged redd			the redd of May 8th had been enlarged
11-May-11	64.9	45	0.11	2,580					
12-May-11	53.1	39	0.47	3,450					
13-May-11	62.1	37.9	0	2,410					
14-May-11	75	39	0	2,420					
15-May-11	63	48.9	0.14	3,390					
Survey total					**16**	**11**	**1**	**10**	

Table 2.
Weather at Concrete, WA and Steelhead Redds Found by Day and Estimated Period When the Spawning Occurred in 2014 at Five Mid Skagit Basin Tributary Streams and When Active Spawning Was Observed

Period of time when conditions likely stimulated steelhead spawning shaded gray Some of more relevant considerations in **bold**

Day	**High**	**Low**	**Concrete**	**NF Stilly flow**	**Sthd redds**	**Sthd redds**	**Sthd redds**	**Sthd redds**	**Sthd redds**	**Notes**
	(°F)	(°F)	precip (inch)	(cfs)	Savage	Mill	O'Toole	Finney	Dry	
1-Jan-11	44.1	39.9	0.06	1,020						
2-Jan-11	44.1	37.9	0.19	1,050						
3-Jan-11	45	36	1.03	2,150						
4-Jan-11	43	33.1	0.02	1,380	0				1	
5-Jan-11	43	30.9	0	1,150	0	0				
6-Jan-11	39.9	30	0.02	1,040						
7-Jan-11	39.9	32	0.07	1,430						
8-Jan-11	41	37	**0.65**	**2,790**						
9-Jan-11	43	39.9	**0.93**	**3,590**						
10-Jan-11	45	37	**0.67**	**3,630**		0			0	
11-Jan-11	46.9	37	**2.06**	**11,500**						
12-Jan-11	**46.9**	41	**0.96**	**7,070**						
13-Jan-11	**46**	36	**1.64**	**10,100**						
14-Jan-11	**46.9**	44.1	**1.44**	**7,240**	0					
15-Jan-11	**48**	42.1	0.03	**3,560**	0	0				
16-Jan-11	**48.9**	34	0	2,440					1 active	

17-Jan-11	46	34	T	1,990						
18-Jan-11	45	30	0	1,730						
19-Jan-11	43	32	T	1,520						
20-Jan-11	45	33.1	0	1,330	0					
21-Jan-11	46.9	33.1	0	1,210						
22-Jan-11	46	33.1	0.01	1,130						
23-Jan-11	50	30	0	1,040	1 inactive					likely spawned Jan 12-16
24-Jan-11	48.9	30	0	984						
25-Jan-11	51.1	32	0	990						
26-Jan-11	55	30.9	0	944						
27-Jan-11	51.1	30.9	0	888						
28-Jan-11	43	30.9	0	863						
29-Jan-11	**44.1**	39.9	0.18	**1,430**						**0.85" rain at Birdsview**
30-Jan-11	**45**	36	**0.4**	**1,930**	0	0				**0.65" rain at Birdsview**
31-Jan-11	**45**	36	**0.34**	**1,540**						**0.25" rain at Birdsview**
1-Feb-11	41	32	0.01	1,230						
2-Feb-11	42.1	32	0.03	1,050				1 inactive	2 inactive	likely spawned Jan 30-Feb 1
3-Feb-11	41	28.9	0	941				0		
4-Feb-11	39	28	0	846						
5-Feb-11	39	19.9	0	744						
6-Feb-11	32	18	0	668						
7-Feb-11	34	17.1	0	702						
8-Feb-11	36	21	0	650						
9-Feb-11	39	21	0.02	664						
10-Feb-11	36	30	0.14	756						
11-Feb-11	41	33.1	**0.62**	**1,590**		0			0	
12-Feb-11	46	36	**0.82**	**2,460**						
13-Feb-11	51.1	37	0.31	**2,070**						
14-Feb-11	50	37.9	0.22	1,850						
15-Feb-11	46	37	0.21	2,270						**1.35" rain Birdsview**
16-Feb-11	**46.9**	37	**0.67**	**2,650**	0	0			0	
17-Feb-11	**42.1**	36	**0.44**	**2,370**						**0.65" rain Birdsview**
18-Feb-11	**42.1**	36	**0.42**	**2,400**						**1.5" rain Birdsview but snow at upper elevations**
19-Feb-11	**43**	35.1	**0.95**	**2,380**	0	0			1 active	**0.9" rain Birdsview**
20-Feb-11	43	33.1	0.47	1,820	2 inactive	0			0	2 inactive redds upper Savage less than week old; active sea-run cutthroat spawning at Dry
21-Feb-11	48	33.1	0.41	1,610						
22-Feb-11	43	28.9	0	1,360						
23-Feb-11	35.1	30.9	0.9	1,290						
24-Feb-11	34	30.9	0.82	1,410						
25-Feb-11	34	32	0.64	1,880						
26-Feb-11	44.1	33.1	0	1,810						
27-Feb-11	53.1	34	0	1,740						
28-Feb-11	48.9	35.1	0.18	1,710						
1-Mar-11	52	37	T	1,600						**from Feb 22-28 cold & snow & creeks too low for entry**
2-Mar-11	39	30.9	0.34	2,400						**2.0" rain Birdsview**
3-Mar-11	37	32	**1.45**	**6,500**						**1.05" rain Birdsview**
4-Mar-11	41	36	**1.4**	**6,900**						
5-Mar-11	41	36	**1**	**9,970**						
6-Mar-11	50	39	**0.83**	**13,400**						
7-Mar-11	45	41	**1.1**	**9,570**	0	0				creeks running high too high to survey well
8-Mar-11	57	37	0	**4,870**						
9-Mar-11	45	37	**1.72**	**12,600**						
10-Mar-11	**52**	42.1	0.11	**6,720**						thaw & rains began Mar 1[-2] with high bankfull flows thereafter with no survey conditions
11-Mar-11	**52**	39.9	0	**4,330**						
12-Mar-11	**57.9**	34	0	3,240	0				1 active 1 inactive	possibly another active redd at Dry but it was not counted due to the 2 fish on the one known active redd having dropped downstream as well
13-Mar-11	62.1	32	0	2,690	1 inactive	0	0			Savage redd made past 2 days just above Skagit entry; first O'Toole survey since Nov

14-Mar-11	60.1	37	0.35	**4,440**						
15-Mar-11	55.9	41	0.3	**3,540**	1 inactive					redd made within few days
16-Mar-11	50	41	**1.37**	**10,800**						
17-Mar-11	41	37	**0.78**	**5,630**						
18-Mar-11	46	34	0.06	3,500						
19-Mar-11	48.9	34	0.16	3,820	0				0	
20-Mar-11	43	36	**0.43**	3,550						
21-Mar-11	43	30.9	0.05	2,820		0			0	
22-Mar-11	52	30.9	0	**1,890**						**NF Stillaguamish landslide makes gage unreliable for a week or so**
23-Mar-11	44.1	32	0.2	1,080				0	0	Finney too turbid to survey
24-Mar-11	**54**	36	T	1,960						
25-Mar-11	**63**	39	T	1,980						**0.425" rain Birdsview**
26-Mar-11	**50**	41	0.27	2,650						**0.425" rain Birdsview**
27-Mar-11	**55**	41	0.15	2,580				1 active		barely enough visibility to survey
28-Mar-11	55	42.1	0.05	2,550	0	0				
29-Mar-11	45	42.1	**0.88**	**4,280**	0					**1.0" rain Birdsview**
30-Mar-11	45	41	**0.75**	**4,970**	0	0			0	**1.45" rain Birdsview overnight**
31-Mar-11	50	36	0.33	3,520						
1-Apr-11	61	35.1	T	2,600						
2-Apr-11	62.1	35.1	0	2,080	0	0				
3-Apr-11	60.1	37	0	1,840						
4-Apr-11	54	39	0.2	1,890						
5-Apr-11	55.9	41	0.06	2,000						**0.425" rain Birdsview**
6-Apr-11	48.9	43	**0.46**	**3,220**						**0.425" rain Birdsview**
7-Apr-11	**59**	43	0.07	**2,480**			1 inactive			1-2 wks old or more, likely Mar 21-22 or Mar 31-Apr 1
8-Apr-11	**69.1**	45	0	**2,610**						
9-Apr-11	**53.1**	37.9	**0.6**	**3,570**						
10-Apr-11	**57.9**	36	T	2,420						
11-Apr-11	**60.1**	37	0	2,020						
12-Apr-11	**55**	41	0.01	1,820						
13-Apr-11	**63**	37	0	1,680	0	0				
14-Apr-11	69.1	37	0	1,590				8 inactive		1 redd a month old; 2 redds ~Mar 31-Apr 1; 2 redds 3-4 wks old; 1 redd 2-3 wks old; 1 redd 1-wk old; 1 redd 2-3 days old;
15-Apr-11	68	39	0.01	1,590						
16-Apr-11	55	44.1	0.22	2,240						
17-Apr-11	48	44.1	**0.61**	**5,340**						
18-Apr-11	50	42.1	**0.61**	**5,380**	0	0				
19-Apr-11	54	37.9	0.01	3,180	0					
20-Apr-11	53.1	39	**0.6**	**4,770**						
21-Apr-11	57	39.9	T	3,200						
22-Apr-11	**64**	44.1	**0.49**	3,190			1 inactive			~Mar 21-25; first sighted Apr 7 & estimated 1-2 wks old
23-Apr-11	55.9	41	0.17	3,190					0	
24-Apr-11	**57.9**	41	**0.96**	**4,630**						
25-Apr-11	52	39.9	0.32	3,780						
26-Apr-11	**59**	37.9	0	2,890						
27-Apr-11	57.9	39	0.29	2,760						
28-Apr-11	46.9	39.9	**0.88**	2,780						
29-Apr-11	**59**	39.9	T	2,350						
30-Apr-11	**73.9**	44.1	0	2,220		2 inactive				1 redd 2 wks old; 1 redd 3-7 days old
1-May-14	**82.9**	45	0	2,470						
2-May-14	**84.9**	48	0	2,800	0				1 inactive	redd 3-7 days old
3-May-14	**73**	46.9	0.17	3,130						
4-May-14	52	46	**0.61**	**5,370**						
5-May-14	48.9	46	**0.94**	**7,330**						
6-May-14	**57**	46	0.08	4,060	0	0		0	0	Finney too turbid; other creeks too high the previous 2 days
7-May-14	60.1	45	0.05	3,070			1 inactive			1-2 days old
8-May-14	66.9	45	0	2,700						
9-May-14	63	45	**1.22**	**7,010**						
10-May-14	50	44.1	**0.39**	**5,100**						

11-May-14	55	45	0.02	3,480		0	0			
12-May-14	**66.9**	46.9	0.01	2,890					1 active 4 inactive	active redd determined when redd found May 14th; others made within 24-36 hours
13-May-14	**78.1**	46.9	0	2,660						
14-May-14	**80.1**	52	0	2,670				7 inactive	0	6 Finney redds 2-4 days old; 1 redd 1-2 wks old
15-May-14	**82.9**	52	0	2,790		0	0			
16-May-14	**84**	52	0	2,670				2-inactive	0	both redds ~2 wks old
17-May-14	**70**	52	0	2,310						
18-May-14	**66**	48	0	2,090						
19-May-14	**64.9**	48	0	2,490						
20-May-14	**69.1**	51.1	0	2,000						
21-May-14	**69.1**	45	0	1,810				1 inactive	0	within the week
22-May-14	68	46	0	1,740			1 inactive			within 1-3 days
23-May-14	77	51.1	0	2,100						
24-May-14	64.9	51.1	0.19	2,510						
25-May-14	66.9	48.9	T	1,870						
26-May-14	55.9	48.9	0.21	2,060						
27-May-14	61	48	0.15	1,970						
28-May-14	66	48	0	1,630						**0.525" rain at Birdsview**
29-May-14	59	48	0.3	1,660						**0.375" rain at Birdsview**
30-May-14	60.1	46.9	0.05	1,540				0	0	
31-May-14	71.1	46	0	1,430						
1-Jun-14	73.9	46	0	1,420						
2-Jun-14	72	46	0	1,400						
3-Jun-14	75	48	0	1,420						
4-Jun-14	68	48.9	0	1,330						
5-Jun-14	69.1	46.9	0	1,240						
6-Jun-14	72	46	0	1,150						
7-Jun-14	77	46	0	1,100						
8-Jun-14	77	46	0	1,060						
9-Jun-14	75	51.1	0	1,070						
10-Jun-14	72	48	0	1,030						
11-Jun-14	64	46	T	922						
12-Jun-14	73.9	46	0	**910**						**0.725" rain at Birdsview**
13-Jun-14	69.1	52	0.46	**1,320**						
14-Jun-14	55	51.1	0.23	1,250						
15-Jun-14	55.9	50	0.04	1,070						
16-Jun-14	63	48.9	0.05	1,300			1 inactive			~2 wks old
Survey total					**24**	**20**	**8**	**10**	**21**	

Appendix G.

Table 1.
Mean Air Temperature per Month in Fahrenheit at Concrete, WA from 2010 to 2014

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2010	41.44	42.89	45.45	48.43	52.63	58.47	64.77	64.76	60.1	53.34	40.23	38.85
2011	37.48	36.59	41.61	43.95	51.19	57.73	60.47	63.9	61.53	50.98	40.62	37.5
2012	36.18	40.33	39.9	49.72	53.34	55.37	63.03	65.9	61.05	50.89	43.88	38.15
2013	35.82	39.91	43.82	48.13	55.84	60.1	65.32	66.08	61.92	50.69	42.88	35.05
2014	40.27	36.32	43.19	48.95	57.32	59.58	65.6	67.73	....	....	....	....
mean	**38.24**	**39.21**	**42.79**	**47.84**	**54.06**	**58.25**	**63.84**	**65.67**	**61.15**	**51.48**	**41.90**	**37.39**

Table 2.
Mean Precipitation per Month in Inches at Concrete, WA from 2010 to 2014

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2010	9.55	4.68	5.73	5.83	5.85	3.26	0.2	0.58	7.38	4.74	9.8	11.31
2011	14.09	6.11	11.73	7.19	3.73	1.46	1.91	0.21	2.18	5.5	12.59	4.33
2012	12	9.38	11.62	5.2	4.14	4.22	2.18	0.01	0.33	9.88	11.25	12.01
2013	9.27	5.2	7.65	7.21	3.41	3.33	0.06	2.25	9.08	3.08	8.65	6.85
2014	10.7	8.28	14.08	6.57	4.39	2.54	2.13	2.04	....	....	....	....
Mean	**11.12**	**6.73**	**10.16**	**6.40**	**4.30**	**2.96**	**1.30**	**1.02**	**4.74**	**5.80**	**10.57**	**8.63**

Table 3.
Mean Streamflow per Month in cfs at the North Fork Stillaguamish River from 2010 to 2014

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	2,751	1,333	1,417	1,807	1,747	1,668	500	275	1147	1,786	3,189	4,962
2011	4,768	1,733	2,751	2,609	2,453	2,096	1194	542	416	1,097	2,843	1,931
2012	2,762	2,649	2,391	2,949	2,686	2,059	1178	427	275	1,825	3,738	2,531
2013	2,228	1,819	2,952	3,188	2,409	1,361	634	354	1019	1040	2157	1470
2014	2602	1533	4850	2844	2884	1135	692	364	....	....	....	....
Mean	**3,022**	**1,813**	**2,872**	**2,679**	**2,436**	**1,664**	**839**	**392**	**714**	**1,437**	**2,982**	**2,724**

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

DEIS COMMENTS: PUGET SOUND SALMON & STEELHEAD HATCHERY PROGRAMS

1 message

Pete Soverel <soverel@msn.com> Mon, Jan 19, 2015 at 3:27 PM
To: "PSHatcheryEIS.wcr@noaa.gov" <pshatcheryeis.wcr@noaa.gov>

Please find attached the comments of Wild Salmon Rivers (dba The Conservation Angler) re:

> Public Commentary submitted with Respect to Draft Environmental Impact Statement on Two Joint Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs, NOAA Fisheries, July 2014 and two attachments ("A" and "B" above).
> Peter Soverel
> President

3 attachments

ATTACHMENT B –The_Reproductive_Ecology_of_Oncorhynchus_mykiss_in_Mid_Skagit3_1-15-2015.docx
10224K

DEIS comments tca.doc
113K

DEIS COMMENTS WFC – ATTACHMENT A.doc
185K

January 20, 2015

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, Washington 98115
PSHatcheryEIS.wcr@noaa.gov2015 January

RE: Public Commentary submitted with Respect to Draft Environmental Impact Statement on Two Joint Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs, NOAA Fisheries, July 2014

Dear Regional Administrator Stelle:

Thank you for providing the opportunity to submit public comments on the draft environmental impact statement referenced above ("DEIS"). These comments are submitted on behalf of Wild Salmon Rivers, dba The Conservation Angler.

At issue is the request to authorize "take" of threatened salmonids under the Endangered Species Act ("ESA") resulting from 133 hatchery programs. As the DEIS notes, this is the first evaluation under the National Environmental Policy Act ("NEPA") on the effects of the hatchery programs operating within the entire geographic boundaries of the affected listed species—the Puget Sound Chinook salmon evolutionary significant unit ("ESU") and the Puget Sound steelhead distinct population segment ("DPS"). NMFS' determination of whether, and if so, how, the Puget Sound hatchery programs can continue to operate without jeopardizing the survival and recovery of these threatened species is a critical decision affecting the entire region.

Unfortunately, the DEIS is grossly deficient lacking even basic analysis of available data or incorporation of current science on the impacts of hatchery fish on the listed wild stocks upon which to evaluate the hatchery programs. The DEIS is instead entirely divorced from the actual standards that govern the determinations that NMFS must make. The DEIS also does not provide the quantitative risk assessment needed to evaluate the risks associated with the Puget Sound hatcheries at issue. We are hopeful that NMFS will address these significant shortcomings in manner that fulfills the requirements and intent of NEPA.

The Conservation Angler associates itself directly and supports explicitly the detailed comments on the DEIS provided by the Wild Fish Conservancy – attached at Attachment "A". Additionally, we attach the report by independent scientist Bill McMillan on hatchery-wild winter steelhead interaction during January-March timeframe (The Reproductive Ecology of *Oncorhynchus mykiss* in Tributary Streams of the Mid Skagit River Basin) which illustrates clearly the high level of risk -- immediate and cumulative – to listed Skagit

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winter steelhead. The interactions documented in this report are, almost certainly, common in other Puget Sound watersheds and pose substantial risks to all Puget Sound listed steelhead in systems with hatchery steelhead releases. The final EIS must examine these risks in detail.

Respectfully,

President, The Conservation Angler

ATTACHMENT "A": Wild Fish Conservancy letter of January xx, 2015

ATTACHMENT "B": The Reproductive Ecology of *Oncorhynchus mykiss* in Tributary Streams of the Mid Skagit River Basin, by Bill McMillan

Wild Fish Conservancy
NORTHWEST
SCIENCE · EDUCATION · ADVOCACY

January XX, 2015

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, Washington 98115
PSHatcheryEIS.wcr@noaa.gov

RE: Public Commentary submitted with Respect to Draft Environmental Impact Statement on Two Joint Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs, NOAA Fisheries, July 2014

Dear Regional Administrator Stelle:

Thank you for providing the opportunity to submit public comments on the draft environmental impact statement referenced above ("DEIS"). These comments are submitted on behalf of the Wild Fish Conservancy.

The task presently before the National Marine Fisheries Service ("NMFS") is momentous. The request to authorize "take" of threatened salmonids under the Endangered Species Act ("ESA") resulting from 133 hatchery programs is unprecedented. As the DEIS notes, this is the first evaluation under the National Environmental Policy Act ("NEPA") on the effects of the hatchery programs operating within the entire geographic boundaries of the affected listed species—the Puget Sound Chinook salmon evolutionary significant unit ("ESU") and the Puget Sound steelhead distinct population segment ("DPS"). NMFS' determination of whether, and if so, how, the Puget Sound hatchery programs can continue to operate without jeopardizing the survival and recovery of these threatened species is a critical decision affecting the entire region.

Unfortunately, the DEIS does not even attempt to provide the analyses necessary for such a determination. The DEIS is instead entirely divorced from the actual standards that govern the determinations that NMFS must make. The DEIS also does not provide the quantitative risk assessment needed to evaluate the risks associated with the Puget

Sound hatcheries at issue. We are hopeful that NMFS will address these significant shortcomings in manner that fulfills the requirements and intent of NEPA.

I. INTRODUCTION.

The DEIS has been prepared in response to the submission of two joint state-tribal RMPs for Puget Sound salmon and steelhead hatcheries. These RMPs and the Hatchery Genetic Management Plans ("HGMPs") associated with them have been submitted to NMFS for review and approval under the ESA 4(d) Rule, specifically Limit 6 of the 4(d) Rule. *See* 50 C.F.R. § 223.203(b)(6). NMFS' approval would provide conditional exemptions from liability for "take" of threatened species resulting from the hatchery programs. 50 C.F.R. § 223.203(c).

The purpose of NEPA is, *inter alia*, to declare a national policy that will encourage productive and enjoyable harmony between man and his environment, to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man, and to enrich the understanding of the ecological systems and natural resources important to the Nation. 42 U.S.C. § 4321. NEPA requires federal agencies undertake processes to "insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken" and that are "intended to help public officials make decisions that are based on understanding of environmental consequences." 40 C.F.R. §§ 1500.1(b) and (c).

To accomplish these purposes, NEPA requires federal agencies to prepare a "detailed statement" regarding all "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. § 4332(2)(C). The "detailed statement," commonly known as an environmental impact statement or EIS, is to describe the environmental impact of the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, alternatives to the proposed action, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. The requirement to prepare an EIS serves two important purposes: 1) it ensures the agency, in reaching its decision, will have available, and will carefully consider, detailed information concerning significant environmental impacts, and 2) it guarantees that the relevant information will be made available to the larger audience that may also play a role in both the decision making process and the implementation of that decision. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989).

NEPA imposes a requirement, independent of the need for an EIS, that agencies "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources." 42 U.S.C. § 4332(2)(E); *Bob Marshall Alliance v. Hodel*, 852 F.2d 1223, 1228-29 (9th Cir. 1988).

II. PURPOSE AND NEED.

The purpose and need statement is a crucial part of crafting and evaluating a reasonable range of alternatives because only a sufficiently broad statement will allow full development of an adequate range of alternatives. *See, e.g., Simmons v. U.S. Army Corps*, 120 F.3d 664 (7th Cir. 1997); *Davis v. Mineta*, 302 F.3d 1104, 1118 (10th Cir. 2002). Agencies cannot unnecessarily limit or interpret their purpose and thereby place unnecessary limits on the range of alternatives. *Id.*; *see also Van Abbema v. Fornell*, 807 F.2d 633, 638 (7th Cir. 1986), *see also 'Ilio'ulaokalani Coalition v. Rumsfeld*, 464 F.3d 1083 (9th Cir. 2006).

NMFS' description of the purpose and need is too vague to conduct any meaningful analysis of the alternatives. NMFS describes its purpose of the action as to "ensure the sustainability and recovery of Puget Sound salmon and steelhead by conserving the productivity, abundance, diversity, and distribution of listed species of salmon and steelhead in Puget Sound. *DEIS*, p. 1-8. NMFS explains its need as to:

- Respond to the request of the co-managers for an exemption from the take prohibitions of section 9 of the ESA for their hatchery programs triggered by submission of RMPs and appended HGMPs under Limit 6 of the 4(d) Rule.

- Provide, as appropriate, tribal and non-tribal fishing opportunities as described under the state and tribal co-managers' Puget Sound Salmon Management Plan implemented under *United States v. Washington*.

Id. However, NMFS does not provide any quantitative description of what is necessary to achieve these objectives. NMFS' failure to adequately define the purpose and need of the programs prevents any meaningful evaluation of the alternatives.

Importantly, the DEIS states that "NMFS, as a matter of policy, will accept some impacts that may result in increased risk to the listed species to provide limited tribal fishing opportunity. This approach recognizes that the treaty tribes have a right to conduct their fisheries within the limits of conservation constraints." *Id.* at p. 1-9. Yet, NMFS provides no quantitative criteria related to risk to the ESA-listed species at issue and no description of quantitative criteria by which NMFS determines how tribal fisheries contribute to such "increased risk," nor how that incremental level of risk is determined, and how it is further determined that the incremental risk falls within the "conservation constraints." Similarly, the DEIS provides no description, quantitative or otherwise, of what level of "fishing opportunities" are necessary or appropriate. The failure to provide such criteria is inevitable, given NMFS' refusal in the DEIS to employ a quantitative risk assessment.

In order to evaluate the alternatives for hatchery production listed in the DEIS, there needs to be a common currency in terms of which each alternative is measured in order that the probable outcomes of adopting one or another of the alternatives can be

estimated and compared to one another. The requisite currency must be objective and quantitative if the comparison is to provide a basis for sound and responsible public decision making, as required by NEPA. Where several objectives are to be pursued—for example, avoiding extinction, preserving the genetic diversity, fitness, and evolutionary potential of the extant wild salmon and steelhead populations, meeting Federal trust responsibilities to treaty tribes—these objectives must also be interpreted in terms of a common currency that is directly relevant to ESA concerns and evaluated accordingly. The DEIS fails to approach the comparison of alternatives in this way.

Many of the hatchery programs are funded by the United States (*e.g.,* by the Bureau of Indian Affairs). Is this NEPA process intended to fulfill NEPA requirements for such funding? If so, the purpose and need section of the DEIS should address this issue.

III. ALTERNATIVES.

"NEPA requires an EIS to describe and analyze 'every reasonable alternative within the range dictated by the nature and scope of the project.'" *Alaska Survival v. Surface Transp. Bd.*, 705 F.3d 1073, 1087 (9th Cir. 2013). The "touchstone" for evaluating the adequacy of an agency's NEPA efforts is whether the "selection and discussion of alternatives fosters informed decision-making and informed public participation." *California v. Block*, 690 F.2d 753, 767 (9th Cir. 1982); *see also Nat'l Highway Traffic Safety Admin.*, 538 F.3d at 1217 (describing the alternatives analysis as the "heart" of a NEPA evaluation). "[A]gencies should 'rigorously explore and objectively evaluate all reasonable alternatives' that relate to the purpose of the project." *Alaska Survival*, 705 F.3d at 1087.

A. <u>The "No Action" Alternative</u>.

The DEIS fails to identify and describe a proper "no action" alternative for several reasons. Under the "no action" alternative, NMFS would not make a determination on the RMPs, but the hatchery programs would continue to operate at the levels described in the RMPs and HGMPs.

Agencies must include a no action alternative in their NEPA analyses and give the no action alternative "meaningful consideration" in order to avoid violating NEPA's mandates. *See Bob Marshall Alliance v. Hodel*, 852 F.2d 1223, 1230 (9th Cir. 1988). "The no action alternative is meant to provide a baseline against which the action alternative . . . is evaluated." *Ctr. for Biological Diversity v. U.S. Dep't. of Interior*, 623 F.3d 633, 642 (9th Cir. 2010). A no action alternative is supposed to "facilitate comparison of the environmental impacts of the proposal and the alternatives." *Valley County v. United States Dep't of Agric.*, 2012 U.S. Dist. LEXIS 106667 (D. Idaho July 27, 2012) (citing 40 CFR § 1502.14) (internal quotation omitted). NEPA's required no action alternative "is meaningless if it assumes the existence of the very plan being proposed." *Friends of Yosemite Valley v. Scarlett*, 439 F. Supp. 2d 1074, 1105 (E.D. Cal.

2006) (finding that a no-action alternative could not properly include elements of an illegal plan).

The DEIS improperly assumes that the hatchery operations would continue operating in the manner described in the RMPs and HGMPs absent NMFS' approval. These programs have been conducted illegally without approval under the ESA 4(d) Rule. Further, many of the hatchery programs have been funded by the United States without NEPA and/or ESA compliance for such funding. The "no action" alternative should assume the programs will be discontinued. By failing to include a true "no action alternative," NMFS did not compare the effects of the proposed action against the effects of taking no action, thereby rendering NMFS' analysis virtually meaningless. As a result, the DEIS fails to meet the NEPA's purpose and mandate regarding the no action alternative.

Even if it were appropriate to identify the "no action" alternative in the manner proposed in the DEIS, the DEIS' description of this alternative is deficient because it does not account for changes in hatchery programs that have occurred since the RMPs and HGMPs were submitted—such as the reductions in the Chambers Creek steelhead hatchery programs—and it does not account for the fact that there are currently releases of Chambers Creek steelhead from only one program in Puget Sound (that in the Skykomish River) under the terms of a Consent Decree enter in *Wild Fish Conservancy v. Anderson*, W.D. Wash. No. 2:14-CV-00465-JLR (April 28, 2014), and that, due to the potential for future litigation, the Chambers Creek steelhead hatchery programs are not likely to operate again without ESA authorization. Accordingly, the "no action" alternative does not even describe current hatchery production as the DEIS purports.

B. <u>Reasonable Alternatives Not Included</u>.

The DEIS is also deficient for failing to consider a reasonable range of alternatives, including alternatives that were eliminated from detailed analysis. Such alternatives include (1) one where all hatchery program currently in violation of the ESA would be terminated; (2) one that maximizes the recovery potential for ESA-listed species; and (3) one that eliminates the use of non-native stocks (*e.g.*., the Chambers Creek steelhead and the Skamania steelhead programs, and Chinook programs using unlisted out-of-basin hatchery stocks detailed in DEIS Table 1.5-1, pages 1-14 to 1-19).

Under Alternative 3—Reduced Production—hatchery programs would be reduced by 50% in watersheds having Chinook salmon populations in recovery categories 1 and 2. This alternative should be made much more specific to ESA recovery concerns by including the requirement that additional program reductions would be required in all basins in which the 50% reduction fail to reduce pHOS of non-listed hatchery stocks to 5% or failed to achieve a PNI of at least 0.50 where listed hatchery stocks were involved and served a conservation purpose. There should also be alternatives considered that are intended to benefit the recovery of threatened Puget Sound steelhead and an alternative that is intended to benefit both threatened Chinook salmon and steelhead in a similar manner.

The alternatives selected for further consideration predetermine that, to the extent that NMFS acts on the submitted RMPs, it will approve them in some manner. It is inconsistent with NEPA for NMFS to determine that the RMPs comply with the requirements of the 4(d) Rule before completing the NEPA processes. There should be alternatives considered under which NMFS would determine that the RMPs and appended HGMPs are not approved because they do not meet legal requirements and/or that they are approved upon requirements to ensure that the RMPs and HGMPs comply with the 4(d) Rule.

The reasons provided in section 2.5 for not considering other specific alternatives are unconvincing. In particular, the alternative to incorporate all HSRG recommendations (section 2.5.2) is rejected on the grounds that "the co-managers are already implementing HSRG recommendations" (page 2-27). This is simply false. Most Chinook salmon hatchery programs are in violation of the HSRG's pHOS standards for segregated hatchery programs or the HSRG's PNI standards for integrated conservation hatchery programs (see our Comments below on the Green River Chinook salmon hatchery programs and the discussion of it in Appendix C of the DEIS). The HSRG repeatedly identifies the importance of local adaptation and reiterates the need to avoid transfer of hatchery fish among watersheds, yet many Puget Sound hatcheries routinely violate this principle. In any case, an alternative requiring compliance with the HSRG's out of basin transfer and pHOS and PNI standards that have been accepted by NMFS scientists should be fully developed and included among the alternatives.

An alternative to eliminate Chinook salmon hatchery programs from watersheds with recovery categories 1 and 2 Chinook salmon populations (section 2.5.4) is rejected for a variety of conflicting reasons: "because it would not meet the purpose and need … and would not meet ESA requirements of conserving listed Chinook populations supported by conservation hatcheries…." and "it may not meet treaty trust responsibilities." DEIS, p. 2-27. A modified alternative or set of alternatives should be developed that retain conservation hatcheries narrowly configured to meet only conservation purposes (not both harvest and conservation) for specific populations. Such an alternative could apply to both category 1 and 2 populations or only to category 1 populations, as suggested above for Alternative 3.

Further, the rejection of this alternative on grounds that it "may not meet" treaty trust responsibilities begs the question of what precisely these responsibilities are: specifically, how many hatchery fish must be produced and harvested by each Treaty Tribe in order to meet minimum trust responsibility requirements? This level of specificity is critical in order for the public to understand the precise nature and magnitude of the trade-offs between furthering recovery and satisfying legal trust obligations that NMFS may claim are involved in any specific case.

Climate change poses a considerable risk to the recovery of listed Puget Sound Chinook and steelhead populations. Among the most significant threats are increases in summer and fall water temperatures in freshwater rearing habitats and reduced summer

baseflow, both of which will reduce rearing capacity (for example, Mantua et al. 2010). Most hatchery facilities throughout Puget Sound obtain the majority of their water from surface water withdrawals from streams and rivers. These are considerably wasteful and will be increasingly so as the streamflow impacts of climate change advance. Water use reduction measures, such as water reuse and recirculation, will likely be required if hatchery facilities are to sustain even reduced levels of production in the near future while maintaining critical levels of instream flow to sustain wild fish. The DEIS should consider this critical issue. Alternatives that involve timely transitions to water supply and water use technologies for specific hatchery facilities should be developed and included in the DEIS. Economic impacts analyses should also be developed to account for the costs associated with the need to employ such water conservation technologies in order to more accurately reflect the cost of sustaining the levels of hatchery production associated with each alternative.

IV. ENVIRONMENTAL CONSEQUENCES.

"NEPA requires that a federal agency 'consider every significant aspect of the environmental impact of a proposed action…[and] inform the public that it has indeed considered environmental concerns in its decision-making process.' In order to accomplish this, NEPA imposes procedural requirements designed to force agencies to take a 'hard look' at environmental consequences." *Earth Island Inst. v. U.S. Forest Serv.*, 351 F.3d 1291, 1300 (9th Cir. 2003) (internal citations omitted). An EIS must provide full and fair discussion of significant environmental impacts and shall inform decision-makers and the public of reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment. 40 C.F.R. § 1502.1.

"The 'hard look' must be taken objectively and in good faith, not as an exercise in form over substance, and not as a subterfuge designed to rationalize a decision already made." *W. Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 491 (9th Cir. 2011). The EIS must include a discussion of adverse impacts that does not improperly minimize negative side effects. *Id.* "Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA. General statements about possible effects and some risk do not constitute a hard look absent a justification regarding why more definitive information could not be provided." *Id.* (internal citations omitted).

As described below, the DEIS fails to take the required hard look at the environmental consequences of NMFS' proposed action.

A. <u>The DEIS Does Not Adequately Address Whether the Alternatives Will Meet the Requirements of the 4(d) Rule.</u>

The proposed action for which the DEIS has been prepared is NMFS' review and evaluation of two RMPs and appended HGMPs submitted under Limit 6 of the 4(d) Rule. Yet, the DEIS does not contain analyses of whether any of the alternatives satisfy the requirements for approval under the 4(d) Rule. The DEIS is therefore insufficient.

An EIS must adequately address the statutory or regulatory considerations that govern the proposed federal actions. The Ninth Circuit Court of Appeals has observed:

> "In order to decide what kind of an environmental impact statement need be prepared, it is necessary first to describe accurately the 'federal action' being taken." Thus, just as "where an action is taken pursuant to a specific statute, the statutory objectives of the project serve as a guide by which to determine the reasonableness of objectives outlined in an EIS," so too do the statutory objectives underlying the agency's action work significantly to define its analytic obligations. Put differently, because "NEPA places upon an agency the obligation to consider every significant aspect of the environmental impact of a proposed action," the considerations made relevant by the substantive statute driving the proposed action must be addressed in the NEPA analysis.

Or. Natural Desert Ass'n v. Bureau of Land Mgmt., 625 F.3d 1092, 1109 (9th Cir. 2010) (internal citations omitted).

Here, the "federal action" for which the DEIS has been prepared is:

> [NMFS'] review and evaluation of two resource management plans and appended hatchery and genetic management plans submitted jointly by the fishery co-managers for hatchery programs in Puget Sound, under Limit 6 of the 4(d) rules for Puget Sound Chinook salmon and steelhead that are listed under the Endangered Species Act.

The DEIS further states that NMFS' purpose and need for the proposed action is to "[r]espond to the request of the co-managers for an exemption from the take prohibitions of section 9 of the ESA for their hatchery programs triggered by submission of RMPs and appended HGMPs under Limit 6 of the 4(d) rule. DEIS, p. 1-8.

The 4(d) rule includes criteria for NMFS' approval of RMPs under Limit 6. NMFS may approve RMPs where:

> (i) The Secretary has determined pursuant to 50 CFR 223.209 and the government-to-government processes therein that implementing and enforcing the joint tribal/state plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs.
>
> (ii) The joint plan will be implemented and enforced within the parameters set forth in *United States v. Washington* or *United States v. Oregon*.

50 C.F.R. § 223.203(b)(6). Further, as NMFS has noted, any HGMPs submitted as part of a RMP under Limit 6 of the 4(d) Rule must meet the criteria of Limit 5. *E.g.*, DEIS, p. 1-11. This requires that the HGMP: clearly state goals and performance indicators,

utilize concepts of viable and critical salmonid population threshold, appropriately reflect priorities through the broodstock collection programs, include specified protocols, evaluate, minimize, and account for genetic and ecological effects on natural populations, describe the interrelationships and interdependencies with fisheries management, apply to adequate artificial propagation facilities, include adequate monitoring and evaluation that exists to detect and evaluate the success of the program and any risks to the recovery of listed ESU, and provide for evaluating monitoring data and making revisions to assumptions, management strategies, or objectives. 50 C.F.R. § 223.203(b)(5)(i).

There are thus extensive regulatory criteria that apply to the proposed "federal action"—NMFS' review and evaluation of the RMPs and HGMPs under the 4(d) Rule. The DEIS does not adequately address these criteria and whether or how any of the alternatives or the RMPs and HGMPs meet the criteria. Remarkably, the DEIS does not include an analysis of whether the alternatives will appreciably reduce the likelihood of survival and recovery of threatened salmonids. In fact, the DEIS states that it will not document whether the RMPs and HGMPs meet the requirements of the 4(d) rule, but that those issues will be addressed in ESA documents. *E.g.,* DEIS, pp. 1-10 to 1-12. This does not fulfill the requirements of NEPA and it frustrates the ability of the public to understand and comment on NMFS' proposed action and alternatives thereto.

The DEIS should make more extensive use of the four Viable Salmonid Population (VSP, sensu McElhany et al. 2000) parameters in its analyses of the impacts of specific hatchery programs on individual populations within the Puget Sound Chinook ESU and steelhead DPS. These parameters are population abundance, population growth rate, population spatial structure and population diversity. The latter includes diversity in life history parameters such as age-at-smolting, age-at-first maturation, frequency of repeat spawning (steelhead), fecundity, run timing, morphology, and genetic diversity (VSP, pp. 12-20). Assessments of the impacts of each alternative on specific populations should include analyses of the probable impacts of hatchery programs on each of the four parameters of individual wild populations likely to be directly and indirectly affected by the program. Such analyses would provide critical information of particular relevance to the ESA-related impacts of the programs, and thus to the assessment of the likelihood of take and jeopardy resulting from NMFS' approval of particular HGMPs and RMPs. In addition, such analyses of the impacts of alternatives on specific populations would also facilitate the analysis of the impacts of alternatives on the listed species under climate change impacts, as well as the analysis of cumulative effects.

B. <u>The DEIS is Deficient for Failing to Include a Robust Quantitative Risk Assessment</u>.

A complete and accurate quantitative risk assessment is necessary to fulfill NEPA's mandate to take a "hard look" at the environmental consequences of the hatchery programs. The DEIS is deficient in this regard.

The DEIS notes that the "specific focus of this EIS is how the alternatives affect existing risks and benefits to listed salmon and steelhead, with emphasis on natural-origin

Chinook salmon." *DEIS*, p. 4-5. Yet, risks to listed salmon and steelhead are neither described in an appropriately quantitative manner, nor in terms clearly related to relevant categories of the ESA, such as take, recovery, risk of extinction, or jeopardy, that are the categories directly relevant to NMFS' evaluation of the RMPS and specific HGMPs. Nor are risks described quantitatively in terms of the VSP parameters or in terms of critical or viable thresholds of abundance as these terms are employed in the Puget Sound Chinook Recovery Plan or the Puget Sound Chinook Salmon Harvest RMP. The disclaimer, *DEIS*, pp. 4-7, is inadequate and does not represent the use of best available scientific and commercial data. The scientifically credible approach to risk assessment in the face of uncertainty (including "inadequate" or "insufficient data") is provided in the recent Report by the National Research Council "Assessing Risks to Endangered and Threatened Species from Pesticides" by the Committee on Ecological Risk assessment under FIFRA and ESA (FIFRA Report), National Academy Press 2013, Chapter 1 pages 14-15, and Chapter 5 pages 148-152.

The so-called "risk assessments" contained in the DEIS are not *bone fide* quantitative risk analyses, nor summaries of such analyses. They are at best qualitative characterizations of suspected levels of risk and, consequently, provide no way to determine whether or how future events would confirm or disconfirm the estimated "levels of risk."

Most significant to the ESA context that the DEIS should be assessing, these vague, qualitative assessments of risk fail altogether to account for uncertainty and its impact on the (quantitative) risk. The greater the absence of quantitative data and the more qualitative inference must be relied on to estimate the risk posed to listed populations of salmon and steelhead by specific hatchery programs and facilities, the greater the uncertainty and hence the greater the risk involved. Only an appropriate quantitative risk assessment framework, as discussed for example in the FIFRA Report, can accomplish this. By falsely contrasting quantitative data and analysis with "qualitative inference," the DEIS fails to recognize the need for, much less to employ, a quantitative risk assessment framework to conduct the risks assessments required and the subsequent specific evaluation of RMPs and HGMPs that NMFS must make, and for which it is the purpose of the DEIS to provide the necessary analytic framework.

Table 4.2.2, *DEIS*, p. 4-8, reflects this critical failure. The description of the basis upon which the assessments of the risks the alternatives pose to listed salmon and steelhead are made clearly shows that the assessments rely on purely qualitative or at best semi-quantitative methods. Further, the description shows that none of the risk assessments employ terms directly related to the ESA, such as the VSP concepts of productivity, abundance, spatial diversity, and genetic/life-history diversity.

Several sections of the DEIS reveal the vague, semi-quantitative, character of the so-called "quantitative" categories of risk employed in the DEIS and the determination of levels of risk. *E.g., DEIS*, pp. 4-9, 3-3 to 3-4, and Appendix B, pp. B-1 to B-34, B-46 to B-55, B-62 to B-69. The definition of 'risk' is inadequate. "A risk in this EIS is defined as the possibility of a loss or injury to natural-origin salmon and steelhead from the

development and use of hatchery facilities, hatchery programs, and hatchery-origin fish." A more specific, probabilistic definition or characterization of risk such as that provided by the FIFRA Report cited above is needed, and should be employed together with appropriately revised analyses in a new DEIS.

The DEIS fails to adequately define the objectives of the action or to conduct any meaningful assessment of the likelihood of the various alternatives at achieving the vague objectives that are stated. The DEIS is deficient for failing to conduct any quantitative risk assessment of the various alternatives.

The inadequacies of the risk assessment for the Green River Chinook Programs are illustrative of these deficiencies. The analyses of the impacts on juvenile wild (natural-origin) listed Green River Chinook salmon from competition or predation from the Green River Chinook and coho hatchery programs are based on simulation analyses of competition and predation using the PCD Risk model developed by Dr. Craig Busack and colleagues at WDFW. The PCD Risk model analyses reported in Appendix D are dated (possible outdated), as they were conducted in 2006 and thus do not include any updated information for 2006 through 2013. The documentation for the model explicitly qualifies the conclusions that can be supported by the results of the model, noting that the model "does not attempt to capture effects due to indirect ecological mechanisms" and merely attempts to "provide a heuristic toll for risk assessment and reduction, not a complete ecological model of the mortality process it simulates," and concludes by cautioning that "results from this assessment should be treated as risk indices in evaluating fish production programs." *DEIS*, Appendix D, p. D-2, lines 10 - 17.

Thus, the assessments derived from application of this model to evaluate the risks of competition and predation on juvenile natural-origin (ESA-listed) Chinook salmon in freshwater from Puget Sound coho and Chinook salmon yearling and sub-yearling hatchery programs are not quantitative, probabilistic risk analyses of the kind that is needed to fully describe and estimate these risks in the context of the ESA as described previously in these Comments. In fact, none of the results from analyses using the PCD Risk model reported in Appendix D provide quantitative estimates of take due to competition or predation impacts of juvenile hatchery fish on listed juveniles nor do they even indicate how the index scores (the only metrics reported as the output from the model simulations) are or might be related to take, jeopardy, and related ESA categories. It is also important to note that no PCD Risk model analyses of the competition and predation risks posed to listed Chinook salmon juveniles by steelhead hatchery programs were conducted, even though hatchery steelhead juveniles pose the greatest predation risk to listed juvenile Chinook salmon of all hatchery species in most river basins. *See, e.g., DEIS*, Appendix C, Table C-93, for Green River Chinook salmon.) The absence of such analyses is further evidence that analyses of these risks in the DEIS are not fully up to date.

The discussion of risks to natural-origin Green River Chinook from Green River Chinook and coho hatchery programs is described in Appendix C of the DEIS, pages C-144 to C-163. Highlights from these analyses not only demonstrate the failure of the

DEIS to conduct appropriate quantitative risk analyses but the inability of the DEIS to derive a consistent and risk-averse conclusion from the analyses it does conduct.

It is important to note that Green River hatchery Chinook subyearling and yearling programs are considered to be part of the Puget Sound Chinook salmon ESU and are therefore listed under the ESA together with their natural-origin conspecifics. Although the majority of returning hatchery-produced adults are intended for harvest in marine and in-river tribal and non-tribal commercial, tribal ceremonial and subsistence, and recreational fisheries, they are also considered by NMFS to contribute to the recovery of the natural-origin Green River Chinook population. Consequently, theses hatchery programs are evaluated under "benefits" for their contribution to the viability of the natural-origin population as well as to harvest. *See DEIS*, Appendix C, Sections 4.10.3.2, pp. C-155 to C-161.

The results for competition risks posed by Green River Chinook, coho, and steelhead programs are summarized as "High" under alternatives 1, 2, and 4 and "Moderate" under Alternative 3. *DEIS*, Appendix C, Table C-92. The results for predation risks posed by the Chinook, coho, and steelhead programs are summarized as "High" under all alternatives. The results for genetic risks posed to Green River natural-origin Chinook from Green River hatchery Chinook are summarized as "High" under Alternative 1, 2, and 4, and "Moderate" under alternative 3. *DEIS*, Appendix C, Table C-94. These risk levels are based on a presumed risk-averse approach whereby if one of the component risk categories in the Tables is rated "high," the overall risk level is rated "high." However, even these overall ratings do not reflect the cumulative risk because they do not include results from other risk categories that are estimated to occur in addition to competition and predation risk categories. So, even these "high" semi-quantitative overall risk levels do not fully reflect the risk posed and thus the overall "high" risk ratings should be considered under-estimates.

The genetic risks are particularly important to an overall assessment of risks and benefits when, as in the case of Green River Chinook salmon, the hatchery programs are alleged to serve a conservation purpose and to provide a viability benefit to the listed population. The assessment of genetic risks posed to natural-origin Green River Chinook salmon "are primarily based on PNI estimates from the AHA Model…". These are considered "High" under alternatives 1, 2 and 4, and "Moderate under alternative 3. The high rating appears to be based on a PNI of 0.23 and the moderate on an estimate of PNI of 0.36. Both of these are well below the minimum threshold of 0.50 recommended by the Hatchery Science Review Group ("HSRG"), whose standards in this regard NMFS has adopted for the HGMPs. These low PNI values reflect the fact that more than 50% of natural-origin spawners each year are returning first-generation (F1) hatchery fish (*See, e.g,* Table 2.2.2.6, p. 5, of the Green River Soos Creek fall Chinook HGMP final of December 2012 and appendix C, page C-156).

Moreover, there is no protocol requiring that a minimum proportion of the annual broodstock of Green River hatchery Chinook be natural-origin adults. Green River hatchery Chinook have very low smolt-to-adult return rates, suggesting low overall

fitness due to domestication selection of the hatchery broodstock over many generations. The high proportion of F1 hatchery fish spawning in the Green River is therefore likely to have driven down the fitness of the remaining natural-origin Green River Chinook population. The continuation of high levels of F1 hatchery spawners under all alternatives will most likely continue to keep the fitness of the natural-origin population depressed, and may drive it even lower. When added to the competition and predation risks from all of the Green River hatchery programs, the genetic risk imposed on the natural-origin Green river Chinook population has a high probability of preventing the recovery of this key member of the Puget Sound Chinook salmon ESU.

The high risk of significant past and continuing adverse genetic impact make it very unlikely that the Chinook hatchery programs are providing a significant conservation, viability, benefit. However, the DEIS (appendix C) does not come to this conclusion. Rather, the DEIS rates the viability benefit as "Moderate" for alternatives 1, 2, and 4, and "Low" for alternative 3 under which hatchery release numbers would be reduced, but not low enough to significantly raise the PNI level to the minimum level of 0.50 recommended by the HSRG, much less to the level of 0.67 recommended for integrated conservation hatchery programs.

The benefit of a (conservation) hatchery program to the viability of the affected listed natural-origin population is to be based on the four Viable Salmonid Population (VSP) parameters: abundance, (genetic) diversity, spatial structure (distribution of spawners and rearing juveniles in the river basin), and productivity (annual population growth rate). The DEIS rates the contribution to abundance a benefit based purely on the number of F1 hatchery spawners in the wild, which comprise over 50% of the total annual spawning population. *DEIS*, Appendix X, p. C-156, lines 14-19. As noted previously, this in large part accounts for the very low level of PNI, contrary to HSRG and, presumably NMFS' own, standards.

More importantly, the abundance of hatchery-origin (F1) spawners is only important when the short term abundance of the natural-origin population is dangerously low (near or below a critical abundance threshold), which is not at all the case with Green River Chinook salmon. In this circumstance, any contribution of hatchery-origin fish to total abundance of the natural-spawning population must consider the productivity (fitness) of the hatchery spawners and the total spawning population. There is every reason to believe that the large number and proportion of F1 hatchery spawners, which has occurred for multiple generations up to the present, has reduced the fitness of the remaining natural-spawning population through genetic introgression of maladapted genes. In such a case, a reduction in the number of hatchery-origin spawners (pHOS) is required. This is clearly feasible with low risk to the natural-origin population given natural spawning abundance of more than 1500. In fact, there can be even greater numbers of natural-origin (non-F1 hatchery) spawners if marine commercial (and perhaps also marine and freshwater sport) harvest were further reduced. *See DEIS*, Appendix C, Table C-97, p. C-155 (showing estimated total returns (harvest plus escapement) of Green River Chinook salmon). In short, given the genetic risks and the current data for

the Green river Chinook population, the contribution of the hatchery program to abundance is not an unambiguously positive viability metric.

That the risk that may actually be posed to the natural-origin population by the large absolute and relative number of F1 hatchery Chinook on the spawning grounds is likely to be significant is further indicated by the discussion of the productivity metric. "The benefit of the hatchery program to productivity is unknown." *DEIS*, Appendix C, p. C-157. The DEIS proceeds to dismiss any concern that the unknown productivity of hatchery fish poses a risk to the listed Chinook population by implying that habitat quality in the Green River is entirely responsible for the population's low productivity. The DEIS states that "the productivity of the natural-origin population in the existing habitat is poor….lambda of 0.84" (indicating a declining population), and noting that this estimate of lambda "assumed that the reproductive success of naturally spawning hatchery-origin fish was equivalent to that of natural-origin fish" and then asserts that this "assumption is reasonable because the program would release fish at the subyearling stage." The DEIS nonetheless acknowledges that if "the reproductive success of naturally spawning hatchery fish was assumed to be less than for natural-origin fish, then lambda would be larger." Yet, neither here nor elsewhere in the entire document does the DEIS suggest the importance of testing this by considerably reducing the number and proportion of F1 hatchery spawners and complying with the HSRG's PNI recommendations for conservation hatchery programs. This could be achieved under an alternative that combined reduction in the number of hatchery juveniles released with a set of selective fishery regimes and gear requirements.

As noted previously in these Comments, the uncertainties involved in the estimation of the productivity of Green River natural-origin and hatchery Chinook salmon need to be appropriately evaluated in a probabilistic risk assessment using available information and relevant auxiliary information. There are good reasons to think that reducing the numbers of hatchery-origin Chinook on the spawning grounds is necessary to improve the viability of the natural-origin Green River Chinook salmon population.

Regarding the diversity metric, the DEIS asserts that the program "would benefit diversity, as the hatchery program would continue to serve as a genetic reserve for the composite hatchery-origin and natural-origin population." *DEIS*, Appendix C, pp. C-157 to 158. This fails altogether to acknowledge, much less evaluate, that all that the hatchery program can maintain is the genetic diversity at neutral genetic markers that almost exclusively reflect the process of genetic drift between two or more populations, and that the high degree of gene flow from the hatchery to the natural-origin population that is an intentional outcome of the hatchery program will guarantee that the two populations will not diverge due to drift. This, however, does not at all exclude the possibility that high gene flow from the hatchery to the natural-origin population will disrupt locally adapted gene complexes in the natural-origin population and/or pass maladaptive genes that developed with high frequency in the hatchery population due to domestication selection to the natural-origin population, resulting in lowering the productivity of the natural-origin population. So, the cursory discussion of diversity in appendix C fails to provide a

thorough description of the genetic issues involved, and fails altogether to provide an appropriate probabilistic risk assessment that accounts for all of the data and the attendant uncertainties.

Regarding the spatial structure metric, the DEIS simply asserts that the hatchery program would benefit spatial structure because hatchery-origin spawners would stray to parts of the Green River basin that may be under-seeded by natural-origin spawners due to the low abundance (relative to potential spawning area presumably) of the natural-origin population. This is entirely unconvincing, given the uncertainty about the productivity (fitness) of naturally spawning F1 hatchery fish and the risk that this uncertainty poses to the fitness of the natural-origin population, combined with the uncertainty (and hence risk) concerning the productivity and abundance of the natural-origin population due to the high level of F1 hatchery fish on the spawning grounds and the risks from competition, predation, and gene flow posed by the hatchery programs.

The evidence presented and discussed qualitatively and semi-quantitatively in appendix C provides ample reason to conclude that the scale of the Chinook hatchery program under all alternatives (and especially under alternatives 1, 2, and 4) pose a risk to the viability of the natural-origin Chinook population. The full extent of the risk requires a quantitative, probabilistic risk assessment, that the DEIS entirely fails to provide. The failure to conclude that the hatchery programs pose overall risks to the natural-origin Chinook population is an indication that the largely qualitative approach to characterizing risks and benefits to listed natural-origin populations from hatchery programs is inadequate to serve the purposes of NEPA.

A final and closely related failure of the analysis of Green River Chinook in appendix C and of all related analyses in the DEIS is the failure to consider alternative harvest management strategies and methods of fishing as tools for addressing the risks posed by hatchery programs. Appendix C nowhere contains a discussion of alternative, selective fishing gear for tribal and non-tribal commercial fisheries targeting or incidentally encountering hatchery Chinook and coho produced by Puget Sound hatchery programs. Table C-97 and the related discussion of total returns of Green River Chinook clearly show the large number of natural-origin Green River Chinook produced that do not survive fisheries to end up on the spawning grounds. Yet, the appendix contains no discussion of why more natural-origin Chinook could not be allowed to return to the spawning grounds, or why more hatchery-origin fish could not be harvested using selective fishing gears that could release natural-origin (non-adipose-clipped) chinook unharmed, or why such adjustments to fisheries would not benefit the viability of natural-origin Green River Chinook. This is a serious flaw in the DEIS and fails to achieve the purposes of NEPA in the context of the ESA.

C. <u>The DEIS Relies on Stale Date and Outdated Studies</u>.

Several key documents pertaining to the recovery of Puget Sound steelhead and the continuation of segregated steelhead hatchery programs in Puget Sound have been published and/or circulated between NMFS and Washington Department of Fish and

Wildlife ("WDFW") in 2013 and 2014 that are not addressed in the DEIS that should be considered.

One is the Saltonstall-Kennedy (SK) Report on the three-year study of the impacts of the segregated Chambers Creek-origin Marbelmount Hatchery program on wild Skagit River steelhead (Ecological, Genetic and Productivity Consequences of Interactions between Hatchery and Natural-Origin Steelhead of the Skagit Watershed, March 2013).

A second document is the report "Measuring reproductive interaction between hatchery-origin and wild steelhead (*Oncorhynchus mykiss*) from northern Puget Sound populations potentially affected by segregated hatchery programs" by Kenneth I. Warheit of the WDFW Molecular Genetics Laboratory, dated October 10, 2014. This document has been submitted to NMFS as a supporting addendum to five revised steelhead HGMPs submitted at the time of or shortly following the publications of the DEIS.

A third document is a "letter (Sufficiency Letter) from Rob Jones of NMFS' Sustainable Fisheries Division to the Director of WDFW and the Chairwoman of the Northwest Indian Fisheries Commission acknowledging the sufficiency for continuation of ESA Consultation on five "updated Hatchery and Genetic Management Plans (HGMPs) for "early winter" steelhead…" The letter is dated November 12, 2014.

These documents demonstrate the new and controversial analyses of genetic samples from Puget Sound wild and hatchery steelhead that are being considered by NMFS in the context of the RMPs that are the subject of the DEIS. The DEIS should incorporate them and as well as the results of NMFS scientific analyses of them.

The SK report was available prior to the publication date of the DEIS and provides important data and information relevant to the genetic and competition risk Chambers Creek-origin hatchery steelhead pose to wild populations, including the largest extant wild steelhead population in the entire DPS. The DEIS should incorporate this critical information for the public to review. Further, some of the new analyses presented in the Warheit report appear to be in conflict with several of the results and conclusions of the SK Report regarding the threat to wild Skagit steelhead posed by the Marblemount Hatchery program. Since NMFS will be evaluating the five HGMPs referred to in the Sufficiency Letter in light of the conflicting information and analyses presented in the Warheit report, it is important for the public to have a clear understanding of how NMFS interprets the information provided by both reports. This requires that this information be analyzed and included in the DEIS.

D. <u>The DEIS Does not Adequately Describe Adverse Effects.</u>

NMFS recognizes that "hatchery programs can adversely affect natural-origin salmon and steelhead and their habitat through genetic risks, competition and predation, facility effects, natural population status masking, incidental fishing effects, and disease transfer." Despite acknowledging these adverse effects, the DEIS generally fails to provide a detailed discussion of the effects of hatchery programs on salmon, steelhead,

and their habitat that is based on an appropriately quantitative analysis of known or potential impacts and such discussion as does occur does not employ terms appropriate to the ESA context to which the DEIS applies. A more robust discussion is needed about the effects of hatchery operations on wild fish.

E. **The DEIS Does Not Adequately Address Mitigation Measures.**

"An EIS must contain 'a reasonably complete discussion of possible mitigation measures' and a record of decision must state whether 'all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not.'" *Cal. ex. rel. Imperial Cnty. Air Pollution Control Dist. v. U.S. Dep't of the Interior*, 767 F.3d 781, 797 (9th Cir. 2014) (internal citations omitted); *and see* 40 C.F.R. § 1505.2(c). "Without such a discussion, neither the agency nor other interested groups and individuals can properly evaluate the severity of the adverse effects." *Robertson*, 490 U.S. at 352. "Perfunctory descriptions or mere lists of mitigation measures are insufficient." *Alaska Survival*, 705 F.3d at 1088.

The DEIS is deficient for failing to adequately describe mitigation measures such as monitoring, evaluation, and adaptive management. The DEIS relies on monitoring, evaluation, and adaptive management plans that currently do not exist for most hatchery programs and that are not described in any detail for the few that might have identified monitoring needs. Funding for monitoring, evaluation, and adaptive management is either nonexistent, insufficient to accomplish the objective of the monitoring (particularly with respect to timely and accurate measurement of levels of take of listed species) and for the majority of hatchery programs is not reasonably likely to occur. In addition, the DEIS refers to adaptive management plans as central to evaluating and monitoring the impacts of hatchery facilities operations and programs on listed species; yet the plans are not described in any detail whatsoever, are entirely prospective, and have yet to be created much less evaluated for their scientific adequacy with respect to the ESA. This is clear in the descriptions of adaptive management and monitoring as risk mitigation in several sections of the HGMPs and the DEIS. *E.g., DEIS*, pp. 4-2 to 4-3, 4-24 to 4-25.

The description of adaptive management in chapters 2 and 4 are inappropriately general. They fail to provide specific, quantitative guidelines and criteria related to the risks posed to ESA-listed salmon and steelhead by hatchery programs and facilities. In general, this is the result of the DEIS' reliance on the vague language of "minimization" and the use of vague qualitative characterizations of the several categories of risk as "low," "moderate," and "high" as a substitute for the specification of risk-averse quantitative thresholds for parameters like competition, predation, genetic effects, and facility effects applied to specific populations of ESA-listed salmon and steelhead. Moreover, as already noted, none of these qualitative characterizations of risk are related to relevant terms of the ESA, which is the legal framework to which they should be related in order to satisfy NEPA.

Placed in the context of a quantitative risk assessment framework as described in our previous comments on the Draft Elwha EA and the NRC FIFRA Report referenced

above, risk-averse thresholds for the listed risk parameters would reflect relevant uncertainties that may affect the effectiveness of risk aversion measures. This would also include uncertainty regarding the ability of hatchery programs to secure adequate funding for the necessary monitoring that would be required to conduct a bone fide adaptive management program. In short, the DEIS altogether fails to provide any indication of how any specific levels of a risk factor are related to the maintenance and recovery requirements of affected populations. For example, the DEIS states that the "primary objective of incorporating adaptive management and associated mitigation would be to reduce deleterious impacts on natural-spawning fish, to more efficiently and effectively meet hatchery production objectives through changes in maintenance and operations and to better meet specific harvest objectives." *DEIS*, p. 4-3. No quantitative, risk-based, measures are discussed or provided to determine what levels of reduction of "deleterious impacts" are sufficient to achieve the purposes of the ESA with respect to take and jeopardy. This is true throughout the main body of the DEIS and the Appendices.

F. <u>The Economic Analysis is Inadequate</u>.

The DEIS' economic analysis is too narrow and fails to evaluate the economic benefits of recovery of listed ESA-listed salmon and steelhead. The DEIS should describe how the "harvestable surplus" is defined and quantitatively identified, and how this is related quantitatively to ESA issues such as take, recovery, and jeopardy. Chapter 3.3 does not provide commercial harvest data for individual tribes. The DEIS (chapter 3) does not describe/explain the relationship between tribal gross and per capita income from commercial fishery and hatchery operations and individual tribal per capita income, which is required to understand how alternatives affecting hatchery operations will translate to per capita income of individual tribes.

The economic analysis should also address lost opportunities from spending significant financial resources on the hatchery programs. For example, the economic analysis should address the economic and other consequences of diverting resources away from the hatchery programs and into habitat restoration and other efforts to support recovery of self-sustaining wild fish populations.

V. CUMULATIVE EFFECTS.

In a NEPA analysis, an agency must also consider the proposed action along with other actions, "which when viewed with other proposed actions have cumulatively significant impacts." 40 C.F.R. § 1508.25(a)(2). A cumulative impact is defined as "the impact on the environment which results from the incremental impact of the actions when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions." 40 C.F.R. § 1508.7. Under NEPA, cumulative impacts include direct as well as indirect effects, "which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." 40 C.F.R. § 1508.8(a).

In analyzing the cumulative effects of a proposed action, an agency must do more than just catalogue "relevant past projects in the area." *City of Carmel-by-the-Sea*, 123 F.3d 1142, 1160 (9th Cir. 1997). The EIS "must also include a 'useful analysis of the cumulative impacts of past, present and future projects.'" *Id*. This means a discussion and an analysis in sufficient detail to be "useful to a decision maker in deciding whether, or how, to alter the program to lessen cumulative impacts." *Id*. The cumulative impacts analysis for a proposed project must examine past, present, and proposed/reasonably foreseeable actions that have cumulatively significant impacts or are similar in timing or geography. 40 C.F.R. §§ 1508.7, 1508.25, 1508.27(b)(7); *Tomac v. Norton*, 433 F.3d 852, 864 (D.C. Cir. 2006).

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. 40 C.F.R. § 1508.7. The cumulative effects of the proposed action, combined with the cumulative effects of other proposed actions, must be described in detail and quantified. *Muckleshoot Indian Tribe v. U.S. Forest Serv.,* 177 F.3d 800, 810 (9th Cir. 1999). Broad and general statements, "devoid of specific, reasoned conclusions" are not sufficient; neither are one-sided cumulative impact statements. *Id*. at 811.

The DEIS is deficient in its failure to subject the cumulative effects that it identifies to sufficiently detailed analyses. The DEIS must do more than list a suite of general past, present, and likely future activities that may affect the listed species at issue and conjecture about the extent to which likely adverse effects may or may not be mitigated by existing law, rules and regulations. The DEIS must do more than list current and proposed land use rules and regulations and conjecture that they will provide protection of habitats and ecosystems important to salmon to an extent sufficient to assure the preservation and recovery of the listed species. The DEIS fails to provide any detail to demonstrate that it is at all reasonable to conclude that such protection will be secured.

Moreover, the DEIS acknowledges that "it is uncertain if all environmental goals and objectives can be successfully met by such processes… there will continue to be some cumulative environmental degradation in the future from development…". DEIS, p. 5-9. But beyond stating this, the DEIS provides no quantitative or semi-quantitative assessment of the likely magnitude of the impact of these and related regulatory failures on the status of the listed populations in context with the alternatives.

Similarly, in its discussion of Habitat Restoration, *DEIS*, pp. 5-9 to 511, the DEIS acknowledges that "based on a recent review of the implementation of the Puget Sound Chinook salmon recovery plan (NMFS 2011), habitat quality and quantity continues to decline and habitat protection tools currently in place continue to need improvement" *DEIS*, p. 5-10. The sentiment is forcefully reiterated in a report from the Treaty Indian Tribes in Western Washington (Treaty Rights at Risk, 2011). Yet, such admissions are not discussed in any further detail nor followed by any quantitative or semi-quantitative analyses of the likely impacts of these shortcomings on the status of the listed species in the context of the alternatives.

A particularly noteworthy feature of current funding and implementation of habitat restoration for the recovery of Puget Sound Chinook salmon and steelhead is the nearly complete failure of the Washington State Salmon Recovery Funding Board to fund monitoring and evaluation of the effectiveness of the majority of habitat restoration projects funded by the Board. This means that for most funded projects there is little or no information as to the effectiveness of these projects to improve the status of populations of the listed species. This makes it nearly impossible to estimate the extent, if any, to which any of the alternatives considered in the DEIS will avoid imposing additional adverse impacts on the listed species.

There is every prospect that this condition will persist into the foreseeable future. For example, the Puget Sound Partnership continues to propose that habitat restoration projects be funded in all Puget Sound WRIA's (Water Resource Inventory Areas, essentially watersheds). Given the limited funding annually available for these projects, this means that many small-scale projects will be funded rather than a few comprehensive, large-scale projects. NMFS' own scientists have shown that such small projects, even if completely successful, have near zero probability of detecting any positive impact on local salmon population in the face of normal levels of environmental variation affecting salmon survival and reproduction. *See* Roni et al 2010; Roni and Lierman 2008) (it is of note that neither of these relevant publications is cited in the DEIS). Consequently, even proposed or expected levels of current and future habitat restoration in Puget Sound cannot be counted on to compensate for the likely adverse impacts of hatchery programs and hatchery-subsidized harvest impacts on the listed species.

The discussion of the impacts of cumulative effects on listed Chinook and steelhead is altogether vague and non-quantitative. For example, section 5.6.1.1 of the DEIS devotes all of 2 paragraphs to describing the effects of hatchery production in Washington and British Columbia on listed Chinook and steelhead, concluding that these "hatchery releases…, along with other observed environmental trends as described in the following subsections, would affect continued long-term viability of natural-origin salmon and steelhead. Proposed changes in hatchery production under the alternatives analyzed in this EIS would affect risks and benefits, and proposed mitigation measures under adaptive management that are associated with the alternatives would help decrease the overall risk to salmon and steelhead." *DEIS*, p. 5-13. As already detailed in these Comments, there are in fact no specific, quantitative details regarding what kinds of measures are required in order for any particular (and entirely conjectural) adaptive management program to provide risk reduction sufficient for NMFS to approve an HGMP for a particular hatchery program. In any case, the mere assertion that such measures would "help decrease overall risks" is not an acceptable substitute for a quantitative risk assessment of each of the alternatives in the context of the general kinds of cumulative effects broadly described in Chapter 5 of the DEIS.

The DEIS devotes all of one paragraph (8 lines) to Climate change impacts, concluding that under "all alternatives, impacts to salmon and steelhead from climate

change are expected to be similar, because climate change would impact fish habitat for each alternative in the same manner." This is grossly inadequate. Section 5.6.1.1.4 of the DEIS (Competition and Predation Risks) adds little substantive detail, merely noting that "cumulative effects from climate change and development on competition and predation risks would add to the competition and predation risks described under Subsection 4.2, fish, and would be proportional to the amount of hatchery production under the alternatives." *DEIS*, p. 5-16. What is required is a quantitative analysis of the probable range of incremental climate change impacts over baseline conditions for each alternative on each individual component population of the Puget Sound Chinook ESU and steelhead DPS. Absent such an analysis, the public can have no idea of how each alternative will add impacts to baseline conditions under the range of impacts that are expected due to climate change alone. It is these incremental impacts from any alternative chosen that NMFS should evaluate under the ESA.

Similar shortcomings are characteristics of the other elements of subsection 5.6.1 of the DEIS. These comments illustrate how that the DEIS fails to address cumulate effects in the detail required under NEPA.

VI. PREDETERMINED OUTCOME.

Finally, this NEPA process is tainted by NMFS' approval of the Elwha River hatchery programs before completing this EIS process.

Preparation of an EIS is intended to ensure that the agency has and considers detailed information regarding environmental impacts when reaching its decision and it guarantees that information is made available to the larger audience that may also play a role in the decision making process. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989). NEPA procedures therefore must insure that environmental information is available *before* decisions are made and *before* actions are taken. 40 C.F.R. §§ 1500.1(b) and (c). A NEPA document must be "prepared early enough so that it can serve practically as an important contribution to the decisionmaking process and will not be used to rationalize or justify decisions already made.'" *Save the Yaak Comm. v. Block*, 840 F.2d 714, 718 (9th Cir. 1988) (quoting 40 C.F.R. § 1502.5)).

NMFS has already approved the Elwha River hatchery programs under the ESA 4(d) Rule, thereby pre-determining a significant aspect of the decision that is supposedly the subject of this current NEPA process. This violates NEPA and undermines these current NEPA efforts. For example, how can NMFS now consider alternatives to the hatchery programs that it has already approved for the Elwha River? NMFS' unlawful predetermination on the Elwha River hatchery programs likely has significant effects on its ability to consider alternatives for the hatchery programs throughout Puget Sound, thereby tainting this entire process.

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Treaty Indian Tribes in Western Washington. 2011. "Treaty Rights At Risk. Ongoing Habitat Loss, the Decline of the Salmon Resource, and Recommendations for Change." http://treatyrightsatrisk.org/

Add Bill McMillan's latest Skagit report – append a copy?

The Reproductive Ecology of *Oncorhynchus mykiss*
in Tributary Streams of the Mid Skagit River Basin

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Photo 1: Skagit River Sexually Mature Wild Steelhead of 19 lbs 10 oz Caught January 25, 1959

Introduction

The Skagit River is the largest river basin of Washington's Puget Sound. The Mid Skagit River basin for purposes of this report is considered to be the 43 mile (67.6 km) length of the mainstem Skagit and smaller tributaries from the town of Sedro-Woolley (~RM 24) to the entry of the Sauk River (RM 67). At the time of 1895 the Skagit basin had an estimated mean return of over 105,000 wild steelhead (Gayeski et al. 2011). Current wild steelhead returns (2002-2011) are 5-6% of historic levels (Appendix C of McMillan 2012). Wild steelhead harvest alone from 1961-62 through 1965-66 was an average of nearly 13,000, and wild harvest as late as 1974-75 was over 15,000 (Phillips et al. 1981b; and Appendix E). As of 2007, Puget Sound (including the Skagit basin) steelhead have been listed as Threatened under the Endangered Species Act (ESA) (NMFS 2007).

Oncorhynchus mykiss (*O. mykiss* hereafter) is noted for great breadth of life history diversity and unusual plasticity among Pacific salmon species with the most southern range extent (Shapovalov and Taft 1954; Augerot 2005). Wild winter steelhead spawning time in western Washington has been documented as January to June-July by Washington Department of Natural Resources (WDNR) and through independent surveys by the Wild Salmon Center (WSC) (Cederholm 1984; McMillan 2007). The earliest description related to the reproductive ecology of the anadromous life history of *O. mykiss* in Mid Skagit River tributary streams is that of a U.S. Fish Commission egg-taking operation at Finney Creek in 1901 (Ravenel 1902):

Page 84: *"Early in March it was decided to again attempt the collection of eggs of the steelhead trout ... Phinney Creek ... was selected ... and by the middle of the month a rack was completed and net fishing*

commenced under the direction of Mr. Henry O'Malley. Only a few fish were caught, and it soon became evident that the run of steelheads was over. Exploration on Phinney Creek, Grandy Creek, and the Skagit River did not show any large numbers, all testimony seeming to prove that the principal run had gone up in January."

The indicated steelhead migration into Finney Creek prior to mid March, and principally in January, would be necessary to result in the initiation of steelhead spawning at the Sauk River of the Skagit basin reported by the Washington Fish Commissioner (Riseland 1907):

Page 23: *"The steelhead spawn from the first part of February until the 15th of June."*

The breadth of entry time of steelhead to the Skagit River in 1895, the earliest year of commercial catch record in the basin, was described in a U.S. Fish Commission report (Wilcox 1898):

Page 595: *"The several species of salmon and seasons when found are as follows: ... steelhead, from November 15 up to the following spring ..."*

The wild winter steelhead that reproduced in the Skagit basin near their peak historic abundance thought to end about 1895 (Gayeski et al. 2011) had migrations that commenced Skagit River entry in mid November with a major upstream migration in January, and included entry to Finney and Grandy creeks of the Mid Skagit basin. In the case of Finney Creek, steelhead spawning entry was nearly over by mid March. Although spawning time in Finney Creek (RM 47.5) was not mentioned, steelhead likely began spawning at least by early February and ended by mid June as described in 1907 for the Sauk River (RM 67.2) just upstream of the Suiattle River (RM 13.2), likely near today's Hatchery Creek (RM 13.4). This Sauk River location is 32 miles upstream from Finney Creek with an elevation gain of about 242 ft. Photo 1 depicts a wild steelhead in mature male spawning coloration taken near Rockport, WA on the Skagit River on January 25, 1959 by Russ Willis (Western Washington University, Bellingham, WA, 6th Floor of the Wilson Library, in the Heritage Resources, Fly Fishing Collections; additional information pers. com. Danny Beatty, Anacortes, WA who acquired it for the Collections). The 1959 steelhead exhibits the historic attributes earlier described in Skagit basin steelhead.

Between 1914 and 1920 steelhead egg-taking operations for hatchery rearing were recorded at three Skagit River tributary streams (Smith and Anderson 1921 in Table 1, Appendix B). Weirs are difficult to maintain during higher flow events and even today significant escapement of steelhead occurs around weirs (Seamons et al. 2012) despite easier access to weir sites and improved technology since the early 1900s. As a result, the early egg taking operations at Day and Illabot creeks may not have well represented actual return numbers of female steelhead and would be a minimal count. Grandy Creek was the central location at that time, however, for hatchery operations in the Skagit basin (Smith and Anderson 1921) and likely had a more efficient weir. Using the average number of eggs taken per female steelhead from Green River tributary streams between 1939 and 1941 (Pautzke and Meigs 1941), at Grandy Creek the number of female steelhead stripped of eggs ranged from 79 to 1,125 per year; at Day Creek from 29 to 100; and at Illabot Creek from 21 to 158. Even at minimal female numbers represented, it is apparent that Skagit River tributary streams supported considerable steelhead spawning at a date when overall salmon and steelhead numbers were described as already greatly depleted from former times (Smith and Anderson 1921).

As a result of the 1974 Boldt court decision and the subsequent steelhead management changes that occurred in the Boldt Case Area of Washington (Puget Sound and the Northwest Coast) thereafter, data began to be collected from which to manage for a 50% division of harvest between tribal and sport fisheries and eventual

determination of spawning escapements (Cohen 1986). In the case of the Skagit River basin, spawning survey data are available from 1978 to 1981, a time period when 65%-80% of steelhead spawning found was in the tributary creeks (Phillips et al. 1981b). The available evidence indicates that Skagit River tributary streams were historically vital to overall steelhead productivity, and included those of the Mid Skagit basin.

A basic Skagit River steelhead management assumption by Washington Department of Fish and Wildlife (WDFW) has been (WDFW 2004):

Page 118: "*Wild origin winter steelhead have been defined as those fish that spawn after March 15...* (and) *steelhead of hatchery origin that spawn in the wild are defined as those fish spawning before March 15, for management purposes on the Skagit (Woodin et al. 1984)."*

As a result, WDFW steelhead spawning surveys in the Skagit basin have commonly been initiated about March 15th in the assumption that wild steelhead do not spawn prior to that date. In the Skagit basin it was indicated in the same WDFW document:

Page 141: *"... introgression between hatchery and wild fish ... is believed to be low as there is currently substantial temporal separation of hatchery and wild spawn timings, and spawning overlap is believed to be less than 1% (C. Kraemer, WDFW, pers. comm., 12/12/03)."*

Page 142: *"The section of the Skagit River that has been the most heavily spawned by hatchery-origin adults is the area upstream of Grandy Creek between the Cascade and the Sauk rivers..."*

However, the above management assumptions have been largely made with an absence of spawning surveys that could actually document how much hatchery and wild spawning occurs in the Skagit basin prior to March 15th, and where it occurs. Oregon has developed a more thorough ground-truthed approach for monitoring steelhead of its Coastal streams (from Susac and Jacobs 1999):

Page 2: *"The percentage of hatchery origin steelhead spawning naturally in the wild poses a great deal of concern to fisheries managers. The Oregon Wild Fish Management Policy (OAR 635-07-525) sets guidelines as to the percentage of stray hatchery fish permitted to spawn naturally in individual basins and subbasins. It is important for fisheries managers to know the percentage of hatchery strays spawning naturally in the wild. Currently, all of the hatchery origin steelhead released in Oregon and destined to return as adults in 1998 are marked with an adipose fin-clip. We have started to evaluate the feasibility of using visual detection of marked and unmarked adults on the spawning beds to determine hatchery:wild ratios."*

Page 2: *" ... 1) steelhead spend only a short time on spawning beds, 2) fish not actively spawning are elusive, and 3) hard to count and steelhead do not necessarily die after spawning. In addition to difficulties associated with their behavior in spawning streams, the extensive temporal and spatial spawning patterns exhibited by coastal winter steelhead stocks create challenging survey conditions. The spawning season is generally quite protracted, lasting up to 6 months..."*

As a result there are no assumptions about hatchery and wild steelhead spawning that exclude any part of the potential spawning season as monitored in spawning surveys in Oregon:

Page 10: *"Surveys were conducted from mid January to mid May.*

Regarding steelhead spawning further north, winter steelhead spawning was documented to begin on central Vancouver Island's Cowichan River by January in the 1940s (Neave 1949), and in the 1980s was found to begin in January-February at the Queen Charlotte Islands (de Leeuw and Whately 1983; de Leeuw 1984; 1985; 1986; and 1987). At the Situk River of Southeast Alaska, steelhead spawning has initiated as early as February (Johnson 1991).

On becoming a resident of the Mid Skagit basin in 1998, it became of increasing interest what salmonid spawning was occurring at a number of local tributary streams. With a history of doing volunteer spawning surveys as a hobby biologist from 1979 to 1996 on Lower Columbia River streams, and professionally from 1997 to 1998 in the Snohomish basin and from 2000 to 2006 in the urban creeks of King County, the Mid Skagit tributary streams provided near-by interest due to differences in their hydrologic regimes, stream channel characteristics, and directional aspects to the sun. On retirement at the end of 2006 as a professional field biologist for a non-profit fish conservation organization, I had time to consider surveying streams again in the freedom of volunteerism as a hobby biologist.

I first came to familiarize myself with these streams and others in the Skagit basin through angling on moving to the Skagit Valley in 1998. It provided a means to determine *O. mykiss* and *O. clarki* species presence, potential fish passage barriers that may isolate them from each other, or overlaps within each stream that may otherwise occur. However, my commitment to doing regular surveys did not more consistently occur until the fall of 2009 and spring of 2010. These surveys continued to regularly occur through the spring of 2014 during the salmon and steelhead spawning periods at O'Toole, Mill, Savage, and Finney creeks, and at Dry Creek (tributary of lower Finney Creek) in 2013 and 2014. From October 3, 2013 through June 16, 2014 the surveys made at these five Mid Skagit tributaries were made with greater frequency compared to other years with particular intent to increase observations of active steelhead spawning if possible. Surveys were also made intermittently at several other Mid Skagit tributaries during the anticipated steelhead spawning period. The overall goal of the spawner surveys was to gain an understanding of the steelhead which spawn in these streams and to determine the following:

1) earliest and latest steelhead spawning by tributary
2) total steelhead spawning redds by tributary, or tributary reach surveyed
3) hatchery and wild steelhead during active spawning
4) the proportion of steelhead spawning before and after March 15th
5) *O. mykiss* life history mixes (i.e. anadromous and resident) during active spawning
6) steelhead spawn time differences between differing tributaries
7) environmental factors that may determine steelhead spawning time differences by tributary
8) steelhead spawn time overlaps with other salmonids
9) *O. mykiss* fry emergence dates

Determination of spawning prior to mid-March and potential overlaps between wild and hatchery *O. mykiss* were priority objectives due to the lack of historical spawning surveys that could document this in tributary streams of the Skagit basin (or elsewhere in most of Puget Sound and much of western Washington). Although *O. mykiss* reproductive ecology in these tributaries is the focus of this report, the surveys included a complete record of all salmonid spawning found from the beginning of the first autumn storm events that provided anadromous fish access into these tributary streams. In this way it was possible to ensure that the earliest *O. mykiss* spawning was found and how the timing of one species may overlap with another in the need to separately identify their redds based on differing redd characteristics. A further purpose for this report is to

stimulate data collection that over time can result in a broader understanding of the complexity of *O. mykiss* life history diversity necessary for productivity across a broad range of available habitats and to provide an improved template for future monitoring of steelhead in the Skagit basin that can more effectively guide management for wild recovery through a future predicted to include increasing climate change.

Methods

Streams Surveyed

Mid Skagit basin tributary streams were chosen for spawning surveys due to proximity to my place of residence at RM ~46 near the mouth of Savage Creek and from which daily weather and stream flow conditions could be quickly determined. Five of these streams are publicly accessible by walking for their entire anadromous length and met the criteria for either determining a good approximation of the total spawning use by each salmonid species, or a sufficiently long and typical stream reach from which a significant proportion of the spawning by each species could be determined. Table 1 provides the five main streams and 2013-2014 survey lengths; Table 2 provides streams intermittently surveyed. The stream lengths were determined by Google Earth measures in yards (yds) and kilometers (km). Table 2 of Appendix F provides the dates of each 2014 survey from January 1st through June 16th (and other information).

Table 1. Mid Skagit tributary creeks regularly surveyed in 2013-14

Tributary	Anadromous length	Length surveyed	Begin rkm	End rkm	Number of surveys	First survey	Last survey
Finney Ck	20,678 yds 18.908 km	3,825 yds 3.498 km	1.87	5.37	10	2-2-2014	5-30-2014
Dry Ck of Finney Ck	950 yds 0.869 km	950 yds 0.869 km	0	0.87	26	11-6-2013	5-30-2014
Savage Ck	>4,409 yds >4.032 km	4,409 yds 4.032 km	0	4.03	45	10-3-2013	5-6-2014
Mill Ck	1,850 yds 1.692 km	900 yds 0.823 km	0	0.82	29	10-3-2013	5-22-2014
O'Toole Ck	680 yds 0.622 km	680 yds 0.622 km	0	0.62	10	10-4-2013	6-16-2014

Table 2. Mid Skagit tributary creeks intermittently surveyed in 2013-14

Tributary	Anadromous length	Length surveyed	Begin rkm	End rkm	Number of surveys	First survey	Last survey
Quartz Ck of Finney Ck	Unknown	160 yds 0.146 km	0.34	0.49	1	5-16-2014	5-16-2014
Hatchery Ck of Finney Ck	>570 yds; 0.521 km	400 yds 0.366 km	0	0.37	2	3-23-2014	5-6-2014
Grandy Ck	7,950 yds; 7.269 km	2,000 yds 1.829 km	0.30	1.71.	1	2-20-2014	2-20-2014
Cumberland Ck	1,300 yds; 1.189 km	577 yds 0.528 km	0.25	0.78	1	5-2-2014	5-2-2014

Breadth of Time Period for Surveys

To assure that no atypically early steelhead spawning went unrecorded, the 2013/2014 Mid Skagit tributary

surveys began with the first series of storms that recharged the tributary streams in the fall to facilitate anadromous fish passage into them. This occurred early with over 12 inches (30.5 cm) of rain recorded in the Mid Skagit basin in September, the largest amount since I began recording September rainfall in the area in 2002 (Appendix A.). Surveys began in early October but missed the first few days of salmon spawning activity that likely occurred in Finney, Mill, and O'Toole creeks, but redds and carcasses remained to provide good counts of spawning that likely occurred.

In the case of Finney Creek, fall spawning surveys did not occur in 2013 due to the stream conditions often being too discolored to do so, but also because surveys in prior years had already indicated what spawning use occurs there prior to the initiation of steelhead spawning in winter. It was hoped that surveys targeting steelhead could begin in January of 2014, but water conditions were unfavorable to do so until February. At Finney Creek water conditions absolutely dictate survey times which can't be predetermined. Some years there may be too little survey time to provide useful information. This was not entirely the case in 2014 for steelhead at Finney Creek, but as previously indicated, some spawning in January and February may have been missed due to turbidity and this continued through March.

In the case of Dry Creek of lower Finney Creek, entry of pink salmon was not anticipated due to its small size and common dewatering. It was thought to be the last of local Mid Skagit tributary streams to recharge with fall rains and perhaps too little flow to coincide with pink salmon spawning use potential. However, when surveys began there in early November, at the end of anticipated pink salmon spawning, considerable prior use by pink salmon was found and future surveys will be adjusted accordingly.

The surveys remained sustained until the final spawning by steelhead was thought to be found. In most cases this was early to late May, but in the case of O'Toole Creek it had previously been noted that particularly late spawning can occur and a final survey there was made in mid-June. There was also a gap in surveys at O'Toole from November 12th of 2013 until March 12th of 2014. Past surveys of O'Toole Creek have found minimal coho spawning there and chum spawning is typically contained to October. Only twice was early steelhead spawning found there, in both instances near where it joins the Skagit River which may have included river backflow into it. It is one of the coldest streams as previously found and has a substrate where redds can remain visible for considerable time. Because it is somewhat out of the way geographically from the other streams regularly surveyed, it was the choice to exclude during a time period when the other streams were more anticipated to have spawning occurring. It was a choice of where available time was best spent.

My surveys were predicated on historic information that identified Puget Sound historic wild steelhead spawning began in January (Evermann and Meek 1898) and/or February (WDG 1931-1940). In the Skagit basin, Finney Creek steelhead entry for spawning was primarily in January (Ravenel 1902) and steelhead spawning began by at least early February in the Sauk River (Riseland 1907). I anticipated that January and February spawning still occurs and should guide present wild steelhead monitoring. Chambers Creek origin hatchery steelhead, as have been long planted in the Skagit basin, are also known to spawn by December and January and continue into March (Crawford 1979). Their extent of spawning can continue as late as April 27th as found at the Kalama River of the Lower Columbia (Crawford et al. 1978). My prior survey experience in the Mid Skagit basin tributaries found that steelhead do begin spawning in January and this continued to guide the decision to begin spawn surveys by that time in 2014.

Survey Frequency and Timing of Individual Surveys

The frequency of the surveys was determined by a combination of stream conditions from which new spawning entry might be anticipated, the need to survey the appropriate length of stream reach for the available time allotted, and the expected species to be found during a specified time period. Whenever possible surveys were timed to occur shortly after a peak flow event. During the typical fall/winter storm period of November through January this could result in peak flow events occurring and subsiding 2-3 times during a 10-day period. The 2014 storm events occurred in a way to provide difficult survey conditions for weeks at a time from January through March. Finney Creek is the largest of the creeks surveyed (average summer wetted width of 16 m at Quartz Creek entry at rkm 6.6 from Kiffney et al. 2006) and is particularly affected by lingering effects of heavy rainfall. Higher flow periods physically prevent the necessary wading to cover the survey reaches and turbidity is prolonged with inability to see redds. Thus considerable steelhead spawning is unavoidably missed in years of normal to greater winter precipitation. At the other end of the scale, Savage Creek has an extensive low gradient reach with wetlands and a series of ponds that it runs through resulting in moderation of its flows below those points with more gradual reactions to rainfall. It also has a significant upper fork that is particularly low gradient with wetlands and beaver ponds that it drains with related greater stability of flow characteristics. Dry, Mill, and O'Toole creeks all originate from steep mountain slopes which dominate their overall lengths with short 1 km sections or less of lower gradient where spawning occurs near their mouths. As a result their flows rise and fall quickly.

Because of the described differences in response to rainfall and drought, surveys had to be timed to these differences with variable frequency. At Finney Creek surveys were sometimes limited to zero per month or 1-2 per month in worst conditions. At smaller streams there could be as little as 1-3 days between surveys that occurred after a storm event in the hope of not missing any spawning activity prior to the next predicted storm. Any significant storm event could make some redds invisible thereafter. At the other extreme, during longer periods without significant rainfall the surveys could be delayed until a freshet occurred with a resulting wait of three weeks or more before anticipated new spawning. Some streams have particularly long survey reaches that may not fit the available time in a single day. In that case the survey lengths were broken up into shorter units that were done on multiple days within a short time of each other to capture the spawning for each stream reach between higher flow events. As a result of these considerations, surveys prior to March were often made at 3-4 day intervals if the sequence of rainfall and peak flow periods were frequent, after mid-March steelhead spawning survey intervals were often longer in more normal years (2014 being an exception) due to reduced high flow events, redd life being longer, and encountering hatchery steelhead and species other than steelhead less likely. As a result, active spawning sightings are less critical later in the survey season and the surveys were sometimes made further apart (10-14 days for instance).

Making wild and hatchery steelhead determinations was a primary survey objective of the spawner surveys. This meant maximizing the probability of finding active redds, or the presence of live steelhead during the surveys. However, finding active steelhead spawning in the Mid Skagit basin creeks has been a relatively uncommon occurrence. Live steelhead have also been noted as elusive sightings in other areas such as Oregon (Susac and Jacobs 1999). Active steelhead spawning was found in the Mid Skagit basin creeks to occur within 24-48 hours after a stream reaches a peak stream flow, which is typically considered to be the falling limb of the hydrograph. This rule of thumb largely concurs with the guidelines used in steelhead spawning surveys on the Oregon Coast (Susac and Jacobs 1999). In the case of Mid Skagit tributary steelhead, active spawning has most commonly been found during dimmer light conditions of cloudy days, and/or late afternoon and evening. At Prairie Creek in California steelhead spawning most commonly occurred at early morning and evening and steelhead vacated the redds at mid day to find cover for hiding (Briggs 1953). Needham and Taft (1934) found that the majority of steelhead redd construction at Waddell Creek occurred overnight under the confined

conditions of their observation method. The Waddell Creek example is an important consideration but doing the Mid Skagit surveys under the conditions of nightfall with extensive stream walks was not a realistic consideration. Given both past experience and guidance from the literature, cloudy days and late afternoon or evening were targeted for surveys at the Mid Skagit basin tributaries whenever possible as the best compromise regarding the apparent preference of steelhead to actively spawn at night or in otherwise dim lighting.

Estimating redd construction date

Steelhead redds are often found days to weeks after they were constructed. This can be due to unfavorable survey conditions due to high flows and lack of visibility, due to limited time to survey all streams within optimal conditions, or due to having missed sighting a redd until a later suvey date. When an inactive redd (i.e. no fish near the redd identified) was found, its age was estimated based on distinctiveness of the redd pit depth and tailing mound, and by winter or spring dates when the amount of algal growth on surrounding substrate and redds differ.

A redd was classified as built within a few days to a week of being identified if it was prior to March and the redd pit deep and tailing mound were well defined even though there was a small difference in the surrounding substrate coloration due to common absence of algal growth. A redd's age from March onward was similarly classified if it was of similar characteristics but the tailing mound was vey light coloration and surrounding substrate was distinctly darker due to the common presence of algal growth.

A redd was classified as being built one to two weeks earlier if it was prior to March and the redd pit was partially filled or less distinct and the tailing mound was less prominent even though there was little difference in the surrounding substrate coloration due to common absence of algal growth. A redd's age from March onward was similarly classified if it had similar pit and mound characteristics but the surrounding substrate was darker and some algal growth had initiated on the tailing mound.

A redd was classified as being built two to three weeks earlier if it was prior to March and the redd pit was more obscured and the tailing mound more dispersed. From March onward a redd's age was similarly classified if it had similar characteristics but the tailing mound was somewhat paler than surrounding darker substrate.

Redds identified before March were classified as built three to four weeks earlier if the redd pit was difficult to discern and the tailing mound was well dispersed but remained as visibly different from surrounding substrate despite lack of algal growth. From March onward a redd's age was similarly classified if it had similar characteristics but with algal growth on the tailing mound approaching that of the surrounding substrate.

These initial estimates of redd ages were noted in the field book. Subsequently, these redd age estimations were compared to streamflow and weather conditions that would have most likely stimulated spawning entry during or proximate to the estimated redd age range, and/or if it coincided with known spawning observed on the other streams or stream sections in that time frame. Thus final redd aging was based on a combination of these criteria.

Survey Procedure

Date and stream condition were recorded at the beginning of each survey. Flows were described as low, moderately low, normal for date, moderately high, high but surveyable, and high but unsurveyable. Water

visibility was described as clear (sufficient for survey), slightly discolored (sufficient for survey but impaired), and discolored (too diminished for a survey). Weather conditions such as amount of rainfall, snow, or freezing conditions in the days leading up to the survey were also noted. If ice conditions were present that was noted.

Along with a field notebook and a camera(s), surveys preferably began at the downstream end of the survey reach. The streambank was then walked upstream to the extent of the survey reach. However, in some instances of logistic necessity the survey was made by walking downstream. This occurred when access was limited to a bridge or culvert crossing upstream of the reach to be surveyed, or in the case of a larger stream (such as Finney Creek) when the only safe ford to cross the stream was upstream of the survey reach. In order to find passable terrain, the stream channel was crossed back and forth when possible. Care was taken to avoid live fish and redds. Each completed redd was recorded in the notebook by species and whether active or inactive. Sometimes older inactive redds could be difficult to determine, and/or by what species. These redds were typically counted based on probable species evidence, but the question was noted. Redds marked by previous surveyors were also counted (by WDFW in the case of Finney, O'Toole, and Mill creeks) if they similarly fit my redd identification criteria (generally so, but not always). If there was a ribbon associated with it, species and date was noted. If there was a flagged stone that was noted. Each carcass or live sighting was recorded by sex and hatchery or wild origin when possible. Unoccupied redds were considered completed if there remained evidence of a depression at the pit area and a gravel tailing behind. Active redds were counted as complete. A few active redds were difficult to otherwise determine in some habitat types where there are boulders that the spawning fish work around with several resulting scattered pits representing the egg laying by one female steelhead. This led to focused attention in these habitat types to determine if relatively small and scattered pits may be those of steelhead spawning. If several such small pits were found within a 15-30 meter reach of this type of stream habitat it was considered the egg laying of but one female steelhead. In other instances several fresh steelhead redds were found within a 50-100 meter stream reach but only one steelhead spawning pair was sighted. It is possible that just one female steelhead may have constructed all of the redds found (particularly in the smallest streams). However, without evidence to suggest otherwise, each redd found (unless within a few meters of each other) was counted as a separate redd representing that of one female steelhead. In the case of steelhead, coho, and cutthroat redds during overlapping spawning time periods, redd size was also recorded as a check on species use determinations.

I did not mark redds. One reason for this was so as not to confuse others who survey some of the same streams and do mark redds. Secondly, in the case of steelhead and cutthroat their redd infrequency did not require being marked and the number of streams surveyed was low enough so that memory did not tend to confuse newer redds from older ones if they remained visible between surveys at all. In the case of salmon, particularly coho and pink salmon, trying to flag all the redds would not have been particularly helpful due to frequent areas of superimposition or overlaps of redds. A combination of carcass, live fish, and redd counts was made each survey by species. The survey data from the field notebook were then analyzed and recorded at the end of each survey day so as to determine how well the carcass and live counts may or may not fit with the number of redds counted for salmon in particular. The primary purpose was to identify as well as possible steelhead spawning redds from the other species. This required careful examination of each redd by size, depth, and substrate used, and to further determine the most likely species use at that time interval which salmon live sightings, carcass presence, and live steelhead and/or cutthroat sightings helped to provide conclusions.

Determining Species Use by Redd Evidence

As noted in Oregon's steelhead spawning surveys (Susac and Jacobs 1999), because steelhead are so briefly in small streams for spawning, and due to their elusiveness and hiding compared to salmon, one is commonly left with only the remaining redds from which to make counts. Vacated redds pose the problem of determining the species that made them. Coho and sea-run cutthroat are the two species that more commonly spawn in the Mid Skagit basin tributaries during overlapping periods with steelhead. As the surveys have progressed the past five years some differences have been found to guide the methods for determining the species that have left vacated redds. Burner (1951) indicated that of the salmon redds assessed by species, only coho had as much as 10% mud in the substrate used and that they used slower flows than others. He also indicated that redd sizes generally reflect the size of fish (the larger the salmon the larger the redd, all else being equal) and that redd size is inverse to substrate size (the larger the gravel substrate the smaller the redd, all else being equal). These proved to be good guidelines.

In the case of the Mid Skagit tributaries, based on active spawning observations by each species, the smallest redds found were considered those of resident cutthroat (redds less than 1.5 ft x 1.5 ft, 0.25 sq. yds. considered such) or sea-run cutthroat (from 1.5 ft x 1.5 ft to 2 ft x 2.5 ft, 0.25 sq. yds. to 0.56 sq. yds.). Redds considered to be coho were larger (2 ft x 2.5 ft to 4 ft x 6 ft, 0.25 sq. yds. to 2.67 sq. yds.), and those considered to be steelhead larger yet (2 ft x 2.5 ft to 6 ft x 10 ft, 0.25 sq. yds. to 6.7 sq. yds.). Active cutthroat and coho redds were commonly at current edges or in slower currents. Such placements further guided determinations of inactive redds for those species while active steelhead redds were more commonly at mid channel or at edges to stronger currents and in larger substrate which further guided inactive steelhead redd determinations. Active coho redds were particularly found in side channels, even those down to wetted widths a meter or less with substrates that included considerable fine sediment and/or mud rarely if ever used by steelhead which further guided inactive redd decisions per species. Based on these criteria, inactive redd determinations made by species were made with relatively high confidence. Nevertheless, during a one to two week transitional period between coho and steelhead spawning in the Mid Skagit tributaries (latter January to mid February, depending on year and by tributary) a few vacated redds remained of some question regarding species origin. If active spawning was found by one or the other (coho or steelhead) during this period in one of the other four streams, it was considered likely that the questionable inactive redd found in the stream of question was likely made by the same species unless other criteria (such as redd size, location, or substrate size) indicated otherwise.

Determining Hatchery from Wild

Determining hatchery fish from wild was done by observing the presence (wild) or absence (hatchery) of the adipose fin by focused observation of individual fish during live sightings. Steelhead carcasses have yet to be found and can't be anticipated as an aid for determining hatchery or wild origin. Adipose fin presence or absence on live fish sighted has provided the only means to determine spawning time differences between wild and hatchery fish. Concentrated observation is required to determine steelhead adipose presence or absence, yet great care must be taken not to approach so closely as to cause flight and difficulty in finding the steelhead again. This can entail up to 1.5 hours of observation, but 20 to 40 minutes is often enough. It is particularly difficult in larger streams such as Finney Creek, but in the smaller streams the steelhead often spawn in shallow depths of 0.2-0.3 meters and eventually may lift the caudal fin out of the water providing clear momentary view of the adipose fin area. Determination of adipose presence or absence can be greatly facilitated by use of two digital cameras (Canon Power Shot SX50 HS digital camera and Go Pro, Hero 3 digital camera with underwater housing, the latter requiring a four foot long rod of to mount it on to more closely approach the fish beneath the water). The first camera was used for taking photographs of the spawning steelhead from above the surface and the second one for doing so beneath the surface and which was also the sequence used. The potential for

sending an adult steelhead into flight is greater with the underwater camera use, and therefore the choice to use it last. The latter camera was not used until the latter part of the spawning season but was found to be an important tool for both species determinations and whether of wild or hatchery origin.

Findings

Redd Counts

From October 3, 2013 through June 16, 2014, a total of 125 spawning surveys were made at five Mid Skagit basin tributary streams on a regular basis and at four other tributaries on an intermittent basis (Table 1 of Appendix C). The steelhead redds were enumerated by both the 7-8 day period found and adjusted to the estimated spawning date period during 2014 (Table 3).

Table 3. 2014 Mid Skagit Basin Steelhead Redd Counts by 7-8 Day Period

Steelhead redd counts by period found
Steelhead redd counts adjusted to estimated spawning period

Period	Savage		Mill		O'Toole		Finney		Dry		Total	
Dec 24-31												
Jan 1-7												
Jan 8-15		1										**1**
Jan 16-23	1								1	1	**2**	**1**
Jan 24-31								1		2		**3**
Feb 1-7							1		2		**3**	
Feb 8-15												
Feb 16-23	2	2							1	1	**3**	**3**
Feb 24-29												
Mar 1-7												
Mar 8-15	2	2						1	2	2	**4**	**5**
Mar 16-23								2				**2**
Mar 24-31						2	1	4			**1**	**6**
Apr 1-7					2			1			**2**	**1**
Apr 8-15				1			8	1			**8**	**2**
Apr 16-23												
Apr 24-30			2	1						1	**2**	**2**
May 1-7					1	1		3	1	1	**2**	**5**
May 8-15							7	6	5	4	**12**	**10**
May 16-23					1	1	3	1			**4**	**2**
May 24-31												
Jun 1-7												
Jun 8-15						1						**1**
Jun 16-23					1						**1**	
Jun 24-30												
Jul 1-7												
Total	**5**	**5**	**2**	**2**	**5**	**5**	**20**	**20**	**12**	**12**	**44**	**44**

Figure 1.

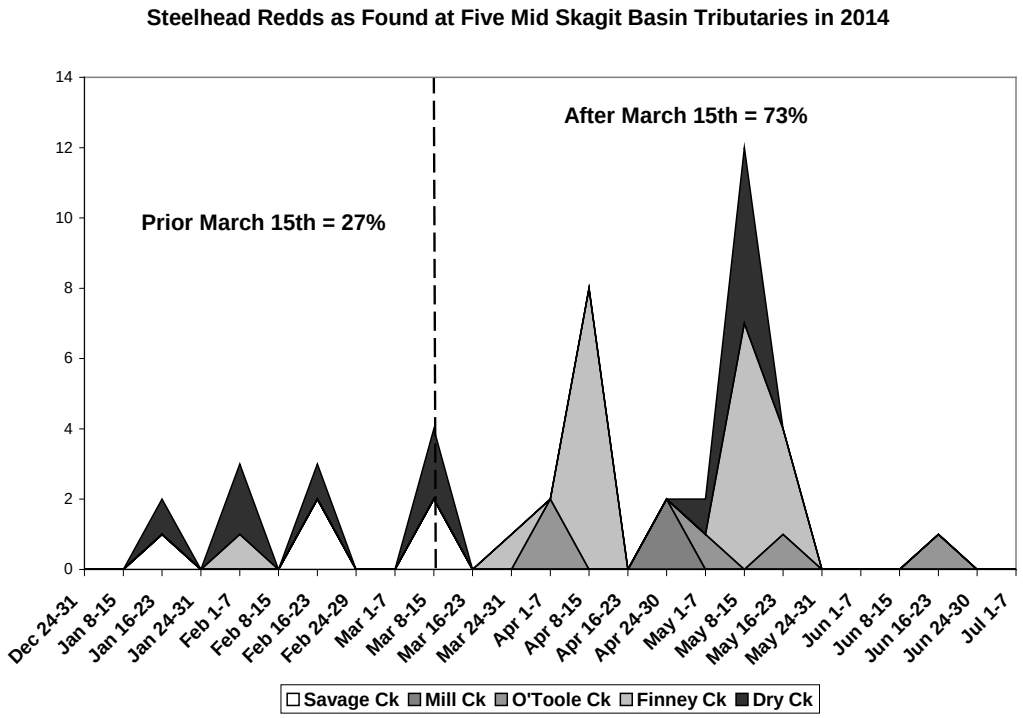


Figure 2.

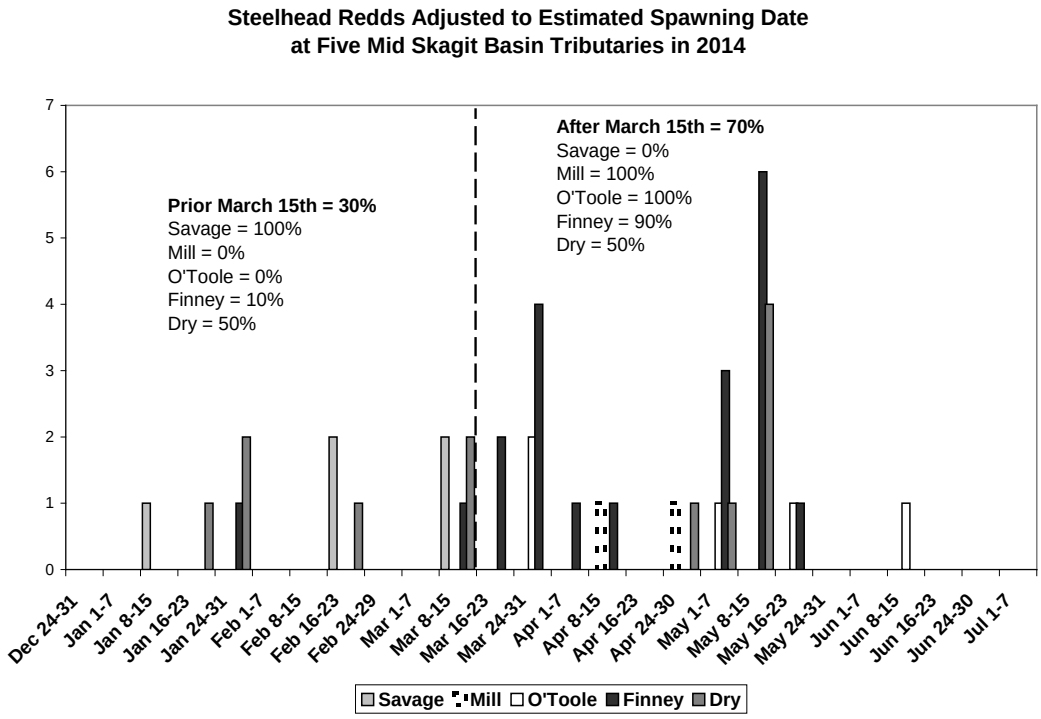


Table 4. Mid Skagit tributary steelhead spawning at streams regularly surveyed in 2014

Mid Skagit tributary	Earliest redd	Latest redd	Total redds	Redd upstream extent	Redds/km
Savage Ck	Jan 23, 2014	Mar 15, 2014	5	Mainstem = 1,997 yds; 1.826 km West Fork = 420 yds; 0.384 km	1.4/km
Mill Ck	Apr 30, 2014	Apr 30, 2014	2	578 yds; 0.529 km	2.4/km
O'Toole Ck	Apr 7, 2014	Jun 16, 2014	5	680 yds; 0.622 km	8.0/km
Finney Ck	Feb 1, 2014	May 22, 2014	20	3,825 yds; 3.498 km	5.7/km
Dry Ck	Jan 16, 2014	May 14, 2014	12	950 yds; 0.869 km	13.8/km

Table 5. Mid Skagit tributary steelhead spawning at streams intermittently surveyed in 2014

Mid Skagit tributary	Survey date(s)	Total redds	Redd upstream extent	Redds/km
Quartz Ck of Finney	May 16, 2014	0	none found	0
Hatchery Ck of Finney	Mar 23, 2014 & May 16, 2014	2	185 yds; 0.169 km	5.5/km
Grandy Ck	Feb 20, 2014	1	1,136 yds; 1.039 km	0.6/km
Cumberland Ck	May 2, 2014	2	852 yds; 0.779 km	3.8/km

Table 6. 2010-2014 Cumulative Mid Skagit Basin Tributary Steelhead Redd Counts by 7-8 Day Periods

Steelhead redd counts by period found

Steelhead redd counts adjusted to estimated spawning period

Date	Savage		Mill		O'Toole		Finney		Dry		Total	
Dec 24-31												
Jan 1-7												
Jan 8-15		1						1				**2**
Jan 16-23	3	2		2					1	2	**4**	**6**
Jan 24-31	1	3	6	4		1		3		4	**7**	**15**
Feb 1-7	1	3			1		3	2	2	2	**7**	**7**
Feb 8-15	4	2		1		1	6	4	5		**15**	**8**
Feb 16-23	4	2	4	3	1				1	1	**10**	**6**
Feb 24-29								1				**1**
Mar 1-7							3	1			**3**	**1**
Mar 8-15	2	2		3			1	2	2	2	**5**	**9**
Mar 16-23								2				**2**
Mar 24-31			4	1		2	1	4			**5**	**7**
Apr 1-7				1	2			2			**2**	**3**
Apr 8-15	1	1	1	3			11	5			**13**	**9**
Apr 16-23						1	1	1			**1**	**2**
Apr 24-30			3	3			2	1		1	**5**	**5**
May 1-7			1	1	1	2		4	1	1	**3**	**8**
May 8-15			3		2		7	6	5	4	**17**	**10**
May 16-23					1	1	5	1			**6**	**2**
May 24-31												
Jun 1-7												
Jun 8-15						1						**1**
Jun 16-23					1						**1**	
Jun 24-30												
Jul 1-7												
Total	**16**	**16**	**22**	**22**	**9**	**9**	**40**	**40**	**17**	**17**	**104**	**104**

The earliest and latest steelhead spawning redds, total steelhead redds, extent of steelhead spawning, and steelhead redds per kilometer by regularly surveyed tributary in 2014 are listed in Table 4 with a resulting six month breadth of steelhead spawning evidence found. The total length of the survey reaches is provided in Table 1 from which steelhead redds per kilometer were determined, except for Savage Creek where the steelhead survey length was 3,805 yds (3.479 km), or 604 yds (0.552 km) less than for total surveys included in Table 1 (Table 1 includes coho surveys further up the West Fork of Savage Creek). The steelhead spawning found at the Mid Skagit tributary streams intermittently surveyed are enumerated by date, total steelhead redds found, upstream extent, and steelhead redds per kilometer in Table 5. Although these surveys were too limited to be of comparative value to those streams regularly surveyed, in the cases of Cumberland and Hatchery Creek significant steelhead spawning per km was found. Grandy Creek was surveyed only once primarily to determine if early steelhead spawning had occurred. Only a little over 1 km of its lower section was surveyed of a total potential steelhead spawning length of at least 5.5 miles (8.85 km) to Grandy Lake. Although Quartz Creek was surveyed during a period when steelhead were spawning elsewhere in Finney Creek basin that it is tributary to, less than 0.20 km was surveyed of what is considered to be 0.80 km spawning habitat available to a cascade (Williams et al. 1975).

The cumulative steelhead redds at each of the five Mid Skagit tributaries regularly surveyed in the longer 2010 to 2014 period were enumerated by 7-8 day periods when they were found and also as adjusted to reflect their estimated spawning date in Table 6. The cumulative redds and live fish sightings for all species by tributary stream during this longer 5-year period along with notes about actual dates of redds and details related to live fish sightings are in Tables 1, 2, 3, 4, and 5 of Appendix C. At the five Mid Skagit basin tributaries regularly

Figure 3.

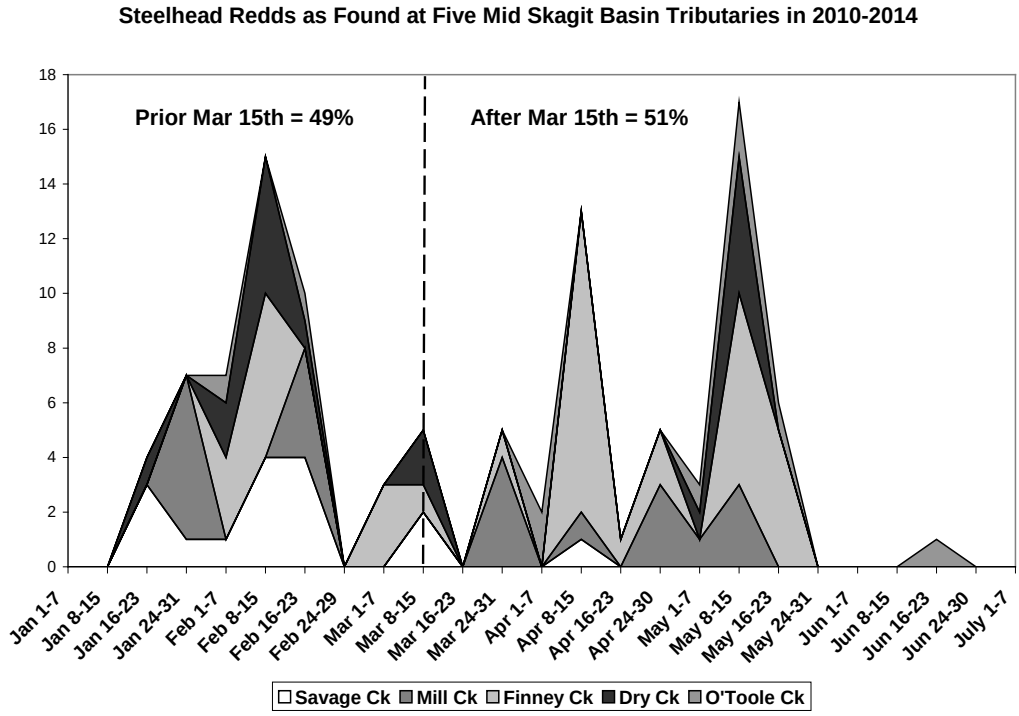


Figure 4.

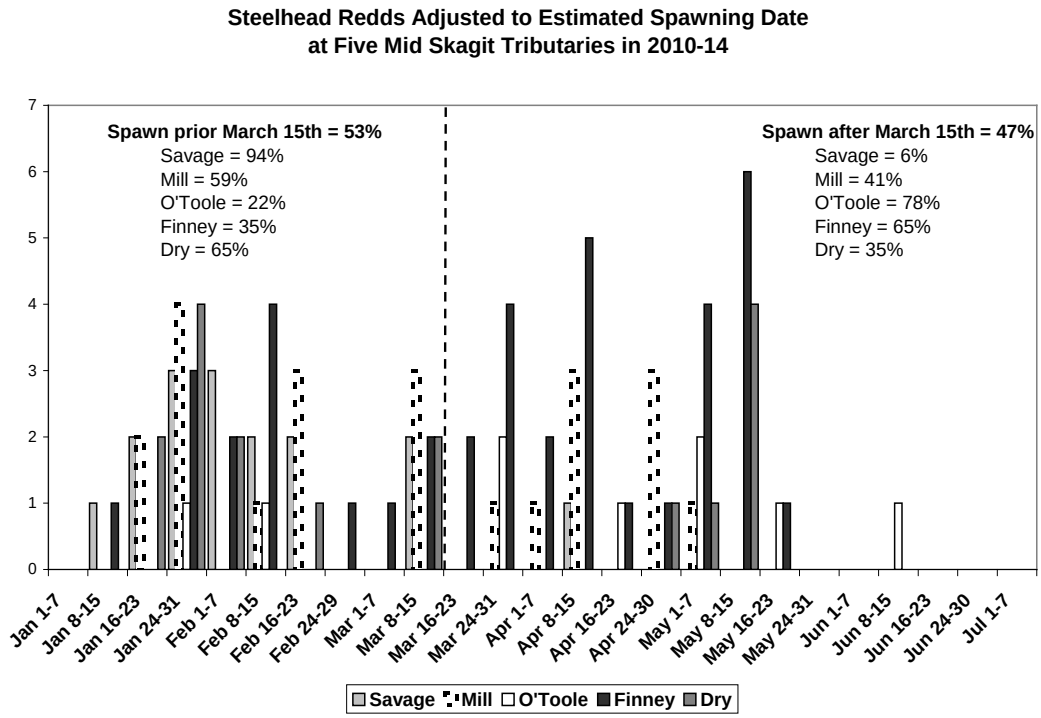


Table 7. Finney Creek Redd Counts by Time Period Found and as Adjusted to Reflect Estimated Spawning Period in 2010 and 2014

7-8 day period	2010 redds by period found	2010 redds by spawn period	2014 redds by period found	2014 redds by spawn period
Jan 16-23				
Jan 24-31		1		1
Feb 1-7	1		1	
Feb 8-15		1		
Feb 16-23				
Feb 24-29		1		
Mar 1-7	3	1		
Mar 8-15	1	1		1
Mar 16-23				2
Mar 24-31			1	4
Apr 1-7		1		1
Apr 8-15	3	4	8	1
Apr 16-23	1	1		
Apr 24-30	2	1		
May 1-7		1		3
May 8-15			7	6
May 16-23	2		3	1
May 24-31				
Totals	**13**	**13**	**20**	**20**

Figure 5.

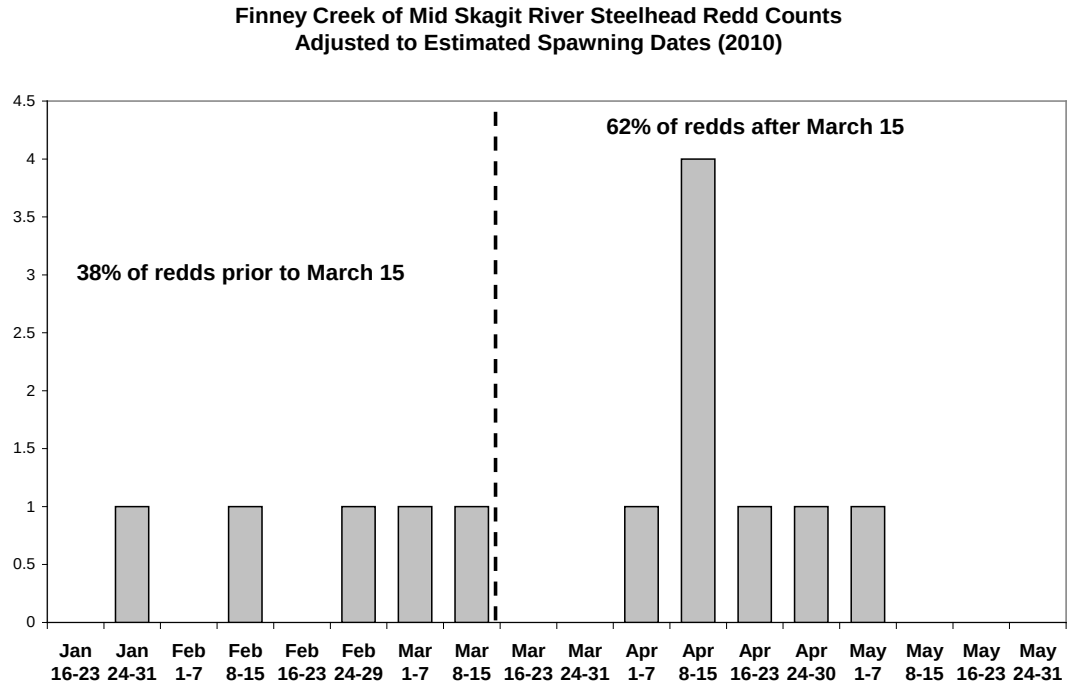
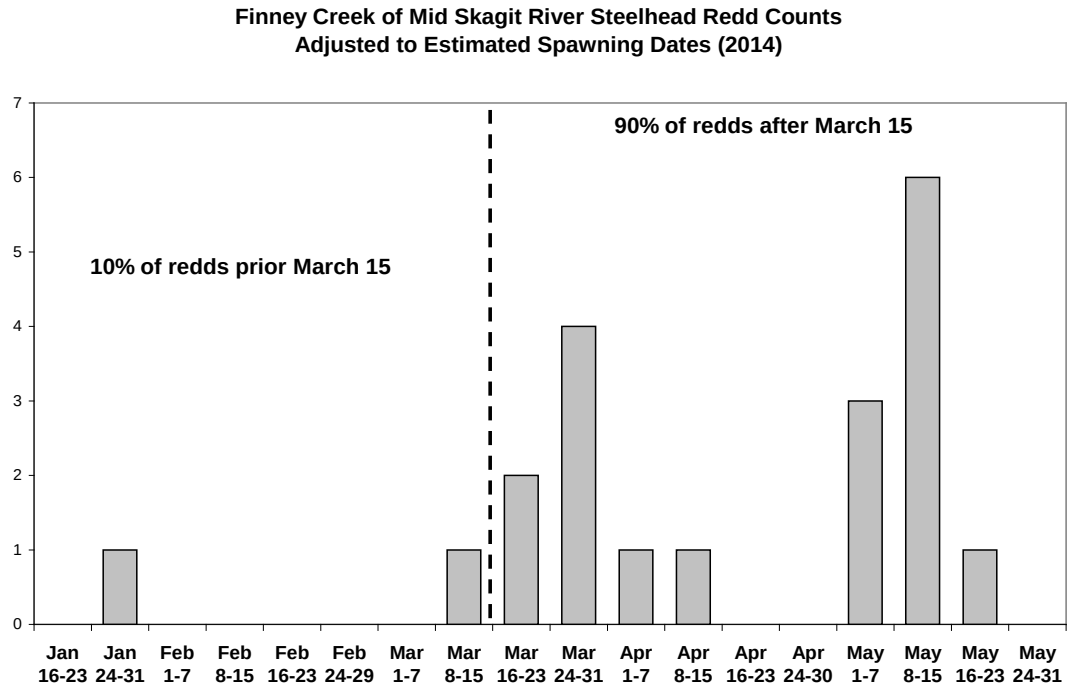


Figure 6.



surveyed from 2010 to 2014 the percentage of redds as found by 7-8 day intervals prior to and after March 15th are in Figure 3, and the percentages similarly found prior to and after March 15th in 2014 are in Figure 1. The

cumulative redds at each tributary from 2010 to 2014 as adjusted to reflect the estimated spawning date by 7-8 day intervals with percentages prior to and after March 15th are in Figure 4.

Finney Creek is the largest of the tributary streams regularly surveyed. Relatively similar intensity and duration of redd counts occurred at Finney Creek in 2010 and 2014 in which the age of each redd was also evaluated for its actual spawning date (Table 7). In 2010, 28% more spawning occurred prior to March 15th than in 2014 (Figures 5 and 6). Peak spawning in 2010 (early to mid April) was a month earlier than in 2014 (early to mid May), but the initiation of spawning was the same both years (late January).

Spawning Times Found for Wild and Hatchery Steelhead, Resident *O. mykiss*, and Other Salmonid Species

A primary purpose of the Mid Skagit basin tributary spawning surveys was to document whether hatchery steelhead spawning occurs, and if it overlaps with wild spawning. This could only be determined through visual observations of active spawning. A particular emphasis was placed on making active steelhead spawning observations during the 2014 steelhead spawning period of January through March when wild and hatchery overlaps in spawning time were thought to most probably occur. This entailed spending 0.5-1.5 hours of observation time when active spawning was found to make wild from hatchery determinations.

Sighting steelhead on spawning streams has been reported as relatively uncommon on the Oregon Coast, not only due to relatively small numbers compared to salmon but due to their nature to flee and hide (Susac and Jacobs 1999). This was similarly found in the Mid Skagit basin tributary surveys. During Mid Skagit tributary surveys active spawning was most commonly observed at late afternoon/evening and/or on cloudy days. It was also found that active spawning was most likely to occur within a 24-36 hour period after significant rainfall with streamflows dropping after their peak. The timing of the 2014 surveys was particularly adjusted to reflect this whenever possible. However, diminished lighting that steelhead apparently prefer for spawning has inherent limitations in visually determining the presence or absence of the adipose fin necessary for wild or hatchery identifications. Photographs were taken when active spawning was found as an aid to determine adipose presence or not, but absence of light also results in photographs with less definition than in brighter light. Nevertheless, photographs proved of great value. The active steelhead spawning found in Mid Skagit tributaries from 2010 to 2014 by sex and whether of wild, hatchery, or unknown origin is provided in Table 8. The resident *O. mykiss* life history is identified and listed if found as part of the active spawning mix. Also, the active spawning of *O.clarki* that is known to hybridize with *O. mykiss* is listed as observed.

The increased frequency of spawning surveys in 2014 resulted in the sighting of five incidences of female steelhead actively digging redds, or in the vicinity of where recent redd activity occurred. Four of these sightings occurred at Dry Creek, the smallest of the streams surveyed and the one where the greatest percentage of survey time occurred in ideal survey conditions of relatively low and clear flows very shortly after storm events. Spawning surveys at Dry Creek were not initiated until mid February of 2013 in the prior assumption that it was not a steelhead spawning stream based on earlier indications by other Skagit basin surveyors and due to my own brief observations contained to a bridge crossing near its mouth. Therefore the Dry Creek data is limited to two years, but it is now apparent that it is not only an important steelhead spawning stream but one which may provide a particularly reliable stream for effective monitoring of steelhead spawning at Mid Skagit tributaries. In the previous four years of surveys active steelhead spawning was only observed twice, once at Savage Creek and once at Finney Creek.

The resident form of *O. mykiss* was part of, or potentially a part of the spawning life history mix as determined at both Dry and Finney creeks. At upper Dry Creek, on January 16th of 2014 the only mate found with a hatchery female steelhead actively digging a redd was a wild male resident *O. mykiss*. However, the actual spawning act was not observed and could have potentially included a male steelhead thereafter. Another resident male *O. mykiss* was observed as part of the steelhead spawning mix at Dry Creek on March 12th of 2014. At Finney Creek on March 4th of 2010 and March 28th of 2014 a potential resident *O. mykiss* may have been present as part of each spawning mix. Throughout the adult steelhead collection period on Finney Creek in 2010 (related to the Skagit River steelhead acoustic tracking and tissue sampling for genetic analysis) a

Table 8. Species, life history, sex, and origin of live fish observed on redds occupied by female steelhead by tributary in cumulative surveys of the Mid Skagit basin in 2010-2014

Tributary	Date	Wild sthd ♀	Wild sthd ♂	Hat sthd ♀	Hat sthd ♂	? sthd ♂	Wild res *O. mykiss* ♂	Wild *O.clarki* ♂
Finney Ck	3/4/2010	1*				1*		
Savage Ck	1/19/2011			1	1	2**		
Dry Ck	1/16/2014			1			1	
Dry Ck	2/19/2014	1				1		1*****
Dry Ck	3/12/2014			1		1	1	
Finney Ck	3/28/2014	1***	1***			1****		
Dry Ck	5/12/2014	1	1					
Total		4 (21%)	2 (10.5%)	3 (15.8%)	1 (5.3%)	6 (31.6%)	2 (10.5%)	1 (5.3%)

* A large wild female darted off a redd along with the wake of at least one other fish as the mate; whether a male steelhead or larger resident *O. mykiss* was unknown; it was counted as a male steelhead of unknown origin

** These 2 male steelhead were vividly red-striped and fled on being sighted; the 2 hatchery steelhead did not flee; behavior suggested that the 2 fleeing fish were wild males but no sure visible evidence of adipose fin presence was made

*** This female and male steelhead were in slightly turbid water conditions that prevented seeing adipose fin presence or absence; due to their large size of an estimated 81-86 cm or more they were considered probable wild steelhead

**** It was not possible to determine if this was a smaller male steelhead or large resident male *O. mykiss* of an estimated 46-51 cm or if of wild or hatchery origin; a significant number of resident *O. mykiss* were sampled in Finney Creek in the winter and spring of 2009 for DNA analysis of similar size as were a few steelhead in the mainstem Skagit from 2008 through 2011

***** Probable male sea-run cutthroat based on finding a male *O.clarki* of similar size in the same place the next day spawning with a female *O.clarki*

significant number of resident *O. mykiss* of 15-20 inches (38.1-50.8 cm) was sampled (Pflug et al. 2013). Nearly all were males and most were in mature spawning maturation in the same time period as when the steelhead sampling occurred from early March to early May. As found on the Washington Olympic Peninsula Coast, the resident life history of *O. mykiss* found spawning was gender specific, males apparently mating with female steelhead (McMillan et al. 2007). This also concurs with observations at Waddell Creek in California in one of the earliest studies of steelhead spawning that included presence of male resident *O. mykiss* as part of the presumed spawning mix (Needham and Taft 1934).

The period of overlap for hatchery and wild *O. mykiss* spawning was January 16th through March 12th as found in the Mid Skagit tributaries, a total of 56 days (about two months). If the male *O. mykiss* of unknown origin

and life history that was part of the spawning mix at Finney Creek on March 28, 2014 was a hatchery origin steelhead it would lengthen the time period another 16 days (2.5 months total).

Figure 7.

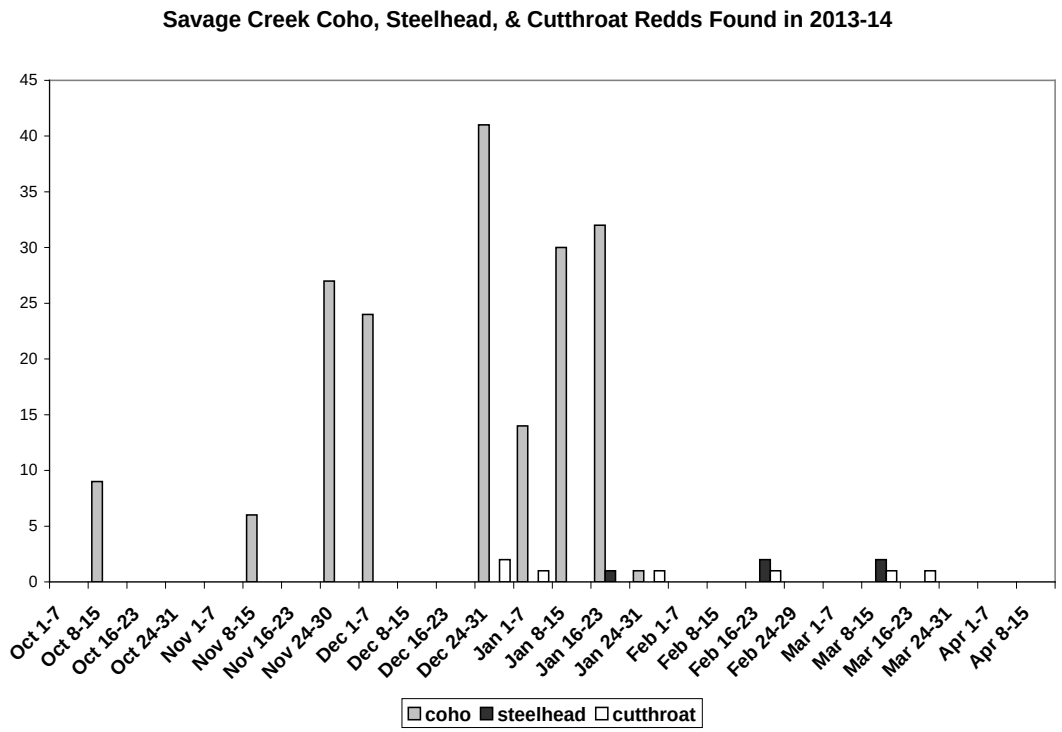


Figure 8.

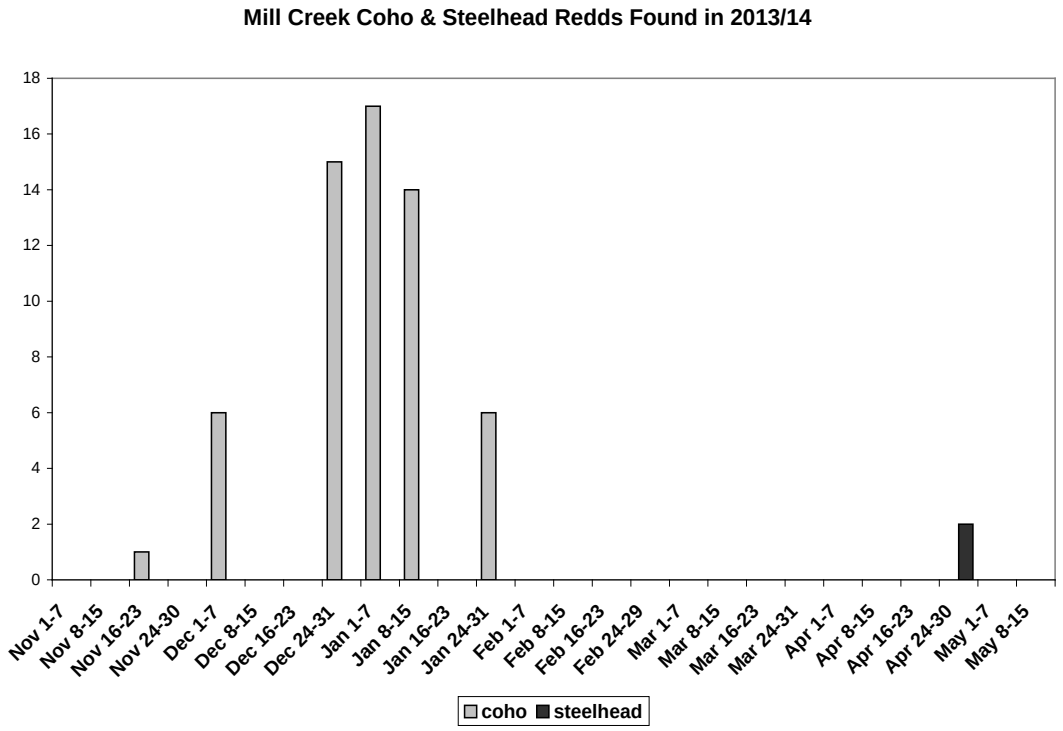


Figure 9.

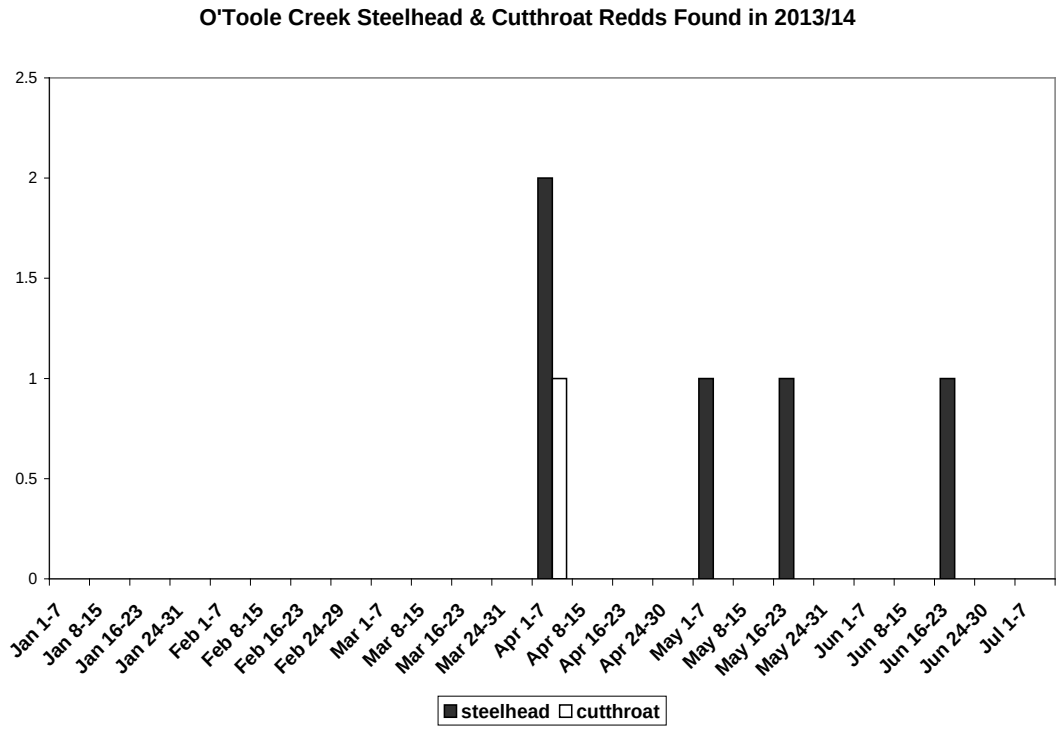


Figure 10.

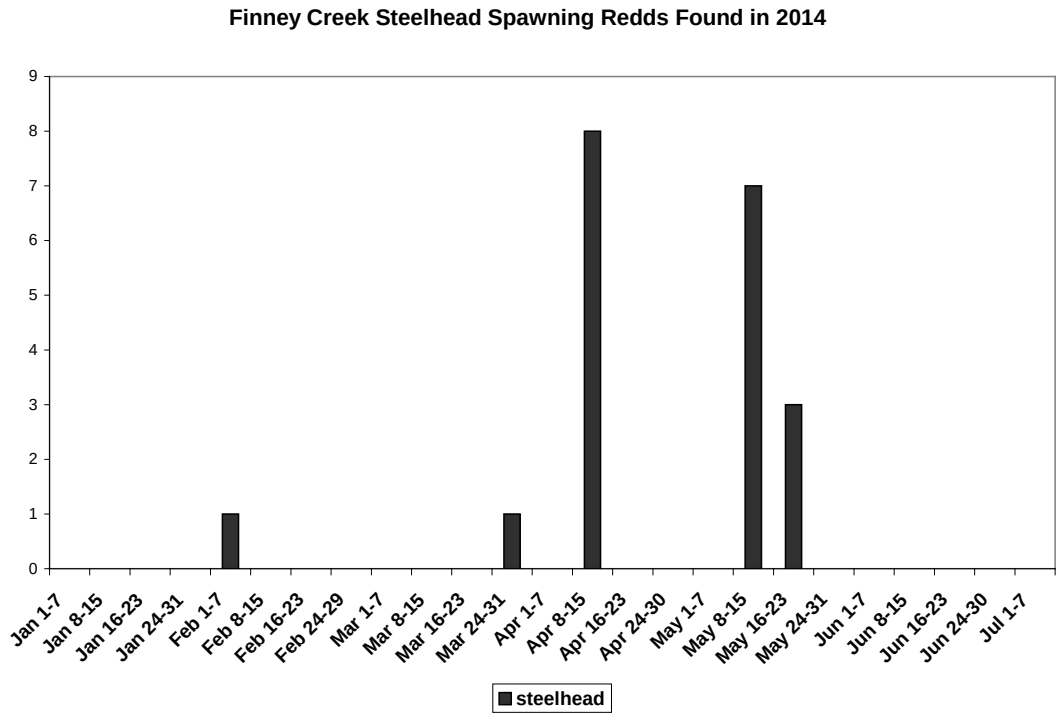
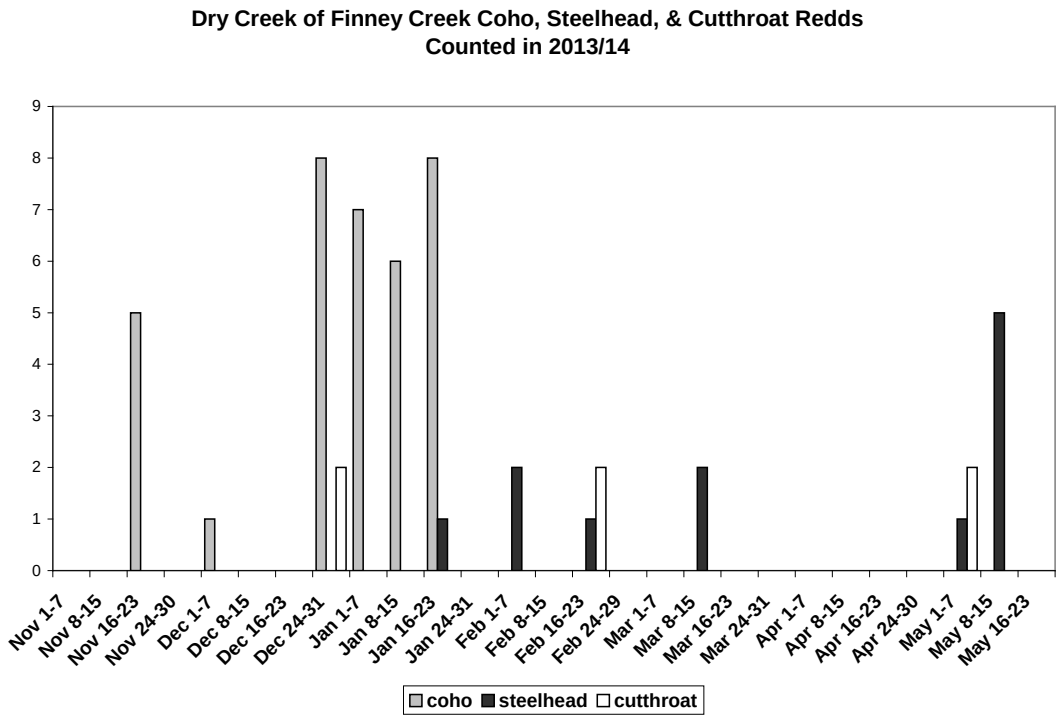


Figure 11.



In 2013-14 particular emphasis was also placed on determining what spawning overlaps may occur between steelhead and other species. Two other species of salmonids were found to have overlapping spawning periods

with steelhead (and resident *O. mykiss*), coho salmon (*Oncorhynchus kisutch*) and sea-run cutthroat (*Oncorhynchus clarki clarki*). This temporal overlap was more so for cutthroat than for coho. The first redd thought to be that of a sea-run cutthroat was latter December at both Dry and Savage creeks. The first and only active sea-run cutthroat spawning was found at Dry Creek on February 20th. The final redd thought to be that of a sea-run cutthroat was at Savage Creek in latter March, and a probable sea-run or resident cutthroat, or *O. mykiss* redd was found at Dry Creek in early May. The last live sea-run cutthroat was a male photographed at O'Toole Creek on May 15th. Figures 7-11 portray the overlaps with the other species as found at Dry, Mill, Savage, and O'Toole creeks during the 2013-14 October through early June survey period. In the case of O'Toole Creek, coho spawning has not been found to be very prevalent in previous years of surveys and in the 2013-14 surveys the temporal window of their potential overlap may have been missed due to a survey gap there from November 12, 2013 to March 12, 2014. At Finney Creek no surveys were made from October through January, primarily due to the difficulty of finding temporal survey windows that provided sufficient clarity to see redds or fish. In all instances in 2014, the transition from coho spawning to steelhead spawning was abrupt and well defined with but a minimal overlap over a one to two week period in mid to latter January.

Differences in Steelhead Spawning Time Found by Tributary

The differences in steelhead spawning times by tributary found in 2014 can be determined from the list of redd counts that have also been adjusted to estimated spawning dates in 7-8 day intervals in Table 3, and the differences by tributary over the five year period of 2010-14 are in Table 6. Steelhead redds as found by specific day for all years are listed in Appendix C, and in 2010 and 2014 in Appendix F (Tables 1 and 2). In 2014, the percentages of steelhead spawning prior to March 15th by tributary were: Savage Creek, 100%; Mill Creek, 0%, O'Toole Creek, 0%, Finney Creek, 10%, and Dry Creek 50% (Figure 2). Over the five year period of 2010-14, the percentages of steelhead spawning prior to March 15th by tributary were: Savage Creek, 94%; Mill Creek, 59%; O'Toole Creek, 22%; Finney Creek, 35%; and Dry Creek, 65% (Figure 4).

Determining Why There Were Steelhead Spawn Time Differences and Why It May Differ by Tributary

It was hypothesized that steelhead spawning time is determined by adaptations to environmental characteristics of spawning location among which are: temperature and streamflow/precipitiation during the spawning period, and perennial/intermittent flows that may determine egg-to-fry survival success. Each of these three factors was separately considered and evaluated from the data that were available, although in the cases of temperature and precipitation/streamflow the data available were not site-specific (Appendix G, Tables 1, 2, and 3 provide air temperature, precipitiation, and streamflow data primarily used from 2010 to 2014). However, even if more precise measures had been available by day and by hour it remained that the great majority of redds found were inactive and not in active spawning use. In some cases redds were estimated to not only be several days old, but weeks old. Without doing daily spawning surveys (commonly impossible due to adverse stream conditions) it may be impossible to develop a precise enough measure of when steelhead spawning actually occurs to be statistically informative enough to determine if correlations to environmental factors such as water temperature, air temperature, precipitation, or streamflow are significant or not. Nevertheless, each of these factors was considered and evaluated from what was available.

a) Temperature: stream temperatures were not measured during each spawning survey due to occurring at varied times of day, and differing days, at each tributary and would not necessarily provide equal comparative factors. There was no access to temperature loggers that could have been placed in each of the five primary tributary streams surveyed that would have been useful for recording water temperatures over the entire

spawning season of surveys. However, as previously indicated, even given a good measure of stream temperature per day and by hour, it remained that the great majority of redds found were inactive and not in active spawning use and a more precise measure of daily and hourly stream temperatures may not have resulted in any more informative comparison of water temperature to spawning time than the less direct methods used.

What was available was a former baseline of stream temperatures that I took in a number of Mid Skagit basin tributary streams in 2002 in preparation for spawning surveys that were then first planned. They were taken at 10-12 day intervals during a significant portion of the steelhead spawning season at near expected daily temperature peaks in latter afternoon (Table 9). While no record was found of stream temperatures for any of the tributary streams surveyed for 2010-2014, there is a long-term daily record of high, low, and mean air temperatures taken at the lower Baker River in Concrete, WA of the Mid Skagit basin that dates back to 1905 and with an interval of complete data from 1909 to 1915 and continuous information from 1931 to the present (WRCC). This historic baseline of air temperature information was used as a potential proxy for water temperature patterns that would have occurred, if not specifically the temperature of each stream. Monthly mean air temperatures were compared to the monthly steelhead redd counts and evaluated with Pearson's correlation coefficient to determine if there was a significant relationship or not.

b) Streamflow/Precipitation: there is presently no streamflow gaging station on any of the Mid Skagit tributaries that were surveyed. However, there was such a station at Finney Creek with streamflow recorded in cubic feet per second (cfs) in the period of 1943-48 (USGS 1943-1948). The North Fork Stillaguamish River has a streamflow gage between Arlington and Oso with streamflow data in cfs that is continuous dating from 1928 to the present. North Fork Stillaguamish streamflows have been considered to provide a surrogate for Finney Creek streamflows (USGS 1928-2014), and from which streamflow patterns during the steelhead spawning period at Finney Creek can be considered relatively equal (and potentially other Mid Skagit basin tributary streams). Alternatively, at the lower Baker River in Concrete, WA there is a long-term mean precipitation record kept that is of the same duration as previously described for air temperatures. It was hypothesized that precipitation pattern may provide a proxy for streamflow patterns at some Mid Skagit basin tributaries where the North Fork Stillaguamish/Finney Creek streamflow relationship may not as well fit. As with air temperatures, both monthly mean streamflow and precipitation were compared to the monthly steelhead redd counts and evaluated with Pearson's correlation coefficient to determine if there were significant relationships or not.

c) Perennial/Intermittent: it was hypothesized that steelhead spawning may be particularly limited in duration at those tributary streams that go intermittent by late June to early July due to the lack of subsequent egg-to-fry survival that may occur if spawning took place beyond a certain point in time. To test this, each creek that was regularly surveyed was subsequently examined after the end of the 2014 steelhead spawning season at regular intervals through June, July, and August to determine if any part went intermittent, when, where, and how far the intermittency occurred both downstream and up. Perennial streams were also determined in this same period.

Stream Temperature Findings

Reasons for the differences in steelhead spawning time found among the Mid Skagit tributaries could be related to water temperature as one measurable environmental effect (Cederholm 1984). Among the considerations for temperature differences by tributary was the buffering effect on flows and temperature during the spawning period as a result of ponds, lakes, or wetlands that may affect spawning time, or the directional orientation of a

tributary watershed (facing north and away from winter sun, or facing south and into the winter sun, for instance) may result in warmer or lower average temperatures, or the proportional distribution of the watershed area between higher and lower elevations.

The Table 10 stream temperatures were recorded on a Fahrenheit (F) scale with added conversions to Centigrade (C). Bell (1973) indicates that steelhead spawning occurs at 3.9-9.4 C (39.0-48.9 F). Bovee (1978) indicates steelhead spawning occurs at 4-13 C (39.2-55.4 F). These sources likely capture the general range of steelhead spawning temperatures found in Washington. Temperatures greater than 4.0 C (39.2 F) were considered adequate to initiate steelhead spawning. Temperatures of 3.9 C (39.0 F) were considered marginal for initiation of steelhead spawning. Using these criteria, Grandy Creek in 2002 would have provided adequate peak spawning temperatures throughout the February 9 to April 15 period. If the marginal temperature peaks are included, both the mainstem Mid Skagit River and Finney Creek could have initiated steelhead spawning through most of that same period. Mill and Pressentin creeks had adequate to marginal temperature peaks to initiate steelhead spawning for three of the seven temperature points in that period. O'Toole Creek had only two of those seven temperature periods adequate for spawning. In all three of the latter creeks, these temperature periods were confined to latter March onward. In the case of Grandy Creek (only rarely surveyed), with warmer water temperatures within the range for steelhead spawning throughout the February to April period of 2009, important considerations are a lake in its headwaters and a south facing aspect of the drainage into the winter sun on the north side of the Skagit Valley. The combined lake and orientation to the sun is a likely combination from which to anticipate the warmer winter/spring stream water temperatures found and that steelhead spawning temperatures occur there at what may be a particularly early date. Although Grandy Creek was surveyed early in the spawning season (February) in 2010, 2011, 2013, and 2014 with steelhead redds found in the surveys three of those years (2010, 2013, and 2014) whose estimated spawning dates included January, no later surveys were done for comparison (Appendix C). Nevertheless, it is apparent that Grandy Creek is one of the Mid Skagit basin tributaries where steelhead spawning prior to March 15th is common.

While the Table 10 data is generally useful as a potential guide to determining what stream characteristics and subsequent peak spawning temperatures might temporally stimulate steelhead spawning to occur in the Mid Skagit area, it includes only three of the five creeks regularly surveyed in 2014 (Finney, Mill, and O'Toole creeks) and one creek rarely surveyed (Grandy Creek).

Table 9. Mid Skagit basin peak stream temperatures at 10-12 day intervals

Stream Orientation & etc.	**Temp F/C**	**Water temperature by 10 day intervals February 9 to April 15, 2002**							**Mean Temp**
		2/9	**2/19**	**3/2**	**3/12**	**3/24**	**4/3**	**4/15**	
Grandy Ck (faces south & lake & wetland headwaters)	F C	40.5 4.72	40.5 4.72	41.0 5.00	40.0 4.44	44.25 6.81	46.0 7.78	42.25 5.69	42.08 5.60
Skagit River (5 dams & reservoirs)	F C	39.0 3.89	39.5 4.17	39.5 4.17	38.5 3.61	43.75 6.53	44.0 6.67	40.5 4.72	40.68 4.82
Finney Ck (faces n.w. & long lower reach of low gradient)	F C	39.0 3.89	39.5 4.17	38.5 3.61	38.5 3.61	42.5 5.83	45.0 7.22	40.75 4.86	40.54 4.74
Mill Ck (faces north)	F C	38.5 3.61	38.5 3.61	37.5 3.06	38.0 3.33	40.0 4.44	40.0 4.44	39.5 4.17	38.86 3.81

Pressentin Ck	F	38.0	38.5	36.5	37.5	39.75	40.25	39.0	38.50
(faces north)	C	3.33	3.61	2.50	3.06	4.31	4.58	3.89	3.61
O'Toole Ck	F	38.0	38.0	36.0	37.0	39.5	39.75	38.75	38.14
(faces north)	C	3.33	3.33	2.22	2.78	4.17	4.31	3.75	3.41

Temperatures shaded in light gray are within the common range of steelhead spawning (Bell 1972, 3.9-9.4 C; Bovee 1978, 4-13 C) and dark gray marginally included. (Orcutt, 1968, indicated Idaho steelhead in the headwaters of the NF Clearwater River spawn at 2.2-8.3 C, but it is at a much higher elevation than Western Washington streams. Nevertheless, it suggests that steelhead can spawn at lower temperatures.)

From summer temperature data at the five Mid Skagit tributaries regularly surveyed in 2014 (Table 10), on June 16th of a cloudy, cool day Finney Creek was again the warmest temperature and O'Toole Creek the coldest with Mill Creek slightly warmer than O'Toole. However, the mainstem Mid Skagit River was nearly as cold as O'Toole Creek. This was to be expected in June due to peak snowmelt from the North Cascade Mountains then occurring with several headwater origins from glaciers. Savage Creek, which runs through a series of ponds and wetland areas from 0.5 to 1.0 kilometer (km) above entry to the Skagit River, was 4.4 C warmer 135 meters (m) below the largest main pond than 125 m above it. Dry Creek, an otherwise unnamed tributary of lower Finney Creek, was colder than Finney and lower Savage Creek, but warmer than Mill, O'Toole, and upper Savage Creek.

Flows rapidly diminished and heated from late June to mid July, except in the mainstem Mid Skagit River. The period from July 9 to July 14 of 2014 on the Mid Skagit Valley floor had afternoon peaks of 80-85 F (26.7-29.5 C) as taken near the mouth of Savage Creek. While the mid June temperatures were taken during a cooler and stable temperature day, as can be common in June in the Mid Skagit Valley, the mid July temperatures represent what is a common high temperature period during most summers in the Mid Skagit Valley. Morning temperature was taken at Mill Creek on July 13th as representative of cooler tributary streams during warmer

Table 10. Mid Skagit River and five tributary creek air and water temperatures in summer of 2014

warmest by date coolest by date

Creek	Section	Date	Time	Weather	Air Temp		Water Temp	
Finney Ck	3.5 km above mouth	6-16-2014	4:05 pm	cloudy cool	57.0 F	13.9 C	57.0 F	13.9 C
Dry Ck of Finney	250 m above mouth	6-16-2014	4:00 pm	cloudy cool	57.0 F	13.9 C	51.5 F	10.8 C
Mill Ck	90 m above S. Skagit Hwy	6-16-2014	4:20 pm	cloudy cool	57.0 F	13.9 C	49.5 F	9.7 C
Savage Ck	125 m above main pond	6-16-2014	5:15 pm	cloudy cool	57.0 F	13.9 C	51.0 F	10.6 C
Savage Ck	135 m below main pond	6-16-2014	5:10 pm	cloudy cool	57.0 F	13.9 C	59.0 F	15.0 C
O'Toole Ck	70 m above S. Skagit Hwy	6-16-2014	4:40 pm	cloudy cool	57.0 F	13.9 C	48.5 F	9.2 C
Mid Skagit Riv	Savage Bar	6-16-2014	6:15 pm	cloudy cool	58.0 F	14.4 C	49.0 F	9.4 C
Mill Ck	25 m below S. Skagit Hwy	7-13-2014	10:20 am	sunny warm	69.0 F	20.6 C	57.5 F	14.2 C
Savage Ck	250 m above main pond	7-13-2014	9:35 am	sunny warm	66.0 F	18.9 C	54.5 F	12.5 C
Savage Ck	135 m below main pond	7-13-2014	10:00 am	sunny warm	68.0 F	20.0 C	69.5 F	20.8 C
Finney Ck	4.0 km above mouth	7-13-2014	8:30 pm	sunny warm	70.0 F	21.1 C	70.5 F	21.4 C
Dry Ck of Finney	450 m above mouth	7-13-2014	8.15 pm	sunny warm	70.0 F	21.1 C	63.5 F	17.5 C
Savage Ck	135 m below main pond	7-13-2014	8:48 pm	sunny warm	69.0 F	20.6 C	75.0 F	23.9 C
Mill Ck	25 m below S. Skagit Hwy	7-13-2014	8:52 pm	sunny warm	68.0 F	20.6 C	59.5 F	15.3 C
O'Toole Ck	70 m above S. Skagit Hwy	7-13-2014	9:00 pm	sunny warm	68.0 F	20.0 C	59.5 F	15.3 C
Mid Skagit Riv	Savage Bar	7-13-2014	9:15 pm	sunny warm	68.0 F	20.0 C	55.0 F	12.8 C
Savage Ck	135 m below main pond	7-14-2014	8:13 pm	sunny warm	70.0 F	21.1 C	75.5 F	24.2 C

Savage Ck	450 m above main pond	7-14-2014	8:30 pm	sunny warm	68.0 F	20.0 C	58.0 F	14.4 C
Finney Ck	3.5 km above mouth	8-16-2014	4:45 pm	cloudy warm	69.5 F	20.8 C	68.0 F	20.0 C
Dry Ck of Finney	350 m above mouth	8-16-2014	4:30 pm	cloudy warm	69.5 F	20.8 C	62.0 F	16.7 C
Mill Ck	30 m above S. Skagit Hwy	8-16-2014	3:00 pm	cloudy warm	69.5 F	20.8 C	59.5 F	15.3 C
Savage Ck	450 m above main pond	8-16-2014	5:20 pm	cloudy warm	69.5 F	20.8 C	58.0 F	14.4 C
Savage Ck	below main pond dry	8-16-2014	5:05 pm	cloudy warm	69.5 F	20.8 C	dry	
O'Toole Ck	70 m above S. Skagit Hwy	8-16-2014	3:20 pm	cloudy warm	69.5 F	20.8 C	59.0 F	15.0 C
Mid Skagit Riv	Savage Bar	8-16-2014	5:45 pm	cloudy warm	69.5 F	20.8 C	59.5 F	15.3 C
Finney Ck	3.5 km above mouth	8-28-2014	8:00 pm	cloudy warm	65.0 F	18.3 C	70.0 F	21.1 C
Dry Ck of Finney	400 m above mouth	8-28-2014	7:50 pm	cloudy warm	65.0 F	18.3 C	62.0 F	16.7 C

summer weather periods, and at Savage Creek to measure both the inflow temperature to its pond/wetland reach as well as the outflow. Evening temperatures were taken on July 13-14 at all of the streams to represent water temperatures at near their peak during warmer summer periods (although evening may represent some slight cooling from what may be an actual peak a few hours earlier). The highest temperatures were at Finney Creek (70.5 F; 21.4 C) and Savage Creek below the uppermost pond (75.5 F; 24.2 C). At the latter juvenile coho and undetermined species fry were active and seemingly healthy. The coolest temperatures were at O'Toole Creek (59.5 F; 15.3 C) and the Mid Skagit River (55.0 F; 12.8 C). The summer peak air temperature occurred on August 11th at 93 F (33.9 C) near the mouth of Savage Creek (near Birdsview) and was preceded by several days in mid to high 80 F (26.7 C) range. Unfortunately, no time was available to take stream temperatures in that time period, but Finney Creek would have peaked considerably higher than on July 13th as the stream with the probable warmest summer peak temperature of those that remained wetted. Savage Creek below the ponds went dry by early August as the previous water temperature peak. On August 28, even at late evening after a mild late afternoon high of 70 F (21.1 C), Finney Creek was also 70 F, while Dry Creek was 62 F (16.7 C) just upstream of where it was dry.

The combined findings of water temperatures taken from early February to Mid April (Table 9) in the steelhead spawning period at Mid Skagit Basin tributaries and the shift to mid June and later (Table 10) indicate that the shift to maximum water temperatures beyond which steelhead spawning may cease at 9.4-13.0 C (48.9-54.5 F) as previously indicted by Bell (1973) and Bovee (1978) likely begins sometime between May and mid June at four tributaries (Savage, Mill, Finney, and Dry creeks), while continuing into June at O'Toole Creek. The actual steelhead spawning found in these same five tributaries further confirms this likelihood (Table 7).

Between 2000 and 2011 stream water temperatures were recorded at several Mid Skagit tributary streams at broadly spaced times while doing sampling or spawning surveys (Table 11). For the most part they merely confirm the previous temperature findings in Tables 10 and 11. However, it includes the active spawning period of January 19, 2011 at Savage Creek with the water temperature taken at the spawning location below

Table 11. Mid Skagit Basin Tributary Water Temperatures Taken at Varied Times Compared to Air Temperatures

Active steelhead spawning period

Tributary	Date	Time	Water temp (F)	Concrete air temp (F) low-high	Birdsview air temp (F)	Notes
Mill	7-21-2000	2:20pm 4:30pm	55 55	n/a	80 afternoon high	....

Mill	7-3-2007	3:45pm	54	52-78.1	....	....
O'Toole	2-3-2010	3:00pm	42	37-48	....	El Nino year
Mill	2-4-2010	2:30pm	42	37-44	....	El Nino year
Finney	2-6-2010	1:30pm	44	35-50	....	El Nino year
Pressentin	2-8-2010	1:30pm	41.5	41-48	....	El Nino year
Grandy	2-8-2010	2:15pm 3:30pm	44 44	41-48	....	El Nino year
Finney	4-13-2010	afternoon	44	39.9-60.1	....	El Nino year
Cumberland	6-25-2010	12:30pm	54	55-75.9	....	....
Mill	1-19-2011	4:50pm	39	36-39.9	....	....
Savage	1-19-2011	4:40pm	42	36-39.9	....	active spawning below pond outlet & where temperature taken
Mid Skagit	1-19-2011	5:00pm	40	36-39.9	....	....
Grandy	2-2-2011	2:00pm	40	27-39.9	21 morning low	very cold morning

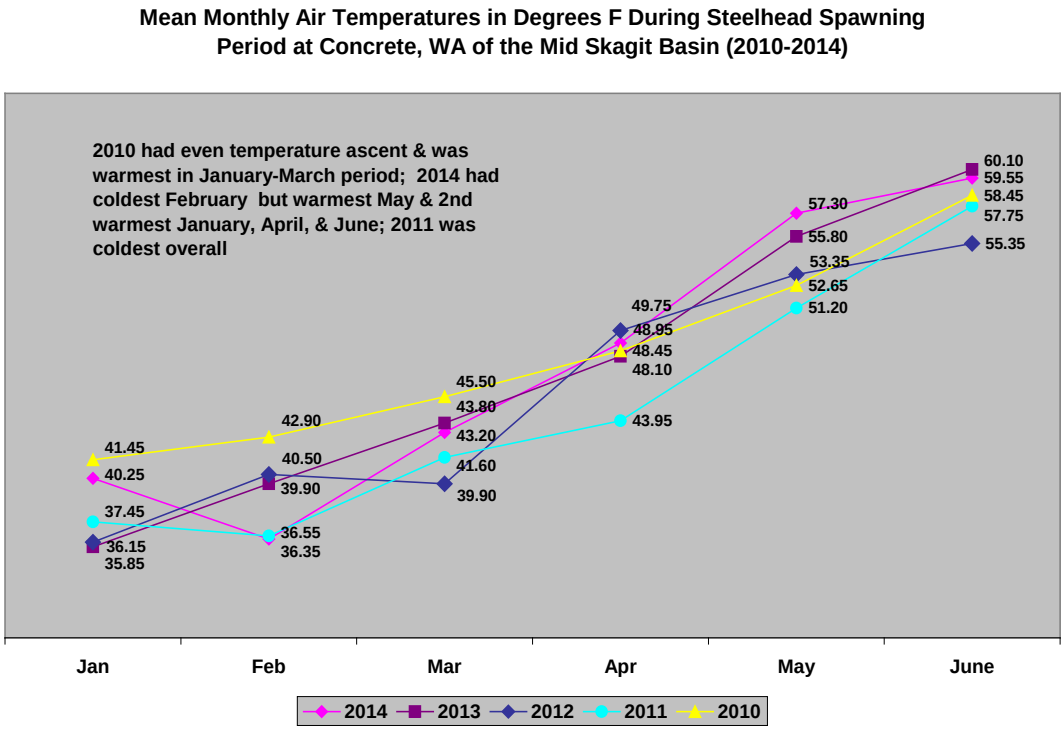
upper Savage pond. The water temperatures were similarly taken at the same day and time at nearby Mill Creek and the Mid Skagit River. The table also includes the Concrete, WA air temperature range (low and high) for each day (north side of the Mid Skagit River) and that at Birdsview, WA (south side of the Mid Skagit River) if available for the same days. The active spawning found at Savage Creek was on a relatively cool day (air temperature at Concrete being a low of 36 F and a high of 39.9 F) and at a water temperature of 42 F. At the same time, Mill Creek was 39 F and the Mid Skagit River 40 F, both cooler. Savage Creek was well within the temperature range indicated in the literature for steelhead spawning (depicted in Table 9) while that at Mill Creek and the Mid Skagit River were at the low to marginal end of the spawning temperature range. Between February 4 and 8 of 2011 there was a period of relatively stable air temperature and weather conditions during which afternoon water temperatures were taken at Mill (42 F), O'Toole (42 F), Finney (44 F), Grandy (44 F), and Pressentin (41.5 F) creeks of the Mid Skagit basin.

While the above stream temperature findings provide indicators of when typical steelhead spawning time windows can begin in Mid Skagit basin tributary creeks according to literature sources, and which of the streams tend to run cooler or warmer, there was only the one active spawning-to-temperature comparison made that also included temperatures taken at other nearby tributaries and the Skagit River during the 2010-14 cumulative spawning surveys made, that being Savage Creek on January 19, 2011 as compared to Mill Creek and Skagit River temperatures at the same time (Table 11).

Air Temperature Findings

Although average monthly water temperatures were not kept for any of the tributaries surveyed, and no similar data have been found available, monthly air temperature data is available for Concrete, Washington of the Mid

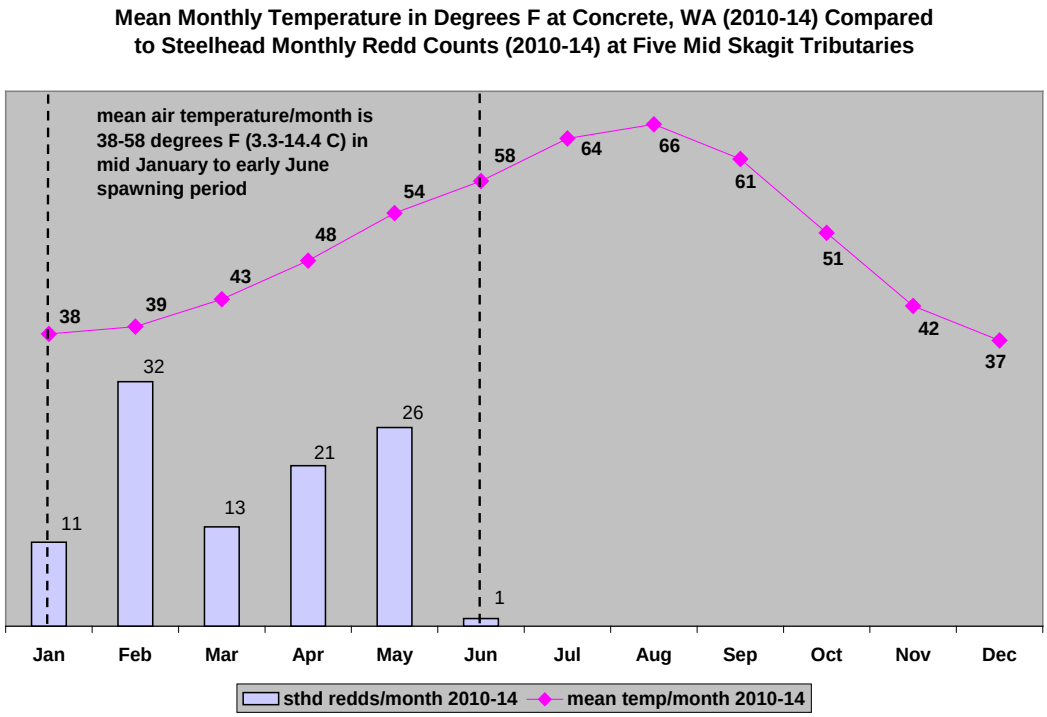
Figure 12.



Skagit basin (WRCC 2014) and may provide a proxy for water temperature trends if not water temperatures themselves. Figure 12 provides the mean monthly air temperature patterns for each year at Concrete during the steelhead spawning period from 2010 to 2014 (Appendix G, Table 1 provides the temperatures per month). The monthly air temperatures in 2010 were higher from January to March than the other years and progressed upward at a gradual and even rate that ended up cooler in May compared to other years. The February mean air temperature was colder in 2014 than the other years but warmest in May and second warmest in January, April, and June. On whole, 2011 was the coldest of the years during the steelhead spawning period.

Steelhead spawning redds per month by date found at the Mid Skagit basin tributaries as compared to monthly mean air temperatures during the steelhead spawning period of the 2010-2014 surveys (Figure 13) suggest that steelhead spawning generally increases as mean air temperatures do from January (38 F, or 3.3 C) through May

Figure 13.



(54 F, or 14.4 C). The exception to what is otherwise an even progression of steelhead redds to increasing mean monthly air temperature is February as the month found with the single greatest number of steelhead redds. However, when the 2010-2014 steelhead redds found were adjusted to estimated spawning date, presumably the more relevant comparison, it results in what appears to be a slight inverse relationship to mean temperature per month with spawning apparently diminishing as temperatures rise (Figure 14).

While it was obvious during the surveys that a number of redds found were several days to several weeks old, the actual spawning time could only be estimated by personal judgment based on amount of algae on the redd, how vague its pit or tailing had become, and/or the prior periods when there had been spawning in near-by tributaries or otherwise what had seemed the best stream conditions for steelhead entry into these streams. In a number of instances, the judgments made regarding spawning date could have been pushed forward into the next month or dropped back into the following month. In this regard, spawning survey methods as limited by weather/water conditions do not lend to precision of spawning date determination by month for all redds. For this reason, both the dates when the redds were found and the estimated spawning dates have been comparatively evaluated for temperature (as well as for precipitation and streamflow).

A further evaluation of the potential relationship of air temperatures to the steelhead redds by date found in the primary steelhead spawning period from January to June was made (Figure 15) with a resulting Pearson's correlation coefficient, or "r", of - 0.3501, which is not statistically significant using critical values from the

Figure 14.

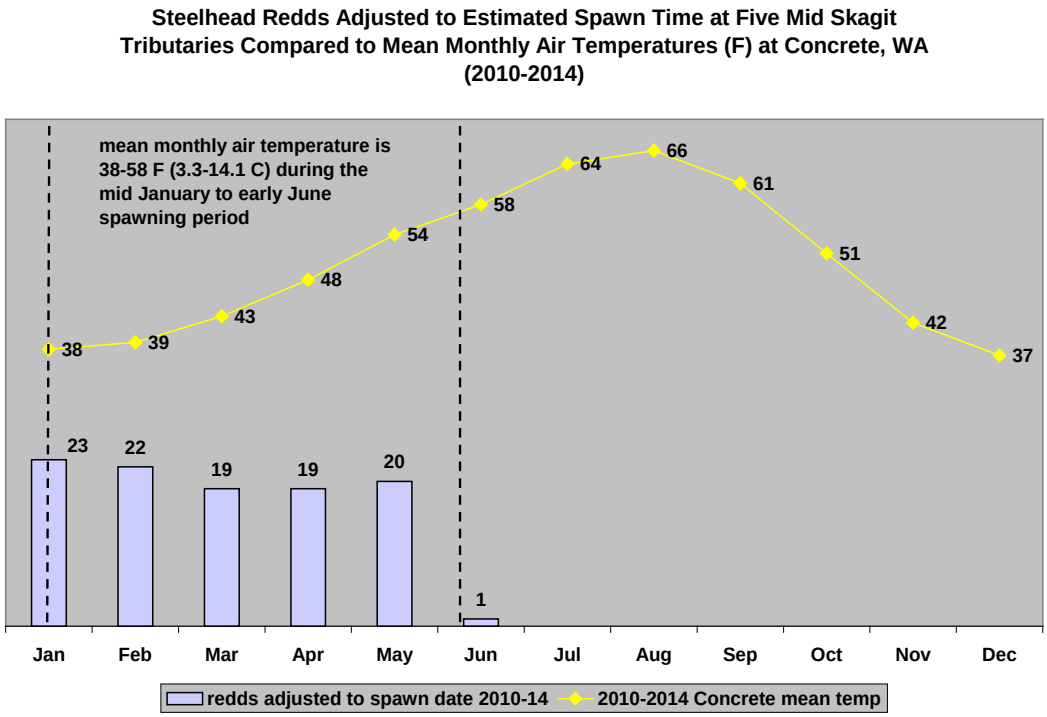


Figure 15.

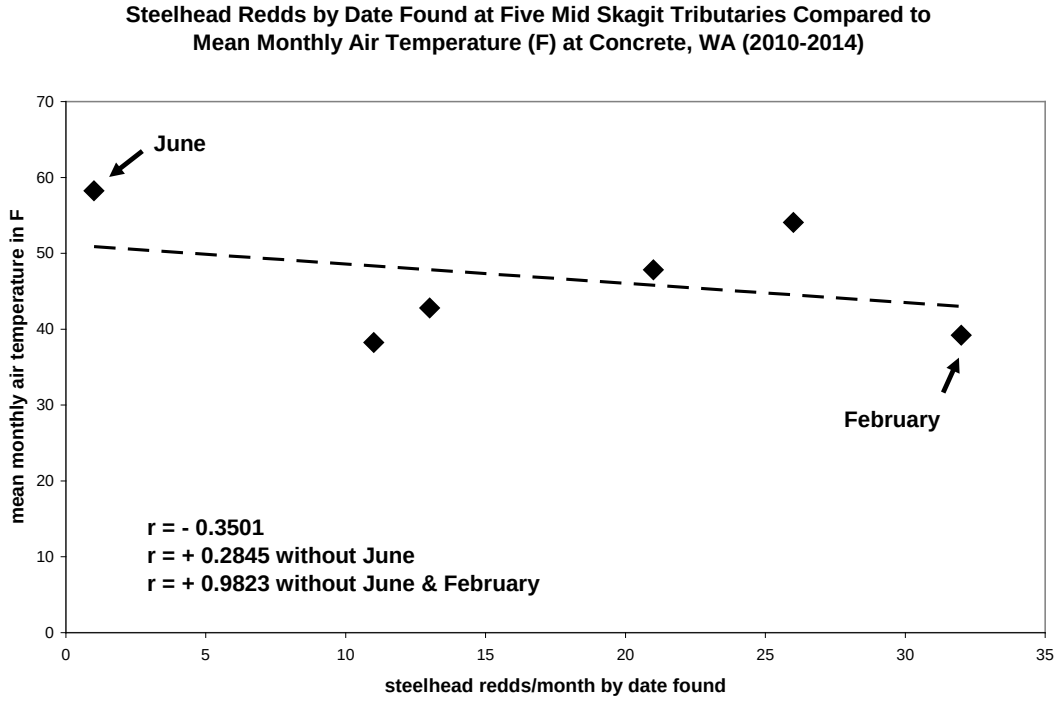
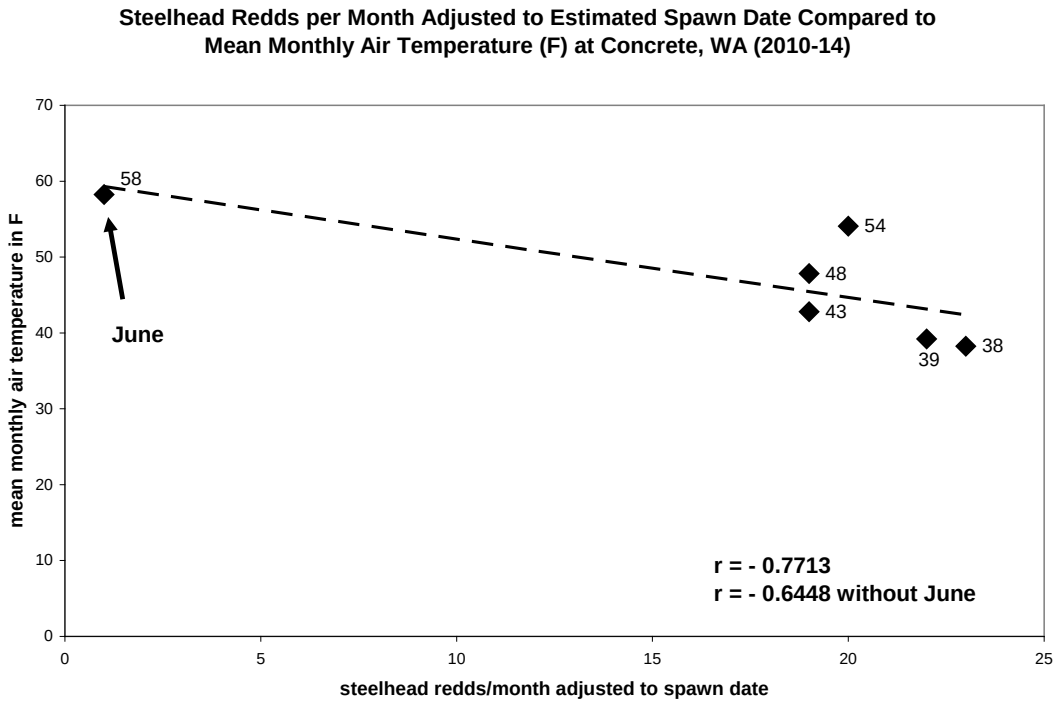


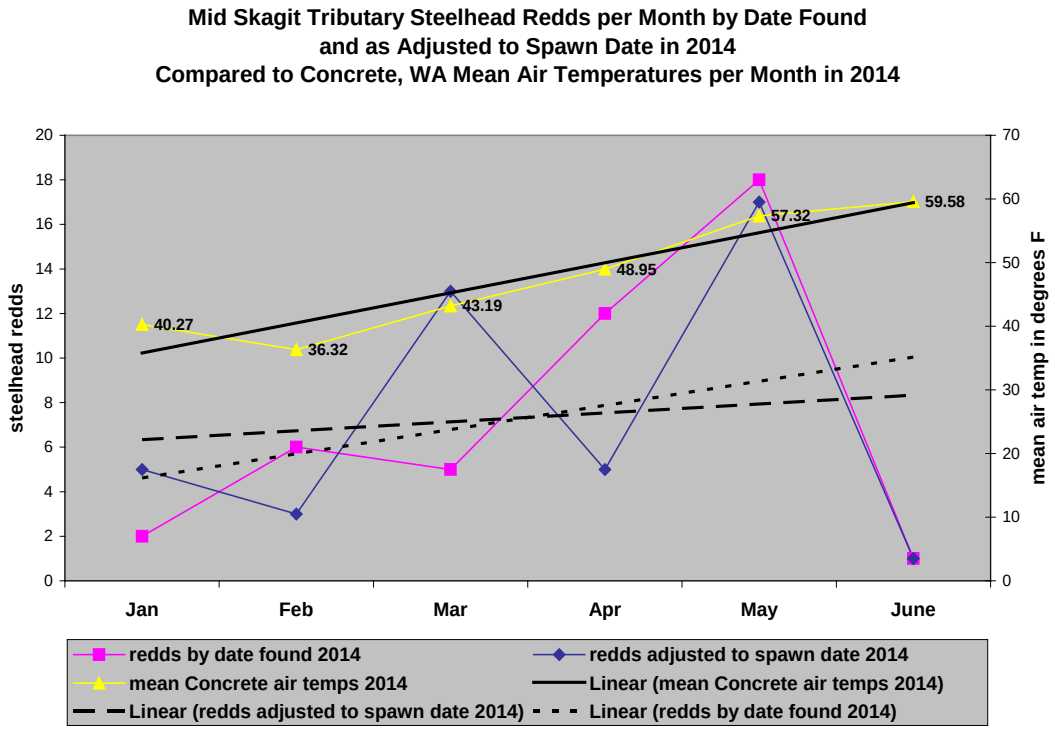
Figure 16.



Pearson's correlation coefficient table. If June is eliminated as the month when only one steelhead redd was found, "r" reverses to + 0.2845, which is also not statistically significant. If February is excluded as the outlier month in the pattern "r" is + 0.9823 and is highly significant, but to exclude February would be to ignore the one month with the greatest steelhead redd count. When the steelhead redd to air temperature correlation is determined after the redds are adjusted to estimated spawning date (Figure 16) for the January to June full spawning period "r" reverses to - 0.7713 and is statistically significant. However, if June is excluded as outside the more typical spawning period "r" is not significant at - 0.6448. Although there is a significant negative correlation of spawning to increased air temperature if redds are adjusted to spawning date and including June, the redds were so limited in June (with air/water temperature increases that limit spawning) that eliminating June is potentially the better evaluation. Given the range of findings, there may be some other relationship that is more primarily driving steelhead spawning than air temperature. Alternatively, the monthly level of temperature to redd date, or to spawning date, comparisons over the 2010-2014 period may not be specific enough to portray the daily temperature variations that could still be a main driver of steelhead spawning.

The steelhead spawning redds adjusted to estimated spawning date at the Mid Skagit tributaries are also compared to mean air temperatures per month at Concrete in 2014 alone (Figure 17). The general trendline for the redds by date found is more similar to that of the mean monthly air temperature trend than when the redd counts are adjusted to estimated spawning date. Nevertheless, the latter trend has a general ascending pattern but the actual spawning occurs in greater peaks and valleys between months. A further evaluation of the relationship of air temperatures to the 2014 steelhead redds as found was made (Figure 18) with a resulting "r"

Figure 17.



of + 0.3230 which is not statistically significant, although if June is excluded (with only one redd found) it results in an "r" of + 0.9060 which is significant. If the 2014 steelhead redds are adjusted to estimated spawning date as compared to mean monthly air temperature (presumably the more appropriate evaluation) it results in an "r" of + 0.1907 which is not significant, and if June is excluded the "r" increases to + 0.7396 but which is still not quite statistically significant (Figure 19).

At the specific tributary level only Finney Creek had enough redds per year in 2010 and 2014 to provide a useful comparison of spawning to air temperature. The redd counts were adjusted to represent the estimated spawning dates in Figure 20 with an apparent increase in spawning as monthly air temperature increased from January through June both years (but spawning only into May). Rather than an even progression spawning occurred in alternating monthly peaks and valleys in 2014 when a particularly cool February with no spawning was followed by a March spawning peak. A second higher spawning peak occurred in May as it warmed after April. In 2010 the air temperatures were more evenly gradual with similarly gradual increases in spawning until a sudden peak in April with little thereafter. During the generally warmer early spawning period of 2010 the peak in mid April was a month earlier than that of mid May in the colder early spawning period of 2014. The Pearson's correlation coefficient for monthly spawning at Finney Creek in 2014 compared to monthly mean air temperature at Concrete resulted in an "r" of + 0.7773 and in 2010 an "r" of + 0.2126. While spawning was positively correlated to air temperatures in the January to May spawning period both years (more so in 2014 than 2010) it was not statistically significant.

The combined comparisons of monthly air temperature correlations to spawning time at the Mid Skagit tributaries are erratic. Without more precise dates when spawning occurs it may limit finding a significant temperature/spawning correlation if there is one (and there apparently is related to initiation and end points). However, stream conditions often deny visibility and the ability to find enough active spawning from which to

Figure 18.

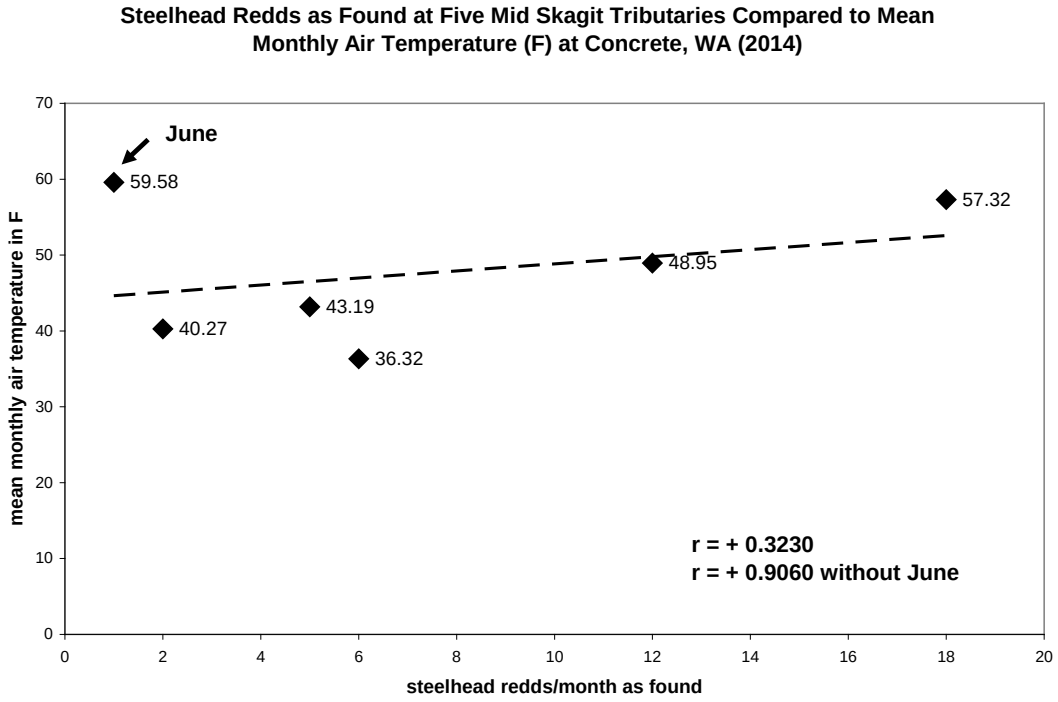


Figure 19.

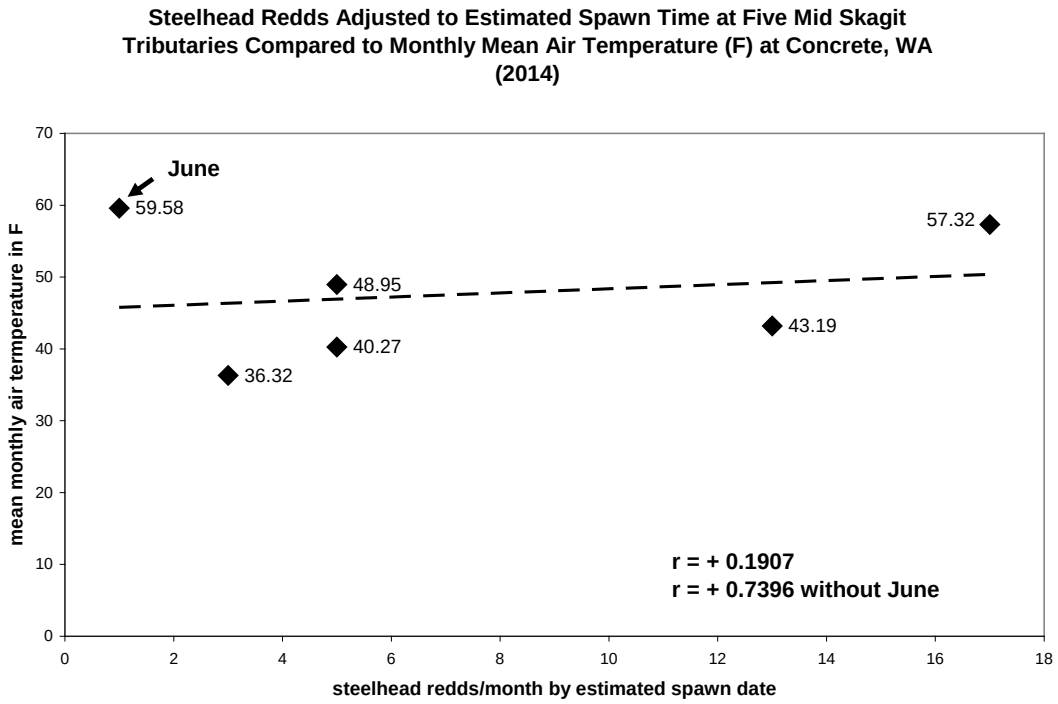
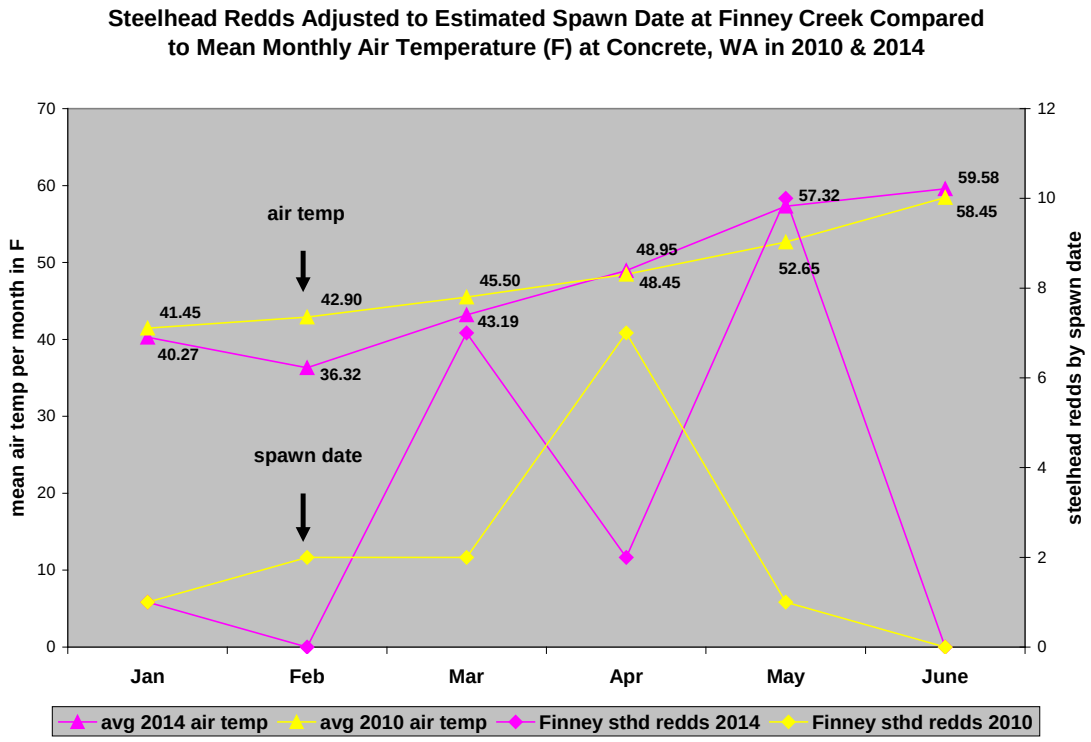


Figure 20.



compare daily temperatures. The Finney Creek shift in peak spawning by 30 days between warmer years and colder years in the early spawning period may well be the most identifiably important temperature relationship. It also concurs with the steelhead spawning survey findings at other Washington rivers (Crawford et al. 1979; Cederholm 1984)) where colder years resulted in later spawning peaks and warmer years in earlier peaks. It also remains that some other factor may be a more consistent driver of steelhead spawning time in the Mid Skagit tributaries, particularly that of intermittent and perennial flows in their selection over time for earlier or later spawning as previously identified.

Precipitation and Streamflow Relationship to Spawning Findings

There are presently no streamflow gages at any of the tributaries surveyed in the Mid Skagit basin, but 1943-48 streamflow records are available for Finney Creek (USGS 1943-48). Streamflow records for 1928-2014 are also available for the North Fork Stillaguamish River (USGS 1928-2014) and have been used by others as a surrogate for Finney Creek (Nichols and Ketcheson 2013). However, Finney Creek streamflows (or those of the North Fork Stillaguamish River) may not necessarily reflect those of the four other Mid Skagit tributary creeks that have shorter lengths, smaller basin sizes, and differing watershed source attributes. Alternatively, monthly precipitation records dating to 1905 are available for Concrete in the Mid Skagit basin (WRCC 2014) that may provide a proxy for streamflow trends, if not the flows themselves, over a long historical period that is more relevant across all five tributaries surveyed. The combination of the 1943-48 streamflow baseline at Finney Creek and mean precipitation per month in the 1909-15 and 1931-2014 time periods at Concrete also provides the opportunity for streamflow considerations related to steelhead spawning based on available comparative trends over time and toward the future.

At the shorter term scale of 2002-14 my rain gage near the mouth of Savage Creek (near Birdsview, Washington) provides the monthly precipitation during the 2010-2014 spawning survey period that is

geographically closest to the lower basin areas of the five Mid Skagit tributaries primarily surveyed. The precipitation measures at these two locations from 2010 to 2014 are compared to the steelhead redds by the date found at the Mid Skagit basin tributaries in the same period (Figure 21; Appendix A, Tables 1 and 2 provide the precipitation data per month for Birdsview and Concrete). The precipitation gage near Birdsview is on the south side of the Mid Skagit River near the entry of Savage Creek (RM 45.75) while that of Concrete is on the north side, a short distance up the Baker River (RM 56.5) 10.75 miles (17.3 km) upstream. The five Mid Skagit creeks where the surveys occurred are all on the south side of the Skagit River from O'Toole Creek (RM 43.5) to Finney Creek (RM 47.5) with the Birdsview gage near the middle of the 4 mile length of river that all five tributaries enter. Although the Birdsview precipitation is greater than at Concrete in all months except July and August and may be specifically more accurate for the tributary locations, their pattern of temperatures from month to month are very similar during the steelhead spawning period. As a result, for the purposes of this report the Concrete precipitation data have been used as a surrogate for that of Birdsview because of the longer term history for further comparisons.

The Concrete precipitation is further compared to the redds found at the five Mid Skagit tributaries as adjusted to the estimated steelhead spawning dates (Figure 22) which is the more relevant comparison if the estimated spawning dates more accurately represent the actual spawning time. While it was obvious that a number of redds found were several days to several weeks old, the actual spawning time could only be a best judgment based on amount of algae on the redd, how vague its pit or tailing had become, and the prior periods when there had been spawning in near-by tributaries or otherwise what had seemed the best periods for steelhead entry into these streams.

Figure 21.

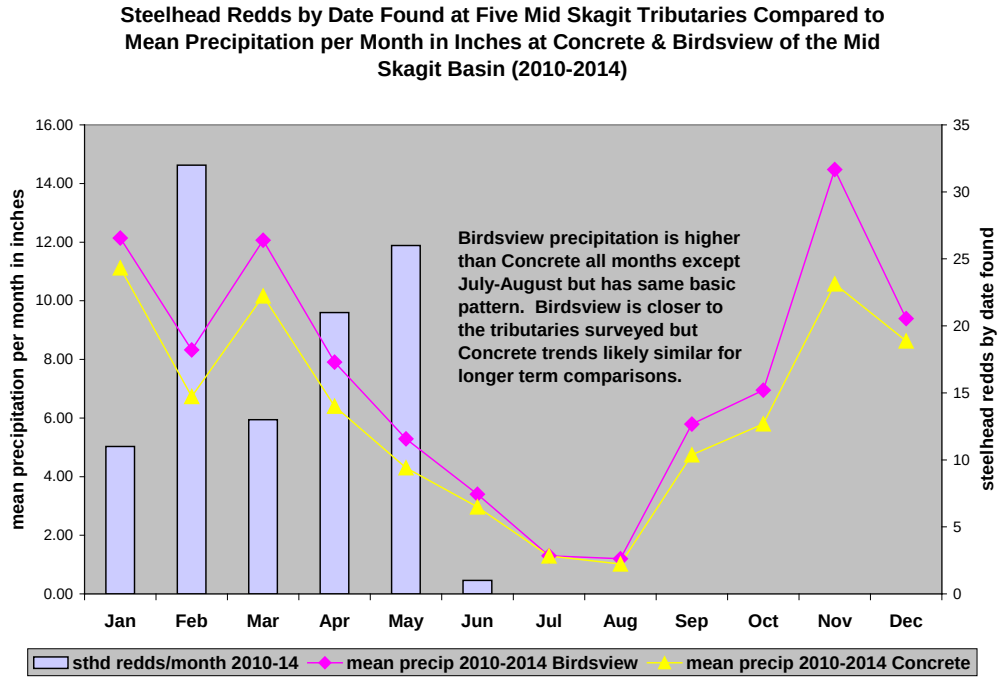


Figure 22.

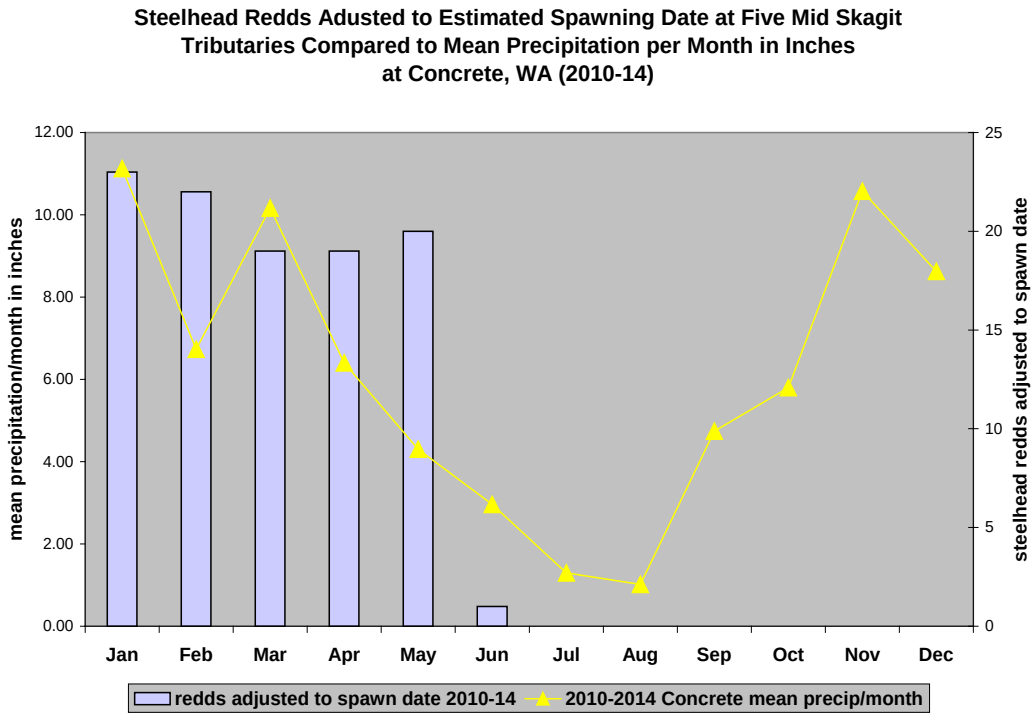
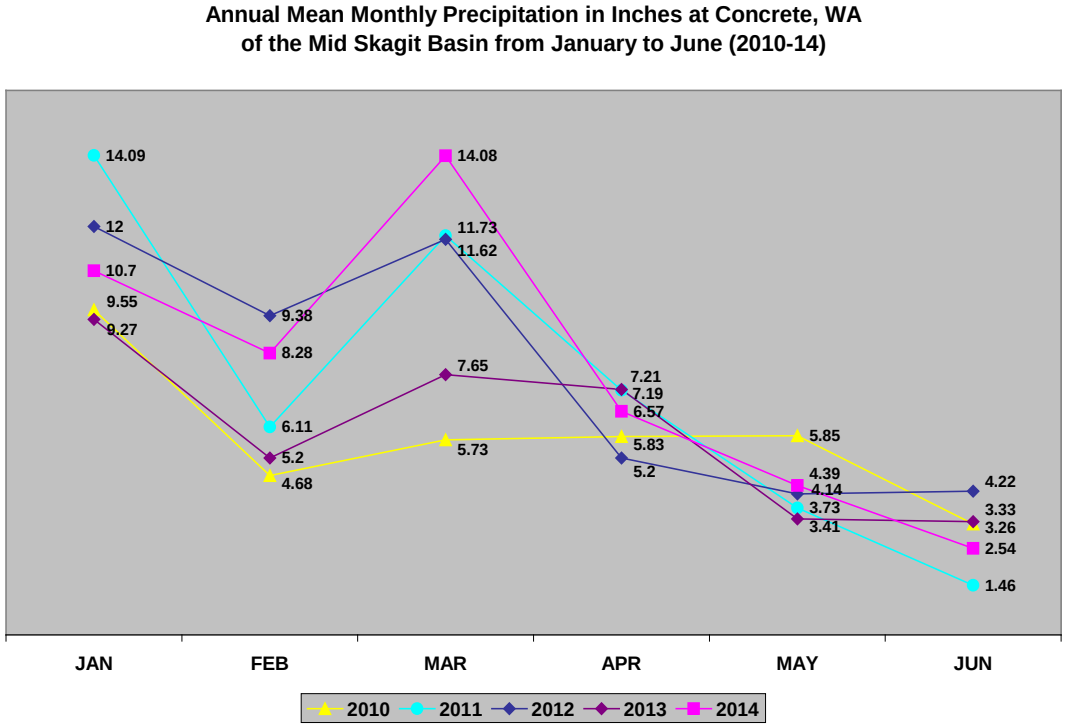


Figure 23.

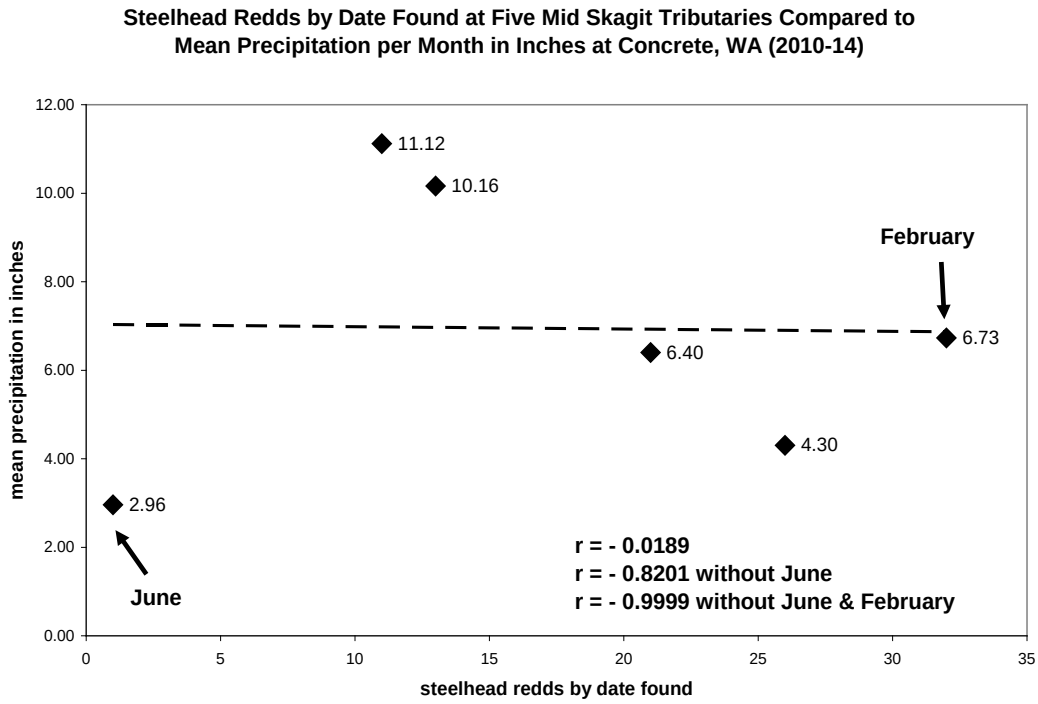


The mean precipitation per month at Concrete for each year during the complete steelhead spawning period of January to June during the 2010-14 Mid Skagit tributary surveys (Figure 23) had the greatest range in

precipitation in March, the smallest ranges in precipitation in April, May, and June, the most precipitation in January and March, and the least precipitation in June.

An evaluation of the relationship of mean monthly precipitation to steelhead redds per month by date found in the full steelhead spawning period from January through June was made with a resulting negative correlation (inverse relationship of precipitation and steelhead redds), or "r", of - 0.0189 (Figure 24). However, this is near zero with little or no correlation. If June is excluded as a month minimally represented in the Mid Skagit tributary spawning findings, the "r" increases to - 0.8201 but it remains a little below what is statistically significant. If February is excluded "r" is - 0.9999 and is highly significant to the point of being for all practical purposes a perfect 1.0. However, as with the temperature considerations, to ignore February would be to ignore the one month with the greatest steelhead redd count. A further evaluation was made of mean monthly precipitation to steelhead redds per month as adjusted to the estimated spawning date in the January through June full spawning period (Figure 25) with a resulting positive correlation (spawning increased with precipitation) and an "r" of + 0.7444 which is below being statistically significant. If June is excluded as the

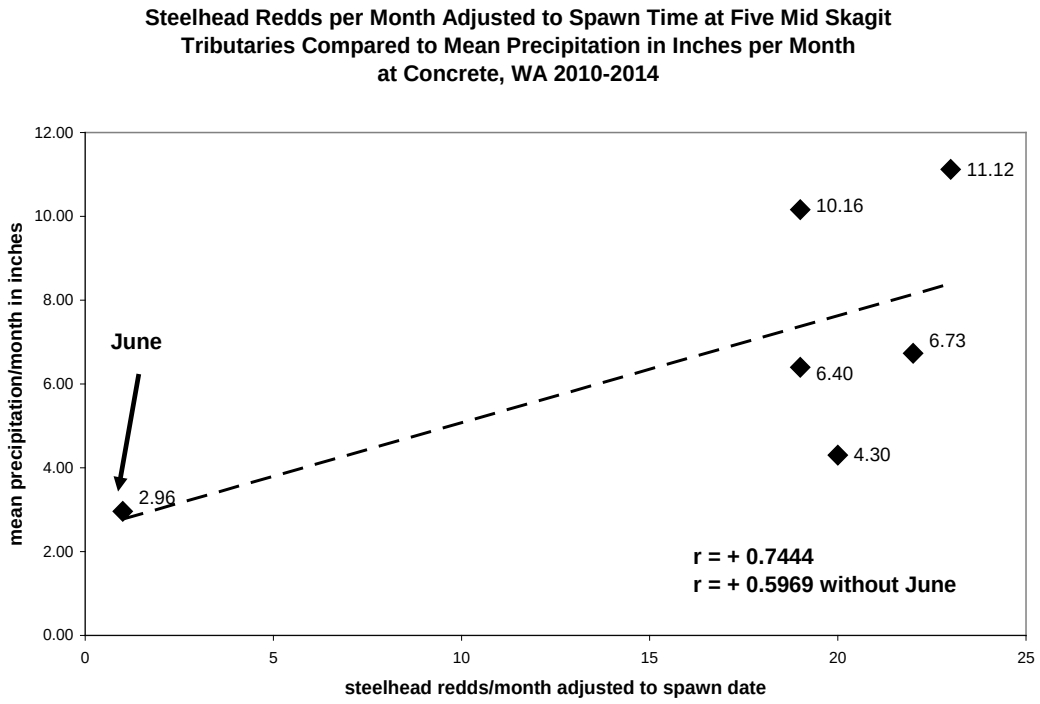
Figure 24.



month least represented in Mid Skagit tributary steelhead spawning "r" decreases to + 0.5969 with even less significance.

Streamflow data from the North Fork Stillaguamish River gage have been used as a surrogate for Finney Creek streamflows (Nichols and Ketcheson 2013). The North Fork Stillaguamish drains the southeast side of Finney Peak. My personal observations over the past 16 years of living near Finney Creek have noted that during high flow event years that Finney often responds more like the streamflows of the North Fork Stillaguamish

Figure 25.



than those for the Skagit or the Sauk rivers from available USGS website data. The mean streamflow per month at the North Fork Stillaguamish from 1943 to 1948 (USGS 1928-2014) can be compared to Finney Creek from 1943 to 1948 (USGS 1943-48) when Finney was gaged, and both of these then compared to North Fork Stillaguamish streamflow during the 2010-14 period when the Mid Skagit tributary spawning surveys occurred (Figure 26). Although the Finney Creek 1943-48 streamflow period has more extreme peaks and valleys than the North Fork Stillaguamish flows in the same period, the patterns of the two are similar regarding how they may influence entry for steelhead spawning and spawning time. The 2010-14 Stillaguamish streamflow pattern (and likely that of Finney Creek) has altered with the former spring peak of May in 1943-48 having shifted to March, two months earlier. The former 1943-48 streamflow valley in March has shifted to February, one month earlier. The historical March valley in spring flow has shifted to a spring peak, a major divergence in pattern that steelhead spawning success must adapt to. The one month of relative stability has been February.

The shift in streamflow patterns can also be compared to precipitation pattern shifts in the same 1943-48 and 2010-14 time periods (Figure 27). As has been established in the prior comparison, 1943-48 mean flows per month for North Fork Stillaguamish & Finney Creek have similar patterns, but it remains that it may not as well reflect the flow patterns of the other Mid Skagit creeks. The precipitation per month at Concrete has greatly increased in January and March with more moderate increases into April and May, but precipitation has not increased in February. Although the precipitation patterns have shifted almost identically to the streamflow patterns in January, February, and March, the 2010-14 streamflow in April has increased at a greater level than the precipitation increase. In the case of Finney Creek and the North Fork Stillaguamish this could be a result of higher elevation snowfall in March that subsequently melts out as much in April as it formerly did with a

Figure 26.

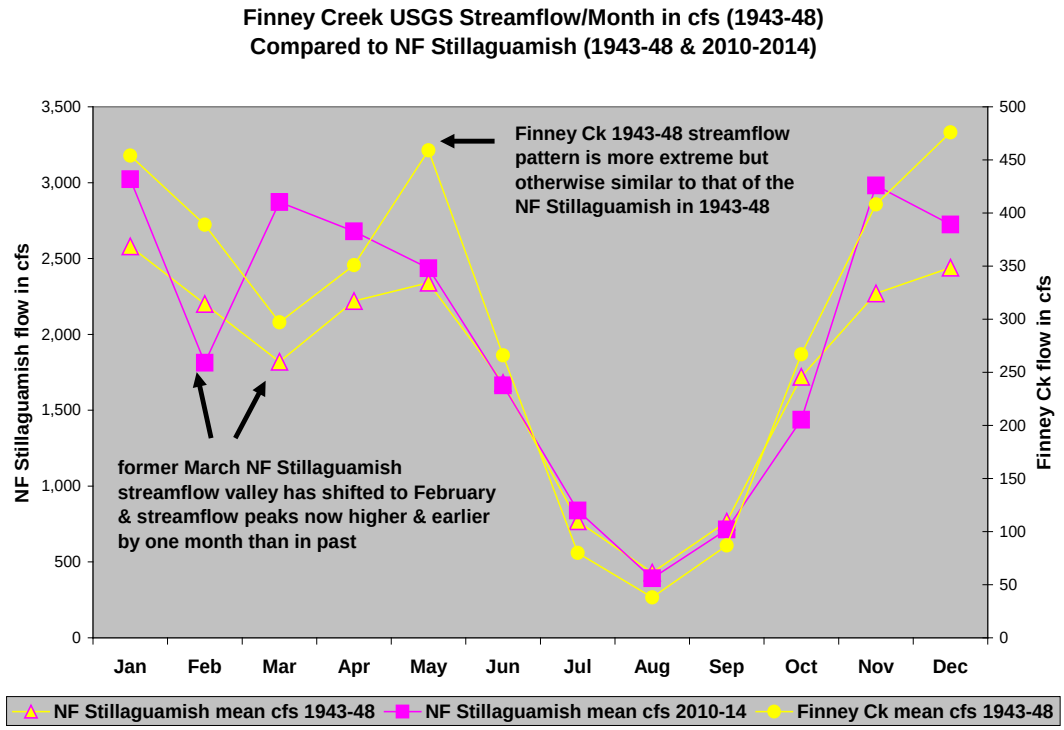
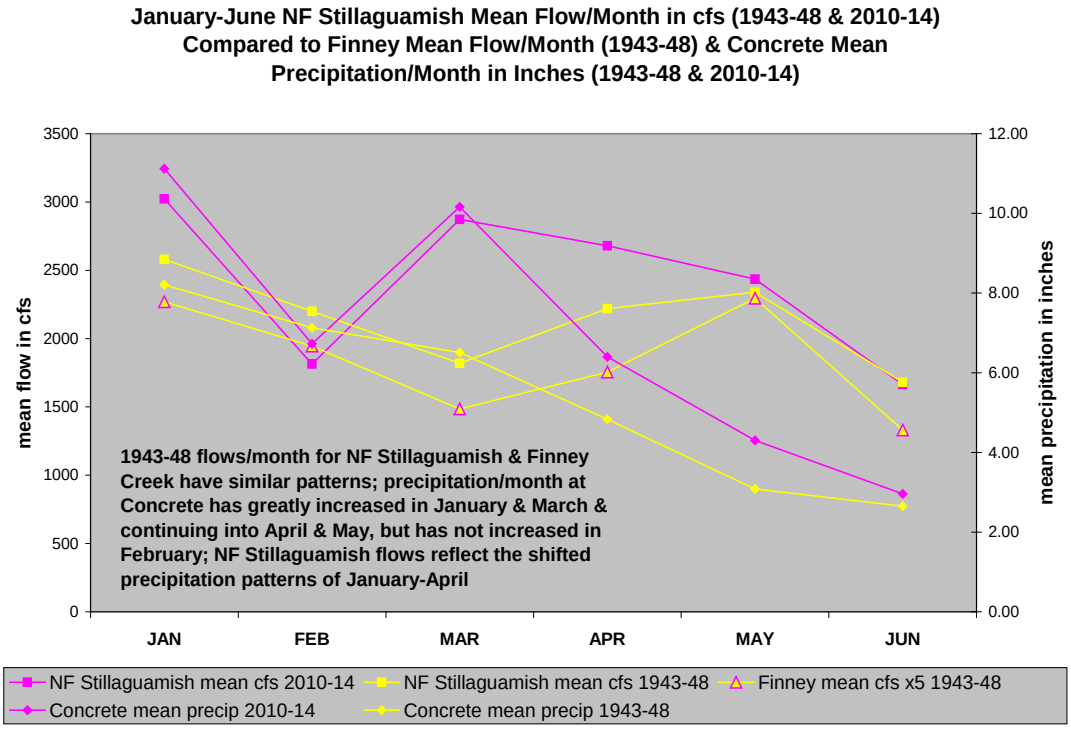

Finney Creek USGS Streamflow/Month in cfs (1943-48)
Compared to NF Stillaguamish (1943-48 & 2010-2014)
NF Stillaguamish flow in cfs
Finney Ck flow in cfs
Finney Ck 1943-48 streamflow pattern is more extreme but otherwise similar to that of the NF Stillaguamish in 1943-48
former March NF Stillaguamish streamflow valley has shifted to February & streamflow peaks now higher & earlier by one month than in past
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
NF Stillaguamish mean cfs 1943-48
NF Stillaguamish mean cfs 2010-14
Finney Ck mean cfs 1943-48

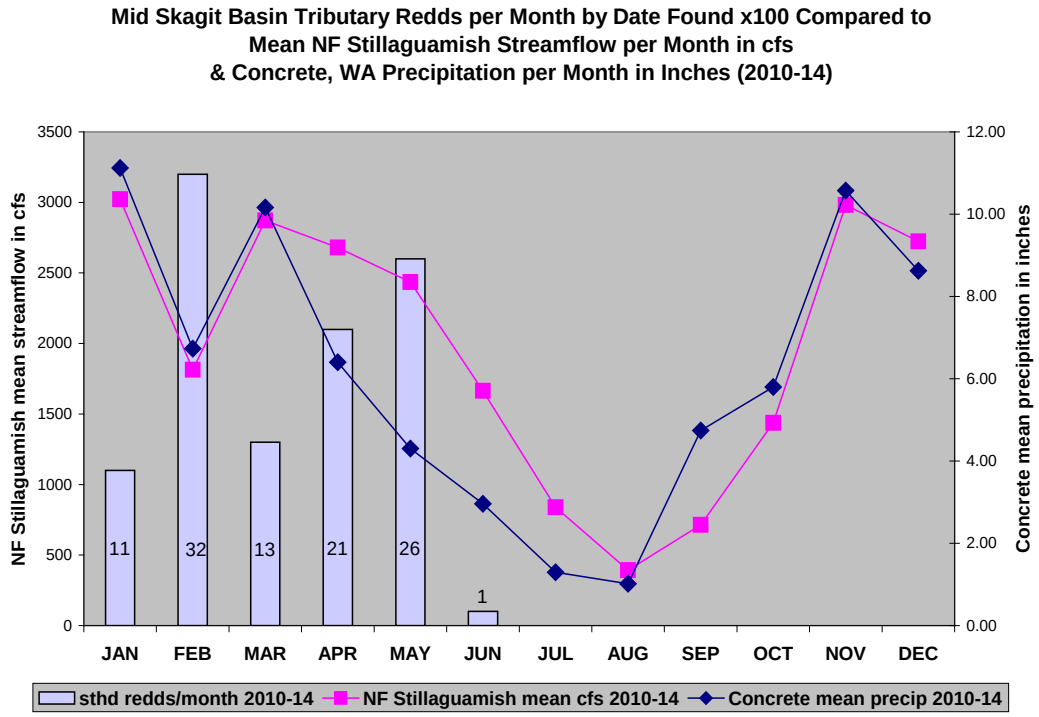
Figure 27.


January-June NF Stillaguamish Mean Flow/Month in cfs (1943-48 & 2010-14)
Compared to Finney Mean Flow/Month (1943-48) & Concrete Mean
Precipitation/Month in Inches (1943-48 & 2010-14)
mean flow in cfs
mean precipitation in inches
1943-48 flows/month for NF Stillaguamish & Finney Creek have similar patterns; precipitation/month at Concrete has greatly increased in January & March & continuing into April & May, but has not increased in February; NF Stillaguamish flows reflect the shifted precipitation patterns of January-April
JAN
FEB
MAR
APR
MAY
JUN
NF Stillaguamish mean cfs 2010-14
NF Stillaguamish mean cfs 1943-48
Finney mean cfs x5 1943-48
Concrete mean precip 2010-14
Concrete mean precip 1943-48

more singular peak in May. This may, or may not be the case with the other Mid Skagit tributary creeks that are shorter streams with smaller watershed sizes dominated by lower elevation conditions of less snowfall.

The North Fork Stillaguamish mean streamflows per month can be further compared to the mean precipitation per month at Concrete in the 2010-14 time period and to the Mid Skagit tributary redd counts per month (Figure 28). This conveys the convex balloon in NF Stillaguamish streamflow (and likely that of Finney Creek) that now occurs in April, May, and June as compared to the concave pattern of precipitation in the same period at Concrete. The balloon in streamflow, as previously suggested, likely represents increased snowmelt from increasing March precipitation falling as snow at higher elevations. The steeelhead redds found at the Mid Skagit tributaries per month and adjusted to reflect estimated spawning date are portrayed in Figure 29 with resulting differences of spawning time related to streamflow from that of the redd counts Figure 28.

Figure 28.



A comparative evaluation of the relationship of mean monthly streamflow from the North Fork Stillaguamish River to steelhead redds by date found in the January to June full spawning period in the Mid Skagit tributaries was made (Figure 30). It resulted in an "r" of - 0.0391 which is near zero with no correlation of significance. If June with its minimal steelhead spawning is eliminated it results in an "r" - 0.95679 which is highly significant using critical values from the Peaerson's correlation coefficient table. However, if the redds are adjusted to reflect the estimated spawning date as probably the more relevant comparison (Figure 31), "r" reverses to + 0.7836 which is not statistically significant and is less so if June is excluded with an "r" of + 0.6197.

Figure 29.

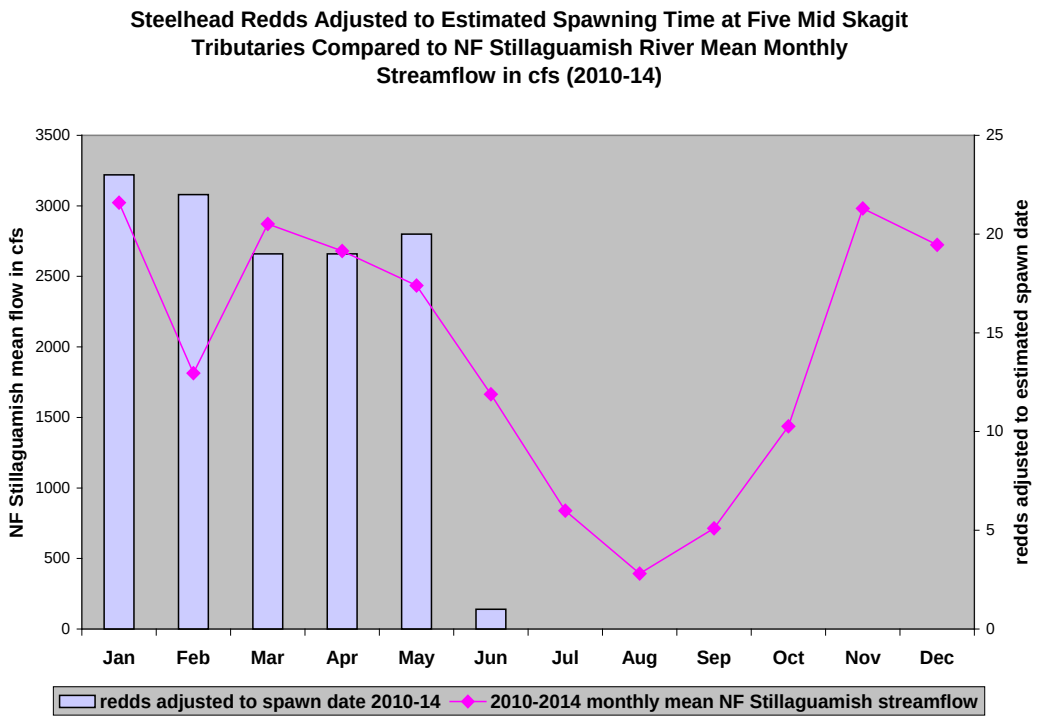

Steelhead Redds Adjusted to Estimated Spawning Time at Five Mid Skagit Tributaries Compared to NF Stillaguamish River Mean Monthly Streamflow in cfs (2010-14)
NF Stillaguamish mean flow in cfs
redds adjusted to estimated spawn date
3500
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
redds adjusted to spawn date 2010-14
2010-2014 monthly mean NF Stillaguamish streamflow

Figure 30.

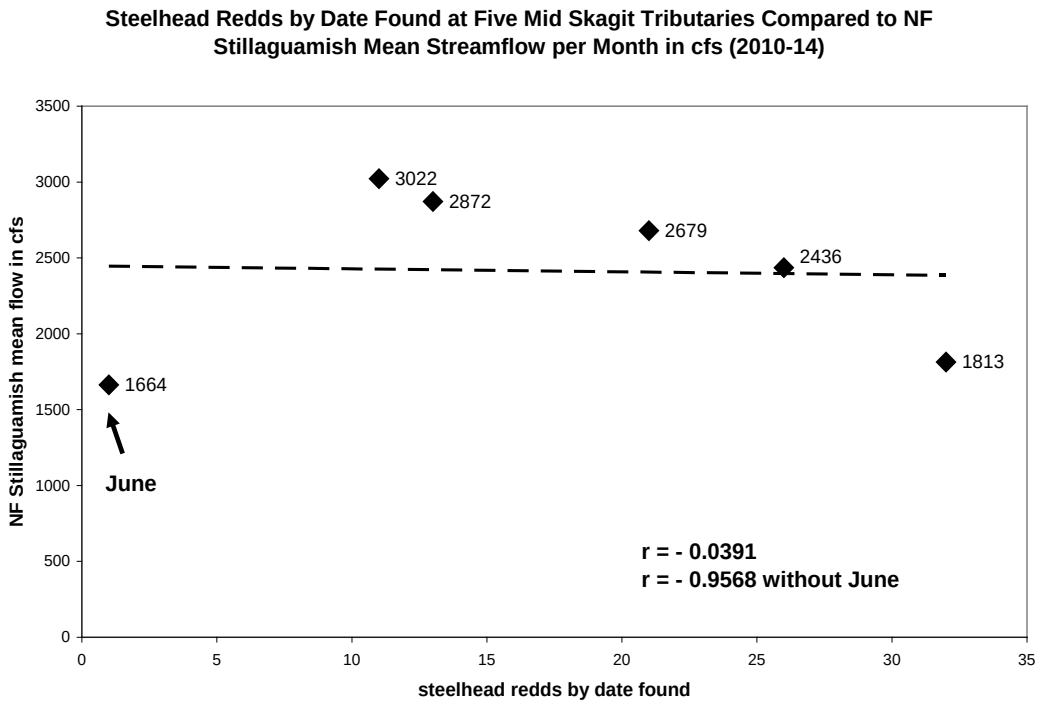
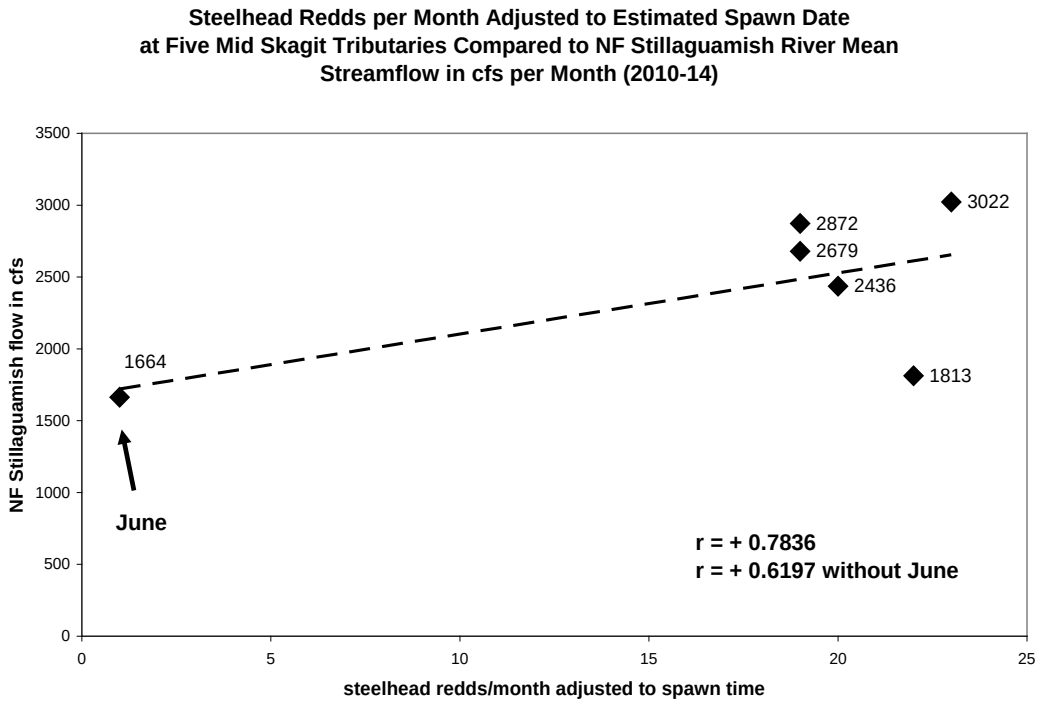

Steelhead Redds by Date Found at Five Mid Skagit Tributaries Compared to NF Stillaguamish Mean Streamflow per Month in cfs (2010-14)
NF Stillaguamish mean flow in cfs
steelhead redds by date found
3500
3000
2500
2000
1500
1000
500
0
0
5
10
15
20
25
30
35
3022
2872
2679
2436
1813
1664
June
r = - 0.0391
r = - 0.9568 without June

Figure 31.



Intermittent and Perennial Flows

Of particular importance for successful reproduction to the smolt stage is how spring and summer hydrology differences in flow patterns may shape spawn time and fry emergence, particularly the effect of intermittent flows if they regularly occur. Intermittent flows annually occur in the anadromous areas of the mainstems of the following three tributaries regularly surveyed in 2014 (Table 12): Savage Creek, Mill Creek, and Dry Creek. The earliest and latest dates the redds were found is also listed as well as the dates and locations of intermittent flows by tributary if that occurred. At Finney Creek the mainstem remains perennial but side channels used for both spawning and rearing commonly go intermittent. Of the five tributaries regularly surveyed, only O'Toole Creek's entire anadromous length remains perennial. The percentages of spawning that occured in each tributary prior to March 15th (and listed by whether intermittent, parts going intermittent, or perennial) as estimated from redd counts in 2014 and the five year period of 2010-14 are shown in Figures 32 and 33.

Table 12. 2014 Mid Skagit steelhead spawning period differences determined by when redds were found and listed by tributary from earliest to latest, and dates of when stream sections went intermittent if that occurred

Mid Skagit tributary	Time period steelhead redds found	Date & location of intermittency
Savage Ck	January 23-March 15	July 10-13 above pond; Aug 1 below
Mill Ck	April 30	July 10-13 from mouth progressing up
O'Toole Ck	April 7-June 16	Remained perennial
Finney Ck	February 1-May 22	May 30 at numerous side channels
Dry Ck	January 16-May 14	June 24-27 from mouth progressing up

Figure 32.

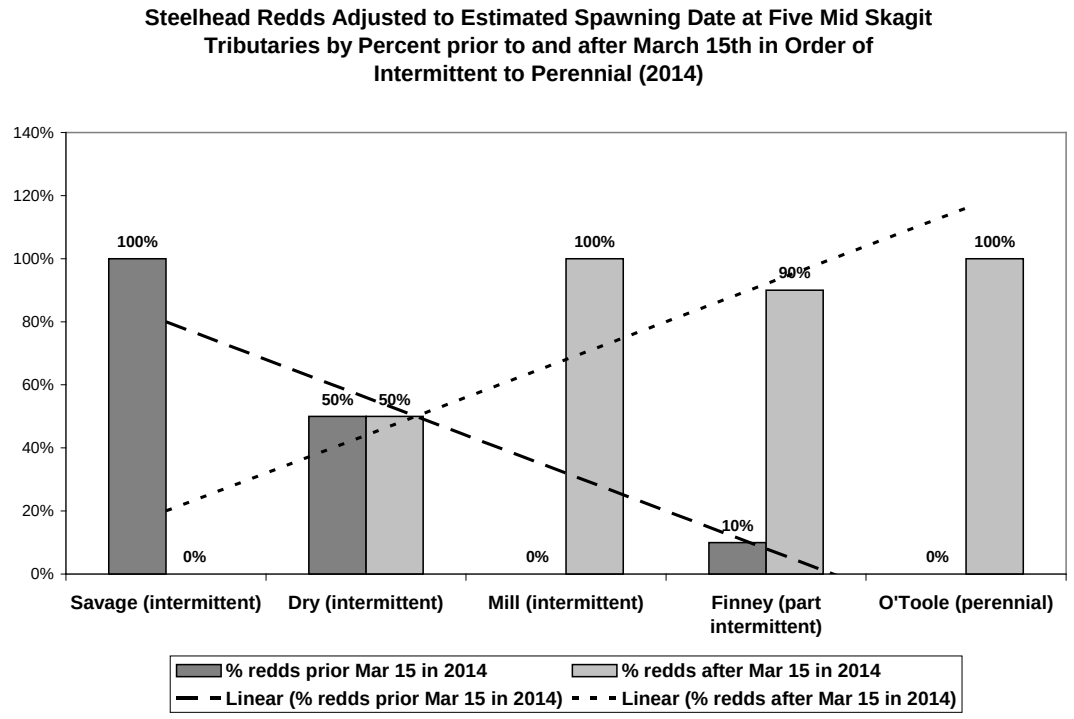
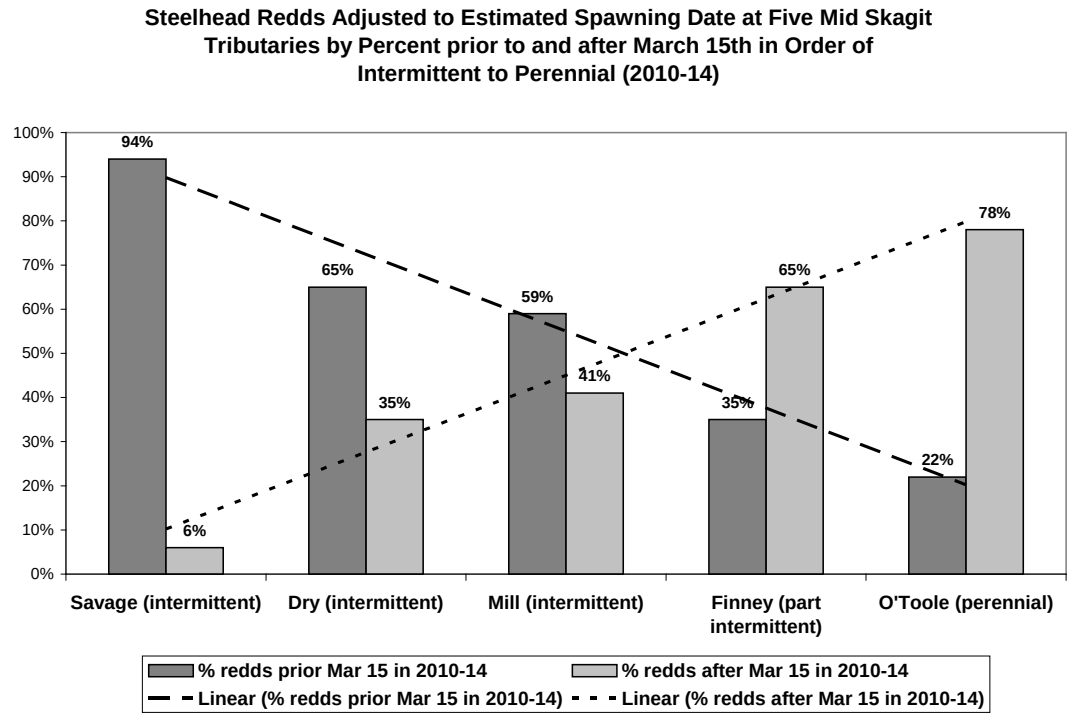

Steelhead Redds Adjusted to Estimated Spawning Date at Five Mid Skagit Tributaries by Percent prior to and after March 15th in Order of Intermittent to Perennial (2014)
140%
120%
100%
80%
60%
40%
20%
0%
100%
0%
50%
50%
100%
0%
10%
90%
0%
100%
Savage (intermittent)
Dry (intermittent)
Mill (intermittent)
Finney (part intermittent)
O'Toole (perennial)
% redds prior Mar 15 in 2014
% redds after Mar 15 in 2014
Linear (% redds prior Mar 15 in 2014)
Linear (% redds after Mar 15 in 2014)

Figure 33.


Steelhead Redds Adjusted to Estimated Spawning Date at Five Mid Skagit Tributaries by Percent prior to and after March 15th in Order of Intermittent to Perennial (2010-14)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
94%
6%
65%
35%
59%
41%
35%
65%
22%
78%
Savage (intermittent)
Dry (intermittent)
Mill (intermittent)
Finney (part intermittent)
O'Toole (perennial)
% redds prior Mar 15 in 2010-14
% redds after Mar 15 in 2010-14
Linear (% redds prior Mar 15 in 2010-14)
Linear (% redds after Mar 15 in 2010-14)

Although intermittent/perennial flows are but one environmental factor that may shape steelhead spawning time by specific tributary through selective adaptation, the percent of estimated spawning prior to March 15th and thereafter as shown by tributary in 2010-14 (Figure 33) indicates these two hydrology types and the extent of anadromous habitat affected within each tributary, are likely primary drivers of steelhead spawning time. Combining the information from Table 12 and Figure 33 leads to a conclusion that there is a direct relationship between intermittency and percent of steelhead spawning prior to March 15th as indicated by the trendlines at the Mid Skagit tributaries in the five year period of 2010-14. Inversely, the same information leads to a conclusion that spawning primarily after March 15th is related to delay in the area and date of intermittency, and especially to the one stream with perennial flow (O'Toole Creek). At the level of annual variables, as in 2014 (Figure 32), the relationship is not as evident as the more complete data from cumulative years. While intermittency is likely a driving factor of earlier steelhead spawning time, colder early air temperatures in 2014 likely delayed spawning as a factor that can vary more greatly and less predicatively on an annual basis than intermittent or perennial flow patterns (Figure 20).

Specific Differences Found by Tributary Regarding Intermittent/Perennial Flow Patterns and Timing

Finney Creek:

Although Finney Creek's mainstem remains perennial there are numerous side channels in the 3.5 km of the 2014 survey reach that go dry even in lower winter/spring flows and increasingly so throughout the summer period. Also, both main channels and side channels can be suddenly vacated during any high flow event due to the unstable nature of its broad channel (Photo 2 and 3). Although juvenile *O. mykiss* movements to the Skagit River are not restricted from mainstem Finney at any time, if side channels are to be effectively used for reproduction the timing of spawning and emergence must fit with the potential for redd dewatering by late May to mid June, or lethal entrapment of emergent fry results with loss of access to the mainstem for escape due to side channels commonly dewatering first at the shallow outlets and inlets.

Photo 2: Finney Creek's continually shifting channel on April 26, 2010, the distant channel now vacated

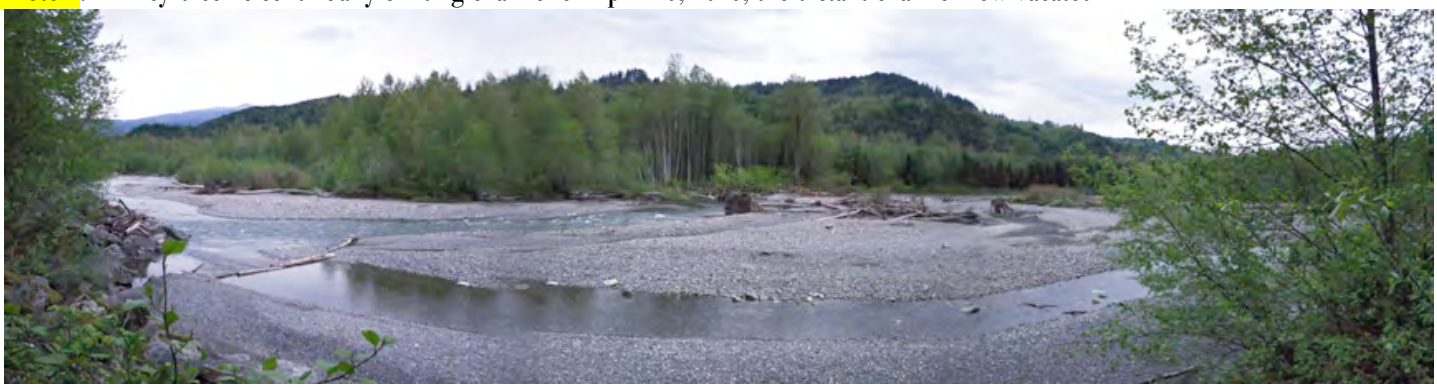


Photo 3: A former mainstem channel at Finney Creek about to go dry on May 30, 2014

Dry Creek (of lower Finney Creek):

The lower 70-250 m typically goes subsurface by late June to early July. By June 27th of 2014 the lower 70 m had gone subsurface with disconnection from Finney Creek. By July 10th the lower 240 m were subsurface and by July 13th the lower 340 m. Rechecked on August 28th the lower 375-400 m were subsurface. About 525 m above the mouth the gradient significantly increases in transition from the valley floor to the valley wall until anadromous fish passage is blocked by a 6-6.5 m waterfall 870 m from the mouth. This uppermost anadromous reach likely remains perennial most, if not all, years (Photos 4, 5, and 6).

The potential for effective steelhead reproduction given the intermittency pattern at Dry Creek suggests several things. A little over half of the available anadromous stream length remains perennial. If spawning occurs in the lower 400 m the newly emerged fry need to either migrate downstream or upstream prior to that section going subsurface. To go downstream requires fry inclination to do so and an emergence date prior to late June. To go upstream may be denied by significant drops over log sills and boulders of 10-12 inches (25.4-30.5 cm) that newly emerged fry may be incapable of. Steelhead reproduction success in the lower 400 m likely requires spawning to occur that results in downstream emergent fry migration prior to the end of June. By contrast, steelhead reproduction may successfully occur throughout the usual steelhead spawning period if located in the upper 470 m of the anadromous length that remains perennial. However, this provides limited rearing space during reduced summer flows. Greater reproduction success to the smolt stage would be anticipated if a considerable proportion of the fry emerged early enough to outmigrate to Finney Creek (and/or the Skagit River) prior to loss of that opportunity by late June.

Photo 4: Dry Creek's clear flow enters turbid Finney Creek providing conducive entry, March 14, 2014

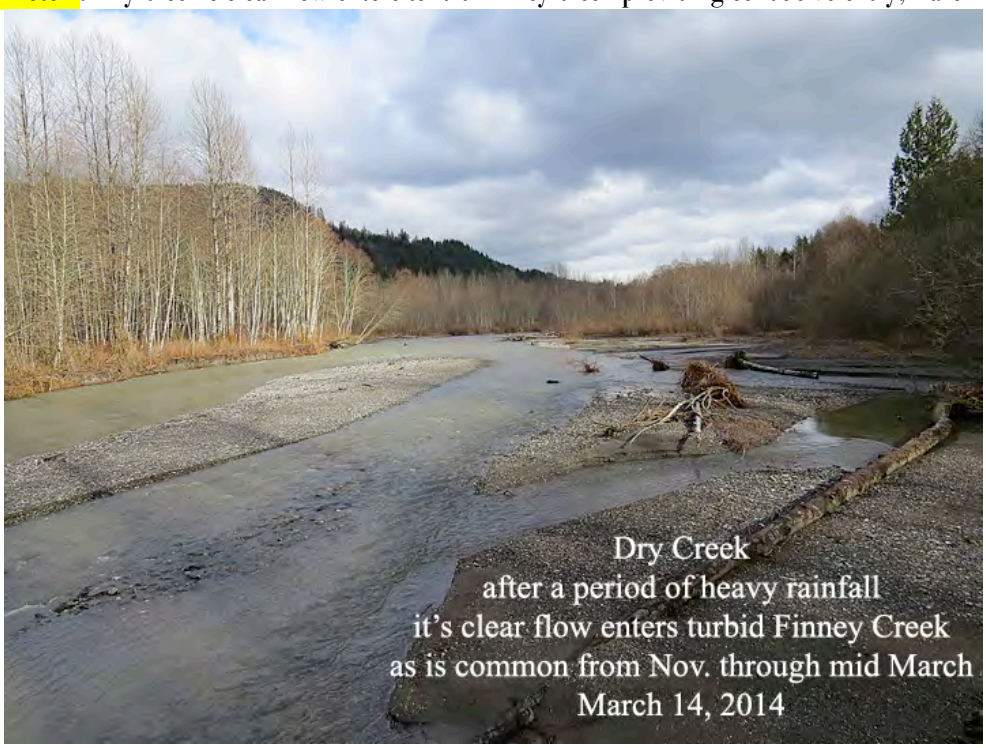


Photo 5: Lower Dry Creek having gone subsurface with disconnection from Finney Creek by June 27, 2014

Photo 6: Dry Creek channel still wetted in the 400-500 meters below waterfall barrier, July 10-13, 2014

Mill Creek:

The lower 355 m from the Skagit River entry to the South Skagit Highway commonly goes subsurface by mid

Photo 7: Mill Creek still wetted for 100 m below South Skagit Highway, July 13, 2014

Photo 8: Mill Creek lowermost 300 meters dewatered and disconnected from Skagit River, July 13, 2014

July or early August, except during wetter summers. By July 13th of 2014 Mill Creek's lowermost 250-260 m had gone subsurface disconnecting it from the Skagit River (Photos 7 and 8). In drier summers this subsurface reach can include the lower 400-450 m as occurred by August 28th of 2014. On July 13th the water temperature 90 m above where it went dry was 14.2 C (57.5 F), still healthily cool for rearing.

Successful steelhead reproduction in the lower 250-260 m of Mill Creek depends on spawning that would be sufficiently early for fry to have emerged by early July and either migrate downstream to the Skagit River or upstream to the perennial anadromous reach. The latter is presently limited by a landslide and associated debris about 730 m above Skagit entry preventing upstream passage for fry to a more extensive higher gradient rearing reach above. This presently leaves about 280-480 m for young-of-year rearing for steelhead that spawn in the first 730 m of stream depending on whether summers are drier or wetter. Early outmigration by a significant proportion of the fry would be anticipated to increase productivity to the smolt stage with greater rearing area.

Savage Creek:

This is a more complex watershed that runs through wetlands and ponds (Photos 9, 10, and 11). The lower 1,475 m from the Uppermost Savage Pond outlet to the mouth typically go subsurface by late June to early July with loss of surface connectivity to the Skagit River (personal observations by B. McMillan since 1998). However, when field checked on July 13th of 2014 this prior pattern altered. Despite June of 2014 being slightly drier than normal (Appendix A), and with no July precipitation up to that time, the entire length from Uppermost Savage Pond to the mouth remained wetted with connectivity to the Skagit River. This may have been due to a beaver dam created near the outlet of the upper pond to the ditched section of Savage Creek in the winter of 2013-14 that South Skagit Highway road maintenance left in place rather than removed. The smaller ponds below the South Skagit Highway go dry by August in all but the wettest summers, but the uppermost

pond (Photo 11) remains watered. The uppermost pond has a depth at the deepest point of 13 feet as recently measured in July of 2014 (pers. com. Nora Kammer, Skagit River System Cooperative). Savage Creek from the Uppermost Savage Pond on upstream about 400 m has also gone dry about the same time as Lower Savage Creek disconnecting it from the pond below. The former pattern of going dry remained the same above Uppermost Savage Pond on July 13th. The first 160-185 m above the pond had gone subsurface (Photo 11) and the next 90-100 m would soon do so. These identified portions of Savage Creek that go intermittent above and below the upper pond combine to create a considerable length of stream that is lethal for steelhead fry unless spawning is early enough to result in their migrations to the Skagit River or the upper pond prior to early June.

On July 14th the evening water temperature 450 m above the uppermost pond was 14.4 C (58.0 F), while 135 m below the same pond it was 24.2 C (75.5 F). The evening air temperature was 20-21 C (68-70 F) with a high air temperature at the afternoon peak of 28.3 C (83 F). Numerous coho fry and other unidentified salmonids were sighted at the point below the pond where the 24.2 C temperature was recorded, seemingly healthy and feeding. Salmonid fry were observed throughout the wetted reach 300 to 600 m above the pond but thousands apparently perished in the more than 200 meters that went dry. By the first of August, Savage Creek below the uppermost pond went dry from lack of rainfall after July 13th.

On July 9, 2014, a 24 inch range probable female steelhead kelt was observed in uppermost Savage Pond (pers. com. Nora Kammer and Eric Mickelson, Skagit System Cooperative) during temperature monitoring of the pond. The pond has apparent values for not only juvenile rearing but potential over-summer survival for late spawning steelhead kelts. The last steelhead redd was observed at a fork of upper Savage Creek on March 15th (Appendix C) and may have been created by the female sighted in the pond downstream on July 9th.

Photo 9: Mid Savage Creek during flow conditions conducive to upstream migration, March 7, 2014

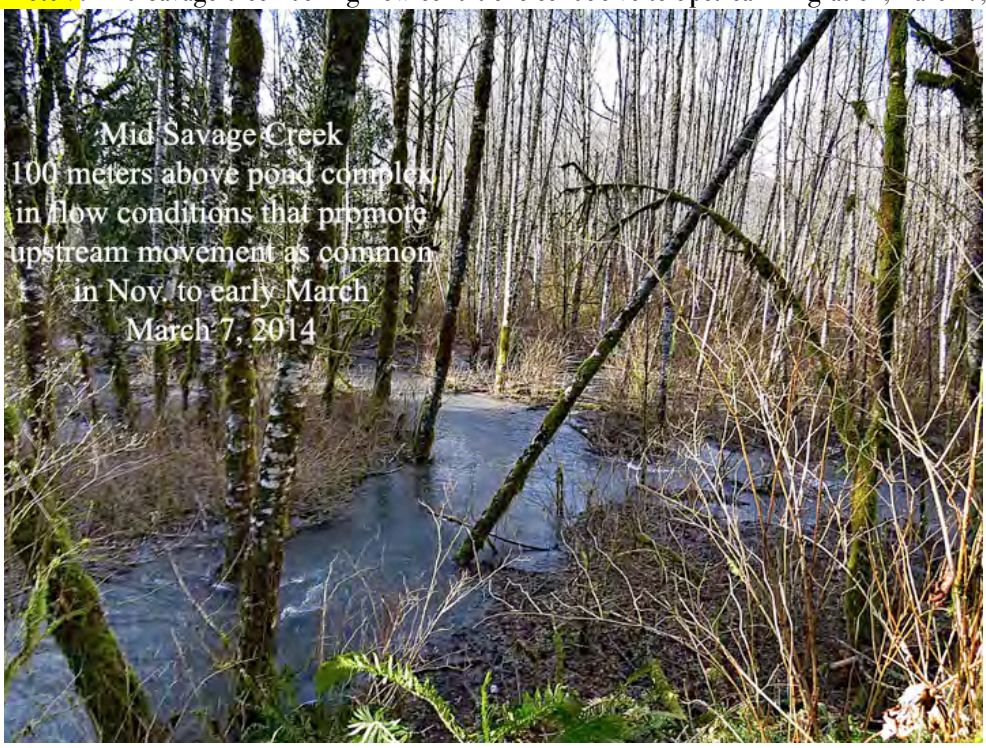


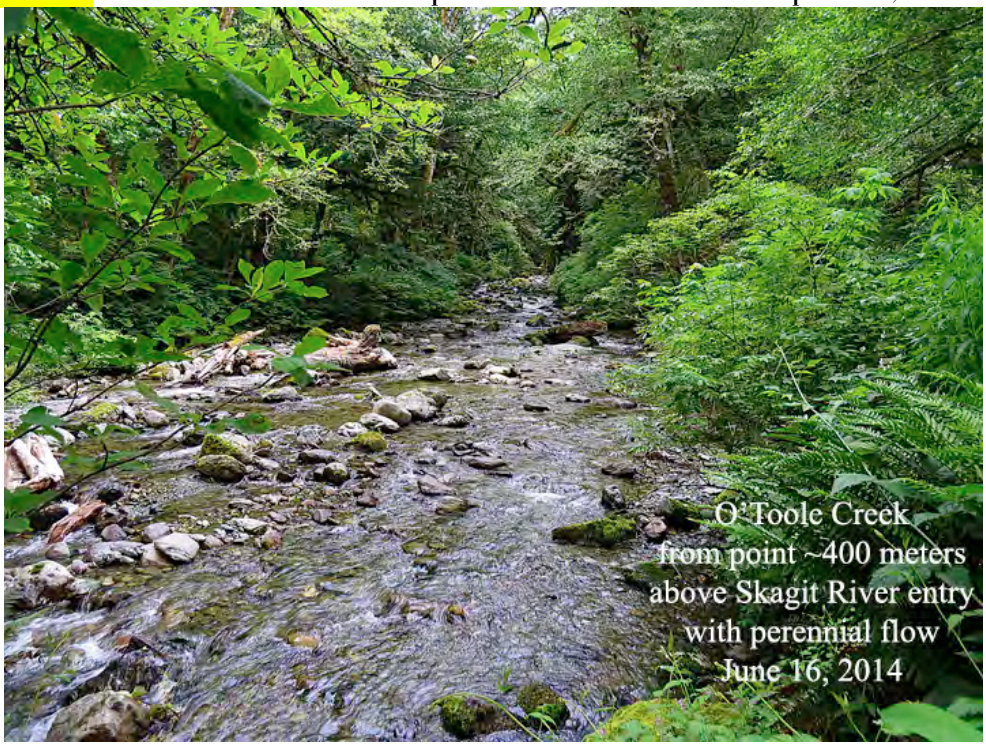
Photo 10: Savage Creek at same point as Photo 10 but looking upstream at dry channel, July 13, 2014

Photo 11: Savage Creek entry to a wetland/pond complex 1500 meters above Skagit River, February 7, 2013

O'Toole Creek:

The entire anadromous length of 620 m to the barrier falls is perennial. As depicted (Photo 12), O'Toole Creek

Photo 12: O'Toole Creek which retains a perennial flow and cold water temperatures, March 14, 2014



has a larger substrate and higher gradient in its lower reaches than the other four streams regularly surveyed. It has a minimal gravel deposition bar at its entry to the Skagit River and throughout the year juveniles have access to the mainstem river with no constraints on steelhead fry movements after spawning. When field checked on August 16, 2014 its water temperature at 3:20 pm was 59 F (15.0 C) with an air temperature of 69.5 F (20.8 C). Both winter and summer it often has the coldest water temperatures measured of the five Mid Skagit tributaries regularly surveyed for steelhead spawning.

O. mykiss Fry Emergence Time and Presence of Other *O. mykiss* Ages

Related to streams being perennial or intermittent, stream checks at the end of the spawning survey season occurred from mid May to mid June to determine when fry emergence was occurring. Photographs were taken using a small underwater camera mounted on a four foot long pole as previously described. The camera was set to take photos automatically at 5-second intervals at varied points under the stream surface to try to determine at what date steelhead fry emergence was occurring prior to going dry and if there was time for fry migration to perennial flow areas within the same stream or to the mainstem the creek was tributary to. The presence of other species of fry was also determined as well as life histories other than fry. The photographs were examined to determine the presence of *O. mykiss* fry and other *O. mykiss* ages present. This entailed enlarging the photographs on a computer monitor to the limits that the resolution of the digital photos allowed from which to attempt making species distinctions. The underwater camera needed for this was not available until May 12th

and may have resulted in missing earliest *O. mykiss* fry emergence. The earliest fry positively determined to be *O. mykiss* were photographed on May 30, 2014 at both Finney Creek and Dry Creek of Finney Creek (Photos 13 and 14). Potential *O. mykiss* fry mixed with coho fry were photographed at lower Dry Creek on May 16th and 21st. Those of May 16th were either large young-of-year (YOY) or very small age 1-plus *O. mykiss* (estimated 40-45 mm), and the photos of May 21st were too low resolution to positively identify as *O. mykiss*. Juvenile salmonids observed in Mid Skagit tributary streams from January 5th to July 10th of 2014 are listed in Table 13 which includes all species and above surface observations.

Table 13. Mid Skagit Basin Tributary Juvenile Salmonid Life Histories Observed by Date in 2014

Creek (section)	Date	Species, life history, & estimated size in mm	Abundance	Method of observation
Savage (lower)	1/5/2014	unknown species; large fry; 35-55mm	50 moving downstream	above surface visual
Savage (lower & mid)	4/19/2014	coho; fry; 20-30mm	dozens	above surface visual
Dry (lower)	5/2/2014	coho; fry; 20-30mm	dozens	above surface visual
Dry (mid)	5/14/2014	O. mykiss; likely 1-plus; 60-100mm	2-3	underwater photos
O'Toole (upper)	5/15/2014	O. mykiss; 1- & 2-plus; 100-175mm	3	underwater photos
Dry Ck (lower)	5/16/2014	O. mykiss; fry or small 1-plus; 40-50mm coho; fry; 25-40 mm	a few scattered dozens	underwater photos
Hatchery (lower)	5/16/2014	O. mykiss; 1- to 2-plus; 100-125mm	2	underwater photos
Dry (lower)	5/21/2014	O. mykiss; fry or small 1-plus; 40-50mm O. mykiss or clarki; 1-plus; 100-125mm coho; fry; 25-40mm	a few scattered 1 dozens	underwater photos
Mill (mid)	5/22/2014	O. mykiss; 1- to 2-plus; 100-150mm coho; fry; 25-35mm	5-6 10-15	underwater photos above surface visual
O'Toole (mid)	5/22/2014	O. mykiss; fry or small 1-plus; 40-50mm O. mykiss; likely 1- 2-plus; 100-150mm	2 5	underwater photos
Dry (lower & mid)	5/30/2014	O. mykiss; fry; 20-30mm coho; fry; 25-50mm	a few scattered hundreds; some moving downstream	underwater photos
Lower Finney (side channel pool going dry)	5/30/2014	O. mykiss; fry; 20-30mm coho; fry & parr; 25-70mm Chinook fry; 30-35mm chum fry; 30-35mm	a few scattered 100-200 10-12 2-4	underwater photos
Dry (lower)	6/6/2014	O. mykiss; fry; 25-35mm O. mykiss; 1- 2-plus; 60-150mm coho; fry; 25-40mm	a few scattered 5-6 many hundreds	underwater photos
Dry (lower)	6/17/2014	O. mykiss; fry; 20-35mm O. mykiss or clarki; 1- 2-plus; 100-175mm coho; fry & parr; 25-70mm	6-10 3 many hundreds	underwater photos
Lower Finney (side channel pool nearly dry) Lower Finney mainstem	6/17/2014	O. mykiss; fry; 20-35mm coho; fry & parr; 25-80mm Chinook fry; 30-40mm coho; parr; 60mm	5-6 100-200 5-6 1	underwater photos
Dry (lower – going dry) Dry (mid) Dry (upper)	6/27/2014	O. mykiss; fry; 20-30mm coho; fry & parr; 25-70mm O. mykiss; fry; 20-30mm O. mykiss; 1- 2-plus; 100-150mm coho; fry & parr; 25-70mm O. mykiss; fry; 20-35mm O. mykiss; 1-plus; 90-125mm coho; fry; 30mm	dozens hundreds dozens 2-3 hundreds few dozen 2-3 2-3	underwater photos
Dry (lower) Dry (mid) Dry (upper)	7/10/2014	O. mykiss; fry; 20-40mm O. mykiss; 1- 2-plus; 80-150mm coho; fry & par; 25-70mm O. mykiss and/or clarki; fry; 20-35mm O. mykiss or clarki; 1- 2-plus; 80-150mm coho; fry; 25-40mm O. mykiss and/or clarki; fry; 20-35mm O. mykiss or clarki; 1- 2-plus	dozens 3-4 many hundreds few hundred 3-4 hundreds many dozens 5-6	underwater photos

O. mykiss of ages 1-plus and probable 2-plus were photographed from May 14th through July 10th at Mill, O'Toole, and Dry creeks of those streams regularly surveyed, and at Hatchery Creek of those infrequently surveyed. The July 10th underwater photographs taken at Dry Creek were the last taken as it was progressively dewatering in an upstream direction leaving a dry stream channel where an estimated several thousand combined juvenile coho, *O. mykiss*, and *O.clarki* perished within the space of 3-4 days. Despite digging down into the gravel at several locations after dewatering no evidence of any fry or parr was found.

Of the five Mid Skagit tributary creeks of survey emphasis, four are known to be subject to intermittent flows in portions of their steelhead spawning areas: Mill, Savage, Dry, and Finney. Dry Creek is the most predictable and extreme of those with intermittent flows, and yet sustains considerable wild steelhead spawning. Each year it begins to go subsurface by latter June to early July with an initial disconnection from its entry to Finney Creek in the lowermost 100 m with a progression of dewatering that continues upstream another 300-400 m, or about half of its 0.85 km anadromous length.

No water temperature data were taken in 2014 with the needed frequency to determine how the dates of the *O. mykiss* fry sightings may relate to their date of egg deposition/fertilization. However, Table 14 provides the ranges of hatch times per water temperature found in the published literature. From that table, steelhead fertilization to fry emergence at 5 C (41 F) would be about 94-101 days (Wales 1941). At 5.5 C (41.9 F) Hardy (2002) indicates a similar period of time if 2-3 weeks is used for hatch-to-emergence. At 10 C (50 F) there is a range of 35-50 days indicated for fertilization to hatch time (Hardy 2002; Shumway et al. 1964; and Wydoski and Whitney 1979) and if the 2-3 week hatch-to-emerge time is used it would indicate 49-71 days. Given the mid January to mid May period of time when steelhead spawning was found at Dry and Finney creeks, a water temperature range of 5-10 C (41-50 F) and subsequent 49-101 days for fertilization to fry emergence provides a reasonably good fit based on the photographic evidence of fry presence in 2014.

Table 14. *O. mykiss* fertilization-to-hatch, hatch-to-emerge, and total emergence times found in literature

Temp	Days to hatch	Days to emerge	Total days to emerge	Reference
2 C (35.6 F)	115	....	....	Quinn 2005
5 C (41 F)	68	....	....	Quinn 2005
8 C (46.4 F)	42	....	....	Quinn 2005
11 C (51.8 F)	28	....	....	Quinn 2005
14 C (57.2 F)	22	....	....	Quinn 2005
5.5 C (41.9 F)	80	....	....	Hardy 2002
10 C (50 F)	31	20	51	Hardy 2002
15 C (59 F)	19	10	29	Hardy 2002
10 C (50 F)	35 *	....	....	Shumway et al. 1964
5 C (41 F)	80	2-3 weeks	94-101	Wales 1941
15 C (59 F)	19	2-3 weeks	33-40	Wales 1941
10 C (50 F)	50	....	somewhat later	Wydoski & Whitney 1979

* Dissolved oxygen considerations from Quinn 2005: decreased O2 delayed hatching at 10 C (50 F) from about 35 days to 40 days in steelhead as cited from Shumway et al. 1964.

Using Table 14 as a guide, the hatchery female steelhead digging a redd with a wild resident *O. mykiss* male on January 16th would result in fry emergence between April 20 to April 27 if the average temperature was 5-5.5 C (Wales 1941; and Hardy 2002). For the wild steelhead sighted on February 19th, fry emergence at that same average temperature would be May 24 to May 31. The possible sighting of *O. mykiss* fry on May 16th, as

occurred at Dry Creek, would be well within the time required from the earlier spawning that was observed. Even earlier emergence is a consideration depending on weather/temperature variables each year, and this could explain the potential *O. mykiss* fry of 40-45 cm, rather than being very small 1-plus aged *O. mykiss*.

Photo 13. *O. mykiss* fry at Dry Creek of Finney Creek, May 30, 2014

Photo 14. *O. mykiss* fry at Finney Creek side channel, May 30, 2014

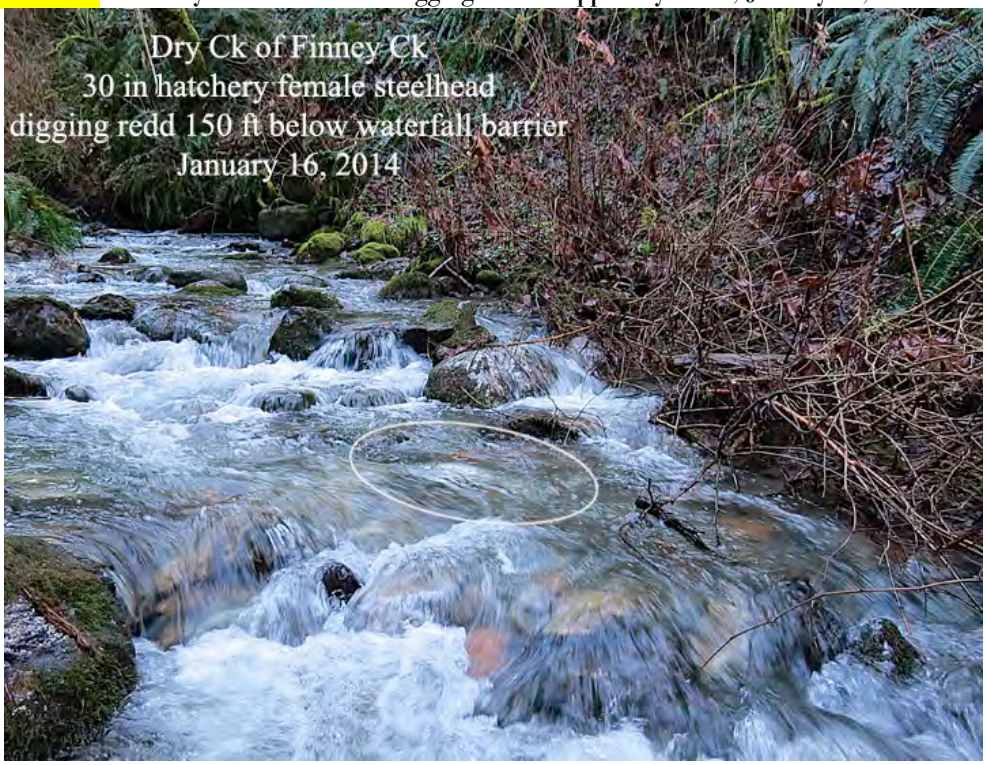
At Savage Creek, numerous coho fry were visually identified without a camera by at least April 19th of 2014. At Dry Creek, many coho salmon fry were observed by May 2nd of 2014. On January 5th of 2014 a school of about 50 juvenile salmonids of an estimated 35-55 mm in length were observed moving downstream at Savage Creek below the upper two ponds about 830 yds (0.76 km) from its entry to the Skagit River. Their size was seemingly too large to be the out-migrating fry of pink salmon that spawned in considerable numbers the previous fall in Savage Creek, and seemingly too small and too early to be coho smolts leaving the ponds. The schooled downstream movement did not seem a likely trait of *O. mykiss* or *O.clarki* parr either. A downstream movement of similar sized salmonids was observed the previous year about the same time at Savage Creek. It was considered that it may be characteristic of one of the salmonid species that uses the ponds for part of its life history and then moves into the Skagit at the peak of winter. There is also a large pond midway downstream to the Skagit River. Perhaps the fry migrate between the ponds to take advantage of some advantageous condition of one over the other. Alternatively, there may have been a prior migration of the same juvenile salmonids from the Skagit River that moved upstream into the creek and ponds for warmer and more stable conditions in the fall than provided by the mainstem river followed by a winter outmigration back again. For whatever reason, it provides an example of the differences individual tributary characteristics can have on salmonids in apparent deviations from what are considered more typical life history patterns.

Discussion

Wild, Hatchery, and Resident *O. mykiss* Spawning Mix in Mid Skagit Tributaries

At the five tributaries of the Mid Skagit basin regularly surveyed in 2014 steelhead spawning began by at least January 16th. At that date a hatchery female steelhead (missing adipose fin) of an estimated 30 inches (76.2 cm)

Photo 15. Hatchery female steelhead digging redd at upper Dry Creek, January 16, 2014



was paired with a wild male resident *O. mykiss* of an estimated 15 inches (38.1 cm). Of particular significance, this spawning activity was observed less than 50 m below the uppermost limit of anadromous migration determined by a 4-5 m waterfall in a tributary of a tributary of the Mid Skagit basin (Photo 15). This indicates there is likely no accessible area within the tributaries of the Mid Skagit basin where hatchery steelhead have not penetrated through straying and where feral spawning has taken place that includes with wild steelhead and/or wild resident *O. mykiss* males. The resident male life history, and/or mature male parr, of *O. mykiss* are an important part of the overall spawning population of a number of steelhead populations throughout their geographic range (Needham and Taft 1934; Savviatova et al. 1973; Seamons et al. 2004; McMillan et al. 2007; Christie et al. 2011).

The first wild steelhead (with adipose fin) was observed on February 19th at upper Dry Creek just 25 m below the barrier falls and within 25 m of where the hatchery female had created its redd a month earlier. Although redd digging was not occurring, and spawning was potentially completed, the wild female (estimated 23 inches, 58.4 cm) was still being vigorously attended by a male steelhead (estimated 24 inches, 61 cm) of undetermined origin (adipose presence could not be determined) in apparent competition with a smaller male. The smaller male (estimated 17 inches, 43.2 cm) was likely a sea-run cutthroat found mated in active spawning with a female sea-run cutthroat (estimated 15 inches, 38.1 cm) near the same location the following day. Although it could not be determined if the wild male sea-run cutthroat had spawned with the wild female steelhead, or if it was present primarily to feed on eggs, it is well documented that hybridization between steelhead and cutthroat occurs in similarly small streams (Taylor 1997; Campton and Utter 1985).

What became evident in the 2013/14 spawning surveys regarding *O. mykiss* is that the spawning grounds of even very small tributaries of the Mid Skagit basin are complex places that include feral spawning hatchery steelhead, hatchery/wild *O. mykiss* spawning interactions at multiple life history levels, and that there is not only probable natural hybridization between steelhead and sea-run cutthroat, but that it may also include wild sea-run cutthroat hybridization with hatchery steelhead. Although the lattermost case was not observed, the spawning presence of time and place by both closely coincided.

It is clear from the Mid Skagit tributary surveys that significant amounts of steelhead spawning occur at or prior to March 15th, but this was less so in 2014 (27%) than for the cumulative 2010-2014 period (49%). Past survey protocols commonly used have been unable to account for this early steelhead spawning due to rarely, if ever, performing surveys on these streams prior to March, or more commonly March 15th. The recent exception to this has been the initiation of February surveys in the upper anadromous section of Finney Creek to determine what is thought to be largely summer steelhead spawning there (pers. com. Brett Barkdull of WDFW). Regarding how much of the early spawning is by hatchery steelhead or wild is limited to making careful observations of active steelhead spawning and resident *O. mykiss* life history mixes. In the 2014 surveys, five incidences of female steelhead associated with spawning redds were encountered with observations and photographs made between January 16th and May 12th (Table 8). The observed spawning participants were composed of 10 anadromous *O. mykiss* life history steelhead (76.9%), two resident life history *O. mykiss* (15.4%), and one sea-run cutthroat (7.8%). Their species, life history, sex, and origin were: 3 wild female anadromous *O. mykiss* (23.0%), 2 wild male anadromous *O. mykiss* (15.4%), 2 hatchery female anadromous *O. mykiss* (15.4%), 3 male anadromous *O. mykiss* of unknown origin (23.0%), 2 wild male resident *O. mykiss* (15.4%), and 1 wild male anadromous *O.clarki* (7.8%). Of the 7 steelhead of known origin, 5 were wild (71.4%) and 2 hatchery (28.6%). Of the 10 fish with steelhead life history, 30% were wild females, 20% wild males, 20% hatchery females, and 30% undetermined origin males. Of the seven steelhead with known origin,

five were wild (71.4%) and two were hatchery (28.6%). If this is applied to the three unknown origin steelhead males it would represent two that were wild and one hatchery. Of the 10 steelhead, it was a 50/50 ratio of females/males.

In 2014 a total of 44 steelhead redds was found in the five Mid Skagit basin tributaries regularly surveyed (Table 4) with another 5 redds found in the four tributaries intermittently surveyed (Table 5). If the fish related to those 44 redds of the regularly surveyed streams in 2014 were similarly occupied as those found in the 5 active spawning participant findings, it would mean 2.6 fish per redd with a total of 114 fish. Of those 114 fish, 88 would be of steelhead life history. Of the 88 steelhead of which the actual redd construction was related, there would be 44 females and 44 males. Of the 26 unknown origin male steelhead 19 would be wild and 7 hatchery. The resulting composition would be 26 wild female steelhead, 18 hatchery female steelhead, 37 wild male steelhead, 7 hatchery male steelhead, 17 wild male resident *O. mykiss*, and 9 wild male sea-run cutthroat.

Due to the small sample size to draw from, the extension of the above breakdown to the number of redds found can only be considered a rough estimate. For instance, one of the unknown origin male steelhead sighted was an estimated 46-51 cm in length that could have equally been a resident *O. mykiss*. It could also be that the unknown origin males were either all wild or all hatchery. However, it does provide an accurate representation that the Mid Skagit tributary streams are complex spawning grounds from mid January to early June regarding wild and hatchery steelhead, their resident *O. mykiss* life history, and their interactions with sea-run cutthroat. This complexity has gone undocumented as a result of the abbreviated temporal window previously used for Puget Sound steelhead spawning surveys that has particularly excluded the ability to determine the level of feral hatchery steelhead spawning that occurs compared to wild and the life history mix that can result in hatchery/wild *O. mykiss* spawning interactions.

Considerations of How Well the Observed Active Spawners Represent the *O. mykiss* Spawning Populations

Because the active steelhead spawner observations were limited to 7 sightings (Table 8) over the five years of the 2010-14 Mid Skagit tributary surveys out of a total of 104 spawning redds found (Table 6), and 5 active sightings in 2014 (Table 8) of 44 spawning redds found (Table 3), it leads to a discussion of how well 7-11% of the spawning activity evidence represents the *O. mykiss* spawning that occurred in these two periods.

It is possible that wild adult steelhead confined to small tributary environments during spawning are particularly elusive and difficult to initially observe and even more difficult to further observe once initially sighted. As but one example, on January 19, 2011 a hatchery steelhead spawning pair was observed (and photographed) in the South Skagit Highway ditched section of Savage Creek at evening of a cloudy day. The two hatchery steelhead, a female and a male, allowed close observation despite the open roadway with my visible presence. A second male steelhead with red gills and sides immediately fled downstream to a culvert (or perhaps even beyond) before it could be determined if there was an adipose fin or not (wild or hatchery origin) and before a photo could be taken. The very different reactions of the one fish to the other two suggested the potential that the fleeing male may have been wild as a result of inherent streambred selection for caution. On return to Savage Creek in the morning of the next day, the hatchery female steelhead was still present with the redd greatly enlarged, but with no remaining evidence of the hatchery male steelhead. However, downstream a male steelhead of more vivid red gill and side coloration than either of the males sighted the previous day was briefly sighted before it fled downstream. A photograph was attempted but with results too blurred to make any determinations. Again the hatchery origin female remained in close proximity without fleeing.

Of 16 steelhead Mid Skagit tributary steelhead observed, including the previously described female observed twice in two days with differing mates (total of 17 sightings to evaluate), 67% of the wild fled when I was sighted, 33% of the wild did not, 0% of the hatchery fled, 100% of the hatchery did not, 67% of the undetermined origin fled, and 33% of the unknown origin did not (Table 15). The known wild steelhead most often fled and none of the hatchery steelhead fled. Most of the unknown origin steelhead fled suggesting more were wild than hatchery, and the unknowns that did not flee were somewhat more likely to be hatchery.

Table 15.

Stream	date	wild flee	wild remain	hatchery flee	hatchery remain	unknown flee	unknown remain
Finney	3/5/2010	1				1	
Savage	1/19/2011				2	1	
Savage	1/20/2011				1	1	
Dry	1/16/2014				1		
Dry	2/19/2014		1*			1	
Dry	3/12/2014				1		1
Finney	3/28/2014	1	1				1
Dry	5/12-2014	2					
Totals		**4 (67%)**	**2 (33%)**	**0%**	**5 (100%)**	**4 (67%)**	**2 (33%)**

* This wild female did not flee as rapidly as its unknown origin mate. Both were in a white water pocket partially shrouded by bubbles. It is possible the female did not actually see me until I moved quite close and then fled. Nevertheless, its mate fled more quickly and this one is counted as having remained.

It is known that wild steelhead selected for spawning and thereafter reared in a hatchery environment result in domestication even within the first generation (Christie et al. 2012a) and that this domestication in hatcheries also occurs in Atlantic salmon (Debesa and Hutchings 2014). The latter have a similar life history to steelhead and an increased vulnerability to predation was found (implying less caution). Domestication via hatchery rearing also occurs rapidly in other fish species such as found in Atlantic cod (Mayer et al. 2011). Not only does domestication occur in the hatchery population on release into the wild, but it is also conveyed to the supplemented wild populations they reside and interact with and with resulting reduced productivity (Reisenbichler and Rubin 1999; Reisenbichler et al. 2004). This can persist even after cessation of hatchery stocking (Araki et al. 2009). How long it takes to be selected out apparently remains little known.

The combined observations of wild and hatchery steelhead reactions to being observed were not entirely conclusive due to including six steelhead of unknown origin, but they favored the probability that wild origin steelhead are more inclined to flee when observed than hatchery steelhead. The reason for these observed differences to human proximity (or that of a large animal) of steelhead in the spawning tributaries could be a result of retained domestication from juvenile hatchery pond rearing in the case of the hatchery steelhead. If this is the case, and significant numbers of wild steelhead flee prior to being observed by the surveyor, the active steelhead spawning sightings would tend to favor hatchery over wild. However, except for Finney Creek, the streams surveyed are very small which greatly favors sighting steelhead presence. Also, due to prior histories of timber harvest, deep pools and cover provided by large woody debris are less common than was likely the historical case for the Mid Skagit tributaries surveyed. This results in fewer places for steelhead to effectively hide in these small streams.

What was conclusively evident was that by increasing the survey frequency in 2014 during the early part of the survey season that is most affected by greater precipitation and streamflows (particularly common in January

and early March), the sighting of active spawning steelhead increased from that of the previous four years. The increased survey frequency at least partly mitigated for the tendency of wild steelhead to potentially flee and evade being sighted more frequently than hatchery steelhead.

Regarding how the steelhead spawning redds found may represent the actual number of female spawners, there are still other considerations. On May 12, 2014 at Dry Creek a wild steelhead pair fled from the pool they were originally in with no redd in that location at the time (Appendix C, in Table 1; and Appendix F, in Table 2). That same day 3 prominent steelhead redds were found in the 100 m downstream of these two fish and 4 more less easily distinguished possible small steelhead redds were dispersed among white water pockets 300-400 m upstream. Of the latter, it was concluded to interpret these apparent diggings as but one extended steelhead redd. All of this spawning activity had occurred since the prior survey of Dry Creek on May 6th, and all redds were considered very fresh. Subsequently on May 13th another survey was made at Dry Creek to determine if the two wild steelhead were still present, or if there was yet another fresh redd. Although there was no finding of the two steelhead, what appeared to be yet another fresh redd was found at the location they had initially fled the previous day. All in all, this was determined to be 5 fresh redds in the same time period as the potential spawning with only two steelhead observed. It remained an unresolved question of whether one wild female may have built 5 redds over some 600-700 m of Dry Creek (of which one was actually a dispersal of 4 separate spawning pits) or if there were yet other females that had entered and spawned unobserved a day or two previous to the May 12th survey. One of the large redds downstream of where the pair was sighted had been constructed at a point where the gravel of the final digging encountered a layer of hardpan clay about 10 inches down. Was that redd subsequently abandoned with further spawning redds at other locations? The wild female sighted (and photographed) was an estimated 26-27 inches (66.0-68.6 cm) in length and appeared not to be completely spawned, if spawned at all. If a number of redds had been built with eggs deposited, a female steelhead that did so would commonly appear thin of body and noticeably egg depleted. However, some female steelhead have been examined (pers. observation) that remain quite thick of body and are not easily distinguished as having spawned. Therefore if this particular female had spawned fully, partially, or not at all could not be conclusively determined. It remains that steelhead spawning in small tributaries may include female steelhead making multiple redds as the most favorable reproductive strategy.

Wild/Hatchery Findings and Genetics Considerations

Steelhead genetics research on the Washington Coast has found significant levels of wild/hatchery hybridization with resulting declines in wild steelhead productivity despite what was thought to be isolative hatchery spawn timing earlier than for wild steelhead (Seamons et al. 2012). Forks Creek, where this research took place, is a low elevation, rain and snowmelt fed tributary of the Willapa River that is not unlike a number of similarly low elevation tributary streams of Puget Sound including the Mid Skagit basin. The genetics findings at Forks Creek are entirely consistent with the 2010-2014 spawning survey findings of the Mid Skagit basin tributaries. The results of the Forks Creek research bear quoting in light of the Mid Skagit spawn survey findings:

"We tested the efficacy of the strategy of segregation by divergent life history in a steelhead trout, Oncorhynchus mykiss, system, where hatchery fish were selected to spawn months earlier than the indigenous wild population. The proportion of wild ancestry smolts and adults declined by 10–20% over the three generations since the hatchery program began. Up to 80% of the naturally produced steelhead in any given year were hatchery/wild hybrids ... Divergent life history failed to prevent interbreeding when physical isolation was ineffective, an inadequacy that is likely to prevail in many other situations."

From the cumulative findings of the active steelhead spawning redds observed on the Mid Skagit tributaries from 2010 to 2014 (Table 16): of 16 total steelhead observed, 6 were wild, 4 hatchery, and 6 of unknown origin.

Table 16. Life history, sex, and origin of live *O. mykiss* observed on redds occupied by female steelhead by tributary in the cumulative surveys of the Mid Skagit basin in 2010-2014 and in 2014 alone

2010-11 data used
2014 data used
2010-14 combined data used

Tributary	Date	Wild sthd ♀	Wild sthd ♂	Hat sthd ♀	Hat sthd ♂	? sthd ♂	**Wild resident *O. mykiss* ♂**
Finney Ck	3/4/2010	1				1	
Savage Ck	1/19/2011			1	1	2	
Dry Ck	1/16/2014			1			1
Dry Ck	2/19/2014	1				1	
Dry Ck	3/12/2014			1		1	1
Finney Ck	3/28/2014	1	1			1	
Dry Ck	5/12/2014	1	1				
2014 Total	**known origin sthd only** **known sthd with resident**	**5 wild = 71%** **7 wild = 78%**		**2 hatchery = 29%** **2 hatchery = 22%**		**3** **3**	**2** **2 res wild**
2010-14 Total	**known origin sthd only** **known sthd with resident**	**6 wild = 60%** **8 wild = 67%**		**4 hatchery = 40%** **4 hatchery = 33%**		**6** **6**	**2** **2 res wild**

Those of known origin were 60% wild and 40% hatchery. If resident males are included it was 67% wild and 33% hatchery as the *O. mykiss* population spawning mix. From the active spawning evidence of 2014 alone the adult steelhead spawning mix was 71% wild to 29% hatchery. If the resident males are included it was 78%

Table 17. Steelhead/Rainbow by Wild, Hatchery, or Unknown Origin of Spawning Mix Prior to March 15th and After at Five Mid Skagit Tributaries in 2010-14 and 2014 alone.

in 2014 with resident O. mykiss included
in 2014 without resident O. mykiss included
in 2010-14 with resident O. mykiss included
in 2010-14 without resident O. mykiss included

	Wild	**Hatchery**	**?**	**% Wild**	**% Hatchery**	**% ?**	**% Wild without ?**	**% Hatchery without ?**
Prior March 15th (2014)	3	2	2	42.86%	28.57%	28.57%	60%	40%
After March 15th (2014)	4	0	1	80%	0%	20%	100%	0%
Prior March 15th (2014)	1	2	2	20%	40%	40%	33%	67%
After March 15th (2014)	4	0	1	80%	0%	20%	100%	0%
Prior March 15th (2010-14)	4	4	5	30.75%	30.75%	38.50%	50%	50%
After March 15th (2010-14)	4	0	1	80%	0%	20%	100%	0%
Prior March 15th (2010-14)	2	4	5	18.18%	36.36%	45.45%	33%	67%
After March 15th (2010-14)	4	0	1	80%	0%	20%	100%	0%

wild and 22% hatchery as the *O. mykiss* spawning population mix. The resulting range was from 60%-78% wild *O. mykiss* and 22%-40% hatchery at the five Mid Skagit tributaries regularly surveyed over the five year period of 2010-14 based on the active spawning evidence.

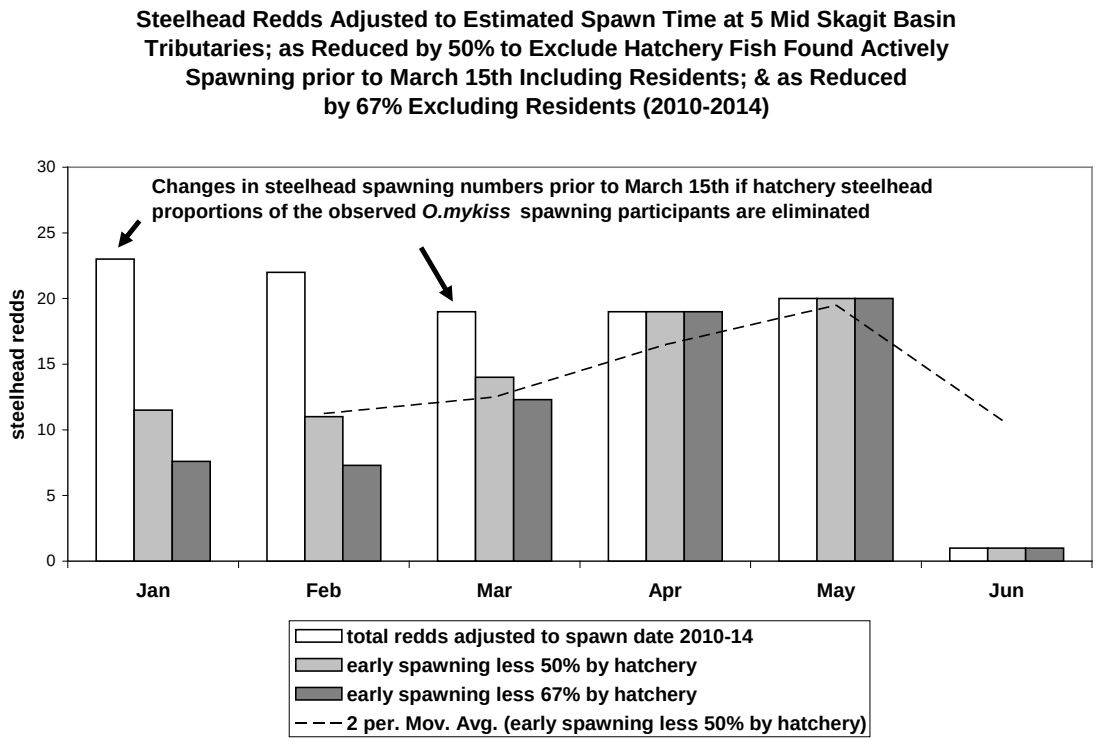
The observed active *O. mykiss* spawning at the five Mid Skagit tributaries that occurred prior to March 15th and after March 15th in 2014 (Table 17) indicates that if the resident life history is included in the spawning mix the known origin participants were 60% wild and 40% hatchery prior to March 15th, and 100% wild and 0% hatchery after March 15th. If the resident life history is excluded it was 33% wild and 67% hatchery prior to March 15th, and still 100% wild and 0% hatchery after March 15th. Over the full five year period of 2010-14 if the resident life history is included in the spawning mix the known origin participants were 50% wild and 50% hatchery prior to March 15th, and 100% wild and 0% hatchery after March 15th. If the resident life history is excluded it was 33% wild and 67% hatchery prior to March 15th, and still 100% wild and 0% hatchery after March 15th. The range of mixes considered prior to March 15th was 33%-60% wild and 40%-67% hatchery. It remains that the spawning participants of unknown origin ranged from 20%-45% of the total spawning mixes and which could alter these outcomes. However, there was little reason to believe that the steelhead of unknown origin were a significantly different mix of wild and hatchery. Judgment calls could have been made in three instances among the six unknowns, one leaning toward hatchery and two leaning toward wild, but rather than try to internally debate it further in each instance these fish were classified as unknowns. In the case of the remaining three unknowns they were simply that.

The percentage of steelhead redds found on or prior to March 15th represent the time period when wild/hatchery spawning interactions between Chambers Creek origin hatchery steelhead and wild steelhead would be more anticipated to occur than after March 15th as a result of more than 50 years of Chambers Creek steelhead selection for early spawning (Crawford 1979). Active hatchery steelhead spawning observations were indeed found wholly within the earlier time period. However, it remains that hatchery steelhead kelts were sampled in the Skagit basin throughout the month of March as well as April between 2008 and 2012 as part of a larger steelhead study (Pflug et al. 2013). Six males of unknown origin were found among the spawning mix in the 2010-14 Mid Skagit tributary surveys of which one was after March 15th and which was of a smaller size that is common for Chambers Creek origin hatchery steelhead. The limitation in active steelhead sightings to draw from in the Mid Skagit tributary surveys may well have otherwise missed documenting hatchery steelhead spawning presence from mid March through April.

If the hatchery percentages of the observed spawning *O. mykiss* spawning mixes are eliminated from the early January to March 15th spawning period, the spawning time that represents that of wild steelhead can be better identified as found in the Mid Skagit basin tributaries over the past five years (Figure 35). The range of hatchery spawning as observed among the active spawning participants prior to March 15th was 50%-67% depending on whether the wild male resident *O. mykiss* were included as part of the spawning population or not (as they should be but which often remain excluded from consideration). This significantly alters the pattern of the monthly steelhead spawning from that which did not take the hatchery component into account. The graphed data then come to better reflect a curve that is top heavy at the May end (the trendline represents the 2% moving average for 50% hatchery reduction level). Although it is tempting to conclude that this is the truer wild steelhead spawning pattern at the Mid Skagit basin tributaries, it does not take into account the probable necessities for a spawning curve that is top heavy toward the earlier time period, rather than the later, for the three tributary streams of the five regularly surveyed that have intermittent flows. Conversely, a pattern that is even more skewed toward the latter period may well be the actual spawning curve that better fits those streams with perennial flows. What Figure 34 can't further depict is the amount of early (or later) steelhead spawning

that includes wild/hatchery hybrid participants and what the overall drain on early wild steelhead spawning productivity has been due to wild/hatchery interactions at all combined levels. It also does not depict what the effects of decades of focused harvest on early return wild steelhead has been as by-catch that targets the hatchery returns at what have been 80%-95% harvest rates set by WDFW and Western Washington Treaty

Figure 35.



Tribes (SASSI 1994; McHenry et al. 1996). It is particularly likely that wild steelhead productivity in those tributary streams of the Skagit River basin that have portions of their mainstems and/or side channels used for spawning that go intermittent have been particularly affected by interactions with hatchery steelhead that apparently target these same spawning areas. It is necessary for early spawning to occur if these streams are to be fully productive for wild steelhead. This will loom even larger in importance given future considerations related to climate change.

The steelhead spawning in Mid Skagit tributaries includes both wild and hatchery steelhead that have overlapping periods of spawning with significant opportunity for hybridization to occur, as would be anticipated from the Forks Creek wild/hatchery steelhead genetic findings (Seamons et al. 2012). The finding of wild resident male *O. mykiss* as part of the spawning mix indicates that they further increase the opportunity for the overall wild and hatchery *O. mykiss* populations to hybridize. The mature male parr life history form of *O. mykiss* was considered to contribute 39% to overall wild steelhead production at Snow Creek of Puget Sound (Seamons et al. 2004). Potential mature male parr contributors to the steelhead spawning mix are fish too small to be have been noticed during the Mid Skagit basin tributary surveys, but the percentages indicated in the literature suggest their probable presence. At Hood River the importance of wild male resident contribution to the steelhead population was described by Christie et al. 2011:

Page 1263: *"... while 20% of steelhead genes come from wild residents. A further 23% of anadromous steelhead*

genes come from matings between two resident parents. If these matings mirror the proportion of matings between residualized hatchery fish and anadromous partners, then closer to 40% of all steelhead genes come from wild trout each generation."

Further Genetic Considerations

Through direct observations of active steelhead spawning during the Mid Skagit basin tributary surveys it has been clearly evident that significant spawning interactions are occurring between wild and hatchery *O. mykiss*. The observed spawning interactions also indicate that gene flow between the wild and hatchery populations of steelhead and the inclusive resident life history of *O. mykiss* are likely occurring at similar levels to the identified spawning participants. Over the full steelhead spawning period the spawning mix was 71% wild to 29% hatchery in 2014, and 60% wild to 40% hatchery in the longer 2010-2014 period. It was 78% wild and 22% hatchery in the case of a mixed steelhead/*O. mykiss* spawning population in 2014, and 67% wild and 33% hatchery in the cumulative 2010-2014 period. In 2008, hatchery steelhead smolt plant numbers were significantly reduced by over 50% (Pflug et al. 2013) with reduced numbers of returning adult hatchery steelhead potentially occurring from 2010 onward. Therefore, the 2010-2014 Mid Skagit basin tributary surveys did not capture what may have been an even higher former level of hatchery steelhead on these spawning grounds. The wild/hatchery spawning interactions observed were all between mid January and mid March. Therefore the earlier return component of the wild steelhead population would be anticipated to have been affected by the greatest gene flow from hatchery steelhead with resulting productivity loss as indicated at Forks Creek on the southwest Washington Coast by Seamons et al. (2011). The only real question about gene flow is at what level it survives to be measured by the present analytical tools and collection methodologies used, and at what hidden level this may occur in eggs, alevins, and very early fry most recently emerged that remains little known. Furthermore, how well are the predominant early spawning areas being sampled from which to best document these wild/hatchery interactions that apparently are most commonly occurring in tributary streams that have some level of intermittency?

Regarding whatever future steelhead genetic work may occur in the Skagit basin regarding a determination of wild/hatchery hybridization, or that of feral hatchery/hatchery spawning, the spawning period when this is most likely to occur as found in the Mid Skagit tributary spawning surveys is from January through March with anticipated fry emergence that could be from late April to mid June. Due to the greatly reduced survival of hatchery/hatchery feral spawning found in numerous steelhead studies, and the reduced survival of wild/hatchery hybrids, it would be anticipated that greater loss of these rearing *O. mykiss* of purely hatchery or wild/hatchery origin would especially occur during their earliest life history stages on exposure to natural selection. The least fit would be anticipated to be most abundant shortly after emergence (or before emergence) with increasing diminishment throughout the rearing period with the more fit being the latter survivors that are much reduced in numbers. Sampling juvenile *O. mykiss* for genetic determinations in the tributaries of the Mid Skagit basin should, therefore, occur as close to emergence time as possible in order to most effectively detect whatever hatchery heritage is present. This time period, depending on annual climate variations, should be from late April to mid June. Any later and it would be anticipated that the hatchery genetic signal (no matter what genetic analytical method is used) in a tributary population of steelhead that may have occurred during natural spawning would have been diminished as a result of natural selection that would favor wild heritage survival and with any hatchery heritage genetic signal increasingly diminishing over the extent of rearing time.

In the case of the Skagit basin, if Chambers Creek origin hatchery steelhead continue to be curtailed from 2014 onward for at least 12 years, as a recent lawsuit settlement agreement has indicated, the last two-salt life history

return of this hatchery stock would be the spawning year of 2015 from the 2013 smolt plants, and continuing into the spawning year of 2016 if some level of three-salt hatchery returns occurs. However, it remains that some level of hatchery introgression into the Mid Skagit tributary *O. mykiss* populations may continue with a genetic signal thereafter for an unknown period through what has been termed the "carry over effect" (Araki et al. 2009). It also remains to be determined if some other hatchery steelhead program may occur from which these considerations for monitoring the Mid Skagit tributary steelhead populations related to potential hatchery effects may remain valid.

The baseline of information on steelhead/*O. mykiss* spawning that has now been collected at Mid Skagit tributaries throughout the breadth of their spawning period can provide a basis to guide juvenile collections for genetic analysis, as well as that of providing a guide for when to initiate future steelhead spawning surveys in a way that can capture the full breadth of spawning by *O. mykiss* that occurs.

Evidence of Skagit Basin Tributary Steelhead Spawning and Genetic Diversity about 35 Years Ago

Of background interest, a study of the genetic structure of wild steelhead throughout the Skagit basin was initiated in 1979 through electrophoretic analysis of tissue proteins from age 0+ juveniles taken at 57 sample sites (Phillips et al. 1981a). Intended to be a three year study, it was abandoned after the first year with no follow up. While no significant differences were found between Skagit and Sauk River steelhead, the Cascade River steelhead were found significantly different. However, the greatest level of gene frequency differences with the greatest variability was found between individual tributary creek samples of the Skagit basin and between the general geographic areas these tributaries are within. Significant portions of the only known remaining copy of this study are missing leaving gaps in what can be understood, but the primary finding of this within-basin genetic differentiation was acknowledged by Phelps et al. (1994). Finney and O'Toole creeks of the Mid Skagit basin were among the tributary streams sampled and genetically evaluated in what remains of that 1981 report. The Phillips et al. (1981a) steelhead genetic study of the Skagit basin was in the same period of time when the tributary creeks of the Skagit basin were supporting 65-80% of all the steelhead spawning (Phillips et al. 1981b) as found by spawning surveys conducted in the Skagit basin from 1978 to 1981. Despite their relatively small size, Skagit tributary creeks have a large presence in its steelhead history. These historical reports on Skagit steelhead tributary findings provide an historical baseline for further comparisons today and as an aid to recovery planning.

Reasons for Steelhead Spawning Time Differences

Water temperature and a combination of precipitation and streamflow levels have been identified as contributive factors controlling steelhead spawning time (Briggs 1953; Shapovalov and Taft 1954; Crawford et al. 1979; Cederholm 1984). Earliest spawning migrations typically occur for salmon and steelhead destined for uppermost watershed locations at both the larger watershed scale and that of smaller tributaries, and differences in both streamflow and temperatures further result in differing general entry times for spawning (Briggs 1953). Streamflow patterns also predictably determine spawning time differences of steelhead in tributaries as compared to mainstem locations which Oregon spawning surveys are planned around (Susac and Jacobs 1999). Intermittent streams have further controls on time of spawning related to successful *O. mykiss* emergence and non-lethal rearing opportunities that fry-to-parr survival ultimately depend on in migrations from drying natal streams to perennial ones for rearing (Everest 1973; Erman and Hawthorne 1976; Boughton et al. 2009). All of these factors are relevant to steelhead/*O. mykiss* spawning found in Mid Skagit basin tributaries. It is

informative to examine the comparative literature regarding steelhead/*O. mykiss* spawning elsewhere and how it may more broadly relate to the Skagit basin in the past and into the future.

Temperature and Precipitation/Streamflow

Cederholm (1984) indicated that a combination of water temperatures and streamflows were the likely drivers of steelhead spawning time differences he found in differing years at the Clearwater River and its tributaries of the Queets basin on the Northwest Washington coast. In seven years of spawning surveys he found a 39 day difference in annual peak spawning dates of wild steelhead prior to hatchery introductions into the Queets basin. The primary correlation in this shifting spawning time peak was thought to be water temperature differences with the earliest peak spawning being in the year when water temperature reached 7 C on or before March 16th but which did not occur in the latest year until April 10th. The 7 C water temperature was the midpoint recommended water temperature for steelhead spawning as determined by Reiser and Bjornn (1979). The 25 day difference they documented in achieving the 7 C water temperature was considered by Cederholm to be relatively comparable to the 39 day differences found in peak steelhead spawning at the Clearwater River and its tributaries surveyed. By contrast, entry time of steelhead did not alter as determined by the lower Queets River tribal steelhead fishery. Therefore the differences in peak spawning dates were likely determined by annually differing environmental factors that occurred after initial Queets River entry, especially water temperature and at a more general long-term scale by streamflows. He also found that tributary spawning time varied widely between streams and on the whole tributary spawning peaked earlier than in the mainstem. Tributary spawning began in January some years and as late as June, virtually identical to that found in the Mid Skagit basin tributaries. Cederholm also indicated that spring steelhead spawning is a disadvantage for some juvenile steelhead due to emerging from the gravel in mid- to late summer (June to August). As a result, many later spawning steelhead are of small size going into their first winter and must spend two or more winters in freshwater with related added mortality prior to smolting. Given this consideration, early spawning as found in Savage, Dry, Finney, and some years Mill Creek in the Mid Skagit basin could result in greater juvenile growth going into their first winter and subsequent higher overall survival; late spawning could result in reduced juvenile growth going into the first winter and reduced survival. This would, however, be balanced by high streamflow peaks in the earlier spawning period and more stable streamflows in the later spawning period that may otherwise select for survival depending on the year and individual stream.

At the Kalama River there were two back-to-back years of significantly different temperature and flow conditions that affected steelhead spawning (Crawford et al. 1979). The 1976-77 winter was one of drought and cold average temperatures while 1977-78 was a winter with a 100-year flood and remained warm and rainy throughout. Steelhead began spawning 37 days earlier in 1977-78 with a resulting two month earlier spawning peak (mid January opposed to mid March) than in 1976-77.

In the detailed studies at Waddell Creek on the California Coast, steelhead waited off the mouth of the creek for spawning migrations upstream until the opening of blocking sand bars occurred with the first fall storms (Shapovalov and Taft 1954). The initial entry of steelhead with earliest storms was comparatively small to that of subsequent entries with each storm that followed until the end of the spawning entry season. The complete breadth of entry as trapped at the Waddell Creek weir was from October 28th through July 21st, but 96 percent of all the steelhead were counted during the 22 weeks from December 3rd to May 5th. Of all fish trapped during the nine years of study (1934-1942), 39 percent of the fish were taken from March 1st onward (61 percent prior to that). Steelhead upstream migration for spawning was dependent on seasonal variations in weather and water conditions with a strong relationship to streamflow. Migration typically ceased at peak flood flows, but could

occur on both rising and falling levels. Climatic conditions were thought to be a factor as was water turbidity and sexual ripeness. It was found that there were two peaks of upstream movement, one in the week ending January 6th and the other for the week ending March 17th.

In the case of the Mid Skagit basin tributaries, both temperature and streamflow appear to have a relationship to spawning entry and time similar to that described at both Waddell Creek and at tributaries of the Clearwater River.

Precipitation/Streamflow Relationships to Spawning Entry

Outside the Mid Skagit basin, the Waddell Creek example of steelhead spawning migrations dependent on storm events and high streamflows (Shapovalov and Taft 1954) is comparable to steelhead spawning entry limitations at the Mid Skagit tributaries. Of the five tributary creeks regularly surveyed, three have gravel deposition bars that have built up at their mouths (Finney, Dry, and Savage creeks) that can restrict anadromous fish entry to periods of higher streamflow in the tributary itself, and/or higher streamflows in the Skagit River or the mainstem the tributary enters. In the case of Dry Creek, its deposition bar is at entry to Finney Creek (Photo 4), but Savage and Finney Creek deposition bars are at entry to the Mid Skagit River (Savage Creek entry Photo 16). This is not unlike the sandbars that must be breached by periodic Pacific storms for entry to Waddell Creek (California Coast) throughout the spawning return period. At two of these Mid Skagit tributaries in 2014, Dry and Savage creeks, 50-100% of steelhead redds found were prior to March 15th (Figure 2). In the cumulative period of 2010-2014 it was 65-94% of the steelhead redds found prior to that date in the same two tributaries (Figure 4). Like at Waddell Creek, steelhead spawning entry prior to early to mid March was dominant at two creeks where spawning entry is controlled by flow, in this case gravel bars at their mouths rather than sand bars.

As an observed example of streamflow effects related to spawning entry (Photo 16): on the evening of January 29, 2014, after lack of rainfall since January 16th, there was 0.85 inch rainfall measured in my gage near the mouth of Savage Creek near Birdsview (Appendix F, Table 2). At the Concrete gage it was 0.18 inch rainfall on January 29th, likely occurring in very early morning, and 0.40 inch on January 30th likely from the previous day with a cumulative total of 0.58 inch probably occurring on January 29th if the Concrete gage was emptied at 8:00-9:00 am each day. As is the common pattern, there was less rainfall at Concrete than at my Birdsview area gage. Although Savage Creek did not appreciably rise in flow, a steelhead (or less likely by that date a coho) twice attempted entry over the shallow bar from the Skagit River. Its splashing was sighted from 100 m upstream. Despite the vigorous efforts it failed to enter and dropped back into the main river, potentially entering later with subsequent continued precipitation and rise in flow. Rain continued for another two days. On spawning surveys of Dry and Finney creeks on February 2nd two inactive redds were found that were likely made after successful entry with the rise in flows due to the initiation of rainfall on January 29th. However, no corresponding redd was found at Savage Creek on January 30th or on February 16th and 18th in the creek sections surveyed. On February 20th two inactive redds were found at Savage Creek, but they were estimated as built within the week not 2-3 weeks previous. This was likely related to 4.4 inches of rainfall measured at my Birdsview gage between February 15th and 19th and 5.27 inches as measured at the Concrete gage between February 10th and 20th rather than the prior rainfall in late January. Steelhead angling remained open on the Skagit River through January 31st with hatchery steelhead legal to harvest. Potentially it was a hatchery steelhead sighted attempting entry to Savage on January 29th that was subsequently harvested, or perhaps with denial of entry on that date the steelhead (or coho) spawned in the mainstem Skagit or nearby Grandy Creek directly across the Skagit River. Alternatively it could have entered and spawned in Savage Creek in one of the

anadromous sections of the creek that was not surveyed on January 30th and subsequent surveys missed it due to significant rainfall occurring during the February 10-20th time period that erased evidence of any redd. It remains that Photo 16 well depicts the necessity for sufficient streamflows required at some Mid Skagit tributaries for steelhead spawning entry to occur.

Photo 16: Savage Creek Deposition Bar at Entry to the Mid Skagit River

Although the Finney Creek deposition bar at entry to the Skagit River is an obstacle at lower October through May flows of typical anadromous fish entry, it more commonly remains navigable for spawning entry due to its larger size and greater overall flow. Both early and late steelhead spawning occur at Finney Creek with 10-38% (average 35%) prior to March 15th (Figures 4, 5, and 6).

From January to June there is generally declining precipitation except for a precipitation spike in March as the average trend in the 2010-2014 Mid Skagit tributary survey period (Figures 21 and 22; and Appendix A, Tables 1 and 2). The steelhead entry and spawning at Savage and Dry creeks are likely driven in part by greater precipitation prior to April. Although February precipitation is about the same as April, January's precipitation can include considerable snow which sustains February flows as it begins to melt in these smaller tributaries of relatively short length dominated by lower rather than higher elevations (Figure 17). Passage over obstructing deposition bars at their stream mouths is likely more favorable for steelhead prior to April if precipitation amount is a proxy for streamflow at these two tributaries. Because of so little of their drainage being at higher elevation they are rain and snowmelt driven with relatively immediate response to precipitation except during generally short periods of snowfall of 1-2 weeks. Although the streamflow data from the North Fork Stillaguamish River may well be a surrogate for the streamflow pattern at Finney Creek (Figures 26) that is more independent of precipitation patterns from March through May (Figure 28), this is less likely at Savage and Dry creeks. Finney Creek's more extensive length at higher elevations prior to meeting the Skagit Valley floor likely results in more delay of snowmelt that has accumulated (Table 18). Snow accumulation from 760-

1070 m is considered transitory with rain-on-snow storms from October to February resulting in most of the peak flows, while the uppermost 479 m to its 1,549 m source at Finney Peak is apparently longer term snowpack (Nichols and Ketcheson 2013). Although other Mid Skagit basin tributaries drain elevations as high as the actual stream channel source of Finney Creek (as determined from Google Earth measures), their elevations that are above 500 m (1,640 ft) are comparatively short stream lengths, while upper mainstem Finney has 6.0 mi (9.66 km) that are above 500 m, plus another 4.48 mi (7.2 km) at two of its larger headwater tributaries. The two Mid Skagit tributaries regularly surveyed with the least lineal lengths of their drainages above 500 m are Dry and Savage creeks, also the streams with earliest spawning and greatest mainstem lengths that go intermittent the earliest.

Table 18. Stream Lineal Lengths, Drainage Areas (if available), and Source/Mouth Elevations for the Five Mid Skagit Basin Tributaries Regularly Surveyed and Rarely Surveyed *****

Rarely surveyed

Least stream lengths above 500 m elevation of Mid Skagit tributaries regularly surveyed

Stream	Length miles miles (km)	Area mi2 (km2)	Source elevation feet (m)	Mouth elevation feet (m)	Stream length above 500 m in miles (km)	Reference
Savage	2.1 (3.4 km) 3.86 (6.2 km)	....	.... 2,715 (828 m)	.... 113 (34.4 m)	0.35 (0.56 km)	Williams et al. 1975 Google Earth measures
Mill	4.6 (7.4 km) 4.7 (7.6 km)	....	.... 3,300 (1,006 m)	.... 112 (34.1 m)	.... 2.58 (4.15 km)	Williams et al. 1975 Google Earth measures
O'Toole	4.0 (6.4 km) 3.5 or 5.6 (5.6 or 9.0 km)	....	.... 2,500 or 3,800 (762 or 1,158 m)	.... 111 (33.8 m)	.... 2.0 or 3.98 (3.2 or 6.4 km)	Williams et al. 1975 Google Earth mearsues
Finney	23.98 (38.6 km) 23.8 (38.3 km)	54 (140 km2)	5,082 (1,549 m) 3,560 (1,085 m)	134.5 (41 m) 125 (38.1 m)	.... 6.0 (9.65 km)	Nichols & Ketcheson 2013 Google Earth measures
Dry	2.1 (3.4 km) 2.4 (3.9 km)	....	.... (604 or 790 m)	.... 167 (50.9 m)	.... 0.15 or 0.43 (0.24 or 0.69 km)	Williams et al. 1975 Google Earth measures
Cumberland	5.4 (8.7 km) 4.1 or 5.0 (6.6 or 8.0 km)	....	.... 2,730 or 2,900 (832 or 884 m)	.... 91 (27.7 m)	....	Williams et al. 1975 Google Earth measures
Grandy	7.6 (12.23 km) .... 7.2 or 8.4 (11.6 or 13.5 km)	.... 19.7 (51 km2)	.... 1,000 or 4,000 (305 or 1,219 m)	.... 113 (34.4 m)	....	Williams et al. 1975 Ames & Bucknell 1981 Google Earth measures
Hatchery	3.4 (5.5 km) 3.3 (5.3 km)	....	.... 3,000 (914 m)	.... 236 (71.9 m)	....	Williams et al. 1975 Google Earth measures
Quartz	3.5 (5.6 km) 3.1 (5.0 km)	....	.... 3,182 (970 m)	.... 234 (71.3 m)	....	Williams et al. 1975 Googel Earth measures

***** Google Earth measures determined were to stream channel ends that could be followed, and source elevations were similarly so and not to the height of the surrounding mountains they may drain.

In the coastal Oregon steelhead spawning surveys it was found that steelhead spawning in tributaries coincided with freshet conditions and that as a result the surveys focused on mainstem rivers during low flow periods and later in the spawning season (Susac and Jacobs 1999). Precipitation in the Mid Skagit basin is greater from January through March than thereafter (Appendix A, Tables 1 and 2) and it would be anticipated that steelhead spawning in the tributary creeks are sometimes driven by this greater precipitation period, particularly in those streams where entry may be otherwise deterred by gravel deposition at their mouths as previously described. The two Mid Skagit tributaries regularly surveyed that have deeper channels at their mouths without a deposition bar to overcome for anadromous fish entry from October through May are O'Toole and Mill creeks.

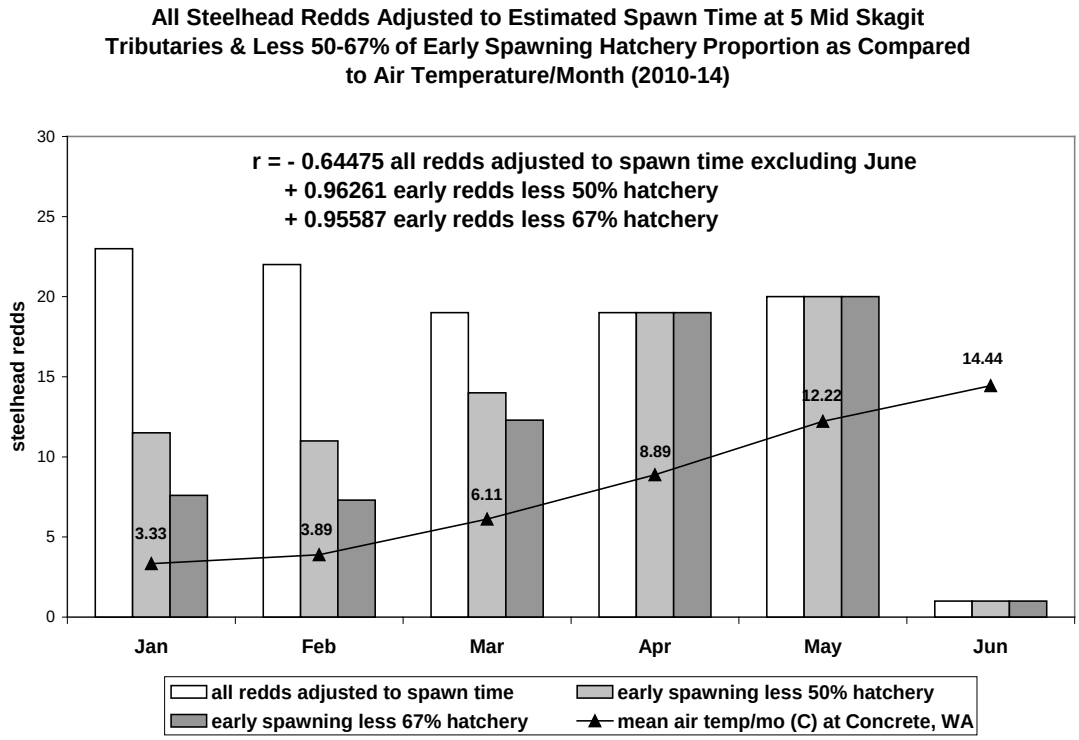
O'Toole Creek steelhead spawning is mostly later in the season (78%) and Mill Creek has both early (59%) and later (41%) spawning by steelhead (Figure 4).

A pattern of earlier entry for steelhead and salmon destined for upper watershed spawning destinations has also long been noted to occur (Briggs 1953), and that this can even occur at the smaller tributary scale as found at Prairie Creek on the California coast. At Prairie Creek earliest spawning more densely occurred in the upper watershed portion and progressively shifted down the watershed through the steelhead spawning period. At the larger Skagit basin level, one would anticipate that uppermost watershed areas would particularly depend on earlier entry time to reach those more distant spawning destination locations. However, this may not necessarily mean earlier spawning than elsewhere in the basin. It was also determined that while both flows and temperatures determined spawning migrations that it was difficult to isolate one from the other:

Page 13: *"In the California north coastal region the stream rises in the winter time almost always seem to be accompanied by sharp temperature increases ... This fact makes it difficult to separate the effects of these two environmental factors."*

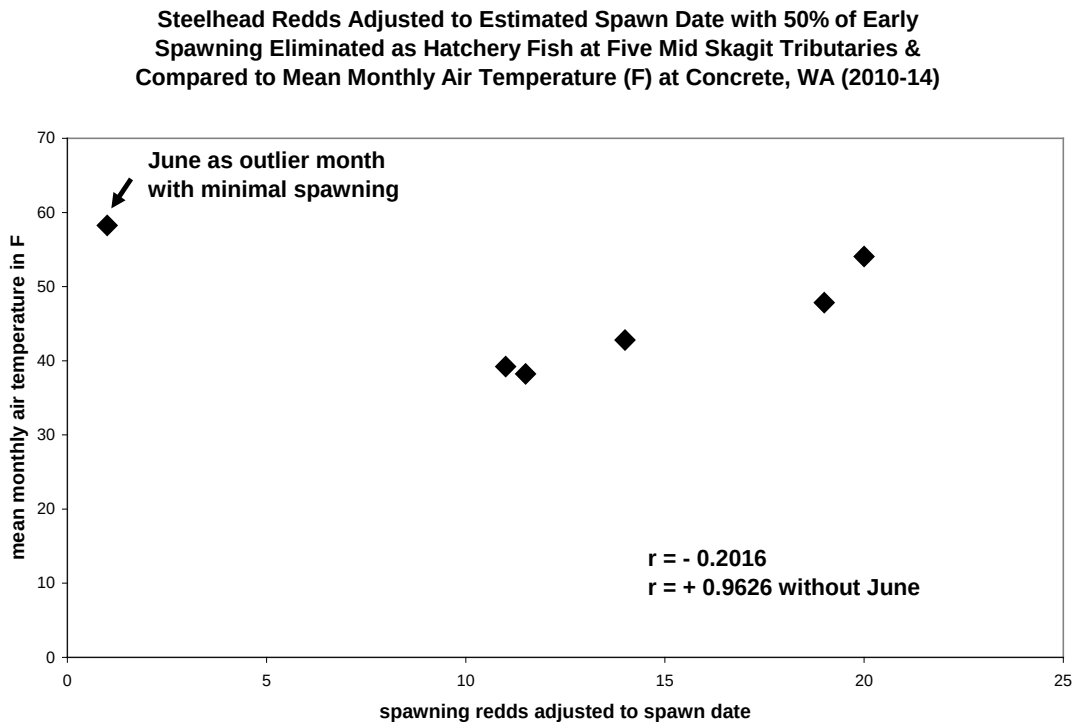
Coinciding environmental variables may also have been a reason for the inability to find significant correlations between flows, precipitation, and temperatures in the Mid Skagit basin tributaries. Furthermore, the hatchery steelhead spawning time may have a somewhat different driver (narrower period of primary spawning time for instance that is determined through hatchery selection) that predominates compared to the generally broader distribution of spawning time for wild steelhead as depicted when hatchery steelhead were eliminated from the spawning mixes in Figure 35. The data that included hatchery steelhead from which correlations were determined between spawning time and air temperature, precipitation, and streamflow may have been one factor

Figure 36.



that confounded the ability to find significant correlations. However, on eliminating 50-67% of the early spawning between January and March 15th to represent the actual wild spawning mix (including residents along with steelhead) found at the Mid Skagit tributaries by eliminating the proportion found to be hatchery steelhead on the active redds, it remained that streamflow and precipitation did not have any more significant correlations

Figure 37.



than previously done. Air temperature, as a surrogate for stream temperatures was another matter and was found to have a much stronger comparative pattern with wild steelhead spawning (Figure 36) and resulting correlation (Figure 37) than previously found when the potential proportion of hatchery steelhead in the overall population was not excluded (Figures 15, and 16). A highly significant Pearson's correlation "r" of + 0.9626 was found (at 50% reduction of early spawning by hatchery fish) if June is eliminated as the outlier month when minimal steelhead spawning occurs in the Mid Skagit tributaries regularly surveyed. June may result in air/water temperatures at low elevation streams commonly beyond the maximums for steelhead indicated by Bell (1973) and Bovee (1978) of 9.4-13 C (48.9-55.4 F).

C. Intermittent and Perennial Streamflows

Everest (1973) found that the high summer steelhead productivity in the Rogue River basin was dependent on intensive spawning use of small tributaries with watershed basin areas of less than 25 square miles and winter streamflows of less than 50 cfs. Most of these streams became intermittent in summer, as early as mid June, and yet supported large steelhead spawning populations in winter while going completely dry in summer. As a result, most fry had to migrate from these streams to larger tributaries or the mainstem soon after emergence. As but one example, Kane Creek was intensively studied and supported more than 2,000 spawning adults despite being dry from August through October. Peak spawning in the 1979-71 water year occurred from late

January through mid February shortly after a peak maximum flow event on January 18, 1971. Peak fry outmigration occurred in May.

It is apparent from the Rogue River example that intermittent tributary streams are not only used by steelhead for spawning, but that they can support very large numbers of spawning steelhead per size of watershed. In the case of the Mid Skagit basin tributaries, the one stream that is of smallest estimated winter streamflow, and with a greater percent of its anadromous length going dry every summer (about 50%), is Dry Creek. Yet, 14 steelhead redds per kilometer were found at Dry Creek in 2014, which was about 2-10 times greater density of steelhead redds found than at any of the other four tributaries (Table 4). Emergence of *O. mykiss* fry was found in Dry Creek by mid to latter May, with probable emergence even earlier. This was sufficiently early to provide downstream migration to Finney Creek, and/or the Skagit River prior to its lower portion going subsurface likely several days prior to its being photographed on June 27th (Photo 5). As at the Rogue tributaries, steelhead spawning began in latter January (hatchery female steelhead and wild resident male) and February (wild female steelhead, undetermined male steelhead, and sea-run cutthroat male) in 2014. In 1978-1981 it was found that 65-80% of Skagit basin steelhead spawning occurred in the tributary creeks rather than the mainstems (Phillips et al. 1981b). However, it was thought that while the majority of the spawning occurred in the tributaries, most of the rearing to result in the adult returns must occur in the mainstems which even at that time were thought to be below carrying capacity and could accommodate still more. Although intermittency was not considered on the Skagit 35 years ago, the movement of juveniles from the tributaries to the mainstems was otherwise of the same pattern as on the Rogue.

Of the five Mid Skagit basin tributaries regularly surveyed in 2014, only O'Toole Creek remained completely perennial throughout the summer period (Table 12; and Photo 12). Significant portions of all the others went intermittent at varied times from May 30th to August 1st. In the case of Finney Creek, the largest of the streams surveyed, its mainstem remained perennial but numerous significant side channels where *O. mykiss* spawn and/or rear began to go intermittent by May 30th. There were known losses of large numbers of mixed salmonid fry and some parr that included *O. mykiss* photographed in late May as these side channels approached complete dewatering (Photo 14). The lowermost tributary of Finney Creek, Dry Creek, went intermittent in its lower 70 m by June 24-27 and progressed upstream as previously described leaving only the upper 400-500 m wetted from mid July onward. Nevertheless, it supported the highest level of steelhead spawning found at 14 redds/km, nearly double the next highest steelhead spawning in any of the other four tributaries regularly surveyed (Table 4). Dry Creek also has the most confined and stable channel of the five streams regularly surveyed, and while its spawning gravel has considerable fine sediment, it is much less so than the gravel of Finney Creek from visual estimates.

In the case of lower Savage and Mill creeks, both have had significant depositions of gravel related to landslides and/or bank erosion further upstream. These gravel depositions are likely related to their logging land use histories and aggravated by major flood events in the Skagit basin that have increased from eight of over 90,000 cfs in the 30 year period of 1948-1977 to fourteen in the 30 year period of 1978-2007, nearly double the flood event frequency of over 90,000 cfs from the earlier period (Appendix D). Weather pattern shifts related to climate change are likely contributing to this and shifts toward increasing changes in flow patterns are predicted to particularly occur in the northern Pacific Northwest (Wade et al. 2013). Despite the present conditions, that may or may not have been the case regarding the prior hydrology and geomorphology histories of these two tributaries, they are annually used for spawning and seasonal rearing by steelhead and other salmonids. They were even more prevalently used by steelhead about 35 years ago (Table 19; and Phillips et al. 1981b). At the time of the 1978-1981 spawning surveys there was no data provided if the streams included at the time were a

mix of perennial and intermittent or not. Presumably portions of the lengths of some were intermittent, as is the case today, but that can't be determined from the information provided. Of the 26 Skagit River tributary creeks surveyed at that time, Finney, Mill, and O'Toole were included for some or all years and steelhead spawning use in the differing eras can be compared (Table 19). Steelhead spawning use has significantly declined in these three Mid Skagit basin tributary creeks since that earlier period based on the 2014 survey findings and is now 35-78% of that in the past. Yet, the wild steelhead preliminary escapement estimate for 2014 is higher than any of the years in the 1978-1981 period (Table 20). The average escapement of 5,670 in that former time is less than 63% of the 2014 preliminary estimate of over 9,000 wild steelhead. Presumably if the tributaries were at former productivity levels present Skagit wild steelhead numbers would be considerably greater.

Table 19. Steelhead redds/km in three Mid Skagit tributaries in 1978-1981 compared to 2014

Stream	redds/km 1978-1981	redds/km 2014	present % of former spawning
Finney Ck	11.9	5.7	48%
Mill Ck	5.0-6.8	2.4	35-48%
O'Toole Ck	10.3-22.2	8.0	36-78%

Table 20. Skagit basin wild steelhead spawning escapements 1978-1981 and 2014

Year	Wild steelhead escapement	Reference
1978	7294	Phillips et al. 1981b
1979	3943	Phillips et al. 1981b
1980	6009	Phillips et al. 1981b
1981	5435	Phillips et al. 1981b
2014	over 9000, as preliminary estimate still to be finalized	per. comm. Brett Barkdull, WDFW, Nov. 6, 2014

Intermittent streams will increasingly be a part of the Northwest future if climate change progresses with continued warming at latitudes north of 45°N (Boughton et al. 2009). *O. mykiss* have adapted to this successfully and productively through much of their southern range and presumably a similar adaptation can transition northward as streams increasingly become intermittent over time. In fact, intermittent streams may even provide the most preferred spawning habitat due to having greater gravel accumulations (Everest 1973; Erman and Hawthorne 1976; Boughton et al. 2009) as occurs at Mill and Savage creeks of the Mid Skagit basin as a result of the probable mix of logging, landslides, increased flood events, and climate change. However, this adaptation and high level of potential productivity from intermittent streams will have to include early enough spawning for *O. mykiss* fry to get out of the gravel and migrate to perennial streams or perennial stream sections within the same streams for continued rearing.

There is a further consideration regarding intermittency and the use of such streams for successful wild steelhead reproduction. Although it was previously indicated that after significant portions had gone subsurface at Dry Creek with the assumption that potentially thousands of fry had perished by not outmigrating earlier, in the case of juvenile Atlantic salmon it has been found that juveniles, both fry and even parr size, can effectively penetrate the hyporheic flow of streams at least 60 cm (24 in) in both vertical and horizontal directions and may potentially include even more extensive movements (Heggenes et al. 2013). It was indicated that hatchery heritage fry may not be equally successful at doing so. At the level of benthic invertebrates, the hyporheic flow of rivers has been found to sustain connected communities 10 m (33 ft) deep and 2 km (1.24 mi) distant from the river channel within its more extensive floodplain (Stanford and Ward 1988). In the case of the Atlantic salmon fry, it indicated that finer sized substrates limited their movements more than larger sized substrates.

Dry Creek has considerable fine sediment in the gravel which may more restrict access to the hyporheic flow that otherwise likely includes both it and Finney Creek as part of an interactive floodplain. At both Dry Creek and Savage Creek, once they began to go subsurface digging down about 30 cm (12 in) did not reveal evidence of fry or parr, alive or dead, nor did the surface of the recently dewatered areas. However, the question remains: could they have been deeper, even a lot deeper? It remains for further consideration. Nevertheless, steelhead spawning time in the three tributaries that go intermittent in the Mid Skagit basin was earlier than the one regularly surveyed that remains perennial with apparent selection for earlier spawning by steelhead in the intermittent streams and likely earlier emergence as an adaptive advantage.

At Sagehen Creek in California, Erman and Hawthorne (1976) found that 39-47% of a rainbow trout population used an intermittent mountain stream to spawn despite the nearby presence of perennial stream habitat. On subsequent emergence the fry moved downstream to Sagehen Creek before the tributary dried up during a dry year (Erman and Leidy 1975). In a wetter year fry also moved downstream even though the streamflow remained permanent but many also remained as almost the only fish occupants of the stream. For whatever reasons that may not always be immediately identified, the intermittent tributary to Sagehen Creek example in California demonstrates the considerable attraction such streams have for *O. mykiss* spawning.

At the Arroyo Seco River, tributary of the Salinas River basin in central California, it was found that there was a spatial and temporal segregation of winter spawning habitat from over summering habitat as used by resident and anadromous *O. mykiss* (Boughton et al. 2009). The eastern side of the watershed was drier, the streams intermittent, spawning gravel aggregations greater, and spawning use was predominant; the western side of the watershed had more rainfall, cooler summer air temperatures, cooler streams with perennial flow, and resulting greater rearing use. It was considered that the fitness of the young-of-year hatching from the intermittent streams of the eastside depended on their ability to access the perennial westside tributaries for summer rearing before being lost to predation, warm temperatures, and intermittency. Of particular relevance to the Mid Skagit basin tributary creeks (Boughton et al. 2009):

Page 102: *"... suitably sized spawning gravels tended to occur in intermittent tributaries ... Significantly, some of the earliest-drying parts of the intermittent tributaries occurred just above their confluences, where they emerged from steep side canyons onto the unconstrained floodplain of the mainstem. This pattern cut off the possibility of emigration from intermittent creeks early in the seasonal drying process. This sort of bottom-up drying pattern might have greater mortality impacts than a top–down pattern, as the fish would retain a greater number of dispersal options for a longer time in the top–down pattern."*

Of further significance for recovery of ESA listed Puget Sound steelhead that includes the Mid Skagit basin:

Page 102: *"In many parts of their range, O. mykiss inhabit snow-fed mountain streams that more effectively store water for summer discharge than the rain-fed system observed in our study. However, many of these are expected to convert to rain-fed systems due to climate change. Under a given amount of annual precipitation, such conversion will produce larger peak flows in winter and lower minimum flows in summer."*

Page 92: "*In parts of North America, 59% of total stream length appears to be either intermittent or ephemeral (Nadeau & Rains 2007), and occurrence of intermittency may expand in the future as climate trends convert snowfed stream systems into rain-fed systems with reduced natural water storage and lower minimum flows. Such conversions are already in progress (Mote et al. 2005; Regonda et al. 2005; Hodgkins & Dudley 2006;*

Knowles et al. 2006), and are expected to affect most of the European, Asian and American continents north of 45°N ...”

A major question for the Mid Skagit basin tributary streams is what has happened to the formerly greater steelhead spawning use found 35 years ago? It is apparent that an increasing shift toward intermittency may not be a limitation on steelhead productivity, but may actually increase the amount of spawning gravel available. If steelhead can’t make effective use of these intermittent streams now, the future will likely only become worse until the present limitations in their steelhead productivity are effectively analyzed and rectified through fishery management changes and/or addressing other habitat constraints. This is particularly critical given that Skagit basin steelhead (and all those of Puget Sound) are ESA listed as Threatened with legal obligations intended for their recovery rather than perpetuating a continued slide toward further depletion. Given that wild steelhead escapements were actually higher in 2014 than in the period of 1978-1981, it is apparent that resolving the present limitations for tributary steelhead productivity in the Skagit basin would likely lead to considerable progress toward wild steelhead recovery.

More Heavily Used Mid Skagit Tributary Spawning Area Characteristics

The one Mid Skagit tributary with proportionally greatest steelhead spawning use in 2014 was Dry Creek with about 14 redds per km (Table 4). Although Finney Creek overall had very dispersed steelhead spawning (less than 6 redds per km), there is a side channel below a logjam of about 150 m in length where 7-8 redds were found in a 40-50 foot (12-15 m) line (Appendix C, in Table 1) in a deep riffle with faster current speed than where most steelhead redds are found. These 7-8 redds were all a result of spawning that occurred in a relatively short period as found May 14, 2014 and photographed at a lower flow two days later (Photo 17). If this section was expanded to a length of 1 km it would result in 46 redds per km at 7 redds found, or 53 redds

Photo 17. A stable side channel at Finney Creek with 7-8 steelhead spawning redds in line

per km at 8 redds found if the majority of Finney Creek was similarly conformed. If this is further expanded to the approximate 10 km length of Finney Creek where winter steelhead spawning primarily occurs, it would result in 460-530 winter steelhead redds in the primary spawning area that may have once included many similar reaches as this 150 yard reach prior to the past 50 year logging history. This excludes whatever other redds may have occurred in this side channel due to the inability to effectively survey it during much of the earlier spawning season in 2014 due to high and/or discolored flows.

Dry Creek is a tributary of lower Finney Creek. Although it is of intermittent flow, it is the one tributary in the anadromous length of Finney basin that continues to have a considerable portion of its 800 m of anadromous length that is forested with conifer trees of larger second growth size. Perhaps as a result of this its channel is well contained (Photos 6 and 18). During the January through May spawning period the wetted width and bankfull width do not greatly differ (Table 21). This contrasts with Finney Creek that commonly has a very broad channel with great differences between wetted and bankfull widths during the steelhead spawning season that includes significant channel shifts during the higher flow events (Photos 2 and 3). Over the past five years of spawning surveys, the most contained and stable channel of Finney Creek in the lower anadromous reach is the side channel below the logjam that has been described. Although this side channel has been enlarging, it still remains well contained with little difference between wetted and bankfull widths during the steelhead spawning period. The steelhead use in this side channel as evidenced by redds has increased since the initial

Photo 18. Lower Dry Creek forested section depicting one of five channel points measured February 15, 2013

formation of this side channel shortly prior to, or near the same time, as the first 2009-2010 period of the initial year of the surveys.

One readily identified commonality between these two areas of Finney Creek's lower basin is their well contained channels during the steelhead spawning period as determined by the relatively small difference

between wetted and bankfull widths. The one other stream of the five Mid Skagit tributaries regularly surveyed that has a similarly well contained channel throughout its anadromous length is O'Toole Creek with 8 redds per kim, the second highest behind Dry Creek.

Table 21. Lower Dry Creek channel measures taken at five points on February 15, 2013

Dry Ck channel point of measure	Location	wetted width	bankfull width
A	34 ft below the Finney logging road bridge	12-13 ft	19-20 ft
B	8 ft above the Finney logging road bridge	11 ft	14 ft
C	90-100 ft above the Finney logging road bridge	9.5 ft	25 ft
D	~275 ft above the Finney logging road bridge	5.5 ft	38 ft
E	~425 ft above the Finney logging road bridge	21.5 ft	26 ft

Regarding streamflows, although no measuring gages occur at either stream, it has been apparent during the surveys that Dry Creek does not react as significantly as Finney Creek to rainfall, that it clears quickly after peak flows (unlike Finney), and that peak flows quickly subside (unlike Finney). The Finney Creek side channel, however, remains wetted longer into the summer period than Dry Creek, and may remain wetted throughout (although it has not been field checked in July and August). This alone would not make later steelhead spawning a reproductive disadvantage in the way it may be at Dry Creek. Regarding this, the 2014 finding of six steelhead redds in the first 12 days of May at Dry Creek, of which five were likely constructed in that period (Table 3; and Appendix C in Table 1), was unexpected given the late June period when it goes intermittent with disconnection from Finney Creek. Furthermore, all but one of these redds was in the stream section that went subsurface June 27th to July 13th in 2014. Spawning at that late date may be at great risk for reproductive success, yet it occurred. Apparently enough years occur when emergent fry can move downstream or upstream to sustain the significant evidence of spawning in May prior to mid month. It has to be a reproductive strategy that is at the thin edge of adaptation to Dry Creek, but which would be anticipated to be an entirely reliable strategy at the one Finney Creek side channel. Another possibility is that Dry Creek's stable channel may result in attraction of straying Finney Creek steelhead searching for more stable spawning sites than are provided by the commonly shifting channels at Finney Creek and associated potential risk through even lower reproductive success they are trying to avoid.

Although sediment levels in the gravel spawning areas were not measured at either Finney or Dry creeks, sediment appears to be particularly high at Finney Creek. However, sediment in the gravel at Dry Creek is not insignificant and may be finer and more compacted than at Finney.

O'Toole Creek, with the second highest steelhead spawning redd density per km, has a relatively confined channel and stable riparian area, in this case of older deciduous trees. Although a great difference between wetted and bankfull widths is not apparent, it is subject to high velocity peak flows due to the majority of the watershed being high gradient and in immediate proximity to the short, lower gradient anadromous area available. Nevertheless, it appears to have the least sediment in the gravel of the five Mid Skagit tributaries regularly surveyed. The gravel, however, in the areas that the steelhead primarily use for spawning is commonly limited to patches at stream edges and behind boulder pockets due to its higher gradient channel and common presence of boulders and large cobble. Yet, pink salmon numbering in hundreds in stronger return years find sufficient gravel to spawn without apparent over crowding (Appendix C, in Tables 1, 3, and 5), and Chinook salmon can number in the dozens (Appendix C, in Table 2). As indicated previously, it is the only

stream of the five regularly surveyed that throughout its anadromous length is perennial inclusive of the channel splits, what few there are. As with Dry Creek and the one side channel at Finney Creek, the one most apparent commonality is a confined channel. In size of channel and streamflow volume, it is considerably larger than Dry Creek with a channel width likely 2-4 times greater depending on area, but which has not been measured.

Of the Mid Skagit tributary streams regularly surveyed, it is Dry Creek that particularly stands out for the amount of steelhead spawning it sustains. Of considerable concern is the potential threat of what the loss of the older second growth forest, much of which is western red cedar, along its lower reaches might result in for steelhead with its potential loss and for lower Finney basin overall if Dry Creek's present use for steelhead spawning were to diminish. There is no stream area in lower Finney Creek that has a similarly retained forested section. The only section with a similarly confined channel is the 150 m side channel of Finney Creek in which its present stability is likely a result of a logjam that has built above it. Unfortunately, this side channel is likely a temporary feature as evidenced by its trend toward enlargement and inevitable movement of the protective logjam due to the stream channel instability surrounding it both upstream and down.

Future Spawning Related to Monthly Precipitation, Temperature and Streamflow Based on Historical Evidence

The over 100 year weather records from a fish collection station on the lower Baker River of the Mid Skagit basin near Concrete, WA provide the opportunity to make comparisons of mean monthly precipitation (Table 22) and air temperatures (Table 23) from 1909 to the present (a gap in data from 1916 to 1930). If broken into three 25 year periods from 1931 to 2005, a 7 year period from 1909 to 1915, and a 9 year period from 2006 to 2014 changes in precipitation and temperature can be determined as being positive (increasing), negative (decreasing), or neutral (little changed or an undetermined) trends over time. This can be estimated by subtracting the lowest reading from the highest each month for each period of time and if these readings are primarily progressing over time in an increasing or decreasing manner across the years of record. This results in a plus, minus, or erratic (essentially neutral) range of differences in readings across years for each month.

Table 22.
Mean Monthly Precipitation (inches) at Concrete, WA of Mid Skagit Basin over Five Periods (1909 to 2014); the Range of Monthly Differences and if Mostly Positive, Negative, or Neutral; and the Precipitation Trend

Positive monthly mean precipitation increasing over time
Negative monthly mean precipitation decreasing over time
Neutral monthly mean precipitation remaining little changed or of undetermined trend over time

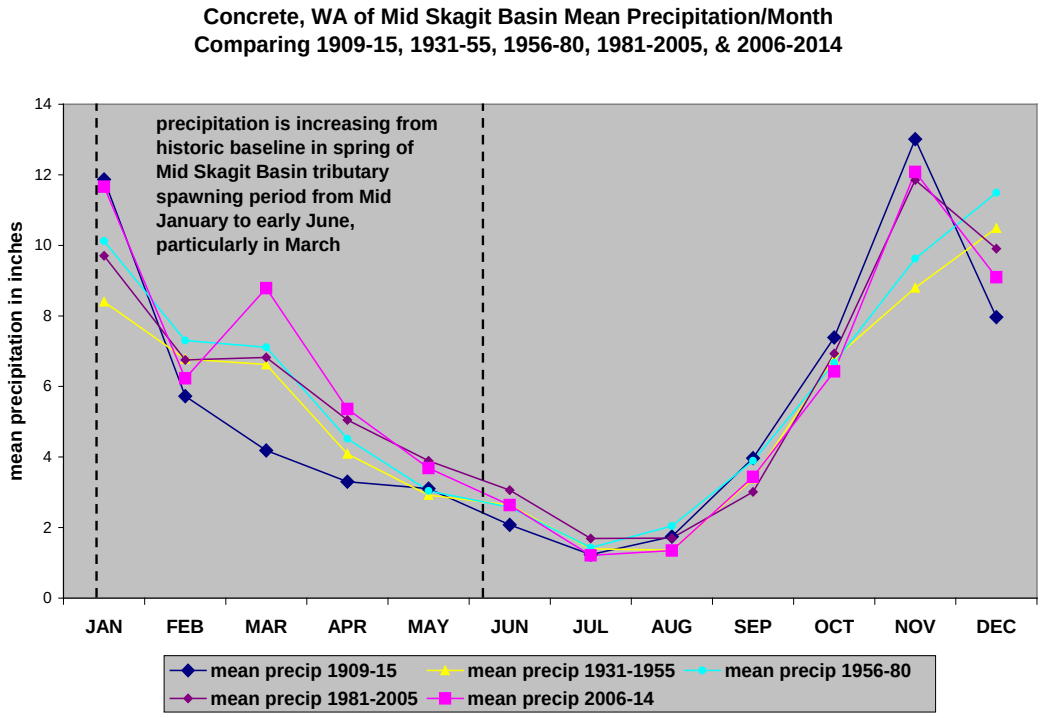
Time Period	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Mean
1909-15	11.87*	5.72	4.18	3.30	3.10	2.08	1.23	1.75	3.97	7.39	13.01*	7.96	65.57
1931-55	8.40	6.78	6.62	4.09	2.92	2.63	1.39	1.36	3.39	6.79	8.80	10.49	63.66
1956-80	10.12	7.30	7.11	4.52	3.04	2.57	1.43	2.04	3.89	6.67	9.62	11.49	69.83
1981-2005	9.70	6.75	6.82	5.05	3.89	3.06	1.69	1.70	3.01	6.93	11.85	9.91	70.37
2006-14	11.66	6.23	8.79	5.36	3.69	2.64	1.21	1.35	3.44	6.43	12.08	9.10	71.97
Range Difference	±3.47 +3.26	±1.58	+4.61	+2.06	+0.97	±0.98	±0.48	±0.69	±0.96	-0.96	±4.21 +3.28	±3.53	+8.37
Trend	**neutral higher**	**neutral**	**higher**	**higher**	**higher**	**neutral**	**neutral**	**neutral**	**neutral**	**lower**	**neutral higher**	**neutral**	**higher**

* Excluding the 7-year period of 1909-15 for January and November results in a progressive increase in precipitation over time, but if that 7-year period is included it is a more neutral pattern of precipitation over time. The 7-year period may be too short to provide as good indication as the three 25-year periods of time from 1931 to 2005.

In the case of precipitation (Table 22 and Figure 37) five months of the year (January, March, April, May, and November show a generally increasing trend over time as does the annual mean. In the cases of January and November of the 7-year 1909-1915 period, the precipitation amount was as high or higher than in the most recent 2006-2014 period, but excluding those earliest 7 years of data the trend is more definitely increasing. It is unknown if the 7-year period of 1909-1915 was reflective of precipitation over the longer 25 year span that would have gone back another 18 years if it had been available. Nevertheless, the annual mean precipitation data indicates it is indeed increasing in annual total amount over time. The Mid Skagit basin is apparently getting wetter and especially so in the steelhead spawning period found in the Mid Skagit tributaries of January through May as the primary spawning months, the exception being February in which precipitation is remaining quite stable. The one month in which precipitation is increasing the most is March (an increase of 4.61 inches at this time from that of 1909-1915) followed by April (increase of 2.06 inches) and May (increase of 0.97 inch). January precipitation is either increasing considerably or remaining neutral, dependent on whether the 1909-1915 data are included or not.

These are the precipitation changes that steelhead are presently adapting to and will continue to adapt to as climate change progresses in its effects on the Mid Skagit Basin if the past 100 year trend continues: generally increasing precipitation during their spawning period, especially in March, and with February the one month with the least change. February would be anticipated to provide steelhead spawning conditions most similar to what shaped their spawning time in the past 100 years regarding precipitation. March, on the other hand, would be the month with the most extreme shift in steelhead spawning conditions from those that shaped their spawning time in the past 100 years regarding precipitation. Precipitation in tributary streams whose drainage areas are dominated by low elevations would be a particularly anticipated driver of streamflows, but this may not be as much the case with tributaries dominated more by high elevations drainage areas that accumulate as snowfall that comes out at a later date as melt water.

Figure 37.



In the case of air temperatures (Table 23 and Figure 38) six months of the year (March, April, May, June, September, and December) show a generally decreasing trend over time as does the annual mean. In the cases of October, December, and the annual mean of the 7-year 1909-1915 period, the temperatures were slightly colder than in the most recent 2006-2014 period, but excluding those earliest 7 years of data the trend is more

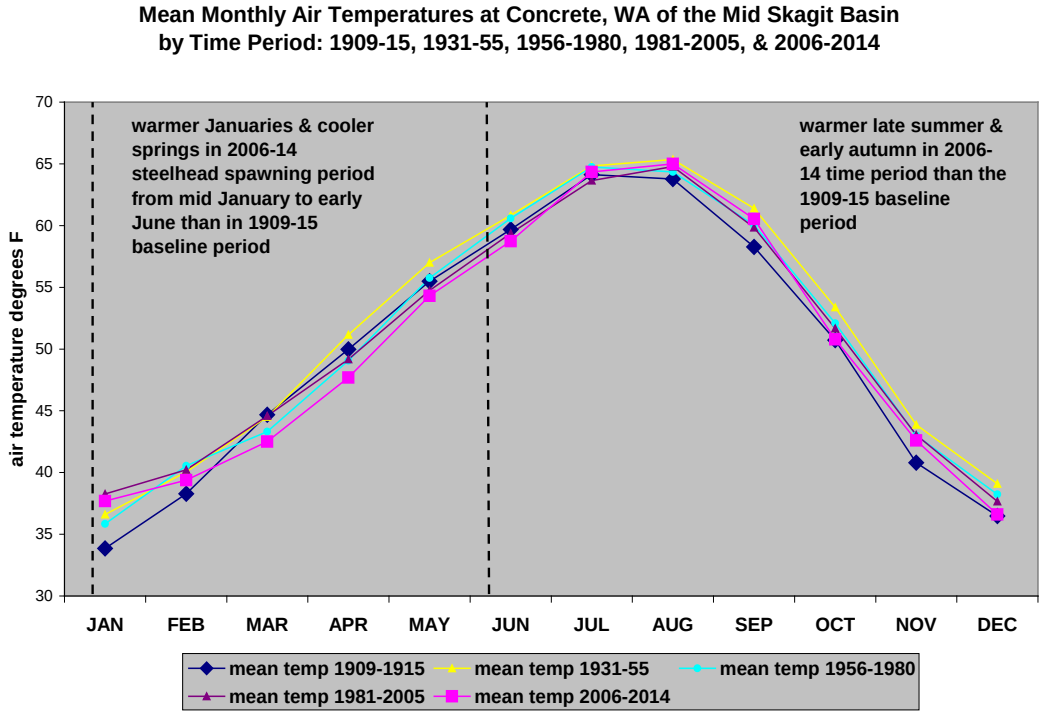
Table 23.
Mean Monthly Air Temperature (F) at Concrete, WA of Mid Skagit Basin over Five Periods (1909 to 2014); the Range of Monthly Differences and if Mostly Positive, Negative, or Neutral; and the Temperature Trend

Positive monthly mean temperatures increasing over time
Negative monthly mean temperatures decreasing over time
Neutral monthly mean temperatures remaining little changed or of undetermined trend over time

Time Period	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Mean
1909-15	33.85	38.28	44.69	49.97	55.49	59.69	64.13	63.77	58.27	50.72*	40.80	36.48*	49.68*
1931-55	36.60	40.06	44.50	51.15	57.00	60.83	64.82	65.35	61.39	53.38	43.87	39.09	51.50
1956-80	35.85	40.56	43.31	49.06	55.75	60.58	64.76	64.35	60.04	52.09	43.00	38.24	50.63
1981-2005	38.26	40.23	44.59	49.16	54.74	59.37	63.65	64.78	59.84	51.67	43.04	37.65	50.58
2006-14	37.69	39.38	42.50	47.69	54.31	58.74	64.34	65.00	60.54	50.78	42.60	36.60	50.02
Range Difference	+4.41	±2.28	-2.19	-3.46	-2.69	-2.09	±1.17	±1.58	±3.12	±2.66 -2.6	±3.07	±2.61 -2.49	±1.82 -1.48
Trend	**higher**	**neutral**	**lower**	**lower**	**lower**	**lower**	**neutral**	**neutral**	**neutral**	**neutral lower**	**neutral**	**neutral lower**	**neutral lower**

* Excluding the 7-year period of 1909-15 for October, December, and the Annual Mean results in a progressive increase in air temperature over time in each of those columns, but if that 7-year period is included it is a more neutral pattern of precipitation over time. The 7-year period may be too short to provide as good indication as the three 25-year periods of time from 1931 to 2005.

Figure 38.



definitely decreasing. It is unknown if the 7-year period of 1909-1915 was reflective of temperatures over the longer 25 year span that would have gone back another 18 years if it had been available. Because the annual mean temperature data is in some question without a clear trend it can't be determined if there is an actual annual change over time. However, what is apparent is that in the full period of steelhead spawning of January to June found in the Mid Skagit tributaries that March (- 2.19 F), April (- 3.46 F), May (- 2.69 F), and June (- 2.09 F) are all getting cooler. Only January is warming, but very much so with a 4.41 F (2.45 C) increase in overall range, or 3.84 F (2.13 C) increase from 1909-15 period to 2006-14. February air temperatures, as with precipitation, are a relatively neutral trend.

These are the air temperature changes that steelhead are presently adapting to and will continue to adapt to as climate change progresses in its effects on the Mid Skagit Basin if the past 100 year trend continues: generally decreasing temperatures during their spawning period, especially in April (- 3.46 F, or - 1.92 C, as the overall temperature change range; - 2.28 F, or - 1.26 C, as the change between 1909-15 and 2006-14) and May (- 2.69, or - 1.50 C F, as the overall temperature change range; - 1.18 F, or - 0.66 C, as the change between 1909-15 and 2006-14), and with February the one month with the least change remaining relatively temperature-neutral. February would be anticipated to provide steelhead spawning conditions most similar to what shaped their spawning time in the past 100 years regarding temperatures. April and May, on the other hand, would be the months with the most extreme shifts in steelhead spawning conditions from those that shaped their spawning time in the past 100 years regarding temperatures that are lower. January, however, is the single month with the greatest temperature shift during the steelhead spawning period in its anomalous increase of 4.41 F (2.45 C) in the overall range, or 3.84 F (2.13 C) increase between 1909-15 and 2006-14. This is a January air temperature shift that would be anticipated to more regularly result in water temperatures that initiate steelhead spawning (3.9-4.0 C, or 39.02-39.20 F) as determined from Bell (1972) and Bovee (1978). The January warming would also be anticipated to result in less snowfall, particularly accumulations of snowpack at higher elevations at this winter date. Cooling in March and especially April, on the other hand, would increase the potential for snow and potentially result in an increasing snowpack at these late dates at higher elevations rather than what may have formerly been snowpack melt conditions. This will result in shifts in snowmelt accumulations at higher elevations in the Mid Skagit basin with stream hydrology shifts that steelhead spawning time is partially shaped by and will continue so into the future if the temperature trends remain on a similar path.

The 86 year streamflow records from the USGS gage between Arlington and Oso, WA on the North Fork Stillaguamish River provide the opportunity to make comparisons of mean monthly streamflows (in cfs) from 1928 to the present (Table 24 and Figure 39). If broken into three 25 year periods from 1928 to 2003 and a 12 year period from 2003 to 2014 changes in streamflow can be determined as being positive (increasing), negative (decreasing), or neutral (little changed or an undetermined) trends over time. As with precipitation and temperature, this can be estimated by subtracting the lowest reading from the highest each month for each period of time and if these readings are primarily progressing over time in an increasing or decreasing manner across the years of record. This results in a plus, minus, or erratic (essentially neutral) range of differences in readings across years for each month.

In the case of North Fork Stillaguamish River streamflow as a surrogate for that of Finney Creek and likely some other tributaries in the Mid Skagit basin (Table 24), four months of the year (January, March, April, and November) have a generally increasing trend over time. Although February has an erratic neutral trend over

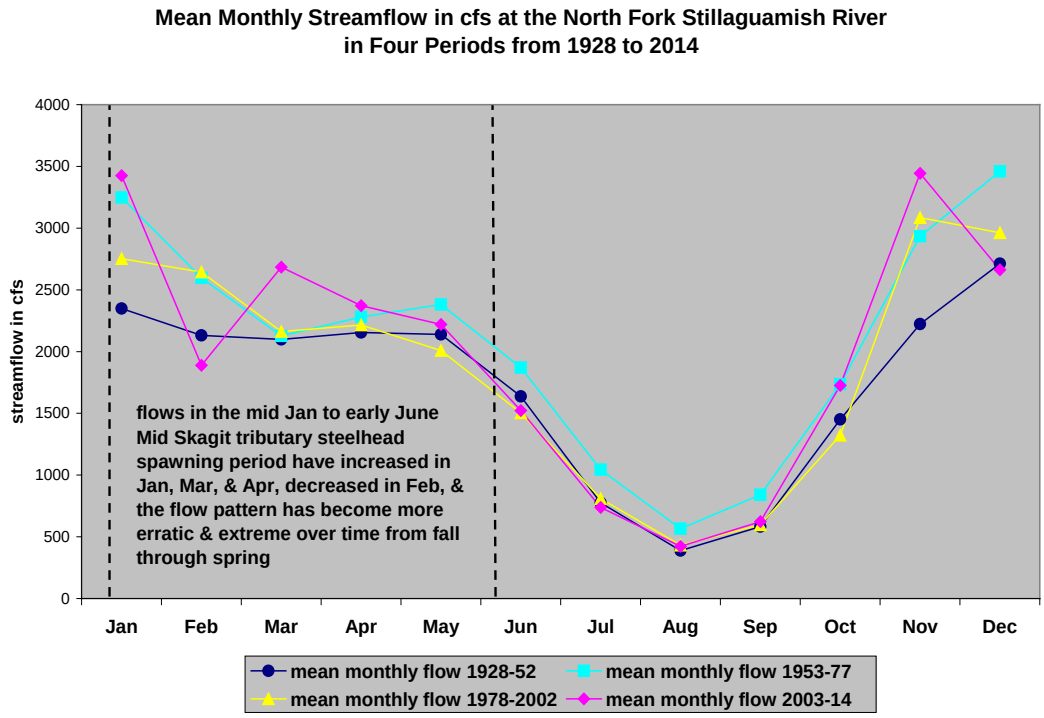
time, the most recent period of 2003-2014 has sharply declined in streamflow. During the primary Mid Skagit tributary steelhead spawning period of January through May, January has the greatest shift in streamflow with an increase of 1,077 cfs from that of 1928-52, although this trend is not as steadily progressing as that of March (587 cfs increase) and April (218 cfs increase). As with January, November has had a large shift to increased flow. Overall, the once relatively even curves of streamflow in the 1928-52 period have become both erratic and extreme in the fall through spring period.

Table 24.
Mean Monthly Streamflow (cfs) at North Fork Stillaguamish River during Four Periods from 1928 to 2014; the Range of Monthly Differences and if Mostly Positive, Negative, or Neutral; and the Streamflow Trend

Positive monthly mean streamflows increasing over time
Negative monthly mean streamflowss decreasing over time
Neutral monthly mean streamflows remaining little changed or of undetermined trend over time

Time Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean
mean monthly flow 1928-52	2348	2132	2098	2154	2139	1637	775	389	583	1451	2223	2712	1720
mean monthly flow 1953-77	3249	2597	2127	2281	2382	1870	1045	566	840	1735	2934	3460	2090
mean monthly flow 1978-2002	2753	2644	2162	2216	2009	1504	809	431	596	1321	3085	2962	1875
mean monthly flow 2003-14	3425	1889	2685	2372	2220	1522	738	423	622	1726	3444	2663	1978
Range Difference	+1077	±755	+587	+218	±373	±366	±307	±177	±257	±414	+1221	±797	±370
Trend	**higher**	**neutral**	**higher**	**higher**	**neutral**	**neutral**	**neutral**	**neutral**	**neutral**	**neutral**	**higher**	**neutral**	**neutral**

Figure 39.



In the case of streamflow there are anthropogenic changes at the environmental level, such as widespread timber harvest, that may be more intensive in one period of time than another with a significant influence on how precipitation and air temperature affect streamflow in the North Fork Stillaguamish basin (and potentially differing considerably in the Mid Skagit basin by specific tributary). Although Figures 37 and 39 indicate that precipitation and streamflow patterns over the past 85-100 years have been generally similar during relatively comparable time periods, a more detailed analysis of this in the examination of timber harvest records may indicate a significant relationship that is not immediately apparent from the data used in the previous tables and figures.

Whatever the origins of streamflow shifts may be steelhead are adapting and will continue to adapt to these changes with spawn timing as climate change progresses, and which they have well enough adapted to in past climate shifts. Although this is a matter of magnitude of what the future may hold, at this point in time it would appear that through the present century Mid Skagit basin steelhead will not encounter stream characteristics that they have not successfully adapted to in the past 10,000-15,000 years after the Cordilleran ice sheet retreated from Puget Sound and steelhead again colonized the streams. What Mid Skagit tributary spawning wild steelhead did not encounter during past periods of climatic change were hatchery steelhead with reduced productivity levels that now inhabit their spawning grounds during significantly overlapping spawning periods. In the case of streamflows, the trend is toward more erratic monthly patterns with greater flow during the initiation of steelhead spawning in January, less flow in February, and increased flow in March and April for those tributary streams that may have similar monthly streamflow characteristics to the North Fork Stillaguamish River.

Steelhead Spawning, Streamflow, Precipitation, and Air Temperature at the Individual Tributary Level of Finney Creek

At the individual tributary level, Finney Creek is the largest of the five Mid Skagit tributaries that were regularly surveyed in the 2010-14 five year period. It is also the stream that drains the greatest amount of higher elevation areas in its watershed and with an historic streamflow record available from 1943 to 1948 (when it had a gaging station). Its streamflows have been found to be similar in monthly pattern to the North Fork Stillaguamish streamflows historically (Figure 26) and is thought to be similarly so today (Nichols and Ketcheson 2013). As a result Finney Creek provides time shots of the changes in streamflow patterns that have occurred between 1943-48 and 2010-14 as compared to the total number of steelhead redds counted at Finney Creek and adjusted to estimated spawning date from 2010 to 2014 (Figure 40). This further portrays the shifting streamflow trends that are particularly occurring in the steelhead spawning period of mid January to May at Finney Creek (and rarely to early June as found overall in the Mid Skagit tributaries). As previously indicated, the one month in the steelhead spawning period with flows that have remained more stable over time has been February from the streamflow data available that is at least in part representative of Mid Skagit tributaries.

Because there is no prior baseline of early spawning surveys from January to early March for comparison, what these streamflow shifts may have resulted in relative to steelhead spawning can't be determined. However, there is now such a baseline from which to make future comparisons as streamflows (and precipitation and temperatures) continue to shift over the coming years as will likely occur with continued climate change. The trend is for increasing streamflows during three (January, March, and April) of the four most important months

Figure 40.

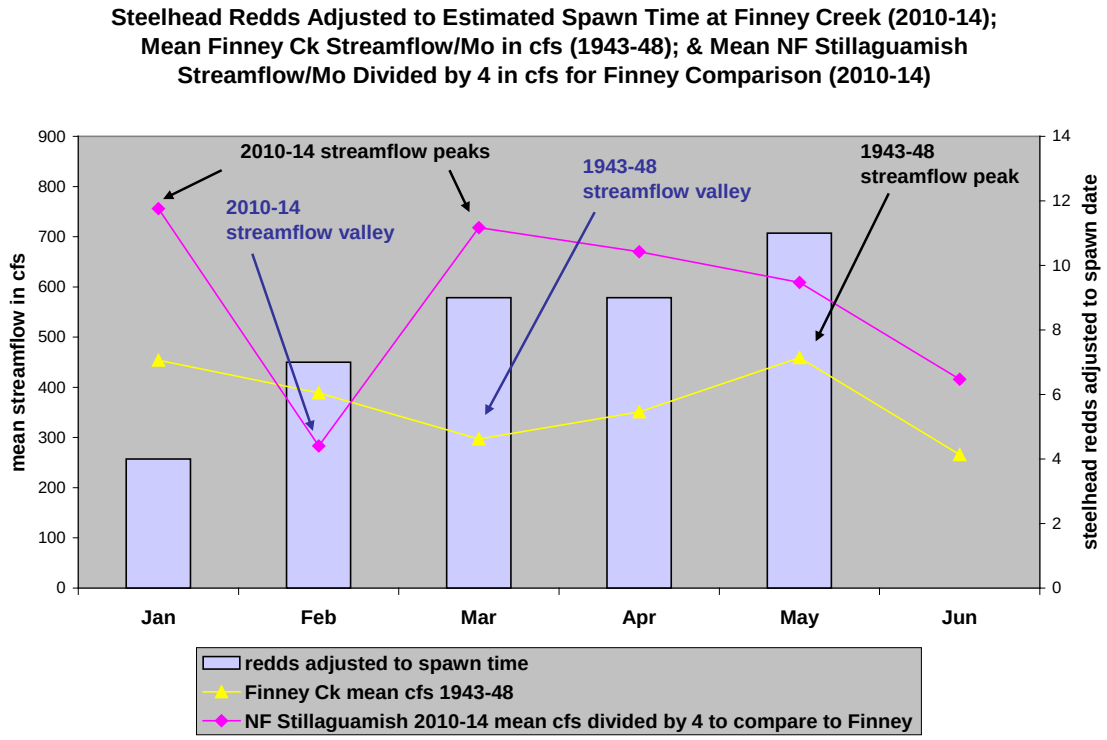
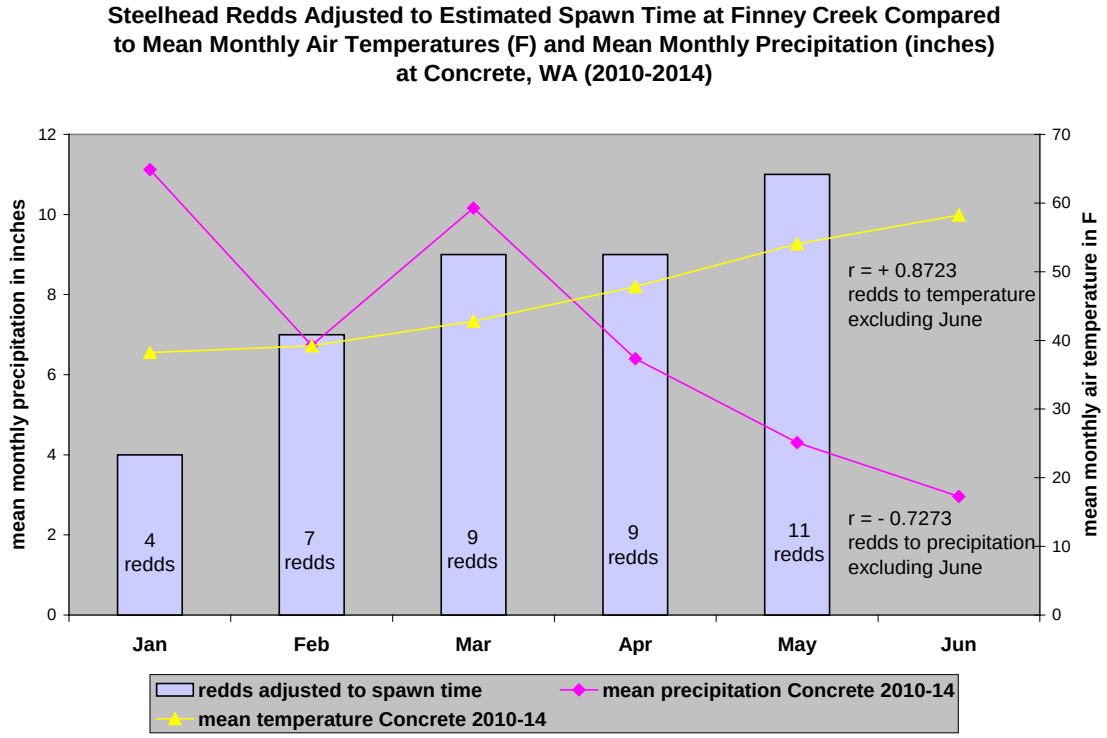


Figure 41.



for steelhead spawning (January, February, March, April, and May). The one month with the least streamflow change that may be particularly important for steelhead spawning adaptation through otherwise increasing streamflows is February if Finney Creek is a good representation for Mid Skagit basin tributaries. As previously determined, Finney Creek has perennial mainstem flow and important side channels used for spawning and/or rearing that have intermittent flow characteristics with resulting steelhead spawning that occurs both early and late (Figures 32 and 33) and does represent to some degree an intermediary stream in this regard. The potential relationship of streamflows to steelhead spawning at Finney Creek, however, is not a statistically significant correlation with a Pearson's "r" of - 0.2080 when excluding June or + 0.4385 when including June (when no redds were found). The actual relationship of streamflows to spawning likely requires more specific spawning dates than estimates of redd dates can provide because streamflows can significantly alter within one or two days of each other at Mid Skagit tributaries when significant precipitation occurs or ceases.

Furthermore, any specific flow may be of less relevance than any sudden rise in streamflow with precipitation followed by a decline when it subsides. This is when actual spawning entry has been observed to most often occur, not only at the Mid Skagit tributaries but elsewhere (Susac and Jacobs 1999).

Regarding precipitation and air temperature means per month at Concrete, Washington during the five year survey period at Finney Creek (Figure 41), there has been a positive correlation ("r" = + 0.8723) of steelhead spawning to air temperature if June is excluded as the outlier month when minimal steelhead spawning has been found in the Mid Skagit tributaries, and with no June evidence found at Finney Creek (although some likely occurs some years when cooler June air/water temeratures may occur). This is a significant correlation of increased spawning with increasing air temperature through May. Regarding precipitation, there has been a negative correlation to steelhead spawning ("r" = - 0.7273) as spawning has tended to be less with increased precipitation, but it is not a significant correlation. The month most out of alignment in the precipitation to spawning pattern has been March with its trend for increasing precipitation.

In the case of the precipitation to streamflow relationship, the choices between negative or positive anthropogenic changes related to the future of the Mid Skagit basin tributary streams may as well determine the adaptive future for steelhead as climate change itself, at least in this century. Anthropogenic change is not only related to habitat. The reproductive success for steelhead will be at least equally determined by decisions made regarding hatchery plants, commercial/sport/subsistence fisheries, and effective recovery of the range of historic life histories that formerly allowed *O. mykiss* to be such a productive species in the Skagit basin and which will determine their ability to reproductively adapt to future change or not across the full spectrum of temperatures, precipitation, and streamflows. Understanding the inherent range of characteristics of *O. mykiss* reproduction that have made them successful will only be determined by a future that includes effective monitoring of the amount, timing, and reproductive strategy shifts of combined anadrous/resident spawning in the vital tributary creeks of the larger basin where 65%-80% of former steelhead spawning occurred. This will also have to include the more obviously understood management of habitat, but preserving the necessary attributes of broad fish life histories needed to sustain themselves through continued change may well more quickly determine their fate (one way or the other) beyond that of habitat alone.

Among the more necessary attributes for reproductive success suggested by the Mid Skagit basin tributary surveys are: run timing; spawn timing; emergence timing; juvenile directional traits displayed shortly after emergence; and presence of resident males to insure fertilization that includes increased life history diversity. There are, of course, further determinations that can include female body size (that can determine redd depth),

female fecundity (not necessarily related to body size), diverse juvenile life histories with differing ages and migrational characteristics, and etc., but which were largely outside the ability of the spawning surveys to determine, and yet need to be determined. Many diverse characteristics thought to be inherited have thus far not been effectively identified through use of analytical genetic technology presently available. As a result identifying diverse life history characteristics in the field are necessary to identify those that evade lab detection. Unfortunately, lab identifications rather than field identifications have often become the primary means on which recovery decisions are based for steelhead. This includes common disregard for history (often depicting life history traits) to fill in biological puzzle parts needed on which to base recoveries sometimes available that date back a century or more.

Conclusion Essentials

The past five years of Mid Skagit basin surveys at five tributaries regularly surveyed for spawning steelhead, salmon, and cutthroat trout found the following:

- confirming old historical records steelhead spawning entry and spawning began in January, not March 15th as has been described in Puget Sound steelhead management documents in more recent history
- 104 steelhead redds were counted in the cumulative 2010-14 period; 49% of the redds were prior to March 15th; when redds were adjusted to estimated spawn time 53% were prior to March 15th
- coho salmon and steelhead have slight overlapping spawning times some years but typically minimal; sea-run cutthroat trout (and resident *O.clarki*) have significant spawning time overlaps with steelhead
- the tributary spawning populations include resident and anadromous *O. mykiss* life histories as well as probable sea-run and perhaps resident *O.clarkii*, with the resident proportions being males
- hatchery steelhead were included in the *O. mykiss* spawning population mix that includes mating with both resident and anadromous life histories and probably wild sea-run and resident *O.clarkii* males
- the proportion of hatchery steelhead actively spawning in the mid January to early June spawning period was a range of 29%-40%; if the wild male resident life history was included in the spawning mix the range was 22%-33% hatchery depending on if 2014 alone or that of 2010-14 cumulatively
- both wild and hatchery origin steelhead were found spawning in the early spawning period of mid January to mid March
- the proportion of hatchery steelhead actively spawning in the mid January to mid March spawning period was 67%; if the wild male resident life history was included in the spawning mix it was a range of 40%-50% hatchery depending on if 2014 alone or that of 2010-14 cumulatively
- although no hatchery steelhead were found spawning after March 15th the unknown origin steelhead after that date were 20% of the total steelhead then observed
- the spawning time of steelhead was found to differ by specific tributary with over 50% of the spawning occurring prior to March 15th at three of the tributaries regularly surveyed and with less than 50% at two
- potential reasons for differences in steelhead spawning time were examined and included differences in air/water temperature, precipitation, streamflow, and intermittent or perennial hydrology from data available with weather records dating to 1909 through the present and streamflows to 1928
- mean monthly air temperature, precipitation, and streamflow were compared to steelhead redd counts (and as adjusted to estimated spawning date) and then evaluated for Pearson's correlation coefficient "r" to determine if there was a significant relationship or not; although both water temperature and streamflow variables have been described by others as important factors in steelhead spawning time the correlations found generally proved to be erratic and not dependably significant; lack of the exact date of most spawnings and the need to use surrogate air temperature data for stream temperatures, and to use

precipitation and North Fork Stillaguamish River streamflow data as a substitute for missing stramflow data at each tributary surveyed may have confounded the ability to demonstrate statistically significant correlations to spawning time

- at the cumulative level of all five tributaries a highly significant correlation was found between average monthly air temperature and steelhead redds per month when adjusted to spawning date if 50-67% of the redds during the early spawning period were eliminated to better reflect wild steelhead spawning
- what water temperature data were taken indicated that steelhead spawning in warmer streams was skewed earlier and in colder streams skewed later; at one tributary with significant spawners in 2010 and 2014 the warmer year (2010) had a month earlier spawning peak than the colder year (2014)
- whether a tributary's hydrology was intermittent or perennial was found to be a particularly probable driver of steelhead spawning time differences regarding whether most was prior to March 15th or thereafter; this was hypothesized to be due to the need for spawning to be early enough for significant numbers of emergent steelhead fry to move either downstream to perennial waters prior to late June to early July when intermittent flows began to disconnect these tributaries from larger downstream water bodies (or upstream if that option was available)
- although intermittency is predicted to increase in northward expansion and is sometimes perceived as a great limitation on steelhead reproductive success, there are examples of great steelhead productivity that occurs in intermittent streams and where gravel accumulations may actually provide better spawning habitat if steelhead life histories have effectively adapted with early spawning and emergence
- steelhead fry emergence was first confirmed by late May at an intermittent tributary and another with side channels going intermittent as found in underwater photographs; steelhead fry in the photographs were likely present dating to at least mid May that could not be clearly identified; photographs earlier than early May did not occur that might have captured even April emergence
- shifts in the monthly pattern of air temperatures and precipitation since 1909 were examined as were streamflows dating to 1928; shifts are occurring that are particularly affecting the steelhead spawning period of January to May; the trends are toward warmer Januaries and neutral Februaries but cooler the other three months; more precipitation occurs each of the months but February; and greater streamflows occur except February and May; a former spring streamflow peak in May has shifted two months ahead to March; steelhead spawning must adapt to these climate changes; the one month with least change is February and may be an important point of stability
- regarding future genetic studies that may occur, it will be important to recognize the early period of time when steelhead fry emergence occurs and that the most likely time period for the hatchery signal to show up prior to significant depletion through natural selection would be fry sampling from May to mid June prior to probable high loss of hatchery and hybrid fry whose life histories may well exclude effective movements from intermittent streams, or stream sections, and vulnerability to predation or other factors that may commonly limit hatchery related characteristics to survive as well as wild
- of the five Mid Skagit tributaries regularly surveyed the one stream attribute identified that resulted in more intensive steelhead spawning use was a well contained channel with least difference between wetted and bankfull widths during the steelhead spawning period
- the Mid Skagit tributary surveys provide a baseline for the full period of steelhead spawning that has otherwise been lacking from which to monitor wild steelhead escapements, the hatchery component of the escapements, and how the steelhead spawning is variable in time and quantity by individual tributaries that have similarly variable environmental conditions that need to be understood and managed for in recovery planning

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Appendices
(A-G)

Appendix A.

Table 1.
Annual precipitation in inches near the mouth of Savage Creek and Birdsview, WA on the Mid Skagit River (2001-2014) with months of heaviest mean precipitation in light gray

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Jan		14.750	14.925	10.600	7.875	23.100	10.650	7.300	16.625	10.150	11.700	13.925	10.775	14.150	**12.810**
Feb		10.350	4.675	4.375	2.625	6.500	7.575	8.100	2.770	5.025	7.825	10.650	7.500	10.625	**6.815**
Mar		10.040	17.200	6.825	9.300	4.425	11.325	9.075	9.475	6.750	13.175	14.425	8.550	17.415	**10.614**
Apr		7.420	5.895	1.375	7.450	5.575	4.695	4.325	5.600	6.575	8.350	8.825	8.710	7.075	**6.298**
May		4.220	3.500	4.350	4.700	3.050	1.500	3.175	6.675	6.000	5.425	4.325	4.135	6.575	**4.433**
Jun		4.430	1.400	3.000	3.225	2.900	3.700	2.775	0.950	4.000	1.440	5.275	3.450	2.825	**3.028**
Jul		1.680	0.000	0.550	1.875	2.025	2.125	1.415	0.500	0.300	1.825	2.175	0.200	2.000	**1.282**
Aug		1.080	0.450	8.450	1.575	0.200	1.750	4.450	1.175	1.725	0.550	0.000	2.525	1.692	**1.994**
Sep		3.060	2.100	9.820	3.525	1.575	4.275	1.250	4.950	7.175	3.400	0.450	**12.150**		**4.478**
Oct	11.300	1.980	17.500	5.975	9.135	2.675	8.000	5.750	14.950	5.300	7.725	11.675	3.100		**8.082**
Nov	14.750	8.960	16.600	13.525	10.475	23.275	7.475	13.575	21.150	11.050	16.150	15.400	15.310		**14.438**
Dec	16.900	14.800	9.000	11.425	11.550	11.825	17.575	9.700	4.835	13.850	6.300	11.585	5.825		**11.167**
Total		**82.770**	**93.245**	**80.270**	**73.310**	**87.125**	**80.645**	**70.890**	**89.655**	**77.900**	**83.865**	**98.710**	**82.230**		**85.415**

Table 2.
Annual precipitation in inches at the lower Baker River near Concrete, WA on the Mid Skagit River (2001-2014) with months of heaviest mean precipitation in light gray

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Jan		11.820	11.730	9.530	6.610	20.180	7.990	6.350	14.850	9.550	14.090	12.000	9.270	10.700	11.128
Feb		8.440	3.740	3.650	1.900	7.140	5.860	7.380	2.030	4.680	6.110	9.380	5.200	8.280	5.676
Mar		7.840	13.940	6.610	7.230	4.080	9.750	7.290	7.140	5.730	11.730	11.620	7.650	14.080	8.822
Apr		7.030	5.400	0.930	5.890	4.690	3.820	3.410	4.340	5.830	7.190	5.200	7.210	6.570	5.193
May		3.210	3.850	3.600	3.590	2.510	1.620	2.880	4.670	5.850	3.730	4.140	3.410	4.390	3.650
Jun		3.700	0.930	2.370	3.130	2.370	3.110	2.370	1.090	3.260	1.460	4.220	3.330	2.540	2.606
Jul		1.110	0.080	0.710	1.630	1.940	1.590	0.910	0.000	0.200	1.910	2.180	0.060	2.130	1.112
Aug		1.120	0.550	6.680	0.970	0.220	1.490	3.970	1.360	0.580	0.210	0.010	2.250	2.040	1.650
Sep		1.900	1.550	8.760	3.440	1.660	2.290	1.460	3.110	7.380	2.180	0.330	9.080		3.595
Oct	10.080	1.360	15.220	5.010	6.840	2.600	8.040	4.040	13.530	4.740	5.500	9.880	3.080		6.917
Nov	10.930	6.940	14.170	11.040	9.380	19.650	6.280	11.910	16.510	9.800	12.590	11.250	8.650		11.469
Dec	13.170	10.610	7.870	9.730	8.250	11.090	13.230	9.630	4.330	11.310	4.330	12.010	6.850		9.416
Total		**65.080**	**79.030**	**68.620**	**58.860**	**78.130**	**65.070**	**61.600**	**72.960**	**68.910**	**71.030**	**82.220**	**66.040**		**69.796**

Appendix B.

Table 1. Skagit River Tributary Steelhead Egg Taking Operations 1914-1920 [tributary spawning steelhead averaged 2,855 eggs/female as found at Green River by Pautzke and Meigs (1941) and was used to estimate Skagit River tributary females from eggs taken]

Stream	Year	steelhead eggs	# females
Day Ck	1914	194,000	68
	1915	263,000	92
	1916	286,000	100
	1917	n/a	n/a
	1918	82,000	29
Grandy Ck	1913	2,679,000	938
	1914	829,000	290
	1915	1,800,000	630
	1916	3,212,000	1,125
	1917	290,000	102
	1918	3,043,000	1,066
	1919	226,400	79
	1920	255,000	89
Illabot Ck	1913	347,500	122
	1914	187,755	101
	1915	60,000	21
	1916	272,000	95
	1917	n/a	n/a
	1917-18	451,500	158

Appendix C.

Table 1. Mid Skagit Basin Spawning Survey Counts from October 3, 2013 to June 16, 2014 Made Regularly at Five Primary Index Streams: Savage, Mill, O'Toole, Finney, and Dry (of Finney) Creeks; and Rarely at Four other Streams: Quartz (of Finney), Hatchery (of Finney), Cumberland, and Grandy Creeks

Savage Creek redd counts							Savage Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7	25						206					
Oct 8-15	140			9			56			1		
Oct 16-23							46					
Oct 24-31												
Nov 1-7												
Nov 8-15				6						2		
Nov 16-23												
Nov 24-30				27						23		
Dec 1-7				24						20		
Dec 8-15												
Dec 16-23												
Dec 24-31			1	41		2			1	35		
Jan 1-7				14		1				17		
Jan 8-15				30						65		
Jan 16-23				32	1					16		
Jan 24-31				1		1				1		
Feb 1-7												
Feb 8-15												
Feb 16-23					2	1						
Feb 24-29												
Mar 1-7												
Mar 8-15					2	1						
Mar 16-23						1						
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**165**		**1**	**184**	**5**	**7**	**308**		**1**	**180**		

Notes:

The pink salmon minimum escapement should be based on the redd count of Oct. 8-15 plus the live counts of Oct. 1-7 and Oct. 16-23. But actual escapement was likely greater due to likely missing earliest spawning in latter Sep.

On Jan. 23rd, the steelhead redd found was large and likely built between Jan. 4-14.

On Feb. 19th, the 2 probable steelhead redds found were likely built within the week; the cutthroat redd within 1-2 weeks all in Mainstem above WF Savage.

On Mar. 12th, one steelhead redd found near the mouth of Savage Ck., and on Mar. 15th another probable steelhead redd was found at WF Savage inside upper end of logging road culvert – the first probable steelhead redd ever found in WF Savage.

Mill Creek redd counts							Mill Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7	124	1					219	2	1			
Oct 8-15							416					
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23				1						3		
Nov 24-30												
Dec 1-7				6						5		
Dec 8-15												
Dec 16-23												
Dec 24-31				15						5		
Jan 1-7				17						8		
Jan 8-15				14						19		
Jan 16-23												
Jan 24-31				6						3		
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30					2							
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**124**	**1**		**59**	**2**		**635**	**2**	**1**	**43**		

Notes:

The pink live and carcass counts were considered most accurate count, but a number of carcasses likely missed due to higher flows washing them out.

Coho escapement should be based on redds.

On April 30th, 2 redds were found both about 200 yds above S.Skagit Hwy; one about 2 wks old & other 3-7 days; first could have been cutthroat but date seemed more likely steelhead.

O'Toole Creek redd counts							O'Toole Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7	149						251					
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7					2	1						
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7					1							
May 8-15												1
May 16-23					1							
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23					1							
Total:	**149**				**5**	**1**	**251**					1

Notes:

Pink escapement should be based on the redd count of Oct. 1-7 plus the live count.

On April 7th, steelhead redd 3.5'x4' & 1-2 weeks old; sea-run cutthroat or resident rainbow redd was 16"x20" in quite large gravel & deep pit & about 1 week old.

On April 22nd, a WDFW steelhead flag marked 4-14-2014 had been considered on April 7th but not marked, it has been added to that survey; it would have been at least 1-2 weeks old at the earlier date.

On May 7th, a steelhead redd in a mid channel pocket was considered & then confirmed as one on May 11th; 2 other WDFW ribbons indicated redds that were highly questionable & unless active I could not count them.

On May 15th, a 15-18" male sea-run cutthroat in dark spawn colors was photographed with underwater camera in pool below falls pool.

On May 22nd, a small 1.5'x2.5' redd was found 200 yds above logjam, either small steelhead or large resident.

On June 16th, a steelhead redd of 1-2 weeks old was found about 80' below the barrier falls in mid-channel 4' x 10' around boulders.

Finney Creek redd counts							Finney Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7					1							
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31					1						3	
Apr 1-7												
Apr 8-15					8							
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15					7							
May 16-23					3							
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:					**20**						**3**	

Notes:

On Feb. 1st, the inactive steelhead redd found was likely constructed Jan. 28-30 shortly after rainfall brought creek up for entry.

On Mar. 28th, an active steelhead redd had at least a 32" female and 32-33" male on it and 18-20" resident or jack steelhead; there may have been another male steelhead and resident as well; visibility was limited by slight discoloration of water -- hatchery or wild origin could not be determined but sizes of main 2 suggested wild.

On April 14th, 8 inactive steelhead redds were found, 1 about a month old, 2 were about 3-4 weeks old, 2 were about 2-3 weeks old, 1 was about a week old, and 1 was just 1-3 days old.

On May 14th, 7-8 steelhead redds found in a long 45-50' line in side channel below logjam; 7 were counted as redds; 6 were likely made within the week and 1 maybe within 2 weeks.

On May 16th, 2 possible redds were found, one 200' below smolt trap site and one 100' below the logjam side channel; the redds were confirmed as such on May 30th.

On May 22nd, a new steelhead redd was found built within a few days below the logging road gate 3/8 mile.

Dry Creek (of Finney Creek) redd counts							Dry Creek Creek live and/or carcass counts					
date	pink	chinook	chum	coho	steelhead	cutthroat	pink	chinook	chum	coho	steelhead	cutthroat
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7	47						31					
Nov 8-15												
Nov 16-23				5						8		
Nov 24-30												
Dec 1-7				1						1		
Dec 8-15												
Dec 16-23												
Dec 24-31				8		2				2		
Jan 1-7				7						5		
Jan 8-15				6						16		
Jan 16-23				8	1					17	1	
Jan 24-31												
Feb 1-7					2							
Feb 8-15												
Feb 16-23					1	2					2	2
Feb 24-29												
Mar 1-7												
Mar 8-15					2						2	
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7					1	2						
May 8-15					5						2	
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												

Total:	**47**			**35**	**12**	**6**	**31**			**49**	**5**	**2**

Notes:

Pink and coho escapements should be based on redd counts.

On Jan 16th, the steelhead redd found was actively occupied by a hatchery female & resident male about 100' below the barrier falls.

On Feb 2nd, the steelhead redds found were likely made with rainfall entry on Jan 28-29.

On Feb 19th, the steelhead redd had a wild female on it but not actively digging; a male steelhead was actively chasing a resident rainbow or sea-run cutthroat male continuously away; in the same location as the Feb 19th steelhead sightings, on Feb 20th a pair of sea-run cutthroat were actively spawning with the male potentially the same as sighted with the steelhead the previous day.

On Mar 12th, the 2 steelhead redds found included one with a hatchery female, a probable wild male, and a 14" male resident rainbow just completing active spawning; they then migrated downstream – the female leaving the creek. It is possible that there was another active redd. A steelhead fled off it, but it is possible that it was the lingering male that had not fully gone out yet with the female. The potentially active redd was not counted..

On May 2nd, a steelhead redd of 3.5x3.5 ft of 3-7 days old was found and 2 smaller redds of 1.5'x1.5' each likely cutthroat or resident rainbow 1-2 weeks old.

On May 12th, 3 new inactive steelhead redds were found and 1 wild male and 1 wild female steelhead upstream of the redds. 4 more possible pocket redds were found that if so were likely created by one steelhead and were counted as one redd.

On May 14th, a possible steelhead redd was found at the log sill plunge pool where 2 live steelhead were sighted on the 12th. The redd confirmed on May 30th.

Quartz Creek (of Finney Creek) redd counts							Quartz Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												

May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:												

Notes:

On May 16th, no evidence of steelhead spawning was found in the 200 yds surveyed above the Finney Ck Logging Rd bridge. The gravel was heavily sedimented with black colored sand and the gravel otherwise small quartz pebbles. The creek channel conformation above the bridge was otherwise good but of poor quality below the bridge as surveyed in past.

Hatchery Creek (of Finney Creek) redd counts							**Hatchery Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23					2?							
May 24-31												
Jun 1-7												

Jun 8-15												
Jun 16-23												
Total:					2?							

Notes:

On May 16th, the 2 possible steelhead redds found were old and likely built 4-6 weeks earlier; 1 was 2.5'x3' and the other 2.5'x4' and potentially built by same fish if actual redds.

Cumberland Creek redd counts							**Cumberland Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7					2							
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:					**2**							

Notes:

On May 2nd, a probable steelhead redd of smaller size at 2.5'x3.5' was 2-3 wks old; a larger 6'x6' definite steelhead redd of same age was at same location as a WDFW steelhead redd ribbon dated 5-18-2012. This was at the end of the WDFW survey point.

Grandy Creek redd counts							Grandy Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23					1							
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:					**1**							

Notes:

On Feb. 20th, the steelhead redd found was built within 7 days or less.

Table 2. Mid Skagit Basin Spawning Survey Counts from October 19, 2012 to April 20, 2013 Made Regularly at Five Primary Index Streams: Savage, Mill, Finney, and Dry (of Finney) Creeks; and Rarely at Four other Streams: O'Toole, Hatchery (of Finney), Pressentin, and Grandy Creeks

Savage Creek redd counts							Savage Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31										2		
Nov 1-7												
Nov 8-15				6						2		
Nov 16-23				3						10		
Nov 24-30				35					2	63		
Dec 1-7				24						80		1
Dec 8-15												
Dec 16-23				7						15		
Dec 24-31												
Jan 1-7				1		6				1		
Jan 8-15				12						6		
Jan 16-23												
Jan 24-31												
Feb 1-7				14	1	10				2		
Feb 8-15					4	10				1		
Feb 16-23					2	1						
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15					1							
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:				**102**	**8**	**27**			**2**	**182**		**1**

Notes:

14 older coho redds of 1-3 weeks old were found Feb. 5-8 & 1 new redd all in WF & uppermost Savage; the coho carcasses for same period were very old.

The steelhead redds found Feb. 5-8 all week to 10 days old.

The 2 steelhead redds of Feb. 23rd estimated 10-12 days old; the cutthroat redd was estimated at 7-10 days old; 2 small resident sized redds were also found that are not included.

The probable steelhead redd of April 14th was only 1-3 days old.

Mill Creek redd counts							Mill Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23		6	1					8	2			
Oct 24-31												
Nov 1-7												
Nov 8-15			9	6					10	4		
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7				5								
Jan 8-15												
Jan 16-23												
Jan 24-31			1	1	4							
Feb 1-7												
Feb 8-15												
Feb 16-23					1							
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31					4							
Apr 1-7												
Apr 8-15					1							
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:		**6**	**11**	**12**	**10**			**8**	**12**	**4**		

Notes:

Of the 4 steelhead redds found on Jan. 31st there were 3 below the bridge that were all built within 24 hr to a few days; the 4th was 300 yds above the bridge in a side channel where coho spawn but its newness & large size suggested steelhead redd.

The redd of Feb. 21st was estimated at less than 2 weeks old; size was marginal between cutthroat & steelhead but lower section of creek suggested latter.

Of the 4 steelhead redds on Mar. 27-28, 1 was less than a week old, the other 3 redds appeared to be about 2 weeks old.

The steelhead redd of Apr 13th was likely at least a week old.

O'Toole Creek redd counts							O'Toole Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23		21	6					16	10			
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23					1							
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:		**21**	**6**		**1**			**16**	**10**			

Notes:

The steelhead redd found Feb. 21st was not there Feb. 1st & constructed between those dates; it was located 15' above mouth at Skagit.

Finney Creek redd counts							Finney Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												

Oct 24-31		17	2					7	3			
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7					1							
Feb 8-15				1	6							
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:		**17**	**2**	**1**	**7**			**7**	**3**			

Notes:

The redd of Feb. 2 was likely ~3 weeks old and large with deep pit in channel below logjam

The redd of Feb. 12 was likely built 5-10 days earlier & was 12' long by 5-6' wide not far above logging gate

Feb. 14th one redd was considered coho and 2-3 weeks old and 4' long by 2' wide and had algae on it; one redd was likely steelhead of 2-4 days old and 4' long by 2' wide; another likely steelhead redd was similarly fresh & 6' long by 4' wide

Feb. 15th one redd was 2-3 weeks old and 6' long by 5' wide, one was 2-3 weeks old and 4' x 4', and one was 2-4 days old and 8' long by 4' wide

Dry Creek (of Finney Creek) redd counts							Dry Creek Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												

Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15				2	5	2						
Feb 16-23												
Feb 24-29						1						
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:				**2**	**5**	**3**						

Notes:

Of the 5 steelhead redds on Feb. 14th, 2 were probable built within 10 days; 3 were somewhat harder to determine due to being 3-4 weeks old.

Hatchery Creek (of Finney Creek) redd counts							**Hatchery Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												

Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15					1							
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:					**1**							

Notes:

The redd found Feb. 15th was considered to be 10-14 days old & size of 4 x 4.5 ft was maginal with cutthroat but redd depth suggested steelhead.

Grandy Creek redd counts							**Grandy Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15				2	5	2						

Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:				**2**	**5**	**2**						

Notes:

Grandy steelhead redds of Feb. 11 looked 10-12 days old; coho redds looked a month old or more.

Pressentin Creek redd counts							**Pressentin Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31		1	11						19			
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												

Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:		**1**	**11**						**19**			

Table 3. Mid Skagit Basin Spawning Survey Counts from October 14, 2011 to May 13, 2012 Made Regularly at Four Primary Index Streams: Savage, Mill, O'Toole, and Finney Creeks.

Savage Creek redd counts							**Savage Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30				60						112		1
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7				16						15		1
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7						1						
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												

May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:				**76**		**1**				**127**		**2**

Mill Creek redd counts							**Mill Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23	41	3					48	3				48
Oct 24-31	4						4					4
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23				14		2						
Dec 24-31												
Jan 1-7				16						8		
Jan 8-15				4						1		
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23				1	1							
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**45**	**3**		**35**	**1**	**2**	**52**	**3**		**9**		

Notes:

The salmon redds on Dec. 21st were first considered even mix of coho & chum but 2014 evidence suggests all coho; the cutthroat redds were smaller.

One large interconnected redd was considered a potential chum at time but 2014 suggests probable coho and counted such.

One inactive redd on Feb 20th had partial algae & considered coho due to age & smaller size; sthd redd large & week or less old.

O'Toole Creek redd counts							O'Toole Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15	147						219					
Oct 16-23	24		4				55		8			
Oct 24-31												
Nov 1-7	3		2				3		4			
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**174**		**6**				**277**		**12**			

Finney Creek redd counts							Finney Creek live and/or carcass counts					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												

Oct 8-15												
Oct 16-23												
Oct 24-31	394	4					749	7				
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**394**	4					**749**	**7**				

Table 4. Mid Skagit Basin Spawning Survey Counts from November 20, 2010 to May 10, 2011 Made Regularly at Three Primary Index Streams: Savage, Mill, and Finney Creeks; and Rarely at Four other Streams: O'Toole, Quartz (of Finney), Hatchery (of Finney), and Grandy Creeks

Savage Creek redd counts							**Savage Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												

Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15				39						84		1
Dec 16-23												
Dec 24-31				2						1		
Jan 1-7												
Jan 8-15				13						10		
Jan 16-23				9	2					7	4	
Jan 24-31					1	1						
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:				**63**	**3**	**1**				**102**	**4**	**1**

Notes:

On the one active steelhead redd in Savage Ditch on Jan 19th there was a hatchery female; 2 males were downstream, 1 hatchery & 1 unknown that fled; next day the redd was greatly enlarged & hatchery female remained; a nearby red-flanked male fled -- possible coho but spots suggested steelhead

Steelhead redd found Jan 31 likely 7-9 days old

Mill Creek redd counts							**Mill Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												

Dec 8-15												
Dec 16-23			3	7								
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31					2							
Feb 1-7												
Feb 8-15												
Feb 16-23					2							
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30					1							
May 1-7					1							
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:			**3**	**7**	**6**							

Notes:

The 2 redds found Jan 31st appeared to be 1-2 weeks old & would coincide with when steelhead spawned in Savage Ck.

The 2 redds found Feb 18 were large sized & built within the week; large stream channel changes due to flood on Jan 17th.

A fresh steelhead redd was intially found April 30 maybe built within a day or 2; a new redd just above & overlapping was found May 8th but was not there on May 7th -- apparently 2 different steelhead.

Table 5. Mid Skagit Basin Spawning Survey Counts from October 19, 2009 to May 13, 2010 Made Regularly at Four Primary Index Streams: Savage, Mill, O'Toole, and Finney Creeks; and Rarely at Three other Streams: Hatchery (of Finney), Cumberland, and Grandy Creeks

Savage Creek redd counts							**Savage Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31	23						33			2		
Nov 1-7												
Nov 8-15			2	5						15		
Nov 16-23			3	3					6	2		

Nov 24-30				38						36		
Dec 1-7				20						9		
Dec 8-15												
Dec 16-23				20						38		
Dec 24-31												
Jan 1-7												
Jan 8-15				2								
Jan 16-23				6								
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23						1						
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30						3						
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**23**		**5**	**94**		**4**	**33**		**6**	**102**		

Mill Creek redd counts							**Mill Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23	43		1				124		4			
Oct 24-31	39	2		1			110	2		1		
Nov 1-7												
Nov 8-15				4			2					
Nov 16-23			1							1		
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												

Jan 16-23				2								
Jan 24-31												
Feb 1-7				1								
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15					3							
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**82**	**2**	**2**	**8**	**3**		**236**	**2**	**4**	**2**		

Notes:

Older redd found on Feb 4 likely that of coho; creek running 42 F at 2:30 pm.

On May 13th a small but deep probable steelhead redd of 2' x 1.5' was found about 2-3 weeks old; another probable steelhead redd of about 3' x 2' was found about a month old; & another 4' x 3' with 2 pits and was about a month old.

O'Toole Creek redd counts							**O'Toole Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**bull trt**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**bull trt**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31	60		2			1	221		8			
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7					1							
Feb 8-15												

Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15					2							
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:	**60**		**2**		**3**	**1**	**221**		**8**			

Notes:

A potential bull trout redd was found Oct. 28th at the tail of pool below the 1st falls; no salmon redds have been found that high up since or before.

A large probable steelhead redd on Feb. 3rd near entry to Skagit no more than week old; warm winter related to El Nino and O'Toole water temp 42F.

A steelhead redd was found downstream of the S. Skagit Hwy bridge with a ribbon marked the day before (5-12-2010) & estimated to be about a week old & was 3' x 2' with a deep single pit; a steelhead redd of similar size about 3 weeks old was found 150 yds below the bridge.

Finney Creek redd counts							**Finney Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7					1							
Feb 8-15												
Feb 16-23												
Feb 24-29												

Mar 1-7				2	3						1+1?	
Mar 8-15					1							
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15					3							
Apr 16-23					1							
Apr 24-30					2							
May 1-7												
May 8-15												
May 16-23					2							
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:												

Notes:

Large redd found Feb 6th probable steelhead 100' above logging gate; sampled for steelhead but only 10" wild steelhead nearing smolt stage caught; water temp was 44 F at 1:30 pm; mild year.

Active steelhead redd on Mar 4th near mouth of creek above Hatchery Ck; large probable wild female on it; the mate fled with wake & unknown steelhead or resident male; 10 days later expanded to vacated 2 redds.

Cumberland Creek redd counts							**Cumberland Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15												
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												

Mar 24-31												
Apr 1-7												
Apr 8-15												
Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Jun 24-30												
Jul 1-7					3							
Total:					**3**							

Notes:

While sampling Cumberland Ck on June 25th a steelhead redd marked on April 19th was still visible; 2 other unmarked redds were found further upstream another 450 yds, both very large and 4-5 weeks old & probably steelhead.

Grandy Creek redd counts							**Grandy Creek live and/or carcass counts**					
date	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**	**pink**	**chinook**	**chum**	**coho**	**steelhead**	**cutthroat**
Oct 1-7												
Oct 8-15												
Oct 16-23												
Oct 24-31												
Nov 1-7												
Nov 8-15												
Nov 16-23												
Nov 24-30												
Dec 1-7												
Dec 8-15												
Dec 16-23												
Dec 24-31												
Jan 1-7												
Jan 8-15												
Jan 16-23												
Jan 24-31												
Feb 1-7												
Feb 8-15					1	1						
Feb 16-23												
Feb 24-29												
Mar 1-7												
Mar 8-15												
Mar 16-23												
Mar 24-31												
Apr 1-7												
Apr 8-15												

Apr 16-23												
Apr 24-30												
May 1-7												
May 8-15												
May 16-23												
May 24-31												
Jun 1-7												
Jun 8-15												
Jun 16-23												
Total:					**1**	**1**						

Notes:

On Feb 8th a probable steelhead redd found midway between Cape Horn Rd bridge and mouth; water temp was 44 F at 2:30 pm.

Appendix D.

Skagit River Peak Flows as Measured at USGS Gage 12194000 Near Concrete, WA (1948-2007)

Floods over 90,000 cfs

Floods over 140,000 cfs

water year	date	gage height (feet)	stream flow (cfs)	water year	date	gage height (feet)	stream flow (cfs)
1948	Oct. 19, 1947	32.99	95,200[6]	1978	Dec. 02, 1977	29.27	70,300[6]
1949	May 13, 1949	26.97	55,700[6]	1979	Nov. 08, 1978	25.19	46,000[6]
1950	Nov. 27, 1949	40.80	154,000[6]	1980	Dec. 18, 1979	38.57	135,800[6]
1951	Feb. 10, 1951	38.99	139,000[6]	1981	Dec. 26, 1980	40.19	148,700[6]
1952	Jun. 05, 1952	24.80	43,500[6]	1982	Jun. 21, 1982	26.20	51,700[6]
1953	Feb. 01, 1953	28.61	66,000[6]	1983	Dec. 04, 1982	33.82	101,000[6]
1954	Oct. 31, 1953	27.39	58,000[6]	1984	Jan. 05, 1984	34.94	109,000[6]
1955	Jun. 11, 1955	27.10	56,300[6]	1985	Jun. 07, 1985	25.20	46,100[6]
1956	Nov. 03, 1955	34.48	106,000[6]	1986	Jan. 19, 1986	32.75	93,400[6]
1957	Oct. 20, 1956	27.84	61,000[6]	1987	Nov. 24, 1986	31.30	83,500[6]
1958	Jan. 17, 1958	24.38	41,400[6]	1988	Nov. 24, 1987	23.96	39,600[6]
1959	Apr. 30, 1959	32.36	90,700[6]	1989	Oct. 16, 1988	29.86	74,100[6]
1960	Nov. 23, 1959	32.17	89,300[6]	1990	Dec. 04, 1989	36.39	119,000[6]
1961	Jan. 16, 1961	30.61	79,000[6]	1991	Nov. 10, 1990	40.20	149,000[6]
1962	Jan. 03, 1962	26.82	56,000[6]	1992	Apr. 29, 1992	26.46	53,300[6]
1963	Nov. 20, 1962	35.73	114,000[6]	1993	May 13, 1993	23.95	39,300[6]
1964	Oct. 22, 1963	29.80	73,800[6]	1994	Mar. 03, 1994	23.39	36,500[6]
1965	Dec. 01, 1964	26.20	52,600[6]	1995	Dec. 20, 1994	27.55	59,800[6]
1966	May 06, 1966	23.43	36,800[6]	1996	Nov. 29, 1995	41.57	160,000[6]
1967	Jun. 21, 1967	29.59	72,300[6]	1997	Jul. 09, 1997	32.46	91,400[6]
1968	Oct. 28, 1967	31.41	84,200[6]	1998	Oct. 05, 1997	30.26	76,700[6]
1969	Jan. 05, 1969	25.82	49,500[6]	1999	Dec. 13, 1998	27.81	61,400[6]
1970	Nov. 04, 1969	23.77	38,400[6]	2000	Nov. 12, 1999	34.15	103,000[6]
1971	Jan. 31, 1971	27.90	62,200[6]	2001	Oct. 20, 2000	22.19	30,900[6]
1972	Jul. 13, 1972	32.54	91,900[6]	2002	Jan. 08, 2002	33.06	94,300[6]
1973	Dec. 26, 1972	25.83	49,500[6]	2003	Jan. 26, 2003	28.60	65,500[6]
1974	Jan. 16, 1974	30.75	79,900[6]	2004	Oct. 21, 2003	42.21	166,000[6]
1975	Dec. 21, 1974	27.16	57,500[6]	2005	Dec. 11, 2004	33.78	99,400[6]
1976	Dec. 04, 1975	36.88	122,000[6]	2006	Jan. 10, 2006	27.01	56,300[6]
1977	Jan. 18, 1977	27.31	58,400[6]	2007	Nov. 06, 2006	39.79	145,000[6]

Appendix E.

Skagit River winter steelhead harvests from 1961-62 to 1965-66 and 1974-75 (Phillips et al. 1981b)

Year	total harvest	% wild	wild harvest	hatchery harvest
1961-62	11782	100%	11782	0
1962-63	13638	86%	11729	1910
1963-64	22216	83%	18439	3777
1964-65	13324	81%	10792	2532
1965-66	16699	68%	11355	5344
1974-75	21731	70%	15212	6518

Appendix F.

Table 1.
Weather at Concrete, WA and Steelhead Redds Found by Day and Estimated Period When the Spawning Occurred in 2011 at Four Mid Skagit Basin Tributary Streams and When Active Spawning was Observed

Period of time when conditions likely stimulated steelhead spawning shaded gray Some of more relevant considerations in **bold**

Day	High	Low	Concrete	NF Stilly flow	Sthd redds	Sthd redds	Sthd redds	Sthd redds	Notes
	(°F)	(°F)	precip (inch)	(cfs)	Savage	Mill	O'Toole	Finney	
1-Jan-11	35.1	21.9	0	2,190					
2-Jan-11	37	24.1	0	2,080					
3-Jan-11	39	24.1	0	1,980					
4-Jan-11	39.9	25	0	1,910					
5-Jan-11	35.1	27	0.03	1,940					
6-Jan-11	37	34	**0.78**	**3,740**	0				only coho spawning found near Savage mouth
7-Jan-11	39.9	35.1	**0.98**	**7,090**					
8-Jan-11	43	35.1	**0.51**	**4,960**					
9-Jan-11	39.9	32	0.1	3,430	0				only coho spawning found upper Savage
10-Jan-11	37.9	28.9	0	2,810					
11-Jan-11	37	28.9	0	2,480					
12-Jan-11	36	30	**0.81**	2,650					
13-Jan-11	36	32	**0.76**	**6,870**					
14-Jan-11	39.9	35.1	**0.69**	**13,000**					
15-Jan-11	43	37.9	**0.62**	**7,810**					
16-Jan-11	43	39	**1.68**	**16,100**					
17-Jan-11	**50**	42.1	**2.83**	**20,400**					Skagit flow peaks **75,000cfs** making ease of entry to creeks; south side Skagit creeks very high
18-Jan-11	**46**	39	**0.72**	**6,710**					**14 days prior Jan 31**
19-Jan-11	39.9	36	0.08	3,680	1 active 2 inactive	0			Savage 42F, Mill 39F, Skagit 40F -- Mill Ck too high to wade upstream bridge
20-Jan-11	42.1	33.1	0	2,780	0				live male steelhead red sides of unknown origin at Savage; hatchery female still present with redd much enlarged
21-Jan-11	37	33.1	**0.97**	**4,590**	0				too high to survey ditch well; only redds thought to be coho in mid section above pond
22-Jan-11	**43**	36	**0.88**	**4,180**	0	0			only a coho carcass found below ditched section Savage
23-Jan-11	**45**	37.9	0.17	2,790					
24-Jan-11	**46.9**	39	0.32	2,700					
25-Jan-11	44.1	41	0.52	3,050					**7 days prior Jan 31**
26-Jan-11	48	41	0	2,370					
27-Jan-11	50	36	0	2,080					
28-Jan-11	46	35.1	0	2,030					
29-Jan-11	42.1	35.1	0.27	3,820					
30-Jan-11	46	33.1	0.37	3,330					
31-Jan-11	43	28.9	0	2,250	1 inactive	2 inactive			redd built after Jan 22 at Savage; 2 redds 7-14 days old at Mill & Jan 20 or Jan 23-24 thought most conducive conditions
1-Feb-11	39.9	27	0	1,850			0		
2-Feb-11	39.9	27	0	1,620					
3-Feb-11	44.1	28	0.03	1,510					
4-Feb-11	42.1	37.9	0.98	2,830					
5-Feb-11	46.9	39.9	0.54	2,610					
6-Feb-11	48	39.9	0.07	2,060					
7-Feb-11	46	39	0.49	3,300					
8-Feb-11	43	35.1	0.23	2,460					
9-Feb-11	46.9	28	0	1,920					
10-Feb-11	46	28	0	1,650					

11-Feb-11	48.9	28.9	0	1,500					
12-Feb-11	42.1	35.1	0.04	1,570					
13-Feb-11	**48.9**	39	**0.58**	**2,400**					
14-Feb-11	**50**	39	**0.17**	**2,230**					
15-Feb-11	**46.9**	37.9	**0.47**	**2,740**					**2.3" rain Birdisview Feb 13-15**
16-Feb-11	44.1	36	0.11	2,040					
17-Feb-11	46	32	0.15	1,760					
18-Feb-11	42.1	32	0.25	1,560	0	2 inactive			redds built within the week or past few days
19-Feb-11	46.9	28.9	0	1,390					
20-Feb-11	48	27	0	1,260					
21-Feb-11	44.1	27	0	1,190				0	
22-Feb-11	39.9	30.9	0.32	1,190					
23-Feb-11	41	28.9	0.4	1,130					
24-Feb-11	32	24.1	0.36	1,040					
25-Feb-11	34	16	0.12	934					
26-Feb-11	33.1	16	0	885					
27-Feb-11	28	19	0.32	906					
28-Feb-11	35.1	27	0.48	979					
1-Mar-11	36	32	0.23	919					
2-Mar-11	37.9	32	0.21	1,030					
3-Mar-11	48.9	34	0.22	1,150					
4-Mar-11	42.1	30.9	0.39	1,070					
5-Mar-11	37.9	30.9	0.51	1,370					
6-Mar-11	46.9	35.1	0.09	1,320					
7-Mar-11	46.9	30.9	0.03	1,160					
8-Mar-11	48	33.1	0.03	1,080					
9-Mar-11	42.1	33.1	**0.46**	1,440	0				only a possible cutthroat redd sighted; still snow on ground
10-Mar-11	42.1	37	**0.59**	**3,320**	0	0			
11-Mar-11	45	37	**0.53**	**3,450**					
12-Mar-11	45	37	**0.23**	**2,390**					
13-Mar-11	42.1	37	**0.19**	**2,620**					
14-Mar-11	44.1	37.9	**0.96**	**4,970**					**Skagit flow up to 20,000 cfs**
15-Mar-11	45	39.9	**0.26**	**3,990**					
16-Mar-11	44.1	39.9	**0.87**	**4,620**					
17-Mar-11	41	33.1	**1.18**	**3,460**					
18-Mar-11	48.9	33.1	0.03	2,580	0	0			despite Skagit being up to 20,000 on Mar 14 no new spawning entry found
19-Mar-11	53.1	34	0.28	2,220					
20-Mar-11	54	32	0	1,910					
21-Mar-11	55.9	32	0.12	1,730					
22-Mar-11	52	39	0.34	1,990					
23-Mar-11	53.1	32	0	1,670					
24-Mar-11	61	32	0	1,510					
25-Mar-11	64	32	0.06	1,500				0	
26-Mar-11	55	37	0.14	1,480					
27-Mar-11	57	36	0.18	1,450					
28-Mar-11	55	39.9	0.12	1,510					
29-Mar-11	53.1	39.9	0.18	1,700					
30-Mar-11	48.9	39.9	**0.92**	**8,460**					
31-Mar-11	44.1	39.9	**2.38**	**16,200**					**Skagit up to 33,500 cfs**
1-Apr-11	53.1	42.1	**0.24**	**6,840**					
2-Apr-11	44.1	39.9	**1.03**	**5,990**					
3-Apr-11	46.9	39	**0.25**	**4,030**					
4-Apr-11	48.9	36	**0.22**	**3,700**					
5-Apr-11	39.9	35.1	**1.04**	**4,150**					
6-Apr-11	44.1	37	**0.48**	**3,710**					Finney creek remaining high and dirty
7-Apr-11	46	33.1	0.1	2,860				0	too discolored to see much
8-Apr-11	53.1	33.1	0.01	2,340				0	better color with 12-14" visibility
9-Apr-11	55.9	33.1	0	2,100					
10-Apr-11	52	39.9	0.02	2,070					
11-Apr-11	46	39.9	**0.98**	**3,510**					Finney very dirty and high
12-Apr-11	48	37	**0.25**	**2,740**					
13-Apr-11	57.9	37	0	2,260					
14-Apr-11	54	37.9	0.18	2,130					
15-Apr-11	46.9	36	**0.47**	2,240					

16-Apr-11	46.9	35.1	0.22	2,410					Finney still too discolored to survey
17-Apr-11	48.9	35.1	0.12	2,300				0	above Rexall Ck relatively clear
18-Apr-11	52	32	0.03	1,960					
19-Apr-11	52	33.1	0.26	1,770					
20-Apr-11	52	33.1	0.07	1,610					
21-Apr-11	53.1	34	0.05	1,580	0	0		0	
22-Apr-11	46.9	35.1	0.18	1,490					
23-Apr-11	61	35.1	0	1,430					
24-Apr-11	70	36	0	1,440				0	
25-Apr-11	57	37.9	0.03	1,660				0	
26-Apr-11	**50**	39.9	**0.29**	**2,140**					
27-Apr-11	**57.9**	39.9	**0.21**	**1,980**				0	
28-Apr-11	**52**	37.9	**0.36**	**2,150**					**Birdsview gage had 0.625" rain in 36 hours**
29-Apr-11	50	36	0.07	**1,930**					
30-Apr-11	55.9	37.9	0.03	1,740	0	1 inactive			very fresh redd made that day or day before
1-May-11	55.9	36	0	1,620				0	
2-May-11	66	35.1	0	1,890					
3-May-11	48.9	42.1	0.32	2,670					
4-May-11	51.1	39	0.06	2,220					
5-May-11	**66**	37.9	0.08	2,120					
6-May-11	**54**	45	**0.15**	2,270					
7-May-11	**54**	45	**0.26**	**2,970**	0	0			**at Birdsview gage there was 0.60" rain;** Mill Ck high
8-May-11	51.1	44.1	**0.14**	**2,950**	0	1 inactive			right in front & beside redd of April 30th & not there previous day
9-May-11	**55.9**	44.1	0	2,320					
10-May-11	**57.9**	45	0	2,080	0	enlarged redd			the redd of May 8th had been enlarged
11-May-11	64.9	45	0.11	2,580					
12-May-11	53.1	39	0.47	3,450					
13-May-11	62.1	37.9	0	2,410					
14-May-11	75	39	0	2,420					
15-May-11	63	48.9	0.14	3,390					
Survey total					**16**	**11**	**1**	**10**	

Table 2.
Weather at Concrete, WA and Steelhead Redds Found by Day and Estimated Period When the Spawning Occurred in 2014 at Five Mid Skagit Basin Tributary Streams and When Active Spawning Was Observed

Period of time when conditions likely stimulated steelhead spawning shaded gray Some of more relevant considerations in **bold**

Day	**High**	**Low**	**Concrete**	**NF Stilly flow**	**Sthd redds**	**Sthd redds**	**Sthd redds**	**Sthd redds**	**Sthd redds**	**Notes**
	(°F)	(°F)	precip (inch)	(cfs)	Savage	Mill	O'Toole	Finney	Dry	
1-Jan-11	44.1	39.9	0.06	1,020						
2-Jan-11	44.1	37.9	0.19	1,050						
3-Jan-11	45	36	1.03	2,150						
4-Jan-11	43	33.1	0.02	1,380	0				1	
5-Jan-11	43	30.9	0	1,150	0	0				
6-Jan-11	39.9	30	0.02	1,040						
7-Jan-11	39.9	32	0.07	1,430						
8-Jan-11	41	37	**0.65**	**2,790**						
9-Jan-11	43	39.9	**0.93**	**3,590**						
10-Jan-11	45	37	**0.67**	**3,630**		0			0	
11-Jan-11	46.9	37	**2.06**	**11,500**						
12-Jan-11	**46.9**	41	**0.96**	**7,070**						
13-Jan-11	**46**	36	**1.64**	**10,100**						
14-Jan-11	**46.9**	44.1	**1.44**	**7,240**	0					
15-Jan-11	**48**	42.1	0.03	**3,560**	0	0				
16-Jan-11	**48.9**	34	0	2,440					1 active	

17-Jan-11	46	34	T	1,990						
18-Jan-11	45	30	0	1,730						
19-Jan-11	43	32	T	1,520						
20-Jan-11	45	33.1	0	1,330	0					
21-Jan-11	46.9	33.1	0	1,210						
22-Jan-11	46	33.1	0.01	1,130						
23-Jan-11	50	30	0	1,040	1 inactive					likely spawned Jan 12-16
24-Jan-11	48.9	30	0	984						
25-Jan-11	51.1	32	0	990						
26-Jan-11	55	30.9	0	944						
27-Jan-11	51.1	30.9	0	888						
28-Jan-11	43	30.9	0	863						
29-Jan-11	**44.1**	39.9	0.18	**1,430**						**0.85" rain at Birdsview**
30-Jan-11	**45**	36	**0.4**	**1,930**	0	0				**0.65" rain at Birdsview**
31-Jan-11	**45**	36	**0.34**	**1,540**						**0.25" rain at Birdsview**
1-Feb-11	41	32	0.01	1,230						
2-Feb-11	42.1	32	0.03	1,050				1 inactive	2 inactive	likely spawned Jan 30-Feb 1
3-Feb-11	41	28.9	0	941				0		
4-Feb-11	39	28	0	846						
5-Feb-11	39	19.9	0	744						
6-Feb-11	32	18	0	668						
7-Feb-11	34	17.1	0	702						
8-Feb-11	36	21	0	650						
9-Feb-11	39	21	0.02	664						
10-Feb-11	36	30	0.14	756						
11-Feb-11	41	33.1	**0.62**	**1,590**		0			0	
12-Feb-11	46	36	**0.82**	**2,460**						
13-Feb-11	51.1	37	0.31	**2,070**						
14-Feb-11	50	37.9	0.22	1,850						
15-Feb-11	46	37	0.21	2,270						**1.35" rain Birdsview**
16-Feb-11	**46.9**	37	**0.67**	**2,650**	0	0			0	
17-Feb-11	**42.1**	36	**0.44**	**2,370**						**0.65" rain Birdsview**
18-Feb-11	**42.1**	36	**0.42**	**2,400**						**1.5" rain Birdsview but snow at upper elevations**
19-Feb-11	**43**	35.1	**0.95**	**2,380**	0	0			1 active	**0.9" rain Birdsview**
20-Feb-11	43	33.1	0.47	1,820	2 inactive	0			0	2 inactive redds upper Savage less than week old; active sea-run cutthroat spawning at Dry
21-Feb-11	48	33.1	0.41	1,610						
22-Feb-11	43	28.9	0	1,360						
23-Feb-11	35.1	30.9	0.9	1,290						
24-Feb-11	34	30.9	0.82	1,410						
25-Feb-11	34	32	0.64	1,880						
26-Feb-11	44.1	33.1	0	1,810						
27-Feb-11	53.1	34	0	1,740						
28-Feb-11	48.9	35.1	0.18	1,710						
1-Mar-11	52	37	T	1,600						**from Feb 22-28 cold & snow & creeks too low for entry**
2-Mar-11	39	30.9	0.34	2,400						**2.0" rain Birdsview**
3-Mar-11	37	32	**1.45**	**6,500**						**1.05" rain Birdsview**
4-Mar-11	41	36	**1.4**	**6,900**						
5-Mar-11	41	36	**1**	**9,970**						
6-Mar-11	50	39	**0.83**	**13,400**						
7-Mar-11	45	41	**1.1**	**9,570**	0	0				creeks running high too high to survey well
8-Mar-11	57	37	0	**4,870**						
9-Mar-11	45	37	**1.72**	**12,600**						
10-Mar-11	**52**	42.1	0.11	**6,720**						thaw & rains began Mar 1[-2] with high bankfull flows thereafter with no survey conditions
11-Mar-11	**52**	39.9	0	**4,330**						
12-Mar-11	**57.9**	34	0	3,240	0				1 active 1 inactive	possibly another active redd at Dry but it was not counted due to the 2 fish on the one known active redd having dropped downstream as well
13-Mar-11	62.1	32	0	2,690	1 inactive	0	0			Savage redd made past 2 days just above Skagit entry; first O'Toole survey since Nov

14-Mar-11	60.1	37	0.35	**4,440**						
15-Mar-11	55.9	41	0.3	**3,540**	1 inactive					redd made within few days
16-Mar-11	50	41	**1.37**	**10,800**						
17-Mar-11	41	37	**0.78**	**5,630**						
18-Mar-11	46	34	0.06	3,500						
19-Mar-11	48.9	34	0.16	3,820	0				0	
20-Mar-11	43	36	**0.43**	3,550						
21-Mar-11	43	30.9	0.05	2,820		0			0	
22-Mar-11	52	30.9	0	**1,890**						**NF Stillaguamish landslide makes gage unreliable for a week or so**
23-Mar-11	44.1	32	0.2	1,080				0	0	Finney too turbid to survey
24-Mar-11	**54**	36	T	1,960						
25-Mar-11	**63**	39	T	1,980						**0.425" rain Birdsview**
26-Mar-11	**50**	41	0.27	2,650						**0.425" rain Birdsview**
27-Mar-11	**55**	41	0.15	2,580				1 active		barely enough visibility to survey
28-Mar-11	55	42.1	0.05	2,550	0	0				
29-Mar-11	45	42.1	**0.88**	**4,280**	0					**1.0" rain Birdsview**
30-Mar-11	45	41	**0.75**	**4,970**	0	0			0	**1.45" rain Birdsview overnight**
31-Mar-11	50	36	0.33	3,520						
1-Apr-11	61	35.1	T	2,600						
2-Apr-11	62.1	35.1	0	2,080	0	0				
3-Apr-11	60.1	37	0	1,840						
4-Apr-11	54	39	0.2	1,890						
5-Apr-11	55.9	41	0.06	2,000						**0.425" rain Birdsview**
6-Apr-11	48.9	43	**0.46**	**3,220**						**0.425" rain Birdsview**
7-Apr-11	**59**	43	0.07	**2,480**			1 inactive			1-2 wks old or more, likely Mar 21-22 or Mar 31-Apr 1
8-Apr-11	**69.1**	45	0	**2,610**						
9-Apr-11	**53.1**	37.9	**0.6**	**3,570**						
10-Apr-11	**57.9**	36	T	2,420						
11-Apr-11	**60.1**	37	0	2,020						
12-Apr-11	**55**	41	0.01	1,820						
13-Apr-11	**63**	37	0	1,680	0	0				
14-Apr-11	69.1	37	0	1,590				8 inactive		1 redd a month old; 2 redds ~Mar 31-Apr 1; 2 redds 3-4 wks old; 1 redd 2-3 wks old; 1 redd 1-wk old; 1 redd 2-3 days old;
15-Apr-11	68	39	0.01	1,590						
16-Apr-11	55	44.1	0.22	2,240						
17-Apr-11	48	44.1	**0.61**	**5,340**						
18-Apr-11	50	42.1	**0.61**	**5,380**	0	0				
19-Apr-11	54	37.9	0.01	3,180	0					
20-Apr-11	53.1	39	**0.6**	**4,770**						
21-Apr-11	57	39.9	T	3,200						
22-Apr-11	**64**	44.1	**0.49**	3,190			1 inactive			~Mar 21-25; first sighted Apr 7 & estimated 1-2 wks old
23-Apr-11	55.9	41	0.17	3,190					0	
24-Apr-11	**57.9**	41	**0.96**	**4,630**						
25-Apr-11	52	39.9	0.32	3,780						
26-Apr-11	**59**	37.9	0	2,890						
27-Apr-11	57.9	39	0.29	2,760						
28-Apr-11	46.9	39.9	**0.88**	2,780						
29-Apr-11	**59**	39.9	T	2,350						
30-Apr-11	**73.9**	44.1	0	2,220		2 inactive				1 redd 2 wks old; 1 redd 3-7 days old
1-May-14	**82.9**	45	0	2,470						
2-May-14	**84.9**	48	0	2,800	0				1 inactive	redd 3-7 days old
3-May-14	**73**	46.9	0.17	3,130						
4-May-14	52	46	**0.61**	**5,370**						
5-May-14	48.9	46	**0.94**	**7,330**						
6-May-14	**57**	46	0.08	4,060	0	0		0	0	Finney too turbid; other creeks too high the previous 2 days
7-May-14	60.1	45	0.05	3,070			1 inactive			1-2 days old
8-May-14	66.9	45	0	2,700						
9-May-14	63	45	**1.22**	**7,010**						
10-May-14	50	44.1	**0.39**	**5,100**						

11-May-14	55	45	0.02	3,480		0	0			
12-May-14	**66.9**	46.9	0.01	2,890					1 active 4 inactive	active redd determined when redd found May 14th; others made within 24-36 hours
13-May-14	**78.1**	46.9	0	2,660						
14-May-14	**80.1**	52	0	2,670				7 inactive	0	6 Finney redds 2-4 days old; 1 redd 1-2 wks old
15-May-14	**82.9**	52	0	2,790		0	0			
16-May-14	**84**	52	0	2,670				2-inactive	0	both redds ~2 wks old
17-May-14	**70**	52	0	2,310						
18-May-14	**66**	48	0	2,090						
19-May-14	**64.9**	48	0	2,490						
20-May-14	**69.1**	51.1	0	2,000						
21-May-14	**69.1**	45	0	1,810				1 inactive	0	within the week
22-May-14	68	46	0	1,740			1 inactive			within 1-3 days
23-May-14	77	51.1	0	2,100						
24-May-14	64.9	51.1	0.19	2,510						
25-May-14	66.9	48.9	T	1,870						
26-May-14	55.9	48.9	0.21	2,060						
27-May-14	61	48	0.15	1,970						
28-May-14	66	48	0	1,630						**0.525" rain at Birdsview**
29-May-14	59	48	0.3	1,660						**0.375" rain at Birdsview**
30-May-14	60.1	46.9	0.05	1,540				0	0	
31-May-14	71.1	46	0	1,430						
1-Jun-14	73.9	46	0	1,420						
2-Jun-14	72	46	0	1,400						
3-Jun-14	75	48	0	1,420						
4-Jun-14	68	48.9	0	1,330						
5-Jun-14	69.1	46.9	0	1,240						
6-Jun-14	72	46	0	1,150						
7-Jun-14	77	46	0	1,100						
8-Jun-14	77	46	0	1,060						
9-Jun-14	75	51.1	0	1,070						
10-Jun-14	72	48	0	1,030						
11-Jun-14	64	46	T	922						
12-Jun-14	73.9	46	0	**910**						**0.725" rain at Birdsview**
13-Jun-14	69.1	52	0.46	**1,320**						
14-Jun-14	55	51.1	0.23	1,250						
15-Jun-14	55.9	50	0.04	1,070						
16-Jun-14	63	48.9	0.05	1,300			1 inactive			~2 wks old
Survey total					**24**	**20**	**8**	**10**	**21**	

Appendix G.

Table 1.
Mean Air Temperature per Month in Fahrenheit at Concrete, WA from 2010 to 2014

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2010	41.44	42.89	45.45	48.43	52.63	58.47	64.77	64.76	60.1	53.34	40.23	38.85
2011	37.48	36.59	41.61	43.95	51.19	57.73	60.47	63.9	61.53	50.98	40.62	37.5
2012	36.18	40.33	39.9	49.72	53.34	55.37	63.03	65.9	61.05	50.89	43.88	38.15
2013	35.82	39.91	43.82	48.13	55.84	60.1	65.32	66.08	61.92	50.69	42.88	35.05
2014	40.27	36.32	43.19	48.95	57.32	59.58	65.6	67.73	....	....	....	....
mean	**38.24**	**39.21**	**42.79**	**47.84**	**54.06**	**58.25**	**63.84**	**65.67**	**61.15**	**51.48**	**41.90**	**37.39**

Table 2.
Mean Precipitation per Month in Inches at Concrete, WA from 2010 to 2014

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2010	9.55	4.68	5.73	5.83	5.85	3.26	0.2	0.58	7.38	4.74	9.8	11.31
2011	14.09	6.11	11.73	7.19	3.73	1.46	1.91	0.21	2.18	5.5	12.59	4.33
2012	12	9.38	11.62	5.2	4.14	4.22	2.18	0.01	0.33	9.88	11.25	12.01
2013	9.27	5.2	7.65	7.21	3.41	3.33	0.06	2.25	9.08	3.08	8.65	6.85
2014	10.7	8.28	14.08	6.57	4.39	2.54	2.13	2.04	....	....	....	....
Mean	**11.12**	**6.73**	**10.16**	**6.40**	**4.30**	**2.96**	**1.30**	**1.02**	**4.74**	**5.80**	**10.57**	**8.63**

Table 3.
Mean Streamflow per Month in cfs at the North Fork Stillaguamish River from 2010 to 2014

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	2,751	1,333	1,417	1,807	1,747	1,668	500	275	1147	1,786	3,189	4,962
2011	4,768	1,733	2,751	2,609	2,453	2,096	1194	542	416	1,097	2,843	1,931
2012	2,762	2,649	2,391	2,949	2,686	2,059	1178	427	275	1,825	3,738	2,531
2013	2,228	1,819	2,952	3,188	2,409	1,361	634	354	1019	1040	2157	1470
2014	2602	1533	4850	2844	2884	1135	692	364	....	....	....	....
Mean	**3,022**	**1,813**	**2,872**	**2,679**	**2,436**	**1,664**	**839**	**392**	**714**	**1,437**	**2,982**	**2,724**

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

RE: Comments on Draft Puget Sound Environmental Impact Statement for Steel head

1 message

Lee Blankenship <lee.blankenship@nmt.us> Mon, Jan 19, 2015 at 9:30 AM
To: fishaholic9@juno.com, PSHatcheryEIS.wcr@noaa.gov
Cc: larryc@matermarine.com, HOFFMAH@dfw.wa.gov, Kirt.Hughes@dfw.wa.gov, rob.jones@noaa.gov, Jim.Scott@dfw.wa.gov, scottjbs@dfw.wa.gov, urabeck@comcast.net, Ron.Warren@drw.wa.gov, mwrecker@wwest.net

Nice letter Hal.

Lee Blankenship
Director of Biological Services
Northwest Marine Technology
Ofc: (360) 596-9400 ext 1019
Cell: (360) 790-6330
Fax: (360) 596-9405
955 Malin Lane SW Suite B
Tumwater, WA 98501
USA

www.nmt.us
http://hatcheryreform.us
www.SeaRanching.org

----Original Message----
From: fishaholic9@juno.com [mailto:fishaholic9@juno.com]
Sent: Sunday, January 18, 2015 2:16 PM
To: PSHatcheryEIS.wcr@noaa.gov
Cc: lee.blankenship@nmt.us; larryc@matermarine.com; HOFFMAH@DFW.WA.GOV; Kirt.Hughes@dfw.wa.gov; rob.jones@noaa.gov; Jim.Scott@dfw.wa.gov; scottjbs@dfw.wa.gov; urabeck@comcast.net; Ron.Warren@drw.wa.gov; mwrecker@wwest.net
Subject: Comments on Draft Puget Sound Environmental Impact Statement for Steel head

To William W. Stelle Jr. West Coast Regional Administrator

I have attached my comments to the draft EIS on Steelhead hatcheries in Puget Sound.Supporting data is included in other attachments.As can be seen in the attachments,I support the continuation of hatchery programs and have submitted comprehensive data to support the position that we have modified hatcheries extensively to meet hatchery reform guidelines and now need to continue the benefits of hatchery production while working on the main problem:mortality of smolts migrating out of Puget Sound.

Hal Boynton -member of Steelhead-Cutthroat advisory group,CCA,Puget Sound Anglers,and Steelhead Trout Club(intervenor in the

Hal Boynton,Steelhead recreational angler

High School Yearbooks

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Puget Sound Fish Hatchery Management

1 message

Don Boyer <don.boyer@comcast.net> Fri, Dec 12, 2014 at 8:36 AM
To: PShatcheryEIS.wcr@noaa.gov

Dear NOAA Fisheries,

I am writing this message regarding Puget Sound steelhead and salmon fish hatchery management.

After several decades of employment, I am looking forward to retirement soon. One of my main retirement activities I plan to enjoy more is steelhead and salmon fishing. I am an active member of various fishing clubs, subscribe to several fishing publications and fish as often as possible. I look forward to my retirement and fishing often. My main fishing areas include the Skagit, Cascade, Nooksack, Stillaguamish and Snohomish rivers as well as various salt water locations (primarily around the San Juan Islands).

I have been monitoring the Puget Sound hatchery management activities over the last several months. Shutting down the Marblemount hatchery preventing the production and release of steelhead brood stock is a huge blow to the steelhead populations in both the Skagit and Cascade rivers. Sadly, this appears to only be the beginning.

If hatchery output is reduced or ended at any of the facilities, fresh and salt water steelhead and salmon fishing opportunities will be significantly impacted negatively. This will have serious implications to the recreational sport fishermen (like me) as well as the tribe and commercial fishing industry. It will also have a huge negative financial and employment impact to the wholesale and retail sporting goods / boating industry in Washington State as well as the Washington Department of Fish and Wildlife revenue they obtain from fishing license sales. Further, it will negatively impact the existing bird and wildlife populations that depend on steelhead and salmon as a food source.

I am very much a proponent to NOT closing or cutting back output from any of the existing fish hatcheries. I strongly encourage hatchery brood stock production for steelhead and salmon increase within the entire Puget Sound area and the Marblemount hatchery restart its steelhead brood stock production as soon as possible. I sincerely hope NOAA Fisheries takes my recommendations into account when finalizing the upcoming Puget Sound hatchery management plans. Thank you.

Regards,

Don Boyer

Bellingham , WA

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Comments on Draft Puget Sound Environmental Impact Statement for Steel head

1 message

fishaholic9@juno.com <fishaholic9@juno.com> Sun, Jan 18, 2015 at 2:16 PM
To: PSHatcheryEIS.wcr@noaa.gov
Cc: lee.blankenship@nmt.us, larryc@matermarine.com, HOFFMAH@dfw.wa.gov, Kirt.Hughes@dfw.wa.gov, rob.jones@noaa.gov, Jim.Scott@dfw.wa.gov, scottjbs@dfw.wa.gov, urabeck@comcast.net, Ron.Warren@drw.wa.gov, mwrecker@wwest.net

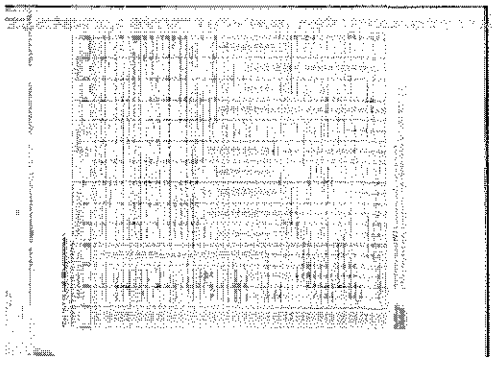
To William W. Stelle Jr. West Coast Regional Administrator

I have attached my comments to the draft EIS on Steelhead hatcheries in Puget Sound.Supporting data is included in other attachments.As can be seen in the attachments,I support the continuation of hatchery programs and have submitted comprehensive data to support the position that we have modified hatcheries extensively to meet hatchery reform guidelines and now need to continue the benefits of hatchery production while working on the main problem:mortality of smolts migrating out of Puget Sound.

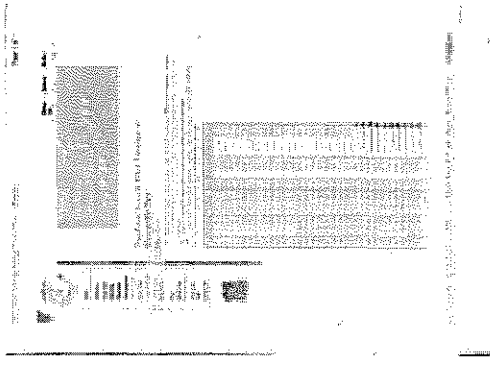
Hal Boynton -member of Steelhead-Cutthroat advisory group,CCA,Puget Sound Anglers,and Steelhead Trout Club(intervenor in the

Hal Boynton,Steelhead recreational angler

4 attachments



Nisqually Steelhead Historical Database.jpg
779K



Bonneville SH Historical ountsc.csv.jpg
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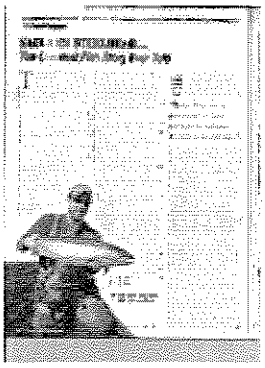


Saugeen river Steelhead.jpg
775K

NMFS Letter.docx
33K

To William W.Stelle Jr. NMFS West Coast Regional Administrator

Comments to the Puget Sound Draft Environmental Impact Statement from Hal Boynton,recreational angler,member and past co-chair of the Steelhad-Cutthroat Advisory Group to WDF&W

I moved to Puget Sound in 1958 after reading and dreaming about Steelhead fishing in my early youth and do not regret the move because fishing here gives me quality of life.Steelhead fishing held up for 30 years due both to hatchery and wild fish returning in harvestable numbers.In 1985 the sportsmen and the tribes harvested over 12,000 hatchery Steelhead and 1,000 wild Steelhead in the Green river and the wild Steelhead still met escapement goals after 30 years of hatchery smolt plants.Also,the hatchery smolt-to-adult return rate (SAR)was 7%;it has now declined to less than .5%.These same Chamber creek Steelhead still return to the Bogachiel, which drains directly into the ocean, at 3%.

When Steelhead runs started to decline and hatchery reform was adopted WDF&W made significant changes in hatchery programs,including reduced plants,release only where traps exist,early spawning of hatchery fish to avoid overlap with wild fish and elimination of hatchery programs.The Wild Steelhead and the Wild Salmon policies were adopted with maximum amounts of introgression of hatchery genes allowed.No studies were ever done to substantiate the maximum amount of introgression allowed from the hatchery fish into the wild fish.

We know from studies such the Hood river that hatchery fish do have reduced fitness when spawning in the wild but there is no evidence that reducing or eliminating hatchery programs in any river in Puget Sound has improved the wild runs.The Nisqually river wild run averaged 4724 fish in the 5 years before hatchery plants were discontinued in 1991 and the run has dropped to an average of 550 from 2005 to 2009.The Cedar river run went extinct after hatchery Steelhead planting was discontinued.Hood Canal ,where Steelhead plants have been discontinued, wild Steelhead have dropped to such a low level that a NMFS rescue program has been instituted .Hatcheries obviously are not the problem.

In 2005 and later years I went with Fred Goetz and proposed to WDF&W with funding from the Steelhead Trout Club that acoustic tags be installed in smolts from the Green river.The program was adopted and later expanded to include the Nisqually,Skagit and Hood Canal rivers.We found that the hatchery Steelhead smolt-to ocean survival(3% in the Green river) was less than than the smolt-to-adult return ratio(SAR) of the 80's (7% in the Green river) with similar results for the Nisqually,Skagit,and Hood Canal rivers.

The only long term monitor of SAR is conducted on the Queets river since 1981;in the period from 1981 to 2006,the Queets SAR averaged 11.7%-in the period from 2006-2010 it averaged 10.6%. indicating that the mortality in the open ocean has remained constant. In recent years smolt trapping has been conducted on the Nisqually river with 60,000 to 100,000 smolts trapped annually.If the Nisqually SAR could be restored to the Queets level,the Nisqually wild run would return to its former level of the 1980's. This is another indication that Puget Sound is the problem

We have now found that the wild Steelhead declines in Puget sound are due primarily to a TAKE in Puget Sound but have not found the cause.The Salish Sea marine survival program is underway but has not

identified the cause of smolt mortality and instituted fixes as they have in the Columbia river.In the Columbia river, where 7 million hatchery fish are planted, outmigration mortality has been greatly reduced by spilling water,improved fish passage at the dams,and barging.The unmarked Steelhead passing Bonneville increased from and average of 31,421 (1994-1998) to 128,461 (2009-2013); over 80% of these Steelhead were wild.In the Columbia they have greatly reduced the Steelhead loss in migrating to the ocean and back to the rivers of origin but in Puget Sound we have not.

The lawsuits of misguided zealots who believe that all we have to do is stop the hatcheries and our wild Steelhead will return to the 1970s levels must be stopped.We are wasting our time and money on lawsuits.

We need to fix the real problem! Puget Sound is killing our Steelhead!

Don,t kill the hatcheries. WDF&W has already made improvements to the hatcheries and plans to make more. Without the hatcheries there will be no Puget Sound Steelhead fishing,reduced quality of life for the mainstream sportsmen,severe economic impact to our small towns,and reduced advocates for our wild Steelhead.

I recommend that NMFS approve the HGMPs and RMPs for the Nooksack,Stillaguamish,Skykomish,Snoqualmie,Green,and Dunginess rivers by Feb 28th,2015 so that smolts can be released in May,2015 to allow a small remnant of our Puget Sound Steelhead program to continue while we solve the real cause of the problem which is Puget Sound.

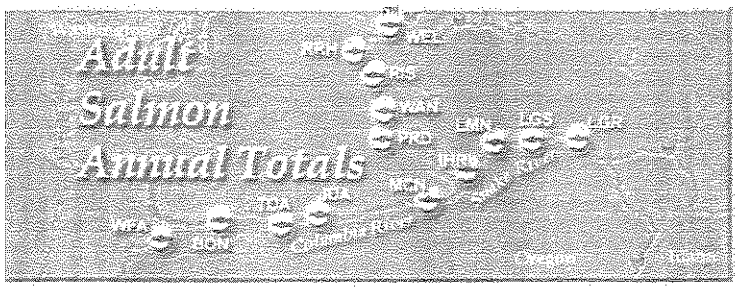
Hal Boynton- member of CCA,Puget Sound Anglers,and the Steelhead Trout Club

Table A10. Nisqually Management Unit
Nisqually River Winter-run Steelhead

Return	Sport Harvest (1Nov-30Apr)			Tribal Harvest (1Nov-30Apr)			Escapement				Total Runsize		
Year (N)	Hatchery	Wild	H&W Total	Hatchery	Wild	H&W Total	Hatchery	Wild Mainstem Only	Tributary Estimates	H&W Total	Hatchery	Wild	H&W Total
1960/61													
1961/62			1,443										
1962/63			1,637										
1963/64			2,951										
1964/65			1,162										
1965/66			2,605										
1966/67			2,958										
1967/68			2,441										
1968/69			2,809										
1969/70			1,346										
1970/71			1,661										
1971/72			637										
1972/73			968										
1973/74			285										
1974/75			843										
1975/76			238										
1976/77			860										
1977/78			1,157										
1978/79			1,414			2,795							
1979/80			2,764		1,317			1,972					
1980/81			1,414		2,114			1,782					
1981/82			1,349	203	1,803	2,006	385	3,807		4,192			7,547
1982/83			1,374	310	2,058	2,368	362	2,705		3,067			6,809
1983/84			1,263	275	1,735	2,010	178	1,304		1,482			4,755
1984/85			1,916	289	2,459	2,748	168	1,599		1,767			6,431
1985/86			1,960	146	1,482	1,628	145	1,620		1,765			5,353
1986/87	211	1,815	2,026	74	1,879	1,953	60	2,022		2,082	345	5,716	6,061
1987/88	156	2,190	2,346	107	2,565	2,672	73	1,916		1,989	336	6,671	7,007
1988/89	71	1,202	1,273	38	1,268	1,306	90	3,817		3,907	199	6,287	6,486
1989/90	68	776	844	28	797	825	40	1,853		1,893	136	3,426	3,562
1990/91	28	240	268	9	639	648	8	642		650	45	1,521	1,566
1991/92	2	13	15		234			2,618		2,618		2,865	
1992/93	33	610	643		250			993		993		1,853	
1993/94	6	3	9		51			804		804		858	
1994/95	0	6	6		17			987		987		1,010	
1995/96	0	4	4		82					0			
1996/97	5	0	5		81			882		882		963	
1997/98	8	2	10		81			721		721		804	
1998/99	3	0	3		31			530		530		561	
1999/00	0	0	0		12			411		411		423	
2000/01	11	0	11		18			240		240		258	
2001/02	25	11	36		59			353		353		423	
2002/03	8	0	8		12			366		366		378	
2003/04	2	0	2	1	10	11		750	*196*	*946*		*956*	
2004/05	7	0	7	1	8	9		190	*35*	*225*		*233*	
2005/06	0	0	0	0	25	25		722	*187*	*909*		*934*	
2006/07	3	0	3	0	29	29		303	*168*	*471*		*500*	
2007/08	0	0	0	1	27	28		515	*232*	*747*		*774*	
2008/09	1	0	1	0	11	11		232	*68*	*300*		*311*	
2009/10				1	9	10		691	*69*	760			

Sport Harvest Catch Record Card data from 2008/09 are preliminary and subject to change as data are verified.

Escapement 2003/04 to present, spawner surveys were expanded to include Mashel, Little Mashel, and Ohop creeks, indicated by italicized numbers.



Home
Adult Data
Smolt Data
Spawning
River Data
Hatchery Data
Survival Data
Travel Times
Lamp Bull Trout
FallChin Team
Documents
Fall Chinook Planning Team
FPAC
What's New
Reporting Sites
Ives Island Data
Useful Links

Steelhead Annual Adult Passage at: Bonneville Dam

Instructions:

- After the html table is done loading, right click here and select either save target as... or save link as (depending on your browser) to save the Comma Separated Value (.csv) file to your computer.
- When browsing the data, click on the column heading to sort the data.
- To learn more about adult passage migration data click here to read the adult metadata.

NOTE: When there are blank fields in the results, it is because there was no data.

Year	StartDate	EndDate	Dam	Steelhead	WildSteelhead
2013	1/1/2013	12/31/2013	BON	234047	99148
2012	1/1/2012	12/31/2012	BON	235303	85472
2011	1/1/2011	12/31/2011	BON	369365	129166
2010	1/1/2010	12/31/2010	BON	416603	156139
2009	1/1/2009	12/31/2009	BON	604970	172383
2008	1/1/2008	12/31/2008	BON	357845	105670
2007	1/1/2007	12/31/2007	BON	325275	82197
2006	1/1/2006	12/31/2006	BON	339301	85082
2005	1/1/2005	12/31/2005	BON	315650	88999
2004	1/1/2004	12/31/2004	BON	313377	97875
2003	1/1/2003	12/31/2003	BON	365821	112823
2002	1/1/2002	12/31/2002	BON	483956	143196
2001	3/15/2001	11/15/2001	BON	633073	149317
2000	3/15/2000	11/15/2000	BON	275178	76192
1999	3/15/1999	11/15/1999	BON	206488	55064
1998	3/15/1998	11/15/1998	BON	185094	35701
1997	3/15/1997	11/15/1997	BON	258385	33580
1996	3/15/1996	11/15/1996	BON	205216	30338
1995	3/15/1995	11/15/1995	BON	202448	28036
1994	3/15/1994	11/15/1994	BON	161978	29451
1993	3/15/1993	11/15/1993	BON	188377	0
1992	3/15/1992	11/15/1992	BON	314975	0
1991	3/15/1991	11/15/1991	BON	274545	0
1990	3/15/1990	11/15/1990	BON	183027	0
1989	3/1/1989	11/30/1989	BON	287798	0
1988	3/1/1988	11/30/1988	BON	279072	0
1987	3/1/1987	11/30/1987	BON	303081	0
1986	3/4/1986	11/30/1986	BON	379891	0
1985	3/15/1985	11/30/1985	BON	343961	0
1984	3/15/1984	11/15/1984	BON	315587	0

Darryl Choronzey

SAUGEEN STEELHEAD...
The Greatest Fish Story Ever Told

The clear-bodied yellow-topped Black Phantom was just passing over the tailout when the float hesitated and dimpled ever so slightly. My 13-foot wand snapped back in that big-bend configuration that acknowledged another fish was caught by surprise and the battle was on.

You just have to love steelhead fishing and the excitement that goes with it. Especially when an angler never knows how an enraged silver-sided trout is going to react at the bite from micro number 8 bait hook piggy-backing a couple of perfectly cured single eggs.

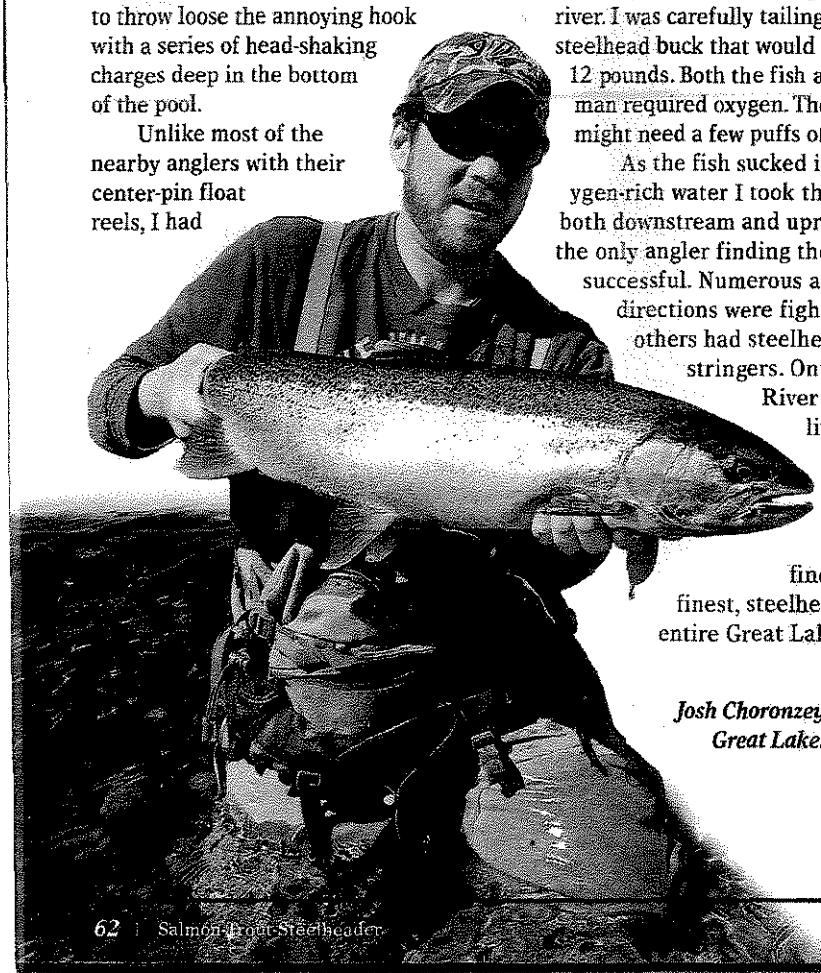
Many fish pull back and head straight for open water but when the hook struck deep into its jaw, this big steelhead exploded up out of the river and carried out two perfect high-flying aerobatic head-over-tail somersaults before crashing back into the water. It was then that the big boy decided to throw loose the annoying hook with a series of head-shaking charges deep in the bottom of the pool.

Unlike most of the nearby anglers with their center-pin float reels, I had my little Revo Premier baitcaster firmly locked down on the top seat of my long rod. As the huge trout thrashed around in the pool the 6-pound Maxima Chameleon monofilament peeled smoothly off the spool. When the steelhead decided it had enough of tug of war, turned and shot down the river it was another matter. The taut mono seemed to melt off that same now-sizzling reel.

The big boy obviously knew where he wanted to go and I had no choice but to climb out of the river and run the shallows after him. To some it might have been a funny sight. A 64 year old with creaking knees attempting to act like a youngster, all the time trying to avoid the obvious downed tree limbs, the unseen slippery boulders and keeping a taut line.

Twenty minutes after setting the hook, I found myself kneeling in the shallows just out from another deep hole on the river. I was carefully tailing a prime silver steelhead buck that would weigh close to 12 pounds. Both the fish and the fisherman required oxygen. The fisherman just might need a few puffs of nitroglycerin.

As the fish sucked in the cold oxygen-rich water I took the time to peer both downstream and upriver. I was not the only angler finding the fishing to be successful. Numerous anglers in both directions were fighting fish, while others had steelhead tied to their stringers. Ontario's Saugeen River was definitely living up to its reputation. The Saugeen had transformed into one of the finest, if not the finest, steelhead rivers on the entire Great Lakes.



Josh Choronzey with a prime Great Lakes steelhead.

I could feel muscle and nerves begin to pulse through the body of the fish as I continued to hold his face up into the current. One strong protest with the tail and I recognized that he was ready for release.

> "Today, that run is estimated to have climbed to between 45,000 to 60,000 fish."

As the majestic creature finned slowly off into the depths of the pool I knew full well a dedicated group of anglers had created a true miracle. The Saugeen was the destination to enjoy one of the finest forms of angling. The sport of steelheading...steelheading at its finest!

Dating back as far as the mid-1960's the Saugeen always provide better than average fishing for migratory Great Lakes steelhead. During the mid-1970s the big river's steelhead production could even be rated as excellent as thousands of Michigan-stocked rainbow trout strayed across from the Wolverine State. By the turn of the century steelhead runs declined whether due to Michigan changing their stocking practices, a changing Lake Huron environment or a combination of both.

Just as the runs of steelhead had dipped to their lowest, a few concerned individuals, two clubs, the Ontario Steelheaders and the Lake Huron Fishing Club approached Ontario's Ministry of Natural Resources with plans to restore the Saugeen back to its former prominence.

The Ontario Steelheaders had been carrying out steelhead restoration work for years on the Saugeen but realized they needed more assistance in the form of bodies, as well as more funding to kickstart the program into high gear. A little more than a decade ago meetings were held with the Lake Huron Fishing Club and the Ontario Ministry of Natural Resources. The LHFC signed on as a full partner and the OMNR assisted with consultation and approval.

11-14-14

If the hatchery salmon and steelhead are stopped. That means the nets will finish off the so called wild or Native fish will in time be extinct. The worst thing that has happen to the fish is the Boldt Decision.

Regards
Chris Crabtree

Chris Crabtree
705 Woodview Ct.
Lynden, WA 98264

ABBOTSFORD WA 980
15 NOV 2014 PM 5 1

NOAA - NMFS
RECEIVED
NOV 17 2014
SEATTLE
West Coast Regional Office

NMF NOAA
West Coast Region
600 Sand Point Way NE
Seattle, WA #98115

98115634900

PShatcheryEIS.wcr - NOAA Gmail Account [illegible]

Reiter ponds

2 messages

Creameans, Kevin D <kevin.d.creameans@boeing.com> Fri, Sep 5, 2014 at 4:27 AM
To: "PShatcheryEIS.wcr@noaa.gov" <PShatcheryEIS.wcr@noaa.gov>
Cc: "Brad@habitatsnorthwest.com" <Brad@habitatsnorthwest.com>

Good morning I can understand A selective fishery rule below Highbridge. Where Boaters are more likely to accidently catch a fish out of season or a wild one. Above the Bridge is one of the last fisheries for the working class Fisherman. Where we can bank fish and have some success. With the seasons being regulated the way they have been I have not noticed a big decline in the amount of fish in the river or the amount I catch. Generally it is a direct reflection on river conditions and weather not over fishing. In closing I think The selective gear is a poor idea and going to effect the amount of fishing. It seems every year there is a new rule and the bureaucracy is always taking a little more here and a little more there. Before long the only place to fish will be a Charter boat out in the Ocean for the Rich.

Creameans, Kevin D <kevin.d.creameans@boeing.com> Fri, Sep 5, 2014 at 7:21 AM
To: "PShatcheryEIS.wcr@noaa.gov" <PShatcheryEIS.wcr@noaa.gov>

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Kevin Creameans

787 Dream☞Liner Interiors

1st Shift Pos 3 Interiors 40-24

425-319-1021

Don't Dream your life away, Live your Dreams!

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

RE: Comments on Draft Puget Sound Environmental Impact Statement for Steel head

1 message

Dave Croonquist <dcroonquist@gmail.com> Sun, Jan 18, 2015 at 11:32 PM
To: fishaholic9@juno.com, PSHatcheryEIS.wcr@noaa.gov
Cc: lee.blankenship@nmt.us, larryc@matermarine.com, HOFFMAH@dfw.wa.gov, Kirt.Hughes@dfw.wa.gov, rob.jones@noaa.gov, Jim.Scott@dfw.wa.gov, scottjbs@dfw.wa.gov, urabeck@comcast.net, Ron.Warren@drw.wa.gov, mwrecker@wwest.net

Well stated, Hal. I am in agreement with your comments.

Dave Croonquist

---Original Message---
From: fishaholic9@juno.com [mailto:fishaholic9@juno.com]
Sent: Sunday, January 18, 2015 2:16 PM
To: PSHatcheryEIS.wcr@noaa.gov
Cc: lee.blankenship@nmt.us; larryc@matermarine.com; HOFFMAH@DFW.WA.GOV; Kirt.Hughes@dfw.wa.gov; rob.jones@noaa.gov; Jim.Scott@dfw.wa.gov; scottjbs@dfw.wa.gov; urabeck@comcast.net; Ron.Warren@drw.wa.gov; mwrecker@wwest.net
Subject: Comments on Draft Puget Sound Environmental Impact Statement for Steel head

To William W. Stelle Jr. West Coast Regional Administrator

I have attached my comments to the draft EIS on Steelhead hatcheries in Puget Sound.Supporting data is included in other attachments.As can be seen in the attachments,I support the continuation of hatchery programs and have submitted comprehensive data to support the position that we have modified hatcheries extensively to meet hatchery reform guidelines and now need to continue the benefits of hatchery production while working on the main problem:mortality of smolts migrating out of Puget Sound.

Hal Boynton -member of Steelhead-Cutthroat advisory group,CCA,Puget Sound Anglers,and Steelhead Trout Club(intervenor in the

Hal Boynton,Steelhead recreational angler

Heavy rains mean flooding
Anywhere it rains it can flood. Learn your risk. Get flood insurance.
http://thirdpartyoffers.juno.com/TGL3131/54bc30fdee93530fc7902st04vuc

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

Re: Puget Sound Hatcheries Draft Environmental Impact Statement

I am a recreational fisherman and currently a member of the East Jefferson Chapter of Puget Sound Anglers. Two of our officers attended your presentation at Fort Worden on September 6th. They presented the 16 page executive summary at our last meeting and briefly explained what the 4 different proposals for the future management plans would entail. After reviewing the information provided I would like to see the approval of Alternative # 4 (Increased Production) as the only alternative to maintaining a quality Salmon and Steelhead resource for current and future generations.

In addition I strongly recommend that NOAA and the WDFW work together to ensure the necessary ESA permits for state hatcheries are obtained as quickly as possible so that our hatcheries will be able to produce salmon and steelhead in compliance with federal environmental requirements.

Thank you,

My Name: James Baldwin

Address: 2023 E. Sims Way #239 City: Port Townsend

State: WA zip code: 98368

Email address: jrbaldwin@olympus.net

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: Charles Borgeson

Address: 650 B St. City: Port Townsend

State: WA zip code: 98368

Email address: clborgeson@gmail.com

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: Melinda Bryden

Address: 1221 Woodland Dr. City: Port Townsend

State: WA zip code: 98368

Email address: melinda@redfernconsultants.com

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: Jay Campbell

Address: 4524 LOPEZ AVE City: PORT TOWNSEND

State: WA zip code: 98368

Email address: jayandirene@cablespeed.com

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: DON DYBECK

Address: 50 NANTUCKET PL. City: PORT TOWNSEND

State: WA zip code: 98368

Email address: THEDONALD@CABLESPEED.COM

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

Re: Puget Sound Hatcheries Draft Environmental Impact Statement

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In addition I strongly recommend that NOAA and the WDFW work together to ensure the necessary ESA permits for state hatcheries are obtained as quickly as possible so that our hatcheries will be able to produce salmon and steelhead in compliance with federal environmental requirements.

Thank you,

My Name: Dave Groves

Address: 145 Mats View Terrace City: Port Ludlow

State: WA zip code: 98365

Email address: dstgroves@live.com

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

Ron Hayes

My Name: Ron Hayes

1221 Woodland Dr.
Port Townsend, WA 98368
ron@redfernconsultants.com

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: Joel C. Janetski

Address: 432 Sunset Blvd City: Port Townsend

State: WA zip code: 98368

Email address: joel-janetski@byu.edu

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: Bob JAUTZ Robert J Jautz

Address: 909 7TH St. City: PORT TOWNSEND

State: WA zip code: 98368

Email address: goldbug@sonic.net

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: JERRY H. JOHNSON

Address: 4002 HOLCOMB ST. City: PORT TOWNSEND

State: WA zip code: 98368

Email address: johnsjerry@gmail.com

Jerry H. Johnson

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: John Johnston

Address: 134 GLACIER RIDGE RD City: QUILCENE

State: WA zip code: 98376

Email address: zero8deltajohn@yahoo.com

NOAA - NMFS
RECEIVED
OCT 17 2014
SEATTLE
West Coast Regional Office

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: Troy McKelvey III

Address: 129B Hancock Street

City: Port Townsend

State: WA zip code: 98368

Email address: troy3@cablespeed.com

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
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Thank you,

My Name: KEN OWEN

Address: 210 N. PALMER DR City: PORT TOWNSEND

State: WA zip code: 98368

Email address: KDANDLR OWEN@YAHOO.COM

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: LARRY Petersen

Address: 184 GROVES WAY City: Port Ludlow

State: WA zip code: 98365

Email address: petersenshine@gmail.com

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: Don Rogers Don Rogers

Address: 611 Cedar ave SP,10 City: Port Hadlock

State: WA zip code: 98339

Email address: _____

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: ROBERT SKOIEN

Address: 103 No. RHODODENDRON DR. City: PORT TOWNSEND

State: WA zip code: 98368

Email address: RJSKOIEN@GMAIL.COM

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: George J Thomas

Address: P.O. Box 6 Port Hadlock City: _____

State: WA zip code: 98339

Email address: _____

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: Katherine B Thomas

Address: 4001 Holcomb St. City: Port Townsend

State: WA zip code: 98368

Email address: tassiet@msn.com

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Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

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Thank you,

My Name: Steve Tucker

Address: 1935 Landes, Port Townsend City:

State: WA zip code: 98368

Email address: Steve@portofPT.com

NOAA - NMFS
RECEIVED
OCT 17 2014
SEATTLE
West Coast Regional Office

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Thank you,

My Name: DONALD WEBERTS

Address: 161 MAPLE DR

City: PORT TOWNSEND

State: WA zip code: 98368

Email address: WALLYCAT57@MSN.COM

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Puget Sound Draft Environmental Impact Statement - Comment

1 message

Larry Franks <pearsonfr@comcast.net> Wed, Dec 17, 2014 at 11:33 AM
To: PSHatcheryEIS.wcr@noaa.gov

Mr. Stelle:

I appreciate the opportunity to comment on the Puget Sound Draft Environmental Impact Statement. I strongly support Alternative 4, increasing production within the facility constraints of present hatchery infrastructure. Hatchery production of salmon and steelhead has been put in place largely to mitigate the impacts caused by population and industrial growth in the Puget Sound, resulting in habitat degradation in several forms. These habitat impacts are going to continue, and the offset of hatchery production will continue to be required. The increase in revenue for the region is significant.

Thanks for your attention,

Larry Franks

BS Fisheries, University of Washington

24001 SE 103rd St.

Issaquah, WA 98027

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Steelhead and Salmon Hatchery Policy

1 message

James Frymire <jamesf@bachbros.com> Fri, Nov 14, 2014 at 8:19 PM
To: "PSHatcheryEIS.wcr@noaa.gov" <PSHatcheryEIS.wcr@noaa.gov>

Hatchery production of steelhead and salmon must continue.
Sportsmen spend thousands of dollars per fish and the tax revenue, along with the other funding, should be used for additional hatchery production.
Of course, we would all like to return to the times of pristine wild fish but it is not reasonable or rationale.
The "Wild Fish Conservancy" return to native fish policy is not realistic- they need to step back and re-evaluate.
Use research dollars in a more effective and efficient way rather than bending to WFC.
JLF

Sincerely,
James Frymire

public input

1 message

Ray Gombiski <ray@murphyauction.com> Mon, Sep 8, 2014 at 3:51 PM
To: "PShatcheryEIS.wcr@noaa.gov" <PShatcheryEIS.wcr@noaa.gov>

To whom it may concern,

I am not going to gripe about what happened in the past with the WDFW and WFC. I simply would like to offer my opinion.

I was in the sport fishing industry for ten years, 4 in Alaska and 6 in Washington. I grew up in my father's footsteps on the Tolt and Snoqualmie Rivers chasing the illusive Steelhead. Today I am a father of two boys under the age of two and I wonder if they will ever know these rivers as I did? Sadly, the days of fishing Steelhead on the Tolt have been lost forever and the shoestring that I had left was hatchery Steelhead in the Snoqualmie. I have reviewed parts of the NOAA draft on Puget sound hatchery Steelhead and have come to the following conclusions:

- Our watersheds are near unrecoverable for a sustainable fishery on Wild Steelhead. Urban development and 100's of years of progress by man have reduced the capabilities for these river to produce to a fraction of what they were.

- We can kid ourselves in that a full recovery is possible. The habitat is too far altered.

- Weather patterns have changed in the last 20 years. Spring high-water events are more common than ever. These events lead to a massive scour of the Steelhead reds that are in the river. (please note that Coho salmon are doing great because they are primarily tributary spawners and steelhead are main stem spawners in the Snoqualmie)

- Commercial fishing in the Saltwater is not selective and with no hatchery fish 100% of fish commercially caught will be endangered wild fish.

In the end I make the point that recovery is only a part of the plan. Quality opportunity and harvest should be considered in the same breath. I ask that NOAA consider opting for the highest hatchery plant rates obtainable to create more than an opportunity. Lets spring board this into something special. Fill the unrecoverable rivers with fish, and keep the recoverable rivers wild (Hoh, Sol Duc, Elwah....etc). This is our chance to take back our title as the Steelhead capital of the world, not just a place that was great in the "good ole days"

Thank you

Ray Gombiski

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Hatchery Plans

1 message

Daniel Horsman <danlhorsman@gmail.com> Wed, Nov 12, 2014 at 9:09 AM
To: PShatcheryEIS.wcr@noaa.gov

I would like to weigh in in favor of continued and increased salmon and steelhead hatchery programs throughout the state of Washington. The benefit of these hatchery programs is a proven fact that is evident in the many salmon and steelhead runs that have been brought back form the brink of extinction.

The so-called "wild fish" supporters do not have any science or evidence to support their position. It seems like a simple decision to me. Hatchery programs are proven to increase the numbers of fish, leading to increased harvest by sport, commercial and tribal fisheries. The hatchery programs positive effect on local and statewide economies is another extremely important measurable benefit. The decrease or elimination of hatchery programs can have nothing but negative consequences.

Let's stick with what we know works.

Very Sincerely,

Daniel Horsman
805 Durrwachter Road
Port Angeles, WA 98363
360-808-6965

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Puget sound Steelhead hatchery program

1 message

irnhdslayr@juno.com <irnhdslayr@juno.com> Sat, Dec 6, 2014 at 12:55 PM
To: PShatcheryeis.wcr@noaa.gov

please do not let wfc or any other group destroy our hatchery Steelhead program

Puget Sound hatchery plans EIS comments

Brad Johnson <Brad@habitatsnorthwest.com> Thu, Sep 4, 2014 at 2:09 PM
To: "PShatcheryEIS.wcr@noaa.gov" <PShatcheryEIS.wcr@noaa.gov>

I am commenting on the WDFW Puget Sound hatchery EIS plans.

1) On the Skykomish River, the Reiter Ponds summer run steelhead broodstock trap should be re-closed until Nov 30 after the 600 broodstock quota is reached. This will allow sportsman to catch these surplus hatchery fish instead of them being trapped and sent to the food banks. Opening the trap again after Nov 30 will then remove any remaining hatchery fish from the river as the re-enter their hatchery stream of origin prior to spawning time.

2) On the Skykomish River, the area above High Bridge upstream to 1000' above the mouth of the Reiter Ponds hatchery should be opened steelhead fishingunder selective fishing (barbless, baitless etc) with wild (un-clipped) fish release rules from Feb 15 (or whenever regular winter run steelhead season closes) to June 1 so that hatchery fish can be caught and removed by sportsman.

Ref: http://www.westcoast.fisheries.noaa.gov/hatcheries/ps_deis/ps_deis.html

Thank you!

Brad Johnson

POB 200, Gold Bar WA 98251

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

2015 PS Hatcheries Public Comment:

1 message

Ken j. Mcleod <alpinequest08@yahoo.com> Tue, Dec 2, 2014 at 7:46 PM
Reply-To: "Ken j. Mcleod" <alpinequest08@yahoo.com>
To: "PShatcheryEIS.wcr@noaa.gov" <PShatcheryEIS.wcr@noaa.gov>

NMFS NOAA
West Coast Region
7600 Sand point Way N.E.
Seattle, Wa. 98115
Subj: 2015 Puget Sound Anadromous Hatchery Fish Management Plan/
Public Comment Input

Date: Dec. 1, 2014
Herein, I submit the following written statements & testimony to the related subject above. I am of firm and resolute endorsement/support of hatchery steelhead & salmon herein all Puget Sound rivers for the overall good of the resource itself, as well as for its vast multitude of users. Therefore, it is essential that the NMFS/NOAA complete the HGMP's for these hatcheries, so that the state can proceed with raising and planting anadromous fish.
Related: Wild winter-run steelhead recovery depends on the use of our hatcheries, primarliy using the same in-river stock, liken to the Wynoochee River system and the past Snider Creek/
Sol Duc brood stock hatchery program - "absolutely no interface with the wild gene pool - same genetics!" At the same time, the use of early-timed winter-run Chambers Creek stock planted in other systems is also essential for sportsfishing. These fish do not interface whatsoever with later run (Feb.-May) wild/native steelhead. They arrive at totally different months and are found at different locales, so there is no real significant dilution of genetics.

Further, I also endorse/support the use of Skamania summer-run stock throughout the state for angling enjoyment, these fish are and have been a great recreational resourse, and they DO NOT interface with wild/native summer-runs in the Puget Sound region, i.e. Deer Creek, Canyon Creek, Nfk Tolt, Nfk Skykomish, Upper Green. Those eletists that will have one believe
otherwise are entirely incorrect and misleading...their "wild only" agenda basically eliminates the harvest aspect of the resource, in turn they promote no bait fishing, no boat fishing, C&R only, no wild fish harvest, and claims that hatchery fish impede wild fish recovery. Not so! All of the above,in my opinion eliminates most users or the common Joe (majority of license buyers) from really partaking, to include the very old and the young.

Lastly, steelhead & salmon management should reley on sound science, not driven by hysterical
emotion, namely "wild zealots" only interested in their own hidden agendas. Remember it's a shared
resource for all...
Sincerely,
Ken J. McLeod

avid fly fisherman
longtime steelheader
member of Snohomish Sportsmen's Assoc.
past pres. (5 terms) Steelhead Trout Club of Wa.

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Comments: Puget Sound Hatchery Environmental Impact Statement

1 message

Bill McMillan <monksend@fidalgo.net> Fri, Jan 23, 2015 at 4:49 PM
To: PSHatcheryEIS.wcr@noaa.gov

January 23, 2015

Bill McMillan
40104 Savage Rd
Concrete, WA 98237
(360) 826-4235
monksend@fidalgo.net

William W. Stelle, Jr.
Regional Administrator
National Marine Fisheries Service, West Coast Region
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE, Building 1
Seattle, WA 98115-0070
(206) 526-6426 Fax
PShatcheryEIS.wcr@noaa.gov

Re: Comments on Puget Sound Hatchery Program DEIS

Dear Mr. Stelle:

As a lifelong angler for salmon and steelhead in Washington who has resided in the Puget Sound region the past 19 years, and formerly in the Columbia River Basin, I appreciate the opportunity to respond to the Puget Sound Hatchery Program DEIS (hereafter The DEIS). I am old enough to have witnessed the high hopes of the initiation of the modern anadromous hatchery program in Washington generally considered to be with smolt plants in 1960 that benefitted from improved diet and resulting outmigration size and timing more conducive for survival (Royal 1972). This has included earliest fishing memories that were largely those of wild salmon and steelhead in the 1950s with resulting experience of the two eras.

These comments are further based on the past 36 years of doing field biology at both the volunteer and professional level. This included initiating volunteer steelhead spawning surveys in 1979 on several Lower Columbia River tributaries and volunteer snorkel surveys at several summer steelhead streams in that region beginning in 1983, all eventually adopted by Washington Department of Fish and Wildlife (WDFW) as primary data collection methods for steelhead management in the area; being American manager in 1995 and 1996 of a remote camp on the Kamchatka Peninsula to study steelhead with Russian biologists funded by the Wild Salmon Center (WSC); ten years employment as field biologist with Wild Fish Conservancy (WFC) beginning in 1996; and cooperative volunteer and contract work after retirement in 2006 with biologists and analysts from the Northwest Fisheries Science Center (NWFSC), the Puget Sound Steelhead Biological Review Team (BRT), the Puget Sound Steelhead Technical Review Team (TRT), WDFW, Seattle City Light (SCL), Seattle Public Utilities (SPU), Skagit River System Cooperative Tribes (SRSC), Upper Skagit Indian Tribe (UST), Swinomish Indian Tribal Community (STC), Sauk-Suiattle Indian Tribe (SST), the Wild Steelhead Coalition (WSTC), and Native Fish Society (NFS).

These comments are also based on the findings in the Skagit River basin as a result of being contracted by SRSC to collect data for, and to be a contributing author of, the steelhead and acoustic tracking studies and resultant reports from 2009 to 2013 (McMillan 2012; Pflug et al. 2013). The Skagit steelhead project included funding from the Saltonstal-Kennedy Grant from NOAA and entailed my contact and dialogue with steelhead biologists from Oregon and British Columbia to determine steelhead trends in those areas to compare to the

Skagit. The purpose of the Skagit studies was to determine the potential effects of hatchery plants on wild steelhead:

The primary finding was (Pflug et al. 2013):

The regional analysis on the effects of hatchery smolt releases on native steelhead productivity among Puget Sound watersheds suggest that hatchery releases have had a longterm negative impact on steelhead population growth rates (see Figure 54). Although differences in habitat quality are likely a major factor explaining the variability in population growth rates (i.e., productivity) among Puget Sound watersheds, the results of this analysis suggest that hatchery practices also have a significant influence on productivity patterns of wild steelhead in this region. This further corroborates our finding that hatchery steelhead releases have had a long-term impact on native steelhead returns to the Skagit River basin.

The recommended action was:

Discontinue the segregated hatchery steelhead program in the Skagit and monitor the results for 7-10 years. Expected responses of this recommendation are threefold: a) elimination of hatchery and wild steelhead competition at all life stages b) a rapid reduction of hybridization rates between hatchery and wild steelhead, and c) an increase in survival of wild steelhead.

The findings of the 2013 Skagit steelhead report were further confirmed by the findings given at Pacific Coast Steelhead Management Conference in March of 2014 by authors from SSRC and WDFW (Ruff et al. 2014). Given the Skagit River findings regarding loss of steelhead productivity related to hatchery plants, and the recommendation for discontinuing the Skagit hatchery steelhead plants based on these results, it provides an important basis from which to evaluate The DEIS. The Skagit River steelhead findings are not unique and represent numerous other science findings related to hatchery impacts on wild populations over the past 35 years in the U.S. and abroad (Natural Resources Wales provides a geographically balanced 49 page bibliography of relevant worldwide science references of which the link must be pasted into a search engine): https://view.officeapps.live.com/op/view.aspx?src=http%3A%2F%2Fnaturalresourceswales.gov.uk%2Fcontent%2Fdocs%2Fword%2Fconsultations%2Fsalmon-stocks-and-hatcheries%2Fbibliography-review-hatcheries-stocking.doc%3Flang%3Den

Among the science findings have been that eliminating hatchery fish could result in increased wild fish returns (Chilcote et al. 2003, 2011; Kostow and Zhou 2006). The recent decision by Wales of Great Britain to discontinue its Atlantic salmon hatchery operations to protect wild stocks is particularly noteworthy for its reasons (Gough 2014):

A major change in the way Natural Resources Wales works to protect wild salmon has been agreed.

A comprehensive review of scientific research found that hatchery-reared young salmon have a much lower survival rate than young wild fish, and can harm existing wild salmon populations.

NRW now intends to phase out salmon stocking by 2015 and close its hatcheries at Mawddach, near Dolgellau and Maerdy near Corwen.

The proposal was confirmed today (Thursday) by NRW's board.

The Cynrig hatchery, near Brecon, will remain open and NRW will assess the possibility of developing a freshwater research centre on the site.

Ceri Davies, Director of Knowledge, Strategy and Planning for Natural Resources Wales said:

"We are passionate about making sure that Wales has a healthy and sustainable salmon population. To do that, we need to use our resources as effectively as possible.

"We've done a lot over the years to improve water quality and, together with our partners, to improve habitats and resolve barriers to migration. We believe the benefits of these are now starting to have effect, and this will improve freshwater conditions for our salmon and other fish.

"Our rivers are an important part of our environment. They provide essential habitats for fish and

other wildlife as well as giving people opportunities to enjoy the outdoors through angling and other water-based activities."

NRW looked at a wide range of scientific evidence from the UK and abroad which suggested there are more effective ways to support salmon in Welsh rivers. A public consultation did not come up with any evidence to the contrary.

Salmon became extinct on the River Taff during the industrial revolution and stocking played a part in its recovery along with some other previously industrialised rivers.

A study has now revealed that, after stocking provided that initial boost to restore the population, more salmon would be produced if fish were left in the river to spawn rather than taken for hatchery rearing.

Money raised from the sale of the hatcheries will be used to improve fisheries in rivers which have previously been stocked, including work to improve habitats or to open new migratory routes.

And NRW will be working with partner organisations to implement these improvement programmes.

The Wales decision was based on a thorough scientific review prior to the actions taken (Uttley 2014) and demonstrates how wild salmon recoveries can indeed occur. If hatcheries may at one time have been instrumental in some Wales Atlantic salmon recoveries their purpose thereafter is apparently more fraught with risk than benefits and investments are better made elsewhere. However, even their part in eventual recovery has been questioned with considerable evidence that straying by wild fish may have equally or more contributed (Milner et al. 2004).

Scotland has not yet fully abandoned hatcheries but has put increasing limitations on them (RAFTS 2014). A quote from this policy report relates to the common failure of enhancement stocking:

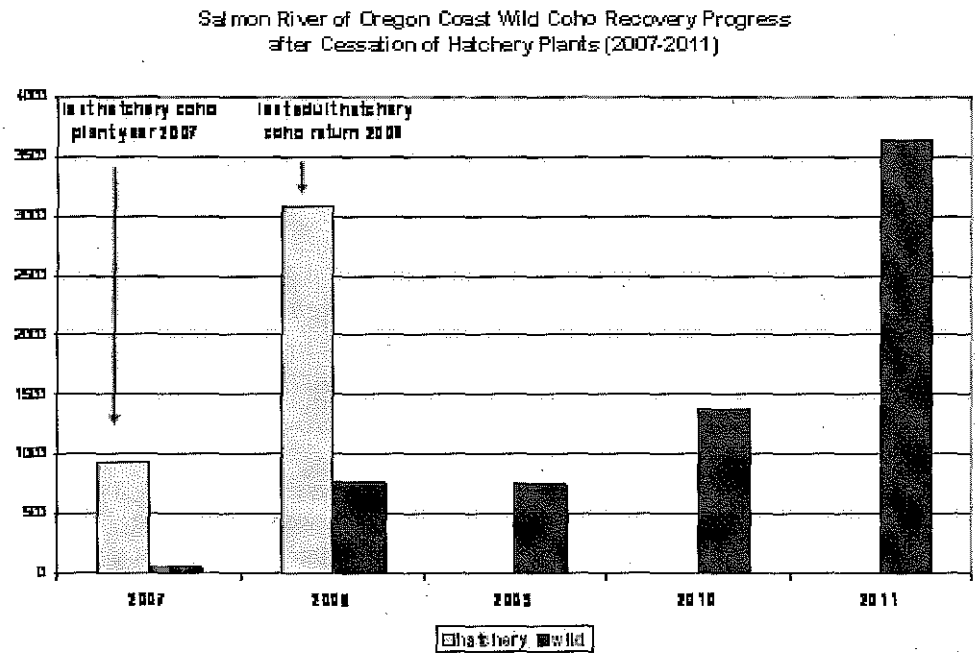
A growing and significant amount of evidence now demonstrates that the efficacy of salmon stocking in the majority of circumstances in Scotland (mainly for 'enhancement' of existing stocks) is at best largely ineffective, and at worst, can have a damaging effect on existing native populations, through removal of wild brood-stock, displacement of existing populations and reduced fitness and reproductive success of any progeny. Key impacts include removal of fish which would otherwise have spawned naturally, restocking eggs and fry in places where the adults would not have naturally spawned, and issues associated with the mixing up of different fish from different parts of a system which can dilute or change natural population structures.

The River Tweed in Scotland provides the example of how wild Atlantic salmon recovery has occurred there once stocking ceased in 1974 as displayed in a prominent graph depicting the time period of 1955-2008 (The Tweed Foundation unknown date-a) and the failure of a later stocking experiment (The Tweed Foundation unknown date-b).

Montana made the decision to eliminate hatchery stream plants of trout 40 years ago as a result of the findings of the reduced wild fish populations the plantings resulted in (Montana Outdoors 2004). It remains the one state in the United States that has managed by the findings of the science with management funding that has shifted to increased investments in habitat protection. This decision resulted in more and older trout after the hatchery stocking ceased and increased angling (Vincent 1980) and which has sustained to this day (Montana Outdoors 2004).

At the Salmon River of the Oregon Coast, a cessation of hatchery coho plants occurred in

Figure 1.



2008 with a positive response in wild coho returns that has also included investments in habitat restoration as well (Bottom and Jones 2010; Jones et al. 2013). Figure 1, depicts the Salmon River wild coho recovery trend based on the data from the Salmon River presentations. The wild coho at the Alsea River of the Oregon Coast, and more broadly the Oregon Coast as a whole, have shown considerable recovery progress with cessation (at Alsea) or otherwise great reductions (Oregon Coast) of hatchery coho plants since the late 1990s in Figures 1 and 2 (from Wilson 2012):

Figure 2 (from Wilson 2012).

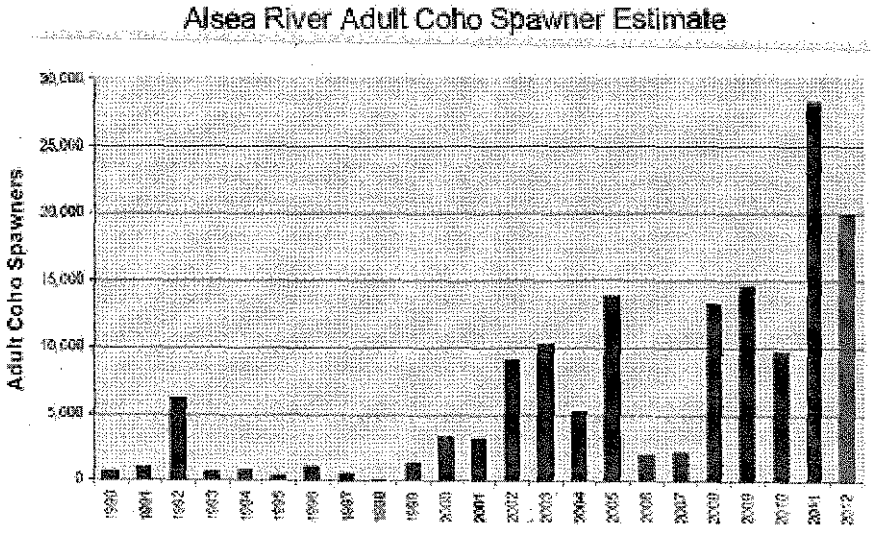
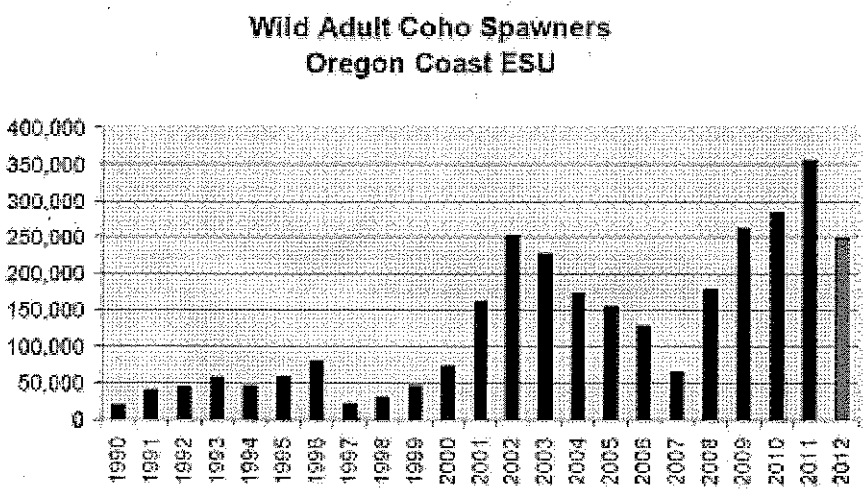


Figure 3 (from Wilson 2012).



Scotland, Montana, and Oregon provide clear evidence of the positive benefits that can occur for wild salmonids with elimination of hatchery plantings.

In British Columbia the recent steelhead management policy framework (MFLNR 2014) describes the great curtailment in hatchery programs and production there based on the following quote from the policy paper:

There are currently no known effective methods to rebuild depressed populations of wild steelhead other than reducing mortality (and in specific circumstances, restore habitat). Research in BC and elsewhere has shown that hatchery supplementation does not rebuild wild stocks, but it can be used to support a fishery at considerable financial cost. Research has also shown that hatchery stocking can reduce the productivity of wild steelhead populations, with the negative impacts increasing with the proportion of the total population that is of hatchery origin. Thus, hatchery augmentation should only be used in special circumstances where impacts on wild populations can be avoided and the expected societal benefits exceed the costs of the program.

The above policy paper is based on a prior science evaluation of wild and hatchery steelhead literature and other British Columbia evidence (Pollard 2013). The paper provides the following graph of the number of stream systems where steelhead hatchery plants have occurred over the historic time frame of 1902 to 2011 with great reductions from a peak of nearly 80 stream systems in the 1980s to what is now 12 (Pollard 2013):

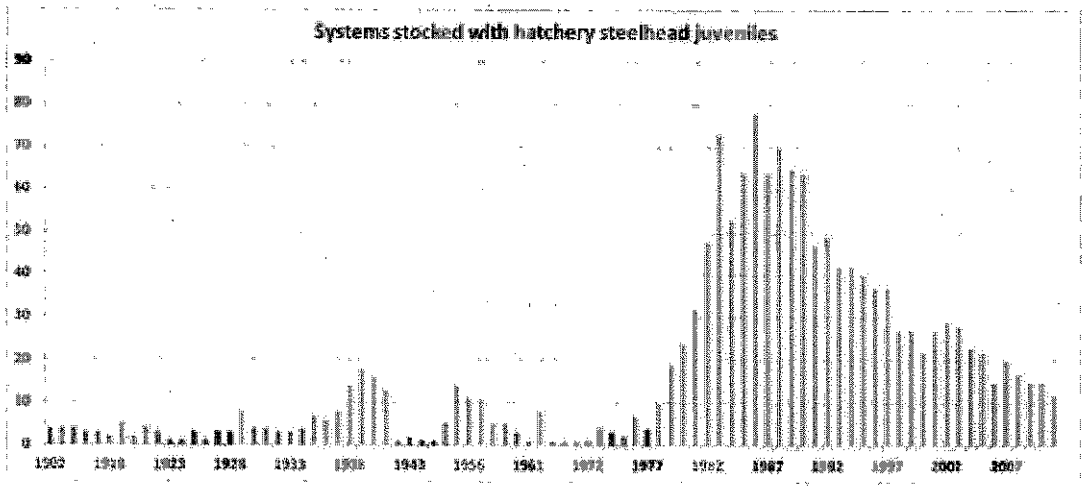


Figure 1. Numbers of waterbodies (almost all are streams) stocked with hatchery steelhead juveniles

The total hatchery steelhead releases throughout British Columbia now number 485,000.

Given the prior examples and available science over the past 35 years, Washington (and apparently NOAA) remains in the scientific backwaters of fishery planning that is long outdated and recently forced through legal processes to enter the modern era in the case of Puget Sound hatchery steelhead.

The purpose of my comments is to evaluate how well this great body of local, regional, and international science is being applied to actual management for wild salmon and steelhead recoveries in Puget Sound related to hatcheries in The DEIS, and what place hatcheries may have or may not have for actual realization of wild population recovery successes, particularly those driven by Endangered Species Act (ESA) listings.

In this regard, I have reviewed and fully endorse the comments to The DEIS by Wild Fish Conservancy. Please refer to those comments as similarly representing my own. I will not further repeat them other than to emphasize WFC's appropriate criticisms in pointing out the legal obligations of The DEIS and its many inadequacies to fulfill and/or address those obligations. My further comments follow.

Hatchery Programs Included in The DEIS:

133 hatchery salmon and steelhead programs (117 HGMPs) are evaluated in The DEIS that produce 146,997,000 hatchery juveniles released into Puget Sound. To put this into perspective, the U.S. Fish and Wildlife Service (USFWS) has enumerated all the hatchery fish produced by species from known sources in each state of the U.S. (Figures 5 and 6).

Figure 5.

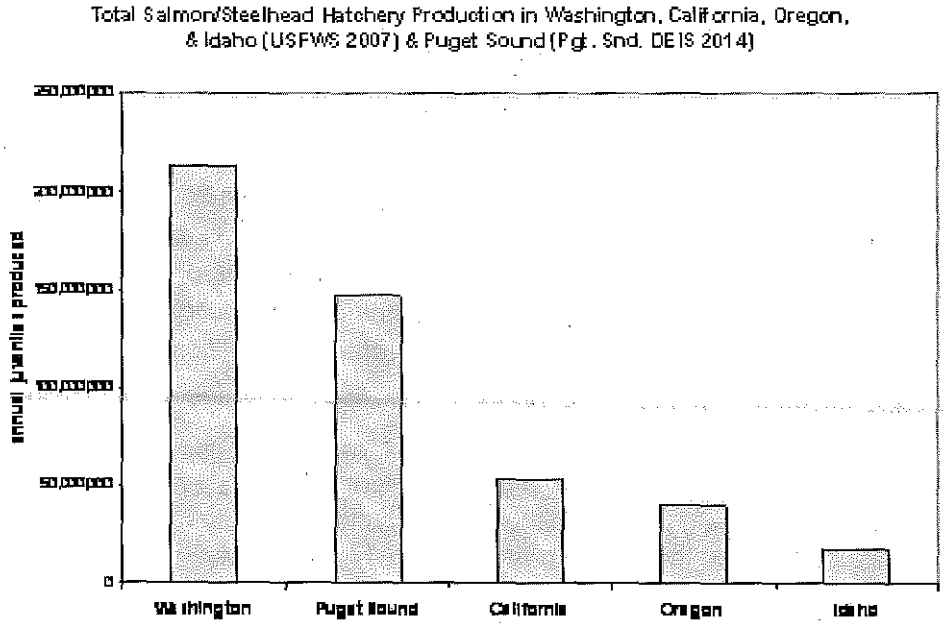
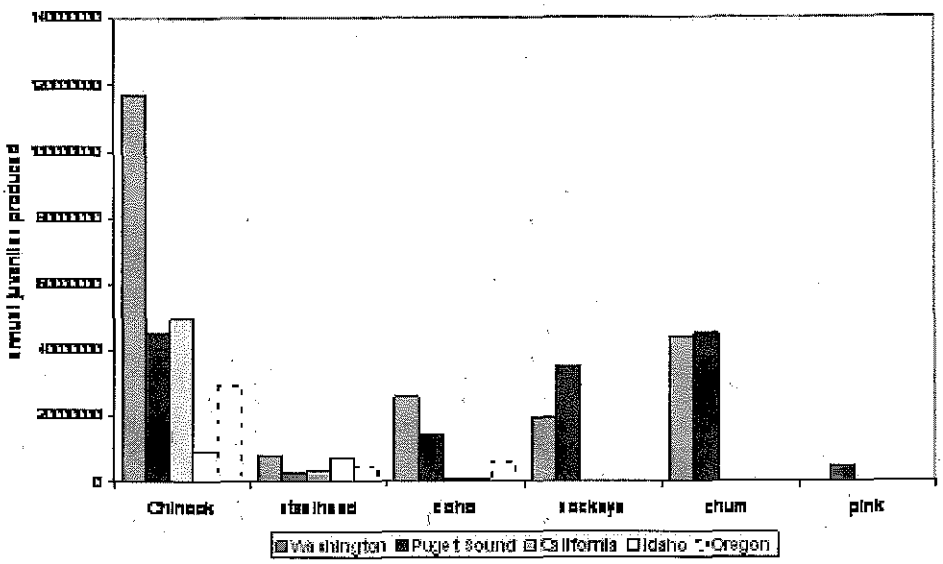


Figure 6.

Total Hatchery Production by Species in Washington, California, Idaho, & Oregon (USFWS 2007) & Puget Sound (Pug. Snd. Hatchery DEIS 2014)



The annual anadromous salmonid hatchery production listed for California is 53,620,901 (USFWS California 2007), for Idaho is 17,932,726 (USFWS Idaho 2007), for Oregon is 40,238,370 (USFWS Oregon 2007), and for Washington is 213,412,980 (USFWS Washington 2007). The Puget Sound proportion of the anadromous hatchery production is nearly 70% of that listed for the entire state of Washington. California's anadromous hatchery production is 36% that of Puget Sound alone; Idaho's is 12% of Puget Sound; and Oregon's is 27% of Puget Sound. The three other states combined hatchery production is 111,791,997 anadromous salmonids, 20% less than Puget Sound alone.

The DEIS describes the supposed need for Puget Sound hatcheries:

As the fish's natural habitat was degraded by human development and activities like dams, forest practices, and urbanization, the role of hatcheries shifted toward mitigation for lost natural production and reduced harvest opportunity.

Washington's hatchery production of anadromous salmonids as indicated by the USFWS (2007) is double that of California, Idaho, and Oregon combined, and that of Puget Sound's alone is significantly greater than those three states combined. Does it follow that the amount of Washington's anadromous fish habitat loss has been two times greater than the three other states combined, and that Puget Sound's amount of lost anadromous fish habitat has been 1.3 times greater than that of the three states combined? Not likely. Idaho's remaining anadromous fish returns have to go through eight Columbia/Snake dams, and large portions of former habitat in the Snake basin are now inaccessible due to dams. California's salmon and steelhead problems are noted for the large amounts of former habitat lost via dams and further compromised by water withdrawals below them.

Regarding remaining habitat quality, there has been little available to effectively analyze the actual amount of available habitat per species and per life history in Puget Sound and how well this habitat is being filled today by wild salmon and steelhead. However, in the case of the Skagit River the spawning area available for Chinook salmon was not found to be a limitation and had the remaining capacity to be used by 200,000 or more Chinook for spawning, yet current use of this habitat by Chinook did not reflect the amount and distribution available (Beechie et al. 2006). In the case of steelhead, some of the most pristine habitat areas available in the Skagit basin are in the upper Sauk and Cascade rivers, yet these same areas were particularly difficult to get sufficient adult wild winter steelhead sample sizes from for genetic analysis (Pflug et al. 2013). In the case of Skagit basin small tributaries in the 1978-1981 time period they supported 65-80% of the steelhead spawning in the basin with only 20-35% in the mainstems (Phillips et al. 1981-b). However, today recent spawning surveys have found that in several overlapping tributaries similarly surveyed in that earlier era that steelhead redds/km are now significantly fewer per kilometer despite the fact that wild steelhead escapement has been determined higher (McMillan 2015, the Summary provided as an attachment, a link to full report in the References, and the full report provided in its comments to The DEIS by WFC). Regarding these recent Mid Skagit Basin tributary surveys, it was found that 50-67% of the early spawning found in these tributaries was that of hatchery

steelhead, and the overall hatchery component of the steelhead spawning in these tributaries through the entire spawning season was 33-40%.

The combined evidence of these Skagit basin examples is that much habitat is not being as productively used as it should be by wild anadromous salmonids (Gayeski et al. 2011), and that hatchery fish may be resulting in this lack of productive use of available habitat. Wild steelhead productivity in habitat above a weir at Forks Creek of Washington significantly declined due to hatchery interactions and despite attempts to select hatchery fish out at the weir and by the false assumption that the hatchery stock used spawned earlier than wild steelhead (Seamons et al. 2012). This would also be the likely case of many habitat areas of Puget Sound based on the Skagit evidence and Forks Creek. The reasons for this could be multiply related to hatchery salmon and steelhead regarding both adult returns, juvenile rearing, and juvenile outmigrations. Regarding adult diminishment to the spawning grounds this can occur as a result of over-harvest in mixed stock fisheries and can include diminishment of some of the formerly productive life histories (such as return time and spawning time) and/or hatchery wild spawning interactions with reduced wild productivity. In the case of hatchery juvenile releases, it can result in density dependency factors (Ruff et al. 2013), increased predation of outmigrating wild salmonids when mixed with outmigrating hatchery salmonids (Thompson and Tufts 1967; Beamish et al. 1992; Nickelson 2003), precocious parr that are ready to spawn on release in the case of steelhead (Viola and Shuck 1995; Pearsons et al. 2003; McMillan et al. 2007).

Regarding hatcheries and supposed loss of harvest opportunity without them as assumed in The DEIS:

In the case of Puget Sound steelhead there is good evidence from the over 65 year history of harvest records dating to 1948 that harvest opportunity has not increased, but rather has diminished with hatchery winter steelhead plants dating to the modern hatchery program with adult returns from 1962 onward for the Skagit, Green/Duwamish, and Puyallup/White basins (McMillan 2012). There is also evidence in the same referenced report that wild winter steelhead populations without a similar history of hatchery winter steelhead plants can provide sustainable harvest opportunity and stable adult returns as found at the North Fork Umpqua River of Oregon. This is shown in by the contrasting figures or the Skagit and the North Fork Umpqua as provided in the following Appendix.

The DEIS further forewarns of the risks of hatchery fish to wild anadromous populations:

Hatchery production also presents risks to natural-origin salmon and steelhead. These include genetic risks from hatchery-origin fish to natural-origin fish as a result of poor broodstock and rearing practices, risks of competition with and predation on naturally spawned populations, and incidental harvest of natural-origin fish in fisheries targeting hatchery-origin fish.

If this is the case, and which a large body of scientific literature confirms, Puget Sound's wild salmon and steelhead populations are at 3 times greater risk from hatchery production than those in the entire state of California, 6 times greater risk than those of all of Idaho, and 4 times greater than those of all of Oregon.

Moreover, the list of risks described in The DEIS is incomplete. While predation is identified as problematic, particularly in freshwater, the predation described is limited to that of hatchery fish preying on wild juveniles that are smaller. However, this ignores the far greater problem posed by indirect predation which is that of the large numbers of predators (birds, aquatic mammals, and other wild and hatchery fish species) attracted by the releases of hatchery juveniles that have no past experience of predator avoidance as part of the domestication that occurs in the hatchery environment. Because wild anadromous outmigrations to the marine environment peak at about the same time as the hatchery outmigrations, they have to migrate through these increased predator populations. There is a discussion of this related to the Skagit River steelhead studies that included NOAA funding through the Saltonstal-Kennedy Grant (McMillan 2012):

The relationship of hatchery releases and predator attraction dates to at least 1967 when it was found that the diets of bull trout and northern pikeminnow shifted from relatively low numbers of wild sockeye juveniles to significantly higher levels dominated by hatchery juveniles at the time of releases of hatchery fish (Thompson and Tufts 1967). At the Big Qualicum River of Vancouver Island large numbers of spiny dogfish targeted the mouth of the river preying on the Chinook and coho smolt releases and also fed on the returning adults. It was concluded that the long-term decline in Chinook survival to the hatchery, and the similar decline of other hatchery produced salmon in the area was related to the dogfish predation (Beamish et al.

1992). On the Oregon Coast a detailed analysis was done to determine the mechanisms that were leading to declining coho productivity (Nickelson 2003). The primary cause was determined to be that of predators targeting large hatchery coho releases and subsequently wild coho mixed in with them with resulting high losses due to predation. Specifically for steelhead in the Salish Sea in a similar geographic area to the Skagit River, hatchery steelhead that had experienced declining productivity at the Seymour River resulted in the experiment of barging the hatchery steelhead smolts to a point well outside the estuary with significantly higher resulting survival (Balfry et al. 2011). One of the reasons considered for the higher survival of the barged smolts was that the estuary was where predators gathered (birds, fish, seals, etc.) and predation risk particularly high in the first few days of seawater exposure. Some other references on predation linked to hatchery fish include: Collis et al. 1995; Einum and Fleming 2006; Handelmann et al. 1996; Steward and Bjornn 1990.

In Norway it has been further found that hatchery releases of Atlantic salmon attracted their wild counterparts to migrate downstream in daylight with them exposing them to predation levels that would not have been as prevalent in the usual night migrations of wild smolts (Hansen and Jonsson 1985). Hillman and Mullan (1989) found that the release of hatchery Chinook salmon at the Wenatchee River caused juvenile wild Chinook salmon to similarly leave their normal habitat and join the school of hatchery fish that was migrating downstream. Once wild fish enter schools of hatchery fish it results in a "mixed stock fishery." This would be anticipated to occur whether migrating adult or juvenile salmonids, and whether the fishers be human, wildlife, or predatory fish species. It would be further anticipated that the wild component of the mixed hatchery/wild population would be reduced at a similar level as the hatchery component by this fishing effort. In the case of the juvenile hatchery releases, there would appear to be no means to alter this problem other than by reducing hatchery releases to minimal numbers that are dispersed over a lengthy release time, or eliminating them.

Steelhead Hatchery Programs Using Chambers Creek Origin Winter Steelhead as Supposed Isolated or Segregated from Wild Steelhead:

Wild salmon and steelhead life history diversity is often more complex than the genetic differences found. Despite the fact that many life history traits such as run-timing and spawn-timing are known to be inherited as known to occur in hatcheries (Crawford 1979) and in the wild (Kovach et al. 2013) the genetic analytical tools of present limitations may not pick up these important adaptive attributes in wild populations. As but one example of great changes in Western Washington steelhead populations, including those of Puget Sound, has been the great depletion of early run-timing of wild steelhead that was historically dominant as late as the 1950s (Larson and Ward 1954; Taylor 1979; McMillan 2008). The modern hatchery steelhead program dates to adult returns in 1962 of large and extensive Chambers Creek origin hatchery steelhead plants noted for early run-timing (Royal 1972; Crawford 1979) and subsequent depletions of wild early-return steelhead since (McMillan 2008). Early run-timing is one attribute that has been found to be occurring among multiple salmon species, trout, and char with climate change (Kovach et al. 2013) and can be anticipated to be an increasingly important adaptive attribute as indicated by the authors:

Regardless of process, these observations highlight the conservation value of preserving life history variation in the face of uncertainty

However, in the case of Washington's winter steelhead this attribute is being lost as was pointed out at the Pacific Coast Steelhead Managers Conference in 2008 (McMillan 2008). Variation in return time and spawning time also has important implications as a means of salmon and steelhead productively filling differing habitat characteristics (Lisi et al. 2013; McMillan 2015).

The spawning time of Chambers Creek origin hatchery steelhead as found in Mid Skagit Basin tributary streams is not isolated from that of wild steelhead (McMillan 2015). Five Mid Skagit Basin tributary streams were surveyed for spawning of salmon and steelhead over a five year period from 2010 to 2014. It was found that 53% of the spawning occurred prior to March 15th and 47% thereafter. From the active spawning participants observed, 33-40% of the total spawning was that of hatchery steelhead throughout the mid January to early June spawning period. Prior to March 15th the hatchery component of the observed spawning participants was 50-67%. Importantly, early spawning was particularly important at the three tributary streams with intermittent flows and one tributary with intermittent side channels. Early spawning was determined to be a necessity to get emergent fry out of the gravel in time to move upstream or downstream to perennial flows. It was these streams where hatchery and wild spawning interactions were primarily found and that the future will likely represent

increasing steelhead spawning tributaries that will be intermittent and require early spawning. The hatchery steelhead spawning in these same tributaries is likely significantly diminishing wild steelhead productivity in them as found at Forks Creek (Seamons et al. 2012).

The Failure of The DEIS to Provide a Range of Alternatives that Address the Hatchery Problem

Washington's continuing use of hatchery production to attempt to mitigate for habitat degradation and loss, rather than actually address what may be the habitat constraints on wild salmon and steelhead production, is particularly concerning in The DEIS's lack of proposed actions to move forward into the realm of modern science's findings. The DEIS only offers four alternatives. One of these, the Proposed Action Alternative merely replicates the same numbers of salmon and steelhead as the No Action Alternative with a continuation of 147 million hatchery fish produced. One, the Increased Production Alternative, would yet further increase the Puget Sound dependency on use of hatcheries for mitigation with 170 million hatchery fish produced, a 16% increase. The only consideration for reducing Puget Sound's dependency on hatcheries, and the associated risks to wild populations associated with hatchery production, is that of an 8% reduction in hatchery fish produced to 135 million. The latter remains 1.2 times greater hatchery salmon and steelhead production in Puget Sound than that of California, Idaho, and Oregon combined.

Sincerely,
Bill McMillan

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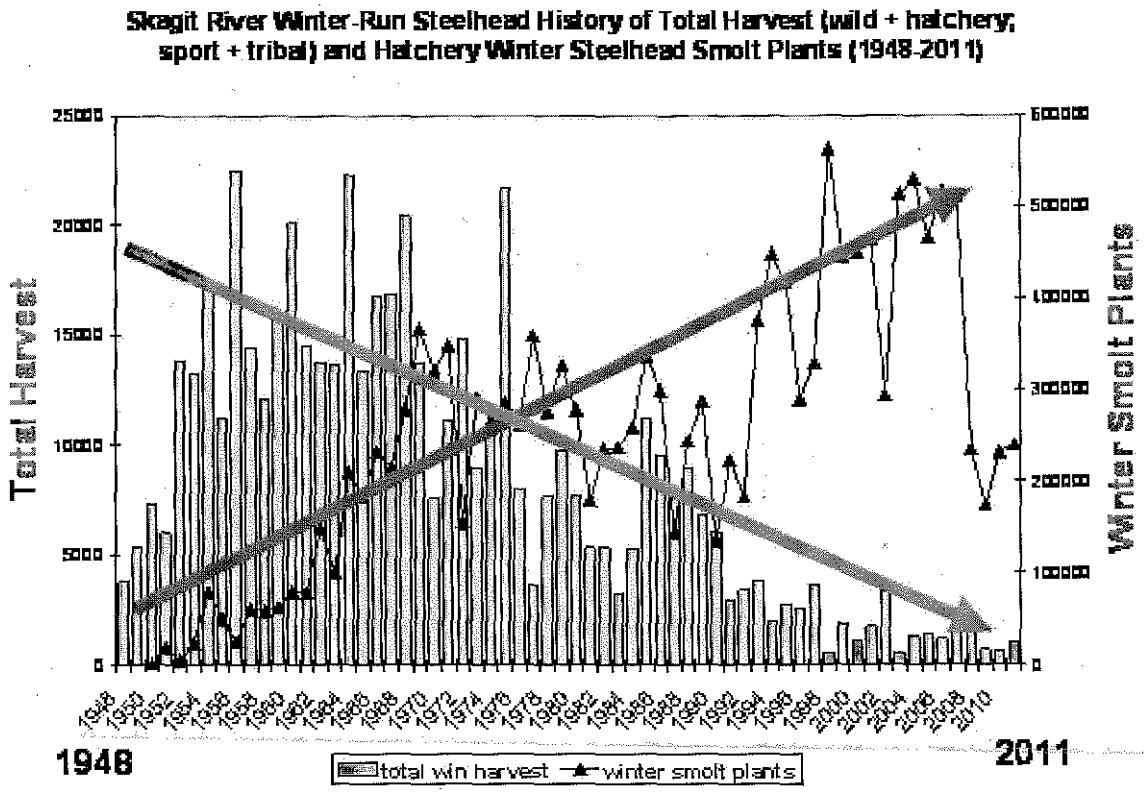
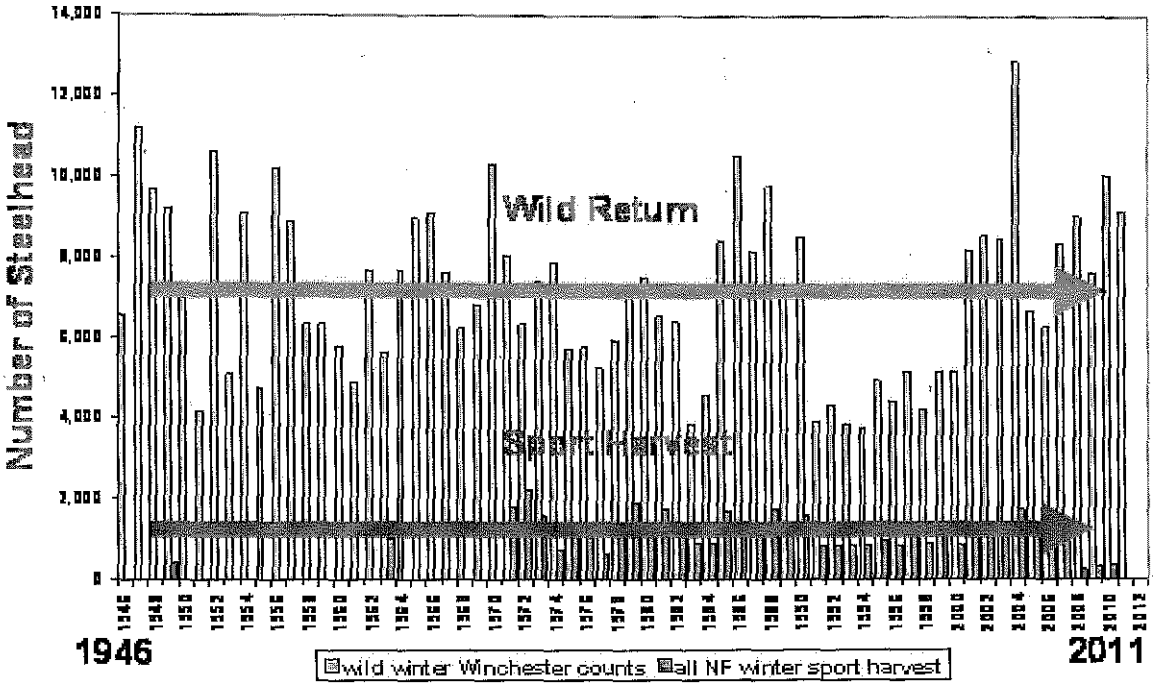
Appendix

Comparisons of Over 60 Years of Winter Steelhead Trends at Two NW Rivers



Skagit River steelhead harvests in 1951-60 averaged 15,000, nearly all wild. The 2001-10 combined harvests of wild and hatchery steelhead averaged 1,500. This loss coincides with a 1994-2007 average of 450,000 hatchery steelhead smolts planted annually in the Skagit — 6,235,000 total. At $1 per hatchery smolt, $6.23 million was spent in 14 years with resulting 90 percent loss of harvest once provided by wild steelhead 50 years ago.

North Umpqua River Wild Winter-Run Steelhead Returns Counted at Winchester Dam & Sport Harvest Without Winter Steelhead Hatchery Plants (1946-2011)



NF Umpqua River wild winter runs of steelhead without hatchery winter steelhead plants have remained stable for 64 years with a return average of 7,150 wild steelhead per year. Steelhead harvest has been similarly stable at 1,200 steelhead per year for 40 years. This record of sustainability has come at no public cost.

Summary_O.mykiss Reproductive Ecology Mid Skagit Tributaries_Final4_1-15-2015.docx
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The Reproductive Ecology of *Oncorhynchus mykiss* in Tributary Streams of the Mid Skagit River Basin

(A Final Summary with the full report still in Draft form)

A wild steelhead spawning pair at Dry Creek, an intermittent tributary of Finney Creek of the Mid Skagit River Basin

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(January 15, 2015)
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Summary

From October of 2009 to June of 2014 regular spawning surveys were independently and voluntarily made for personal fishery interests as a retired field biologist at five Mid Skagit basin tributary streams that support the spawning of the anadromous life history of *Oncorhynchus mykiss* (*O. mykiss*) commonly known as steelhead. The most intensive of these five years of surveys were those from October 2013 to June of 2014 with a total of 125 spawning surveys made at these five tributaries. Puget Sound Steelhead in Washington are listed under the Endangered Species Act (ESA) as Threatened, including those of the Skagit River basin. Several and perhaps all of the same tributaries also support resident *O. mykiss* populations commonly known as rainbow trout. All of the same tributaries also have spawning populations of coho salmon (*O. kisutch*) and pink salmon (*O. gorbuscha*) as well as coastal cutthroat trout (*O. clarki clarki*) of both anadromous and resident life histories. Four of the streams also have spawning chum salmon (*O. keta*) and three have spawning returns of ESA listed Chinook salmon (*O. tshawytscha*).

Winter steelhead spawning surveys in the Skagit basin by Washington Department of Fish and Wildlife (WDFW) have targeted an initiation time of March 15th in the supposition that is when wild steelhead begin to spawn. In fact, management of winter steelhead has been based on the belief that hatchery steelhead spawn prior to March 15th and wild after with little potential for spawning interactions between the two to occur. However, no recent history was found of steelhead spawning surveys that regularly occurred prior to March 15th from which to justify this conclusion in the Skagit basin. Historic evidence from the early 1900s indicates Skagit basin winter steelhead began to spawn by early February and Mid Skagit tributary entry for spawning began by January. On the Northwest Coast of Washington where spawning surveys were initiated in January by Washington Department of Natural Resources (WDNR) from 1973 to 1980, and similarly so during independent surveys by the Wild Salmon Center (WSC) from 1999 to 2003, it was found that wild winter steelhead spawning begins by early January. Other areas of the Pacific Northwest also exhibit early steelhead spawning. For instance, the State of Oregon's spawning survey protocol for coastal rivers is from mid-January through mid-May. In British Columbia wild winter steelhead spawning historically began as early as January on central Vancouver Island and in more recent history by January or February at least as far north as the Queen Charlotte Islands and Southeast Alaska.

The 2009-10 to 2013-14 spawning surveys at the five Mid Skagit tributaries were initiated with the first fall storms that stimulate the upstream migration of anadromous spawning runs. This was to insure that no steelhead spawning was missed and to determine what the overlaps between steelhead spawning time with other salmonids may be. Over the five years the earliest steelhead spawning redd found was January 16th and the latest June 6th. Coho salmon and steelhead were found to have slight overlapping spawning times some years but it was typically minimal. Sea-run and resident cutthroat were found to have significant spawning time overlaps with steelhead. Hatchery steelhead were included in the *O. mykiss* spawning population mix and steelhead mating (both wild and feral hatchery) included wild resident male life histories.

There were 104 total steelhead redds counted in the five years of Mid Skagit tributary surveys (Table 1). Almost half (49%) of the redds were found prior to March 15th, the assumed initiation date of wild steelhead spawning. Over half (53%) of the steelhead were estimated to have spawned prior to March 15th when redd sightings were adjusted for spawn timing (Figure 1). In the five years of surveys a total of 18 *O. mykiss* (14 steelhead, 2 male residents, and 2 undetermined male steelhead or residents) were observed at 7 active spawning redds between January and June (Table 2). The hatchery proportion of the steelhead in the spawning mix was 40%. If the wild male resident life history was included it decreased to 33% hatchery. Both wild and hatchery origin steelhead were found spawning in the early time period of January to mid March. The hatchery proportion of the steelhead spawning mix prior to March 15th was 67% (Table 3). If the wild male resident life history was included it decreased to 50% hatchery. Although no hatchery steelhead were found spawning after March 15th the unknown origin steelhead after that date were 20% of the total steelhead observed. Of particular concern, hatchery steelhead were found spawning to the maximum upstream anadromous extent of the smallest tributaries in the Mid Skagit basin.

The spawning time of steelhead was found to vary between tributaries. Over 50% of the spawning occurred prior to March 15th in three of the tributaries. The two other tributaries had 50% of the spawning occurring after March 15th. Air/water temperature, precipitation, streamflow, and intermittent or perennial hydrology were all examined as potential explanations for the spawn timing differences. Streamflow hydrology best explained the steelhead spawn timing differences. Specifically, whether a tributary's hydrology was intermittent or perennial was found to be a particularly probable driver regarding whether most steelhead spawned prior to March 15th or most thereafter (Figure 3). This was hypothesized to be due to the need for spawning to be early enough for significant numbers of emergent steelhead fry to move either downstream to perennial waters prior to late June to early July when intermittent flows began to disconnect these tributaries from larger downstream water bodies, or upstream if that option were available. Although intermittency is predicted to increase in northward expansion with climate change, and is sometimes perceived as a great limitation on steelhead reproductive success, there are examples of high steelhead productivity that occurs in intermittent streams and where gravel accumulations may actually provide better spawning habitat if steelhead life histories have effectively adapted with early spawning and emergence.

From the limited specific tributary water temperatures taken, the coldest stream had the latest steelhead spawn timing and the four warmer streams earlier. At the cumulative level of all five tributaries a highly significant correlation was found between average monthly air temperature and steelhead redds per month when adjusted to spawning date if 50-67% of the redds during the early spawning period were eliminated to better reflect wild steelhead spawning (Figure 2). Spawn timing also varied by year. In one tributary with significant spawners in 2010 and 2014 the warmer year (2010) had a month earlier spawning peak than the colder year (2014). Active spawning was found to most commonly occur shortly after a flow peak on a falling hydrograph at all tributaries and on cloudy days and/or at late afternoon to evening.

Underwater photographs found and confirmed that steelhead fry emergence occurred by late May at one of the intermittent tributaries and at another with side channels going intermittent by May. Steelhead fry were likely present dating to at least mid May but they could not be clearly identified in the photographs. It is important to note that photographs were not taken prior to mid May which might have captured even earlier emergence.

The one stream attribute identified that resulted in more intensive steelhead spawning was that of a well contained channel with least difference between wetted and bankfull widths (bankfull width/wetted width ratio) during the steelhead spawning period. This was found to be the case at the entire length of the one stream with the greatest steelhead redds/km, and at one particularly heavily used side channel of a stream that otherwise had a broad and actively moving mainstem channel.

Shifts in the monthly pattern of air temperatures and precipitation since 1909 (Tables 4 and 5) were examined as were relevant streamflows dating to 1928 (Table 6). Shifts are occurring that are particularly correlated with the steelhead spawning period of January to May. Air temperature trends include warmer air temperatures in January, less variable temperatures in February, and cooler temperatures in the remaining months. More precipitation now occurs in each of the months except February, as well as greater average streamflow, with the exception of February and May. Historically peak spring streamflow occurred in May, now peak spring streamflow occurs in March. Steelhead spawn timing must adapt to these climate related changes. It is important to note that the one month with least change is February. It may provide an important temporal point of climatic stability for steelhead spawning that has remained little changed the past 100 years.

For historic comparison, three of the five Mid Skagit tributaries regularly surveyed in 2014 were also surveyed in 1978-1981. The steelhead redds/km found in 2014 were 35%-78% of that in the earlier time period (Table 7). Mid Skagit tributaries are now apparently much less productive for wild steelhead than was the case about 35 years ago. This may not necessarily be explained by habitat loss and/or ocean conditions alone. It may be at least as significantly related to loss of steelhead life histories (such as early run-timing and/or early spawning) that can no longer fill formerly productive and widespread habitat that is increasingly left depleted or vacated. At that earlier time, the smaller tributaries were found to support 65-80% of all steelhead spawning in the Skagit basin despite an average escapement estimate of 5,700 wild steelhead, over 63% less than the preliminary escapement estimate of over 9,000 in 2014 (Table 8). If tributaries were at former productivity levels, presumably the 2014 wild steelhead return would have been greater than it was. Identifying and resolving the present limitations for tributary steelhead productivity in the Skagit basin may lead to considerable wild steelhead recovery progress.

The 67% of hatchery steelhead found spawning in Mid Skagit tributaries prior to March 15th was of particular concern that would be anticipated to be most problematic for wild *O. mykiss* populations (that include both anadromous and resident life histories) at tributaries typified by warmer winter flows and/or intermittent hydrology. Four of the five tributaries regularly surveyed had these characteristics. Regarding future genetic studies that may occur, it will be important to recognize the early period of time when steelhead spawning can occur in

Skagit basin tributary streams with subsequent early fry emergence. To indicatively represent the hatchery signal sampling should occur that includes the earliest fry stage prior to significant depletion through natural selection from early May to mid June. After that time increasingly high depletion of hatchery and hybrid fry whose life histories may well exclude effective movements from intermittent streams or stream sections would be anticipated. In general, hatchery heritage would be anticipated to result in increased fry/parr loss over time due to greater vulnerability to predation, or due to other factors that commonly limit hatchery related characteristics to survive as well as wild. The least effective time to find a hatchery genetic signal would be anticipated in juvenile sampling occurring from July onward, and least of all from returning adult steelhead.

These independent 2010-2014 Mid Skagit tributary surveys provide a baseline for the full period of steelhead spawning that has otherwise been lacking from which to monitor wild steelhead escapements, the hatchery component of the escapements, and how the steelhead spawning is variable in time and quantity by individual tributaries that have similarly variable characteristics that need to be understood. Recovery planning can be anticipated to be more effective if it is based on information that effectively represents the reproductive ecology of wild *O. mykiss* populations that include both anadromous and resident life histories. This can occur with further refinement of this spawning survey and reproductive evaluation template that includes habitat differences along with the differing adaptive life history strategies of the fish themselves.

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Tables and Figures
(below)

Tables 1-7:

Table 1. 2010-2014 Cumulative Mid Skagit Basin Tributary Steelhead Redd Counts by 7-8 Day Periods

Steelhead redd counts by period found
Steelhead redd counts adjusted to estimated spawning period

Date	Savage		Mill		O'Toole		Finney		Dry		Total	
Dec 24-31												
Jan 1-7												
Jan 8-15		1						1				**2**
Jan 16-23	3	2		2					1	2	**4**	**6**
Jan 24-31	1	3	6	4		1		3		4	**7**	**15**
Feb 1-7	1	3			1		3	2	2	2	**7**	**7**
Feb 8-15	4	2		1		1	6	4	5		**15**	**8**
Feb 16-23	4	2	4	3	1				1	1	**10**	**6**
Feb 24-29								1				**1**
Mar 1-7							3	1			**3**	**1**
Mar 8-15	2	2		3			1	2	2	2	**5**	**9**
Mar 16-23								2				**2**
Mar 24-31			4	1		2	1	4			**5**	**7**
Apr 1-7				1	2			2			**2**	**3**
Apr 8-15	1	1	1	3			11	5			**13**	**9**
Apr 16-23						1	1	1			**1**	**2**
Apr 24-30			3	3			2	1		1	**5**	**5**
May 1-7			1	1	1	2		4	1	1	**3**	**8**
May 8-15			3		2		7	6	5	4	**17**	**10**
May 16-23					1	1	5	1			**6**	**2**
May 24-31												
Jun 1-7												
Jun 8-15						1						**1**
Jun 16-23					1						**1**	
Jun 24-30												
Jul 1-7												
Total	**16**	**16**	**22**	**22**	**9**	**9**	**40**	**40**	**17**	**17**	**104**	**104**

Table 2. Life history, sex, and origin of live *O. mykiss* observed on redds occupied by female steelhead by tributary in the cumulative surveys of the Mid Skagit basin in 2010-2014 and in 2014 alone

2010-2014 data not used
2010-11 data used
2014 data used
2010-14 combined data used

Tributary	**Date**	**Wild sthd** ♀	**Wild sthd** ♂	**Hat sthd** ♀	**Hat sthd** ♂	**? sthd** ♂	**Wild resident *O. mykiss*** ♂
Finney Ck	3/4/2010	1				1	
Savage Ck	1/19/2011			1	1	2	
Dry Ck	1/16/2014			1			1
Dry Ck	2/19/2014	1				1	
Dry Ck	3/12/2014			1		1	1
Finney Ck	3/28/2014	1	1			1	
Dry Ck	5/12/2014	1	1				
2014 Total	**known origin sthd only**	**5 wild = 71%**		**2 hatchery = 29%**		**3**	**2**
	known sthd with resident	**7 wild = 78%**		**2 hatchery = 22%**		**3**	**2 res wild**
2010-14 Total	**known origin sthd only**	**6 wild = 60%**		**4 hatchery = 40%**		**6**	**2**
	known sthd with resident	**8 wild = 67%**		**4 hatchery = 33%**		**6**	**2 res wild**

Table 3. Steelhead/rainbow by wild, hatchery, or unknown origin of spawning mix prior to March 15th and after at five Mid Skagit tributaries in 2010-14 and 2014 alone

in 2014 with resident O. mykiss included
in 2014 without resident O. mykiss included
in 2010-14 with resident O. mykiss included
in 2010-14 without resident O. mykiss included

	Wild	**Hatchery**	**?**	**% Wild**	**% Hatchery**	**% ?**	**% Wild without ?**	**% Hatchery without ?**
Prior March 15th (2014)	3	2	2	42.86%	28.57%	28.57%	60%	40%
After March 15th (2014)	4	0	1	80%	0%	20%	100%	0%
Prior March 15th (2014)	1	2	2	20%	40%	40%	33%	67%
After March 15th (2014)	4	0	1	80%	0%	20%	100%	0%
Prior March 15th (2010-14)	4	4	5	30.75%	30.75%	38.50%	50%	50%
After March 15th (2010-14)	4	0	1	80%	0%	20%	100%	0%
Prior March 15th (2010-14)	2	4	5	18.18%	36.36%	45.45%	33%	67%
After March 15th (2010-14)	4	0	1	80%	0%	20%	100%	0%

Table 4.

Mean Monthly Precipitation (inches) at Concrete, WA of Mid Skagit Basin over Five Periods (1909 to 2014); the Range of Monthly Differences and if Mostly Positive, Negative, or Neutral; and the Precipitation Trend

Positive monthly mean precipitation increasing over time
Negative monthly mean precipitation decreasing over time
Neutral monthly mean precipitation remaining little changed or of undetermined trend over time

Time Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
1909-15	11.87*	5.72	4.18	3.30	3.10	2.08	1.23	1.75	3.97	7.39	13.01*	7.96	65.57
1931-55	8.40	6.78	6.62	4.09	2.92	2.63	1.39	1.36	3.39	6.79	8.80	10.49	63.66
1956-80	10.12	7.30	7.11	4.52	3.04	2.57	1.43	2.04	3.89	6.67	9.62	11.49	69.83
1981-2005	9.70	6.75	6.82	5.05	3.89	3.06	1.69	1.70	3.01	6.93	11.85	9.91	70.37
2006-14	11.66	6.23	8.79	5.36	3.69	2.64	1.21	1.35	3.44	6.43	12.08	9.10	71.97
Range Difference	±3.47 +3.26	±1.58	+4.61	+2.06	+0.97	±0.98	±0.48	±0.69	±0.96	-0.96	±4.21 +3.28	±3.53	+8.37
Trend	neutral higher	neutral	higher	higher	higher	neutral	neutral	neutral	neutral	lower	neutral higher	neutral	higher

* Excluding the 7-year period of 1909-15 for January and November results in a progressive increase in precipitation over time, but if that 7-year period is included it is a more neutral pattern of precipitation over time. The 7-year period may be too short to provide as good indication as the three 25-year periods of time from 1931 to 2005.

Table 5.

Mean Monthly Air Temperature (F) at Concrete, WA of Mid Skagit Basin over Five Periods (1909 to 2014); the Range of Monthly Differences and if Mostly Positive, Negative, or Neutral; and the Temperature Trend

Positive monthly mean temperatures increasing over time
Negative monthly mean temperatures decreasing over time
Neutral monthly mean temperatures remaining little changed or of undetermined trend over time

Time Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
1909-15	33.85	38.28	44.69	49.97	55.49	59.69	64.13	63.77	58.27	50.72*	40.80	36.48*	49.68*
1931-55	36.60	40.06	44.50	51.15	57.00	60.83	64.82	65.35	61.39	53.38	43.87	39.09	51.50
1956-80	35.85	40.56	43.31	49.06	55.75	60.58	64.76	64.35	60.04	52.09	43.00	38.24	50.63
1981-2005	38.26	40.23	44.59	49.16	54.74	59.37	63.65	64.78	59.84	51.67	43.04	37.65	50.58
2006-14	37.69	39.38	42.50	47.69	54.31	58.74	64.34	65.00	60.54	50.78	42.60	36.60	50.02
Range Difference	+4.41	±2.28	-2.19	-3.46	-2.69	-2.09	±1.17	±1.58	±3.12	±2.66 -2.6	±3.07	±2.61 -2.49	±1.82 -1.48
Trend	higher	neutral	lower	lower	lower	lower	neutral	neutral	neutral	neutral lower	neutral	neutral lower	neutral lower

* Excluding the 7-year period of 1909-15 for October, December, and the Annual Mean results in a progressive increase in air temperature over time in each of those columns, but if that 7-year period is included it is a more neutral pattern of precipitation over time. The 7-year period may be too short to provide as good indication as the three 25-year periods of time from 1931 to 2005.

Table 6.
Mean Monthly Streamflow (cfs) at North Fork Stillaguamish River as a Surrogate for Finney Creek During Four Periods from 1928 to 2014; the Range of Monthly Differences and if Mostly Positive, Negative, or Neutral; and the Streamflow Trend

Positive monthly mean streamflows increasing over time
Negative monthly mean streamflows decreasing over time
Neutral monthly mean streamflows remaining little changed or of undetermined trend over time

Time Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean
mean monthly flow 1928-52	2348	2132	2098	2154	2139	1637	775	389	583	1451	2223	2712	1720
mean monthly flow 1953-77	3249	2597	2127	2281	2382	1870	1045	566	840	1735	2934	3460	2090
mean monthly flow 1978-2002	2753	2644	2162	2216	2009	1504	809	431	596	1321	3085	2962	1875
mean monthly flow 2003-14	3425	1889	2685	2372	2220	1522	738	423	622	1726	3444	2663	1978
Range Difference	+1077	±755	+587	+218	±373	±366	±307	±177	±257	±414	+1221	±797	±370
Trend	higher	neutral	higher	higher	neutral	neutral	neutral	neutral	neutral	neutral	higher	neutral	neutral

Table 7. Steelhead redds/km in three Mid Skagit tributaries in 1978-1981 compared to 2014

Stream	redds/km 1978-1981	redds/km 2014	present % of former spawning
Finney Ck	11.9	5.7	48%
Mill Ck	5.0-6.8	2.4	35-48%
O'Toole Ck	10.3-22.2	8.0	36-78%

Table 8. Skagit basin wild steelhead spawning escapements 1978-1981 and 2014

Year	Wild steelhead escapement	Reference
1978	7294	Phillips et al. 1981b
1979	3943	Phillips et al. 1981b
1980	6009	Phillips et al. 1981b
1981	5435	Phillips et al. 1981b
2014	over 9000, as preliminary estimate still to be finalized	per. comm. Brett Barkdull, WDFW, Nov. 6, 2014

****

Figures 1-3:

Figure 1.

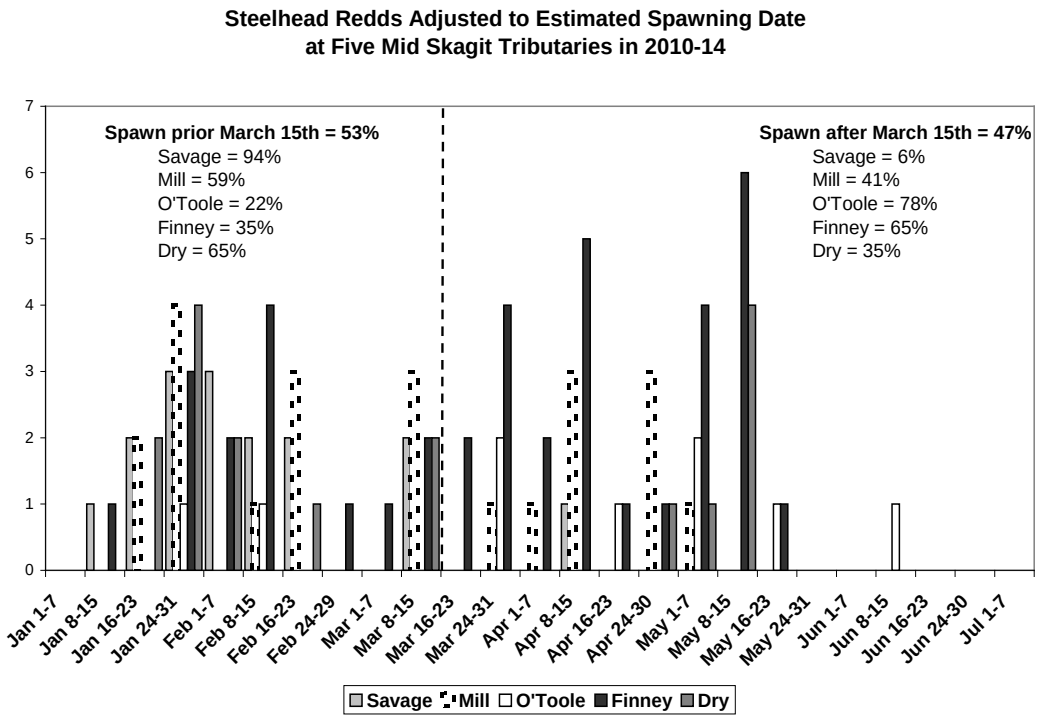


Figure 2.

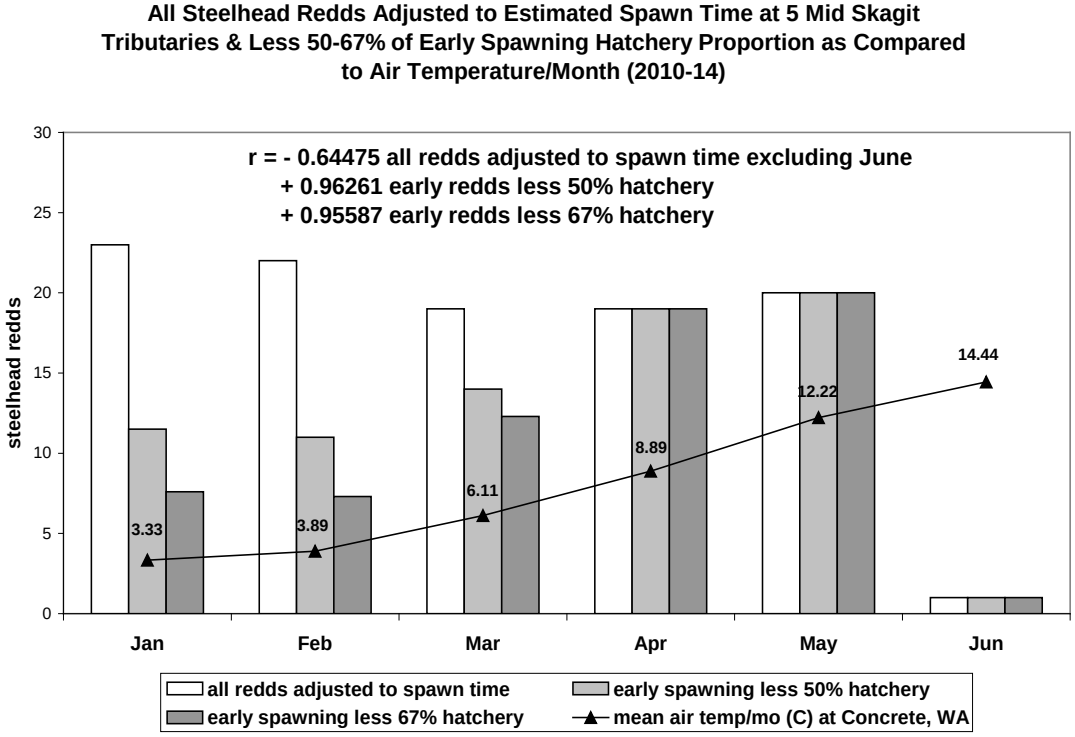
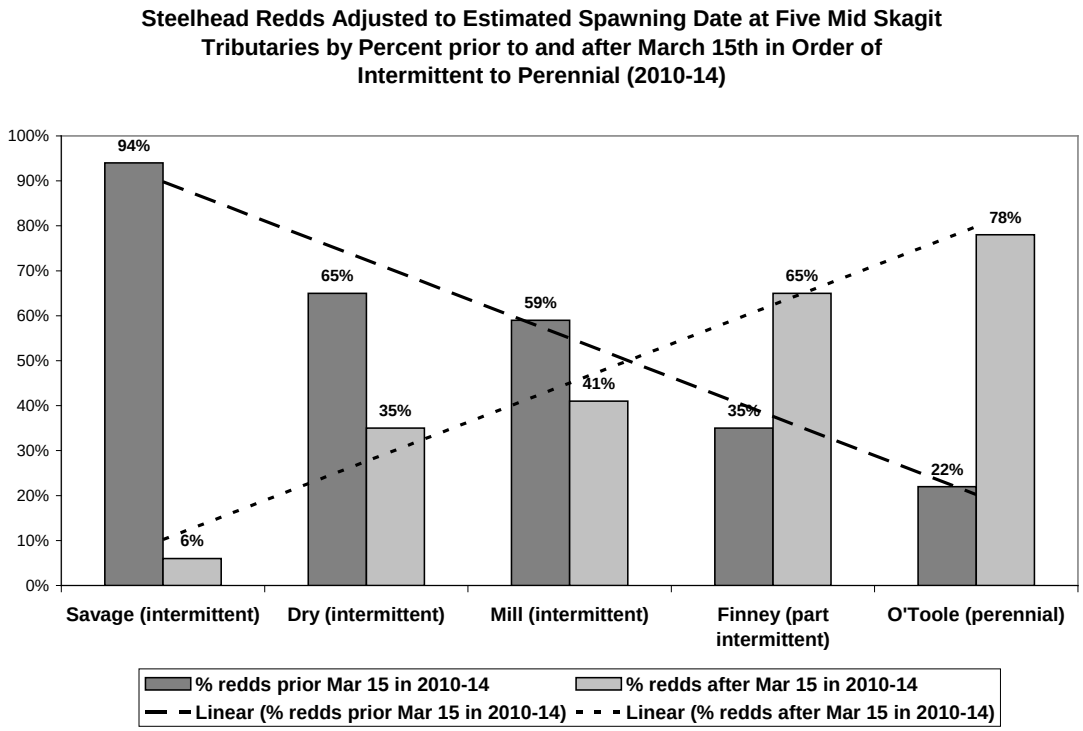


Figure 3.


Steelhead Redds Adjusted to Estimated Spawning Date at Five Mid Skagit Tributaries by Percent prior to and after March 15th in Order of Intermittent to Perennial (2010-14)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
94%
6%
65%
35%
59%
41%
35%
65%
22%
78%
Savage (intermittent)
Dry (intermittent)
Mill (intermittent)
Finney (part intermittent)
O'Toole (perennial)
% redds prior Mar 15 in 2010-14
% redds after Mar 15 in 2010-14
Linear (% redds prior Mar 15 in 2010-14)
Linear (% redds after Mar 15 in 2010-14)

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

decisions

1 message

Shirley Nelson <billandshirleyn@gmail.com> Sun, Sep 7, 2014 at 10:17 PM
To: PSHatcheryEis.wcr@noaa.gov

To NOAA

I would like to respond to the recent decision made to close the Skagit River to Steelhead fishing for the next 12 years.
I am a 71 year old fisherman who has lived in the Skagit Valley for 55 years. I have watched the fish population decline dramatically during that period. I think it's time for some common sense to be presented. Here are my thoughts.

1. I am pretty sure 95% of the people who catch fish don't care whether they are wild or hatchery raised. Seals, Eagles, First Nation, Fisherman, really only want to harvest what is available.

2. Salmon restoration is doing very little to boost returns. We are spending MILLIONS OF DOLLARS planting tree's, building larger culverts, limiting seasons, studying water quality and yet we let net fisherman harvest fish at the mouth's of the rivers with no accountability to anyone. Example 20 net fishing boats at the mouth of the Baker River at the height of the sockeye run this year.

3. The WASHINGTON STATE DEPARTMENT OF FISHERIES has turned into a HUGE LANDHOLDER OF PROPERTY along our rivers in the name of protection. From who?

4. I personally feel that the average fisherman has been SOLD OUT BY FISH AND WILDLIFE. It makes me sick to think that they did not get whatever study in on time to effect the closure of Steelhead Fishing on the Skagit.

5. I doubt that this will make any difference in your decision to know that thousands of us who have funded these programs will not have the opportunity to fish for Steelhead in our lifetimes in the Skagit River.We will get to sit in our boats and watch while gill nets are floated down the river catching EVERYTHING IN ITS PATH !!! THE NETS DON'T KNOW A NATIVE FROM A HATCHERY. OR A STEELHEAD FROM A SOCKEYE OR CHINOOK. The people grinding up the fish for dog and cat food could care less also.

6. To know that a portion of the grant money given to a group through a grant was used to SUE THE STATE. Which is ALL OF US. MAKES ME ABSOLUTELY SICK.

7. Fishing is a huge industry in this state and county. Don't close it off to all because a FEW PEOPLE think every fish has to be NATIVE. If you do you might find yourselves being funded by ONLY this group. Then there would not be money to give grants, buy land, do studies, grow tree's, buy concrete logs, or host PUBLIC WORKSHOPS.

8. Please keep in mind that you are working for ALL of us. Not just a chosen few.

9. Here is an idea on how to increase fish in all rivers. GO TO CANADA AND LEARN HOW TO MANAGE FISHERIES. LOOK AT THE FISH COUNTS IN THE FRAZIER RIVER. I

7. Keep the hatchery's open use current science to negate loss. Limit seasons in rivers for all fisherman to allow for higher returns. (if this means we have to subsidize the First American's with $ to allow this to happen then so be it). If we need a different gene line of Steelhead then introduce one. It appears the people in Idaho have a good gene pool to work from?

8. In conclusion : The Skagit River is one of the shortest rivers in the state. It would seem to me we should be

able to get a decent return of Steelhead without closing it to fishing for 12 years. Please find a better solution.

9. Thank you for allowing me to vent my feelings and hopefully help you to understand that the public CARES about this resource. We are paying you to make the right choices for all of us. Please Do.

Warm Regards

Bill Nelson
P.O.Box 714
Conway, Wa. 98238

11-17-14

To: NOAA FISHERIES DEPT.
RE: FUTURE POLICIES FOR SALMON/STEELHEAD MANAGEMENT IN PUGET SOUND REGION. PUBLIC COMMENTS.

TO WHOM IT MAY CONCERN,

I AM AN AVID SPORTFISHERMAN WHO MOVED TO SEATTLE 14 YEARS AGO, AND AM DISMAYED TO SEE SPORTFISHING OPPORTUNITIES STEADILY DIMINISH IN THE PUGET SOUND REGION.

HERE IS MY OVERVIEW ON THE CONTROVERSY OVER HATCHERIES VS WILD FISH:

IN THE LATE 1800'S AND THROUGOUT THE EARLY 1900'S SALMON AND STEELHEAD POPULATIONS WERE THOROUGHLY DECIMATED BY ALMOST UNLIMITED COMMERCIAL FISHING. AT THE SAME TIME, RIVERS AND STREAMS WERE DEGRADED BY ALMOST UNLIMITED LOGGING IN MOST WATERSHEDS. DAMS LACKING FISH LADDERS WERE ALSO BUILT ON MOST RIVERS, AND ARE STILL PRESENT TODAY.

AS A DIRECT RESULT OF, AND RESPONSE TO, DECLINING SALMON AND STEELHEAD

NUMBERS, HATCHERIES WERE DEVELOPED TO REPLACE FISH THAT WERE OVERHARVESTED AND ALMOST WIPED OUT. IN THE PAST 100+ YEARS HATCHERY FISH AND WILD FISH HAVE INTERMINGLED IN ALMOST ALL PUGET SOUND RIVERS. THEIR GENES HAVE ALMOST CERTAINLY MIXED DURING THAT TIME. THERE ARE PROBABLY NO PURE STRAIN WILD SALMON OR STEELHEAD IN ANY of THE RIVERS.

BECAUSE SPAWNING HABITAT HAS BEEN SO THOROUGHLY DEGRADED BY LOGGING, AND ACCESS TO ADDITIONAL SPAWNING AREAS CUT off BY DAMS (AND CULVERTS ON SMALL CREEKS) IT IS EXTREMELY UNLIKELY THAT WILD POPULATIONS WILL EVER RECOVER TO ANY-WHERE NEAR HISTORIC LEVELS.

WITHOUT AUGMENTING FISH POPULATIONS VIA THE USE of HATCHERIES, THE NUMBERS of SALMON AND STEELHEAD IN THE RIVERS of PUGET SOUND WOULD BE REDUCED TO TINY, RELICT POPULATIONS THAT WOULD NOT WITHSTAND HARVEST AT ANY LEVEL.

GIVEN THAT THE HUMAN POPULATION IN THE PUGET SOUND REGION IS CONTINUING TO RISE, THE PROBLEMS FACING THE ANADROMOUS FISH LIKELY INCREASES ALSO.

CLOSING SALMON AND STEELHEAD HATCHERIES WILL RESULT IN THE COMPLETE END OF SPORTFISHING IN THE PUGET SOUND REGION, WHICH IS TOTALLY UNACCEPTIBLE TO ME.

BETTER MANAGEMENT POLICIES FOR THE OPERATION OF HATCHERIES WOULD HELP MAINTAIN WHATEVER IS LEFT OF THE GENETIC INTEGRITY OF WILD STRAINS. USE OF IN-BASIN BROODSTOCK SHOULD BE PROMOTED OR MANDATED. MARKING OF HATCHERY FISH SHOULD CONTINUE, AND HARVEST OF HATCHERY FISH ENCOURAGED.

CLOSING THE HATCHERIES WILL NOT FIX ANYTHING. THE "WILD" SALMON AND STEELHEAD HAVE ALREADY HAD THEIR GENES COMPROMISED BY THE PRESENCE OF HATCHERY FISH FOR OVER 100 YEARS.

THE DAMS ON MOST RIVERS AREN'T GOING ANYWHERE. LOGGING CONTINUES TO DEGRADE SPAWNING SITES. INCREASING URBANIZATION WILL ONLY ADD TO THE DEGRADATION OF THE RIVERS IN THE FORM OF LEVEE CONSTRUCTION, POLLUTION, CHANNELIZATION, ETC.

I CHERISH THE OPPORTUNITY TO LIVE IN A DENSELY POPULATED METROPOLIS WHILE STILL BEING ABLE TO FISH FOR SALMON AND STEELHEAD. IF THE HATCHERIES ARE CLOSED DOWN, I WOULD PROBABLY GIVE UP FISHING AS A PASTIME, SOMETHING WHICH I'M NOT LOOKING FORWARD TO, AND SOMETHING THAT IS PROBABLY NOT EVEN NECESSARY.

THEREFORE, PLEASE ALLOW HATCHERIES TO CONTINUE OPERATING AND ENSURE THE FUTURE OF SPORTFISHING FOR SALMON AND STEELHEAD IN THE PUGET SOUND REGION.

RESPECTFULLY,

Michael O'Hagan

MICHAEL O'HAGAN

PH # 206-405-2869
email - mohagan33@gmail.com

MICHAEL O'HAGAN
315 MAYNARD AVE. S.
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NOAA - NMFS
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SEATTLE
West Coast Regional Office

NMFS NOAA WEST COAST REGION
7600 SAND POINT WAY NE
SEATTLE, WA
98115

Steve L.

98115634900

PSHatcheryEIS.wcr - NOAA Service Account <psHatcheryEIS.wcr@noaa.gov>

Hatcheries

1 message

Rod <elk@wavecable.com> Thu, Jul 17, 2014 at 7:23 AM
To: PSHatcheryEIS.wcr@noaa.gov

Gentlemen, if we have no large increases of hatcheries, population increase plus government mismanagement will cause the destruction of the fish. It is already a Judge Bolt total disaster!!!!!!!!!!!!!!!!!!!!!!!!!!

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

fish hatchery

1 message

Richard.Schubert <richard.schubert@comcast.net> Sat, Dec 20, 2014 at 2:32 PM
To: PShatcheryEIS.wcr@noaa.gov

In response to an article in the Reel News More time for hatchery talk I would like to add my voice in support of more hatchery fish in Puget Sound. Because of the lost habitat I do not see any way of bring sustainable fishery back to the Puget Sound area. As far as wild fish go we have used hatcheries for so long are there any real wild fish left? That seems to be a hard answer to get. In the past the fishery Dept. turn excess fish into the rivers to spawn naturally. In another article they are calling this last salmon season on the Columba one for the ages. That fishery is almost all hatchery fish isn't it? Concerned Puget Sound Fisherman.

I believe that we / sportsmen need more hatcheries in this state!

1.) LES SKYTA.
1095 ALDER AVE MSYL. WA. 98270

2) Del Klein
20900-66TH Ave Ne Arlington, WA 98223

3 ROSS S. EDDY 3520 98TH ST. N.E
MARYSVILLE, WA. 98270

4 Meaghan A Buser 9225 7th ST SE
Lake Stevens, WA 98258

WILLIAM S. BUSER
5 W S. BUSER 9225 7TH ST S.E.
LAKE STEVENS WA 98258

6. Aaron Kamp 14915 38TH DR SE EE-3017
BOTHELL WA 98012

7. Ramsey A. Rainwater 1036 Beach ave
Ramsey A. Rainwater Marysville, WA. 98270

8 Mike Lewis 5315 71st AVE NE
Marysville Wa. 98270

JASON FIERRE 6915 SILVANA TERRACE RD
STANWOOD WA 98292
Jason Fierre
Johnny Lum 20 South Sunrise B/d Camano Is. 98282
Mark Jones 3810 Sunnyside Blvd Marysville
Rich [illegible] 4917 121 PL NE MARYSVILLE WA 98271
Rodney Gaspar 9404 TULALIP SHORES RD MARYSVILLE WA 98271
Charles A. Olson 10519 3rd PL NE Lake Stevens 98258
DAVID LEWIS 21020 66th AVE NE ARLINGTON WA 98223
Gene Rossnagle Gene Rossnagle 5427 81 ST NE Marysville 98270
Wade Jackson
Walt 17107 West Lake Goodwin Rd 98292
Brian Alexander 5127 Sunnyside Blvd Msv WA 98270
Peter H. Schneider 1227 Short St Marysville WA 98270
Edward A. St. Onge Edward A. St. Onge 10426 41st Ave. NE Marysville 98271
Dennis Swartz Dennis Swartz P.O. Box 88
Everett
Mike Baker
Dennis Baker 1401 6th Marys Wash 98270
[illegible] 1222 Airport View DR. 98274
Tom Laughlin 3724 124th PL NE/msyl. WA

Please continue the hatchery programs in Washington

Thank You for your consideration in this matter & these folks signatures

Thank You.

MR. Les Skyte.

Can this action be put on a Ballot for a Vote → We need a Voice!

Mr. Les Skyta
1095 Alder Ave.
Marysville, WA 98270

Steve Leider

SEATTLE WA 980
21 NOV 2014 PM 6 L

NOAA - NMFS
RECEIVED
NOV 24 2014
SEATTLE
West Coast Regional Office

N.M.F.S. / NOAA West Coast Region
7600 SANDPOINT Way N.E.
Seattle, Washington
98115

98115634900

(no subject)

Inbox x

Christine Tashjian <cwnj237189@gmail.com> Tue, Sep 30, 2014 at 3:25 PM
To: PSHatcheryEIS.wcr@noaa.gov

Please protect our wildlife and landscape. They are very fragile.

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

(no subject)

1 message

Plans <plans@copysource.com> Tue, Jan 20, 2015 at 1:13 PM
To: PSHatcheryEIS.wcr@noaa.gov

S011000637_1501201305000.pdf
1288K

Jan. 20, 2015

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way
Seattle, WA 98115

Subject: Puget Sound Draft Environmental Statement

For 60 years my primary recreation has been dedicated to steelhead, most often recognized as the finest game fish in America. The rivers flowing into Puget Sound have always been a premium source for these fish and have provided millions of hours of fishing pleasure. It appears now that this fishery will disappear as an invaluable resource for the people of the State of Washington: long before another 60 years passes.

A management impasse will soon be reached by WDFW and NMFS/NOAA . NMFS advised WDFW that its management proposals on two Puget Sound Rivers do not meet criteria and rules established by the Hatchery Scientific Research Group (H.S.R.G.). These rules would mean no steelhead smolt releases from the Green River in 2015 and quite possibly none from the Snoqualmie. The apparent continuation of this problem from the 2014 dilemma which cost our State well over $1,000,000 and deprived anglers of thousands of hours of recreation and loss of supplier economic benefits is a sad commentary on the state of management of our salmonid resource.

Hatchery Reform was established by Congress as a "SCIENTIFIC" effort to solve hatchery management problems. However the HSRG charter as set forth by Congress does not require that science, solely, is the way to manage hatcheries. Yet all of the HSRG management requirements are based on scientific research only; even though the document which sets forth the criteria for management specifically states the science alone does not provide all the answers. The document states that "uncertainty is inevitable" in the HSRG scientific efforts. Other passages of the document provide similar confirmation. At the same time HSRG management is dictated solely by science.

This approach must be changed.

The unique experience of dedicated long time fishermen, with hands on experience and all other practical "non science" should most surely be taken into consideration in arriving at best hatchery management criteria.

The following are cases where HSRG requirements would preclude management practices which have worked very well. Many other cases also exist.

Examples:

On the Wynoochee, Solduc, and Satsop Rivers hatchery practices have provided excellent survival.

The Nisqually River, where after many years HSRG consistent management with no hatchery fish planted, there has been no improvement in recovery of wild fish.

The Pilchuck River, where hatcheries provided excellent fishing for both hatchery and wild fish for 100 years or more, up until the 1980's, when both wild and hatchery fish returns dropped precipitously.

Pollution of the Puget Sound Basin is without doubt the major reason for the failure of both hatchery and native fish in Puget Sound. As set forth above it is clearly not the introduction of hatchery fish that causes the problem. Yet, the HSRG can apparently take no action on this since it is not "hatchery science". We must reach understanding that HSRG work that applies to scientific decisions must be considered together with other successful forms of management.

It seems the paramount problem of HSRG is that it believes that Congressional regulations require that they employ science solutions only and that any other approach would jeopardize the validity and legality of the work of all of the dedicated, well intentioned HSRG employees.

It is incomprehensible that reasonable people can not come together to implement good hatchery regulations that work very well; like the foregoing examples. The HSRG should not be held to the requirement that all decisions must be based only on science. The WDFW should be allowed to formulate regulations utilizing science and all other pertinent experience affecting hatcheries.

Money spent on resolution of Puget Sound pollution problems would be far more effective than millions of dollars on ill-advised hatchery reform.

Without cooperation between all parties the situation will only get worse. There will be no fish and no fishing. It is hard to believe that the only way out of this will require Congressional action to correct the confusion which prevents logical action.

Yours very truly

Phil Tucker
360 220 7640

PShatcheryEIS wcr - NOAA Service Account <pshatcheryeis.wcr@noaa.gov>

Puget Sound Hatchery Proposal

1 message

Kelly Turner <qqqqkt@gmail.com> Wed, Nov 26, 2014 at 8:06 PM
To: "PSHatcheryEIS.wcr@noaa.gov" <PSHatcheryEIS.wcr@noaa.gov>

All hatcheries need to be phased out as soon as possible because hatchery stock are proven to be detrimental to wild fish. Resources need to be focused on supporting and rebuilding wild fish stocks.

Water Dragon

Reduce hatchery fish that impede wild recovery efforts

1 message

T Y <tunes2323@yahoo.com> Sun, Oct 5, 2014 at 9:57 AM
Reply-To: T Y <tunes2323@yahoo.com>
To: "PSHatcheryEIS.wcr@noaa.gov" <PSHatcheryEIS.wcr@noaa.gov>

If necessary, reduce catch numbers for tribal interests, sport and commercial takes to take some pressure off overall populations so they can rebound naturally and with less disease incidence.

Fish

1 message

Brian Waugh <waugh1979@gmail.com> Tue, Sep 30, 2014 at 9:04 PM
To: PSHatcheryEIS.wcr@noaa.gov

I want more opportunities to catch steelhead in puget sound. If that means shutting it down for a couple years to get a brood stock program going, so be it. Please dont bow down to the wfc extremists.

DAVID L. YAMASHITA
LAWYER
1303 SOUTH SECOND STREET
MOUNT VERNON, WASHINGTON 98273
TELEPHONE: (360) 336-3631
FAX: (360) 336-5274
E-MAIL: davidyamashita@frontier.com

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West Coast Regional Office

January 9, 2015

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

Re: Public Comments – Puget Sound Hatcheries Draft Environment Impact Statement (DEIS)

Dear Mr. Stelle:

Thank you for extending the time for the public to comment to January 23, 2015.

To give this "response" a measure of credibility I believe it would be appropriate to provide some background information. I also do this for the purpose of emphasizing the broad scope of the sports user groups I speak for.

I am 72 years old and have been an avid fisherman my whole life. I have been particularly avid about steelhead fishing since 1971.

I am a 43-year member of the Wildcat Steelhead Club of Sedro-Woolley. It is perhaps the largest "local" fishing club in the state and has had between four and five hundred members including some who live in distant locales and foreign countries. Many of our state and federal politicians are members.

I have been an enthusiastic advocate for sports fishing opportunities. My advocacy has included exchanging dialogue with our local tribal fisheries managers as well as working with WDFW personnel for nearly four decades.

I have been a guest speaker at meetings of several fishing clubs in this state, and in Wisconsin and Montana.

I have frequently participated in the annual North of Falcon process where the state and tribes set limits, quotas, and seasons for fisheries from the Canadian border into Oregon and Idaho.

I was appointed by former governor Booth Gardner to the first CITIZEN'S ADVISORY COMMITTEE in the late 80's. I served two terms, a total of six years. We worked directly with the director of the Department of Fish and Wildlife. We helped set state fisheries policies, most of which are still in effect.

I can state that I represent the interests of virtually all sports fishermen in the state with the exception of the few fly fishermen who side with WFC.

I happen to be a trial lawyer and am in my 44th year of practing law. Although I have not been involved in any litigation involving fish or wildlife, I certainly do have a good understanding of the legal process as well as some of the legal ramifications of what our retiring director's **capitulating settlement** with WFC could have in the future.

As an attorney, I can state with conviction that I am very familiar with the post-Boldt Decision agreements, including "joint management" policies, requirements and interpretations. One thing I am certain of is that Phil Anderson's "settlement" is a violation of the law set down by Judge Boldt, and a violation of "joint management" which we all know was and is a direct result thereof.

With the above background information I now submit the following comments:

COMMENTS:

It is extremely significant that NOAA take notice of the recent "verdict" in favor of the Steelhead Trout Club (STC) of Washington against WFC's appeal of the state's plans to invest 5 million dollars in improvements to the Tokul Creek Hatchery.

This is a clear "victory" for pro-hatchery fishermen **including the affected tribes**. This should be precedent setting for all state hatcheries and **justify vacating the WDSW/WFC settlement!**

NOAA needs to take notice that it must accelerate its permit process and all other processes that are necessary for our state to complete and finish enhancement projects. **NOAA's delays in part where a cause of WDSW's capitulation.**

One would anticipate there will be a number of lawsuits, probably filed in Federal Court, because there appears to be no doubt that Director Anderson's agreement subverts and, in fact, violates the spirit and rule set down by the Boldt Decision.

I trust you are aware that a number of treaty tribes have already expressed their great displeasure and accurately contend that hatchery fish are part of their treaty rights and cannot be abridged without their consent and/or participation in any process that would affect those rights. I believe any federal court judge would render a Summary Judgment, vacating any and all of the "agreement" based solely upon treaty rights. Our state lawfully committed to "Joint Management"; Anderson breached that by his unilateral capitulated agreement with WFC.

I am most anxious to see what the new WDFW director, our governor, the tribes and the legislature come up with in the near future to set aside the "agreement" which should be done ASAP. NOAA needs to work in that direction as well.

WHAT I BELIEVE CAN AND SHOULD HAPPEN:

Although the science is conflicting as to what harm any hatchery steelhead do if they interbreed with wild stock, that issue does not have to be part of any resolution for the next few years until there is a better consensus among fish biologists concerning that and related issues.

First of all, I have not seen or heard of any similar controversy concerning hatcheries that are intended to raise Chinook, Coho, chum or sockeye. There should be an emphasis placed on maintaining, improving and continuing the use of those facilities and perhaps even expanding them.

There is a reasonable and doable solution with regard to steelhead hatcheries. There are two good examples of hatchery programs that do not involve non-native stock such as Chambers Creek Steelhead which have been planted in Westside hatcheries for years.

One example of what appears to be an excellent steelhead hatchery program is that owned and operated by the Quinault Tribal Nation on the Olympic Peninsula. They use the wild native fish as their hatchery stock. The results speak for themselves.

Perhaps an even better example is the steelhead hatchery on the Clearwater River east of Lewiston, Idaho. It is the largest steelhead hatchery in the United States, if not the world. It has been in operation for approximately 50 years with great success. Significantly, it is funded by the state, the Feds and the Local Tribe.

Their program involves using native fish as hatchery stock. The fish that return are "summer run" and start arriving in mid-summer and are caught into March of the following spring. I am not exactly certain how that hatchery manages to "spread out" the harvest opportunities for such a long time frame (six to eight months) but I believe part of that is well planned "timing". I know they get fish returning to the hatchery in late summer and well into the following year. I also understand they incubate and raise the juvenile fish to smolt size as the adults return. They subsequently release the smolt in well planned and timed frequency. In other words, they have successfully "spread out" their return for harvest over a substantial time frame. They do not need early return "Chambers Creek" brood stock!

If we had a vibrant, wild fish hatchery program in western Washington rivers, such as the Skagit, it would not be difficult to emulate the Idaho program, particularly with the cooperation of both sports and tribal interests.

I can recall catching native steelhead before Thanksgiving and well into December and January even after we had our hatcheries.

I believe, with any luck, we can still find early returning native steelhead and with the cooperation of sports and tribal users, those fish can be used a brood stock in addition to those we know will return in March, April and May. Tubing and trapping early fish can work.

IMMEDIATE REOPENING AND IMPLEMENTATION OF STEELHEAD HATCHERY PROGRAMS AS ANOTHER OPTION:

I realize the state has already released far too many steelhead smolt into lakes rather than into rivers they normally would have, had the "settlement" not occurred, but I believe the programs can be "reclaimed" starting next year and the expected normal return of the fish that were lost due to the settlement could be "recovered" from other sources.

I cannot believe former Director Anderson would agree to settle with WBC based on conflicting science.

We need to **set aside** the unlawful agreement, reinstitute and enhance the steelhead hatchery programs (with better broodstock, e.g. Quinault, Skamania) and force WFC to try to win in court. They have the **burden of proof.** I don't think they can meet it.

In the meantime, every stream/river that has a native steelhead return, such as the Skagit, can and should immediately start a brood stock program with native fish using sportsmen and tribal resources to catch, tube and raise brood stock as has been done in years past. The existing facilities on the Skagit River can be easily restored to acceptable standards. On the Skagit, those native steelhead start returning in relative abundance as early as mid-January and can be harvested throughout late winter and even into mid-June. There was a very successful brood stock program in the '80s conducted by the state and the Wildcat Steelhead Club on the Skagit River. The work of capture, rearing of the adult fish to spawning, nurturing the eggs to hatching plus the juvenile fish to release was mostly done with volunteer labor. In other words, the cost to the state was very nominal. I am not totally aware of how many other rivers have significant native steelhead populations, but any rivers that do can certainly implement similar programs. There would be absolutely no shortage of low-cost volunteer help.

Currently those returning fish are considered "endangered" so no user groups are legally authorized to harvest them, although our local tribes do catch some incidentally when harvesting some Chinook. Just as bad, some non-tribal fishermen have also caught some steelhead above Rockport when harvesting Chinook, which has angered both Indian and non-Indian interests. If my suggestion is implemented, I believe a lot of those issues can and would disappear because it would clearly show that we are trying to enhance the resource so there would be future abundance for all user groups. In other words, we would have a viable steelhead hatchery program using wild steelhead for brood stock. As I have pointed out, I believe some of those fish, if harvested as early as February, will produce offspring that can and would return earlier.

CAVEAT:

Many of us have extended our Coho fishing on the Skagit River well into December. In years past, many of us have caught what we believe to be early native steelhead in November and December when fishing for Coho. It would not be difficult to tether them if we knew we could have a facility available (Barnaby Slough?) to bring them and biologists could identify them and if they were indeed native, could use them as brood stock. Almost all of the fishermen who, like me, fish for the late silvers are quite knowledgeable and would enthusiastically participate in such a program if it were implemented.

There are many potential solutions!

Rather than simply complain, we also need to come up with viable answers.

CONCLUSION:

The "agreement" needs to be set aside (immediately), vacated, or otherwise determined to be unlawful since it is clearly in violation of the terms, conditions and spirit of the Boldt decision and its sequelae.

We need to get some type of agreed program endorsed by the courts and perhaps even mandated that would expedite the type of hatchery programs that would not only benefit all of the user groups but can address the issues WFC raises concerning interbreeding.

COSTS:

Unfortunately, I do not have all of the answers concerning costs. I do believe, however, that our treaty tribes have sufficient funds to substantially support the planning and implementation of the appropriate and necessary programs. I believe the State of Washington will be able to generate sufficient funds by the standard means including license sales since the sports fishing community will be far more inclined to purchase licenses if they know they can have a reasonable opportunity to harvest fish. One would think federal funds should also be available. Aren't we just as important as Idaho?

Respectfully submitted,

DAVID L. YAMASHITA

Cc: Dick Cook
Randy Parker
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Don Collen, Wildcat Steelhead Club
Upper Skagit Fisheries Manager
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January 13, 2015

William W. Stelle, Jr.
Regional Administrator
NMFS West Coast Region
7600 Sand Point Way NE
Seattle, WA 98115

Re: Public Comment - Puget Sound Hatcheries Draft Environment Impact Statement (DEIS)
Specifically Skagit River Hatchery Program

Dear Mr. Stelle:

The purpose of this second letter/comment is to focus specifically on the Skagit River because the "settlement" between the State of Washington and WFC impacted the Skagit far more substantially than any other river system.

The hatchery program on the Skagit River should be immediately reinstituted, which would obviously require vacating former commissioner Anderson's settlement with WFC.

I hope to elaborate more in this letter than I did in my previous one (dated January 9, 2015), and to also provide additional suggestions.

As most everyone is aware, the science concerning impact of hatchery fish on native fish is debatable. The history on the Skagit River strongly suggests the arguments submitted by WFC are without merit. The hatchery program has been in place since the 50's and even though the brood stock (Chambers Creek) was a poor choice (at least in my opinion), most everyone I have communicated with, including biologists, do not believe those fish have negatively impacted the native steelhead.

The native return has been extraordinarily robust well into the 80's even after more than 30 years of hatchery operation. I can verify that we caught an abundance of native steelhead well into April in the mid to late 80's, even after the state implemented the "catch and release" program in 1984 and did not end it for several years thereafter. My friends and I experienced extraordinarily good fishing well through the next 20 years, thereafter.

Even after sports harvest of native steelhead was terminated, we were still allowed to catch and release steelhead on the "reopener" on Memorial Day weekend and more recently on June 1st. I trust you are aware that the Skagit opens for Chinook above Rockport on June 1st every year and below Rockport for catch and release of all fish. Many of us, myself included, will fish above Rockport from the crack of dawn for up to three or four hours and then fish below

Rockport for the rest of the day and release all fish we catch. There have been a number of days (the first two or three days of June) when we have caught several native steelhead (comebackers or spawners) which certainly validate my claim that the native return of wild steelhead is reasonably healthy.

This is somewhat remarkable because our tribes have been harvesting Chinook and "incidentally" harvesting wild steelhead every spring for as long as we can remember.

My point is, there appears to be absolutely no evidence that the hatchery steelhead that have been returning to the Skagit in late winter or early spring have had any negative impact whatsoever against or to the wild steelhead. The tribes have consistently argued that the only reason there have been a reduction of wild steelhead is the degradation of the habitat (inappropriate logging practices and development) as well as nontribal interception or harvest. Nontribal interests have blamed habitat degradation and tribal netting, both illegal and state sanctioned, due to an inappropriate application of "joint management". Regardless, no one has blamed hatchery steelhead except WFC.

Even if there is a significant reduction of returning wild steelhead, the cause is certainly not the fault of hatchery steelhead interbreeding with them. If the parties involved would agree to implement my suggested programs to enhance the wild steelhead population and likewise reinstitute a robust and vigorous hatchery program, most of the problems that are currently existing would not only be addressed but all user groups would be highly motivated to give more than lip service to solving the problems.

BROOD STOCK:

I certainly admit I am not as knowledgeable about choosing brood stock as I would like to be. There are dozens of hatchery programs in the state of Washington, both along our coast and in Puget Sound. Likewise, there are hundreds of steelhead hatcheries nationwide including very successful hatcheries in the great lakes, which I believe use Skamania steelhead stock which I understand originated in the Northwest.

I get the feeling that the State of Washington has been guilty of wearing "blinders" and arrogantly refuses to seek advice from anyone else when developing programs.

This seems to be true in virtually all of the state agencies regardless of what they are assigned to manage, whether it be highways, ferries, any form of land management or fisheries. I believe it is time we have a director, and a governor, who is far more open-minded and less arrogant who would be willing to hire people who are open-minded and willing to explore and expand their horizons. I have little doubt we can find solutions for the issues that have plagued our fish and wildlife department for the past several decades.

It is astonishing that our leadership within the Department of Fisheries lacks vision and/or the ability to look beyond the end of their nose. If biologists within the Department have not been able to come up with solutions, perhaps the new director needs to look beyond those in the Department and reach out to biologists in other jurisdictions. Perhaps we need to look to new blood at the university level or in other states. In seems to me that part of the problem is there

is a great lack of vision and unwillingness to seek solutions but rather to apply old and outdated policies that have been mediocre at best.

The governor needs to select a director that is not chosen based upon cronyism but based upon that person's vision and open-mindedness and willingness to put the resource first.

Respectfully submitted,

David L. Yamashita

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