COMMENTS REGARDING THE PUBLIC REVIEW DRAFT OF
Oncorhynchus mykiss: Assessment of Washington State's Anadromous Populations and Programs; Washington Department of Fish and Wildlife, July 2006

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Introduction

Washington Trout appreciates the opportunity to respond to the Washington Department of Fish and Wildlife's request for comments regarding the public review draft of *Oncorhynchus mykiss:* Assessment of Washington State's Anadromous Populations and Programs. Washington Trout analysts and advocates have read and discussed the public review draft, many of its references, and other supporting literature. Please accept for the record and your consideration Washington Trout's review, including our recommendation for some significant revision.

Washington Trout represents approximately 2000 members in the region. Many use and enjoy rivers, streams, and nearshore saltwater-bodies throughout the Puget Sound, Washington coast, and Columbia River basins for recreational, scientific, aesthetic, and commercial purposes, deriving benefits from robust wild-steelhead populations and healthy aquatic and marine habitats. Many Washington Trout members take an active role in the conservation and recovery of Washington's steelhead and their habitats. Washington Trout conducts recovery related research on wild-fish populations and habitats, advocates for scientifically and legally responsible wild-fish management, and develops habitat-conservation initiatives. We keep our members informed of these activities through regular electronic and printed communication. Public and tribal agencies, scientific institutions, the business community, the conservation community, and the news media have all recognized Washington Trout's credibility in wild-fish ecology and its specific experience in issues associated with steelhead conservation in Washington.

Washington Trout has previously responded to invitations from WDFW to participate in review-processes related to *O. mykiss* management-proposals, including: WDFW's Wild Salmonid Policy; Hatchery and Genetic Management Plans prepared by WDFW for steelhead hatchery programs in Puget Sound and the Columbia River Basin (Gayeski and Vanden Brulle, 2003), and; WDFW Sportfishing Rules Proposals. Washington Trout has submitted information to NOAA Fisheries regarding: NOAA's hatchery listing policy (Gayeski and Vanden Brulle, 2004) and; Critical Habitat Designations for listed populations of steelhead and salmon (Gayeski, 2005B). In June 2005, Washington Trout submitted and presented information to the Puget Sound BRT (Gayeski, 2005A), regarding the extinction risk for the PS steelhead DPS. Most recently, WT prepared and

submitted comments regarding NOAA Fisheries' proposal to list the PS steelhead DPS as a threatened species under the Endangered Species Act (Washington Trout, 2006). Information prepared and submitted by Washington Trout in the reviews cited above relates to the assessment of anadromous *O. mykiss* populations, as well as *O. mykiss* programs being managed or proposed by WDFW. We in some places summarize but do not repeat those comments here in detail, but instead heereby incorporate all relevant parts by reference.

In that context, Washington Trout generally supports WDFW's initiative to develop comprehensive and coordinated steelhead-management plans for Washington state. A thorough and current scientific assessment of Washington steelhead populations and programs will form an important foundation for those management plans. We acknowledge and appreciate the effort undertaken to prepare this public review draft, and we appreciate the inclusion of the public and its advocates in the development process. We encourage WDFW to continue the development of new steelhead-management paradigms, founded on sound science, with the highest priority on the recovery and conservation of declining, threatened, and endangered wild populations.

The public review draft includes valuable information and frank insight regarding the status of Washington's wild-steelhead resource, some sources of its decline, and current threats to its conservation and recovery. The impacts and risks of various management programs are in some places frankly discussed. However, Washington Trout is concerned about several significant weaknesses in the public review draft.

Washington Trout agrees with other reviewers that WDFW's assessment of the current status of many populations suffers from an inadequate and inaccurate historical perspective, leading it to underestimate the historical abundance, diversity, and spatial structure of some populations, and the potential current capacity of some populations and habitats. These deficiencies will lead the Department to underestimate appropriate abundance and diversity targets required to recover many of Washington's wild steelhead population. We also agree with some other reviewers that the public review draft is uneven in tone and substance, that it sometimes allows long-held, internal management assumptions and objectives to influence assessments and findings that should more appropriately be based on scientifically objective evidence and procedure, and; that it omits and ignores some available scientific recommendations. We agree with reviewers who encourage WDFW to seek extensive peer-review of the public review draft by a qualified, independent scientific review panel. (*See comments from:* Bill McMillan; Native Fish Society; Wild Salmon Center; Wild Steelhead Coalition; Sam Wright.)

WDFW's management mandate gives it limited opportunity to regulate land-use and even water-use practices on landscape and even relatively local scales. WDFW will have only limited influence on the direction, scope, and pace of ecosystem recovery and land/water-use reform necessary to recover and conserve steelhead populations in Washington. Of course WDFW still must exercise its enormous responsibility to manage the recovery and conservation of steelhead. It must begin by acknowledging and managing *for* the ecological conditions that exist and can be reasonably expected to

obtain over different time scales, not trying to manage for internal priorities *around* changing conditions it can not control, and by recognizing and acknowledging that the department's essential role in the recovery and conservation of wild-steelhead ecosystems is to preserve intact the actual animal (populations and individuals) central to the sustainable function of those systems.

Specifically, WDFW must manage its hatchery and harvest programs so they do not jeopardize or defer the recovery and conservation of declining, threatened, and endangered steelhead populations. The quality of the science guiding actions in these central areas of WDFW's management mandate will have the most impact on the success of WDFW's essential role in steelhead recovery and conservation. Because of it's significant importance, our experience and history with WDFW regarding the issues discussed, and our confidence in some other reviewers' analyses of the Biology, Management, Diversity, Abundance, and other sections of the public review draft, Washington Trout will focus the substance of these comments on its review of Chapter 3 in the public review draft, "Artificial Production."

While Chapter 3 includes valuable information and frank acknowledgements regarding some of the risks and impacts imposed by hatchery practices, WDFW's analyses of artificial production is largely incomplete and unconvincing. WDFW fails to acknowledge fundamental management failures that should be included in an evaluation of the potential risks and benefits of artificial production. The assessment is dominated by biased assumptions and unsupported assertions. Finally, available scientific information, findings, and recommendations that would tend to undermine WDFW's analysis and apparent management priorities are all but ignored.

Specific Comments

Chapter 3: Artificial Production

Chapter 3 includes valuable information. We are encouraged by frank and some new acknowledgements regarding the risks and impacts of past and current hatchery practices. However, it occurs to us that WDFW fails to close some important circles in its analyses of the potential ecological and genetic impacts of artificial production, failing to acknowledge or evaluate in any meaningful way the scientific and management implications of the fact that many of the riskiest conditions associated with artificial production have indeed obtained in the overwhelming majority of steelhead hatchery programs in Washington for a significant and dangerous period of time.

Tone and language throughout the chapter sometimes suggests a bias in favor of artificial production (of course specific management priorities may have legitimate influence in the final development of a management plan, but a fundamental scientific assessment is not an appropriate place to begin down that slope). Some assumptions employed by WDFW rely on assertions that have never been satisfactorily supported.

WDFW relies on supporting information and independent scientific recommendations that appear to some degree to have been cherry picked to support findings more compatible with status quo management. Specifically, the federally appointed

Independent Science Advisory Board and Salmon Recovery Science Review Panel have published findings and recommendations that tend to undermine some findings in Chapter 3 and potentially require more significant management changes than WDFW appears to contemplate (ISAB, 2003; RSRP 2003); those published reports are all but unmentioned in Chapter 3, and none of the specific findings, concerns, or recommendations of the ISAB or RSRP are identified or addressed in any way. This is a significant and troubling omission. The ISAB 2003 *Supplementation Review* was executed in response to specific queries from NOOA Fisheries to assist in recovery management of ESA-listed salmon and steelhead populations in the Columbia Basin. The RSRP was convened by NOAA Fisheries specifically to advise the agency on scientific matters of salmonid-recovery management. Their findings and recommendations carry significant credibility and authority; WDFW has a responsibility to include those findings and recommendations in its assessment of steelhead artificial production in Washington, and to address how/why it will or will not incorporate them into it's own management-science paradigm.

Key Questions and Introduction

An essential bias in favor of artificial production is suggested or at least encouraged from the very beginning of Chapter 3. The first of four "Key Questions" the chapter proposes to address is worded, "what are the potential benefits of artificial production programs?" A more objective and appropriate question in view of the available evidence should be, *are there any* potential benefits from artificial production? Given the preponderance of evidence and the historical performance of WDFW steelhead hatchery programs, the answer to that question is not self-evidently yes. The Introduction acknowledges that the nine million steelhead juveniles released in 2000 represents a four-fold increase over a forty-year period. It is hard to imagine who might argue that the health of Washington's steelhead resource or even steelhead fishing opportunities have improved since 1960.

The introduction continues the suggestion of bias when it proposes an evaluation of the economic and conservation "benefits" of artificial production and the "potential" risks it "may" pose to declining wild populations. Again it is fallacious and inappropriate to suggest that conservation and economic benefits have been established as fact and that the risks of artificial production may only be "potential."

The rhetoric of "risk assessment" is employed all too loosely in this Chapter and throughout the public review draft. The proper approach to risk assessment is succinctly described by Daniel Goodman in a contribution to a recent American Fisheries Society symposium on the risks of artificial production:

> Quantitative risk assessment consists in determining the array of possible outcomes of a contemplated action, and then associating with each outcome a measure of the net cost (or benefit) of its occurrence and a calculation of the probability that it will occur. The *risk*, then, is the sum of the products of net cost times the probability, over the exhaustive list of possible outcomes. (Goodman, D.

> 2004 "Salmon supplementation: demography, evolution, and risk assessment". Am. Fish. Soc. Symp. 44: 217-232.)

Goodman goes on to describe what is required to provide a risk assessment of the trade-offs between wild population fitness and harvest objectives that are involved when supplementation (or integrated hatchery production) is considered as a possible tool for attaining the dual objectives of insuring wild population health and providing harvest:

> Evidently, a non-emergency justification for supplementation would rest on a policy mandate which gave high enough priority *both* to harvest goals and to conservation goals so that the quantitative trade-off between the two might decide the balance. In order to complete the risk assessment in such a context, the policy mandate would need to state explicitly the quantitative weights for valuing harvest relative to natural spawning fitness of the supplemented stock (ibid.).

Explicit statements of the quantitative weights to be assigned to wild-population fitness and to harvest objects -- which are still for all intents and purposes the fundamental drivers of hatchery production -- should be one of the principle goals of any credible Steelhead Management Plan. Only clear policy-mandated weights can underpin a *bone fide* quantitative risk assessment. The wild steelhead resource is ill-served by loose talk of risk assessment that disguises the absence (for whatever reasons) of clear policy mandates and associated quantitative standards that alone can inform decisions regarding the critical trade-offs involved when such dual objectives are at issue.

These rhetorical constructions are concerning for at least two reasons. They appear to set a tone that continues through Chapter three, and they are the first of several instances where WDFW's failure to acknowledge and address ISAB and RSRP findings appears to compromise WDFW's analyses of artificial production. In 2003 the ISAB found that no conservation benefit has been established for *any* hatchery program, that no hatchery programs are even monitoring for the correct parameters or with scientifically credible procedures to adequately establish any conservation benefit, that at least some artificial-production programs "*almost certainly* impose a large cost on the affected natural populations" (emphasis added), and that scientific theory and evidence "clearly" indicate that even conservation or "supplementation" (or integrated) hatcheries pose "substantial risks" to wild populations. The ISAB found that, "even after many years of conducting various supplementation 'experiments', *the question still remains*, is supplementation an effective strategy to avoid extinction or assist recovery?" (Emphasis added.)

WDFW would be on more objective and scientifically firmer ground to speak about the "potential" benefits and "established" risks of artificial production.

Section 3.2.1 Program Types and Benefits

Washington Trout finds WDFW's economic analysis of steelhead hatchery-program benefits unconvincing, self serving, and scientifically incomplete. In establishing the economic activity provided by the steelhead hatchery program in Washington, WDFW fails to incorporate various public costs of the state steelhead fishery (road maintenance,

traffic, air and water pollution, property damage, etc). Costs attributed to the hatchery program appear to only cover primary production and facility maintenance; It is unclear whether WDFW acknowledges ongoing research costs or the costs of managing the fishery itself. Moreover, as noted above, such putative benefits are at best only one side of the risk assessment coin in the over-riding context of developing (or helping to lay the groundwork for) a management policy to secure the preservation and recovery of Washington's wild steelhead populations.

When evaluating the state-wide economic impact of the steelhead fishery, WDFW should acknowledge and address how much of the economic activity attributable to the steelhead fishery is redistributable among other currently ongoing recreational activities that might not carry the ecological costs of providing steelhead-angling opportunity through artificial production. Finally, the analysis does not appear to evaluate the value of the current hatchery-fueled fishery relative to previous fisheries provided by a mostly wild-fish resource, or the value of the current hatchery fishery relative to the lost value represented by the severe decline in wild-steelhead populations in Washington. For instance, the loss of wild steelhead abundance in Washington may be robbing it of significant tourism income that may not be replaceable with a hatchery fishery.

WDFW's initial description of its two basic types of hatchery programs, isolated or integrated (or recovery/conservation and harvest), while acknowledging the essential risks of isolated programs, fails to acknowledge in a meaningful way the implications of WDFW's significant failure to effectively segregate hatchery and wild steelhead populations, an essential operational goal and risk-management measure of isolated hatchery programs. WDFW's initial and subsequent descriptions and explanations of integrated programs are rather over optimistic and irreconcilable with ISAB and RSRP findings. For instance, in describing conservation-hatchery programs for upper Columbia River steelhead, WDFW cites a NOAA Fisheries Biological Opinion supporting the program as boosting population abundance, while "maintaining or increasing" genetic diversity. A biological opinion is a management process, not a scientific review, and the findings implied by the reference are at significant odds with the ISAB's independent, more credible and authoritative review.

Section 3.2.2 Survival Rates of hatchery Fish
This discussion is generally complete. However, we are concerned that WDFW's encouraging description of the potential benefits of NATURES and Semi-natural rearing techniques may be premature. Some of the studies cited appear to show little effect, and other experiments have failed to yield particularly successful results. See the Yakima River spring-chinook supplementation program. The findings regarding the low and crashing survival rates for Puget Sound hatchery steelhead are alarming. The Puget Sound program appears to be neither working nor paying. This is a good example of WDFW's failure to close a circle and examine the scientific implications of actual conditions relative to its hatchery programs. If the Puget Sound program is not providing adequate "benefit," then the calculation of its relative risks, and the weight of it's impacts on wild populations should be reconsidered.

Section 3.3 Genetic Effects on Natural Populations
The discussion s on genetic impacts are generally thorough. However, in several instances, WDFW again fails to relate specific conditions obtained in its hatchery program to its analyses of hatchery risks and impacts. For instance, in the discussion on outbreeding depression, WDFW acknowledges the conclusion of a NOAA-sponsored panel on the impacts of hatchery straying that, "significant losses might occur" at gene-flow rates under 5%. The discussion fails to acknowledge that WFW's complete failure to effectively segregate hatchery and wild steelhead has likely resulted in gene-flow rates considerably higher than 5%.

The discussion of the genetic risks of isolated programs is by and large frank. We appreciate WDFW's acknowledgement of the complete domestication of Chambers Creek and Skamania hatchery stocks, and the management failure associated with its reliance on these stocks. However, we are concerned over the assertion that the risks to wild populations from domestication are dependent on (implying that they can be ameliorated by) the level of domestication and non-locality in the hatchery stock, and on the level of gene flow. The ISAB and RSRP have concluded that hatchery proponents have not provided enough credible information to make informed judgments about relative risks or their potential for amelioration. We are not convinced that information is available to make a determination on which if any level of gene flow is "safe" relative to other levels.

In an attempt to illustrate the connection between hatchery straying and gene flow, WDFW employs a model that demonstrates how a stray rate of 15% (20 hatchery-origin spawners among 150 natural-origin spawners) results in a gene-flow rate of 6.4%, significantly higher than the "recommended" 5%. However, WDFW again fails to close the circle and relate its analysis to the reality of its hatchery program. It is extremely likely that the rate of hatchery-origin recruits spawning in the wild exceeds 15% by a considerable margin in many watersheds. Beyond ignoring this reality, WDFW immediately notes how gene flow can be minimized in a "well run isolated program," without acknowledging that these "well run" conditions are not obtained anywhere within the overall steelhead hatchery program. The discussion acknowledges that when gene flow rates exceed the "selection coefficient" (thought to be low), the "immigrant" genetic material will replace the native material, and that it does not take much gene flow to replace undomesticated, native genetic material with domesticated material. But again, WDFW fails to acknowledge that this condition has already likely obtained throughout most if not all steelhead hatchery programs. A frank acknowledgement and discussion of these issues should at least inform any evaluation of the actual likelihood of developing a "well run" program capable of effectively minimizing the risks of artificial production.

The discussion on the genetic risks of integrated programs is dominated by biased assumptions, unsupported assertions, a reliance on too few sources, and outright wishful thinking. The discussion is introduced with the statement that integrated programs, "avoid the ecological and genetic risks… for isolated programs." This assertion is unsupported by available evidence and is contrary to ISAB findings. Among other relevant findings, the ISAB concluded in 2003:

- For hatchery programs where the hatchery and natural population are integrated, the empirical basis is inadequate for determining the cost to the natural population.
- Supplementation [integrated] programs carry the risk of causing decreases in the genetic variation present within their target populations, which can lead to inbreeding depression.
- Supplementation [integrated] programs carry the risk of homogenizing previously distinct gene pools, thereby causing a decrease in the genetic variation among salmon populations.
- Supplementation can result in decreased fitness of the target population.
- Current monitoring and evaluation efforts are inadequate to estimate either benefit or harm from ongoing supplementation projects. The correct parameters are not being consistently measured.
- Columbia River Basin supplementation projects are considered to be "experimental". Unfortunately, inadequate replication and widespread failure to include unsupplemented reference streams coupled with a lack of coordination among projects make it unlikely that these projects (as currently conducted) will provide convincing quantification of the benefits or harm attributable to supplementation.
- Many hypotheses and conjectures concerning supplementation are largely unevaluated.

The ISAB findings make clear that WDFW's assertions regarding the potential benefits and reduced risks of integrated hatchery programs are at best premature, likely over optimistic, and at worst disingenuous.

In its discussion on the genetic risks of integrated programs, WDFW focuses on the relative fitness of the hatchery and natural components of the integrated, "composite" population. The discussion appears to ignore some fundamental considerations. By using integrated breeding to improve the fitness of the hatchery component relative to the natural (target) component of the composite population, the fitness of the target wild population will likely be depressed relative to its condition pre supplementation. In other words, as the hatchery and wild populations become more similar, fitness of the hatchery population may improve, but the fitness of the wild population will likely decline. Rather than the hatchery population simply becoming more like the wild population, they are likely to become more like each other. As WDFW acknowledges, its analysis deals only with relative, not overall fitness. The fitness of the hatchery and wild components of the integrated population relative to each other is irrelevant compared to the overall fitness of the population relative to the original unsupplemented population. The significant danger, unacknowledged in WDFW's assessment, is that the "new" composite population is likely to become reliant on the hatchery environment, unable to sustain itself without continual anthropogenic intervention.

The genetic resources germane to the ecological and genetic diversity of a species are the resources directly related to the fitness of individuals within populations over multiple generations. Measures of genetic relatedness between populations or stocks of fish and

genetic markers that are used to measure or to estimate gene flow between individuals and populations are rarely related to the fitness of individuals and populations. Estimates of the amount of gene flow between an indigenous naturally spawning salmonid population and a hatchery population, for example, provide no direct information about either the fitness of the natural population or the impact of the genetic exchange with the hatchery population on the fitness of the indigenous population (See, for example, the discussion of introgression between subgroups within major ancestral lineages in Utter 2001).

Directional selection for adaptation to the hatchery environment and to the life cycle of which hatchery production is a systemic component is widely acknowledged to be an inevitable result of hatchery programs.(Waples 1999, Reisenbichler and Rubin 1999, Goodman 2005). The fact that a hatchery population was founded from members of the local indigenous population and regularly incorporates progeny of natural spawning members of that population as hatchery broodstock therefore provides no assurance that reproductive interactions in the wild between hatchery and naturally spawned fish do not have harmful impacts on the fitness of the local naturally spawning population. Such a hatchery population would be a Category 1a in the lexicon of the SSHAG 2003 report. Category 1a hatchery populations and local wild populations can be identical at loci of neutral markers used to measure gene flow and to characterize genetic "similarity," yet be divergent in characters relevant to fitness in the wild. Both theoretical genetic considerations (O'Hely and Lynch 2001, Ford, 2002, Goodman 2005) and empirical data (Reisenbichler and McIntyre 1977, Resienbichler and Rubin 1999, Utter 2001, Waples 1999, Chilcote, 2003,) attest to this. Selectively neutral genetic markers will provide evidence only of gene flow, not fitness impacts.

A claim about the fitness of a hatchery fish relative to members of the wild population from which it was derived, is likely to be true only for the progeny of first-generation hatchery fish in a captive broodstock program. Such a statement would have to be silent with regard to the ability of such hatchery fish to contribute to the recovery of the wild population from which they had been directly derived in the immediate past, particularly if the hatchery is to remain a regular component of the life cycle of the fish.

The assertion that genetic impacts in hatchery and wild components of an integrated populations can be controlled through regulated gene flow misleadingly implies that neutral markers providing evidence of significant gene flow between hatchery and local wild populations or that show genetic similarity between hatchery and local wild fish also provide evidence that the fitness of the hatchery fish in the wild is identical or similar to fish in the wild population. That implication is false. WDFW should take great care to explain in considerably greater detail what is intended by such assertions and should cite the specific scientific literature that supports them.

WDFW fails to adequately address that it lacks the capability to accurately determine the relative value of the genetic resources related to fitness that may be available in integrated hatchery/wild populations. The findings of the ISAB support the conclusion that WDFW has no current scientific basis for determining the fitness of hatchery salmon

relative to wild salmon, or for evaluating any beneficial impacts to wild populations from genetic interactions with hatchery populations. WDFW has no foundation for any claim that the genetic resources available in hatchery populations offer any potential value to the recovery, conservation, or sustainability of naturally spawning wild steelhead populations, particularly in the face of overwhelming scientific evidence of the ecological and genetic risks hatchery steelhead pose to wild populations, and the poor procedures and performance of existing programs documented in the ISAB review.

Of the eight principal Findings presented in the review, six deal directly with the "substantial risks" presented by hatchery supplementation, or the lack of any adequate "empirical basis" for determining either the costs or the benefits to natural populations of even the best planned and executed hatchery supplementation efforts currently being operated. The review finds that evaluation efforts are "inadequate," that the correct parameters are not being measured, that current hatchery programs are "unlikely" to provide "convincing quantification" of hatchery impacts, that key hypotheses have been left "unevaluated," and that any risk/benefit analysis of hatchery impacts would be "*dominated* by the high level of scientific uncertainty" (emphasis added).

The ISAB summarizes the substance of the review in a single sentence: "Currently available empirical information is inadequate to predict the outcome of *a thoughtful conservative supplementation effort* for any potential target population or on collective populations…." (Emphasis added. It should be noted that the bulk and substance of the review describes how few such "thoughtful conservative" efforts currently exist, which WDFW fails to acknowledge.)

This fundamental issue of the fitness of the composite population that is the intended outcome of supplementation programs (and more generally of "integrated" programs that have been described by WDFW thus far) relative to the baseline fitness of the wild population prior to the initiation of supplementation has been explored in considerable detail by Goodman in the AFS symposium contribution quoted above and in a recent article in the Canadian Journal of Fisheries and Aquatic Sciences (Goodman 2005). The approach employed by Goodman in these two articles provides a clear description of seriousness of the risk that integrated production can pose to the fitness of wild populations, and the factors under management control that directly contribute to such fitness impacts. The risks to wild populations are considerable and are increased by the uncertainty caused by our lack of detailed knowledge about key genetic and ecological factors that can affect wild spawning fitness. These articles should be read by relevant WDFW staff and cited in revisions to the public review draft.

WDFW acknowledges that integrated hatchery programs put target populations, "through a program of adaptation to a mixed hatchery-natural environment." When we speak of a hatchery "environment," we don't mean buckets and concrete raceways or "naturalized" rearing channels; we mean near universal survival to smolt stage, and to smolt at an improved condition relative to smolts reared in the natural "environment." Early life-history survival above 80% cannot obtain in the wild. A population "adapted" to the mixed hatchery-natural "environment" will likely become reliant on continued exposure

to the hatchery environment, turning a likely viable (if struggling) population into a population that requires perpetual hatchery intervention.

In its discussion on empirical studies of genetic changes from hatchery impacts, WDFW acknowledges the limitations of existing studies and discusses the difficulty in obtaining material to analyze the genetic characteristics of wild steelhead populations before they may have been influenced by hatchery impacts. This is a clear example of how acknowledgement of and reliance on ISAB and RSRP findings and recommendations could strengthen WDFW's analyses and management.

The ISAB has recommended the widespread use of unsupplemented "reference" streams (on a variety of spatial scales) to conduct ongoing, controlled comparisons between populations influenced and uninfluenced by hatchery intervention. The RSRP issued a report of Panel meetings held July 2003, to discuss "how modification or closure of hatcheries provides NOAA Fisheries with opportunities to investigate the experimental effects of hatcheries on wild populations." The RSRP specifically endorsed the findings and recommendations of the ISAB, and made several findings and recommendations of its own. The RSRP found, among other things, that "questions on the negative impact of hatchery fish on wild stocks abound… while scant progress has been made toward investigation and resolution of this major topic." The report noted, "In all examples that the RSRP has been able to locate, when experiments were conducted to test claims for the success of hatcheries in promoting the conservation of naturally spawning fish, the initial claims have been proven false."

The public review draft touts new selectively-neutral genetic monitoring tools (particularly singular nuclear elements or SNPs) that may have application to mixed-stock fisheries management, but fails to discuss new genetic techniques such as DNA arrays that will enable direct and indirect measurements of gene expression that can be extremely valuable to addressing fitness questions. The Department appears poised to commit considerable financial resources in SNPs to the detriment of investments in cutting edge genetics technologies that could have direct application to understanding wild population fitness. (See for example, Roberge et al 2006, and Aubin-Horth et al 2005, Rise et al., 2004 and references therein.)

Sections 3.4 and 3.5 Competition and Predation

The discussions on competition and predation are generally thorough and frank. Washington Trout expressed its concern regarding these potential impacts of artificial production in reviews of Hatchery and Genetic Management Plans prepared by WDFW for Puget Sound and Columbia Basin steelhead hatcheries. The public review draft goes much further in its acknowledgements of the likely impacts and risks from competition and predation than WDFW did in its published responses to Washington Trout's reviews of the HGMPs, wherein the department largely dismissed or minimized Washington Trout's concerns regarding competition and predation. In response to other concerns summarized in Washington Trout's HGMP reviews, WDFW committed to making substantive changes to some HGMPS. We anticipate that the new insights discussed in

the public review draft regarding these impacts will influence the revision of relevant HGMPs.

Section 3.7 Discussion
The discussion section begins with the same biased language and assumptions that weaken all of Chapter 3. WDFW repeats the blanket assertion that hatchery production *can* be used to "conserve at-risk natural populations." As noted above, this assertion is unsupported by available evidence and incompatible with the findings of independent researchers and review panels. The discussion describes ongoing hatchery reform, but appears to rely principally on findings from the HSRG, while absolutely ignoring the findings and recommendations of the ISAB and RSRP that would encourage more management change than WDFW appears willing to consider.

When WDFW acknowledges the importance of healthy habitat as it relates to steelhead conservation and the "effective" use of artificial production, it ignores the significant risk that hatchery influences may create "wild" populations that will not be able to sustain themselves without hatchery intervention, no matter the habitat quality.

In discussing goals and strategies, WDFW asserts that integrated programs *can* increase the number, distribution, and productivity of natural spawners, and that isolated programs *can* minimize interactions with natural spawners. As noted in our discussions above, it has not been clearly demonstrated that any of those conditions *can* obtain (see ISAB, 2003). It is also again worth noting that what is certain is that none of those conditions *have* obtained to date, the implications of which are again left completely unaddressed by WDFW's analyses.

In its discussion of a "balanced portfolio" approach of artificial production coupled with habitat improvement initiatives, WDFW acknowledges the need for these programs to be implemented and "tested." There is no adequate discussion on how these programs will be monitored, evaluated, "tested," and adjusted. Here again, acknowledgement and utilization of ISAB and RSRP findings and recommendations would be useful. The ISAB's recommendations for the establishment of unsupplemented reference streams, and the RSRP's recommendation to use hatchery closures to create paired comparative experiments between unsupplemented and supplemented populations should be adopted.

Conclusion
In the context of this review, we find WDFW's analyses in Chapter 3 generally unconvincing and incomplete. We recommend that WDFW significantly revise Chapter 3, relying more heavily on the findings and recommendations of the ISAB, RSRP, and other independent researchers cited above.

REFERENCES

Aubin-Horth, N., B. H. Letcher, and H. A. Hofman. 2005. "Interaction of rearing environment and reproductive tactic on gene expression profiles in Atlantic salmon." Journal of Heredity 2005: 96(3): 261-278.

Chilcote, M. 2003. Relationship between natural productivity and the frequency of wild fish in mixed spawning populations of wild and hatchery steelhead (Oncorhynchus mykiss). Canadian Journal of Fisheries and Aquatic Sciences 60: 1057-1067.

Ford, M. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology 16(3): 815-825.

Gayeski, N., 2005A; Stock-Recruit Analyses of Five Major Populations of Puget Sound Winter Run Steelhead; Washington Trout, June 6, 2005; Submitted to NOAA Fisheries PS Steelhead Biological Review Team.

Gayeski, N., 2005B; Comments Re NOAA Fisheries' December 2004 proposed critical habitat designations for 13 Evolutionarily Significant Units of Pacific salmon and steelhead in Washington, Oregon, and Idaho; Federal Register volume 69, No. 239 74572 (Dec. 14, 2004) Docket Number [030716175-4327-03]; RIN Number [0648-AQ77]; Washington Trout, March 14, 2005; submitted to Branch Chief, Protected Resources Division, NMFS.

Gayeski, N., R. Vanden Brulle, 2003; Comments on WDFW Chinook, Coho, and steelhead Hatchery and Genetic Management Plans for Puget Sound; Washington Trout, August 1, 2003; Submitted to Washington Department of Fish and Wildlife, see http://wdfw.wa.gov/hat/hgmp/#pugetsound

Gayeski N., R. Vanden Brulle, 2004; Comments on NOAA Fisheries Proposed Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead; Washington Trout, November 12, 2004; submitted to Branch Chief, Protected Resources Division, NOAA Fisheries.

Goodman, D. 2005. "Selection equilibrium for hatchery and wild spawning fitness in integrated breeding programs". Canadian Journal of Fisheries and Aquatic Sciences 62: 374-389.

Independent Scientific Advisory Board. 2003. Review of Salmon and Steelhead Supplementation. ISAB 2003-3.

Lynch, M. and M. O'Hely 2001. Captive breeding and the genetic fitness of natural populations. Conservation Genetics 2: 363-378.

Recovery Science Review Panel. 2003. Hatchery Experiments and Monitoring. July 21-23, 2003.

Reisenbichler, R. and J. D. McIntyre 1977. Genetic differences in growth and survival of juvenile hatchery and wild steelhead trout, Salmo gairdneri. J. Fish. Res. Board Can. 34: 123-128.

Reisenbichler, R., S. Rubin , L. Wetzel, S. Phelps, in press. Natural selection after release from a hatchery leads to domestication selection in steelhead, Oncorhynchus mykiss. Chapter 27, Pages 371-383 In K.M. Leber, H.L. Blankenship, S. Kitada, and T. Svåsand [editors] Stock Enhancement and Sea Ranching: developments, pitfalls, and opportunities. 2nd edition. Blackwell Science Ltd, Oxford.

Reisenbichler and Rubin 1999. Genetic changes from artificial propagation of Pacific salmon affect the productivity and viability of supplemented populations . ICES J. Marine Sci. 56: 459-466.

Rise, M. L., K. R. von Schalburg, and G. D. Brown. 2004. "Development and application of a salmonid EST database and cDNA micro-array: data mining and interspecific hybridization characteristics." Genome Research 14: 478-490.

Roberge, C., S. Einum, H. Guderley, and L. Bernatchez 2006. "Rapid parallel evolutionary changes of gene transcription profiles in farmed Atlantic salmon." Molecular Ecology 15: 9-20.

Utter, F. 2001. Patterns of subspecific anthropogenic introgression in two salmonid genera. Reviews in Fish Biology and Fisheries 10: 265-279.

Waples, R.S. 1999. Dispelling some myths about hatcheries. Fisheries 24: 12-21.

Washington Trout 2006. Comments Regarding Noaa Fisheries *Puget Sound Steelhead Proposed Listing* (71 Fr 15666); June 2006. Submitted to Branch Chief, Protected Resources Division, NOAA Fisheries.