

DAVID H. BECKER (OSB # 081507)  
Law Office of David H. Becker, LLC  
833 SE Main Street # 302  
Portland, OR 97214  
(503) 388-9160  
davebeckerlaw@gmail.com

Attorney for Plaintiff Native Fish Society

PETER M.K. FROST (OSB # 91184)  
Western Environmental Law Center  
1216 Lincoln Street  
Eugene, OR 97401  
Tel: (541) 359-3238  
Fax: (541) 485-2457  
frost@westernlaw.org

Attorney for Plaintiff McKenzie Flyfishers

**IN THE UNITED STATES DISTRICT COURT**  
**FOR THE DISTRICT OF OREGON**  
**PORTLAND DIVISION**

**NATIVE FISH SOCIETY,**  
**MCKENZIE FLYFISHERS,**

Plaintiffs,

v.

**Case No.: 3:12-cv-431-HA**

**THIRD DECLARATION OF**  
**CHRISTOPHER A. FRISSELL, Ph.D.**

**NATIONAL MARINE FISHERIES**  
**SERVICE, REBECCA BLANK,** Acting  
Secretary of Commerce, **WILLIAM STELLE,**  
Regional Administrator, NMFS, **OREGON**  
**DEPARTMENT OF FISH & WILDLIFE,**  
**ROY ELICKER,** Director, ODFW,  
**BRUCE McINTOSH,** Acting Fish  
Division Administrator, ODFW, **CHRIS**  
**WHEATON,** Northwest Region Manager,  
ODFW,

Defendants.

---

I, Christopher A. Frissell, declare the following matters are personally known to me and to which I am competent to testify under penalty of perjury of the laws of the United States:

1. My current address is 39625 Highland Drive, Polson, MT. I have been retained by Plaintiffs to provide expert opinion testimony on salmon management, hatchery effects and recovery in this matter. This declaration supports the plaintiffs' Motion for Partial Summary Judgment. I previously submitted two declarations in support of the plaintiffs' motion for a preliminary injunction.

### **PROFESSIONAL QUALIFICATIONS**

2. I have 31 years of professional experience of field research and review of conservation planning and management with trout, salmon and steelhead in western North America. I held research faculty appointments at Oregon State University and the University of Montana Flathead Lake Biological Station for 14 years, for 12 years held the position of Senior Staff Scientist and later Director of Science and Conservation for a non profit conservation organization, the Pacific Rivers Council, and presently work as a fishery and watershed science consultant.

3. I received Bachelor of Arts (B.A.) degree in Zoology with High Honors at the University of Montana in 1982, and Master of Science (M.S) and doctoral (Ph.D.) degrees in Fishery Science from Oregon State University in 1986 and 1992, respectively.

4. In the course of my work, I have conducted and directed numerous observational field studies of salmon, steelhead and trout behavior in response to habitat features, both natural and man-made or man-influenced. I am familiar with the scientific literature on wild fish

response to habitat, and the literature on how hatchery fish and hatchery operations, particularly by way of behavioral and genetic alterations, but also by way of simple overwhelming numbers and artificially selected locations of release, can adversely affect naturally occurring fish and overall population dynamics. I have also spent considerable effort reviewing in detail ESA listing determinations and recovery plans for salmon and trout species, and in review of fishery management and conservation and species recovery programs by state and federal agencies. For example, in 1998-2000, I served as a member of the Northwest Power Planning Council Ecological Work Group, which developed the Multi-Species Framework as a template and for fishery and wildlife planning, including assessment of hatchery management options, in subbasins of the Columbia River Basin.

5. From about 2004 until 2010 as Senior Staff Scientist for the Pacific Rivers Council, I was deeply involved in scientific support for successful litigation of California's hatchery programs state-wide under the California Environmental Quality Act. This work required me to engage in comprehensive and ongoing review of the literature pertaining to all aspects of salmon and trout hatchery operations and their environmental impacts on naturally occurring fishes and other species, and it necessitated my review of numerous specific hatchery operations in California and how their impact on wild fish and other biota might be minimized or avoided.

6. I have published more than 30 articles in scientific journals and symposia proceedings, served as primary or co-author on twelve books or book chapters, and written more than 25 research reports concerning how salmon, trout, and other native species survive and prosper in freshwater ecosystems, and how management can be successfully shaped to protect and restore threatened and endangered trout and salmon species.

7. Attached hereto as Exhibit 1 are my curriculum vitae, which includes a list of all my peer reviewed publications.

8. I have not provided expert testimony at trial or deposition during the last four years.

9. My normal hourly rate is \$120 per hour and I worked 22 hours preparing this declaration.

#### **MATERIAL REVIEWED IN PREPARING THIS STATEMENT**

10. For the purpose of preparing this declaration, I reviewed the following documents: 1) NMFS, 28 September 2012, *ESA Section 7 Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation* (hereafter referred to as BiOp); 2) NMFS 28 September 2012, Memorandum for Barry Thom from Robert Turner, *Hatchery and Genetic Management Plans submitted by Oregon Department of Fish and Wildlife for the artificial propagation of salmon and steelhead in the Sandy River, Oregon*; 3) Oregon Department of Fish and Wildlife's (ODFW) 31 May 2011 updated *Hatchery and Genetic Management Plans* for Spring Chinook, coho salmon, winter steelhead, and summer steelhead, as submitted to NMFS (hereafter referred to as HGMPs); 4) NMFS, September 2012, Final Environmental Assessment: Determination that the Hatchery and Genetic Management Plans for Sandy River Programs Submitted by the Oregon Department of Fish and Wildlife Satisfy the Endangered Species Act Section 4 (d) Rule under Limit 5 (hereinafter referred to as EA); 5) ODFW 31 December 2012 letter to Rich Turner (NMFS), Re Hatchery Genetic Management Plan Compliance Report 2012 – Sandy Fish Hatchery; 6) Schroeder, K. (ODFW), *Sandy Basin Spring Chinook Spawning Surveys – 2010*; 7) Schroeder, K. and three others, 2011, *Sandy Basin Spring Chinook Spawning Surveys – 2011*; 8) Schroeder, K. and three others, Draft

31 December 2012, *Sandy Basin Spring Chinook Spawning Surveys – 2012*; 9) U.S. Forest Service (USFS) 2012 spring Chinook spawning survey data; 10) Oregon Department of Fish & Wildlife and NMFS, Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead – 2010; 11) Email from Todd Alsbury (ODFW) to Rich Turner (NMFS) dated June 25, 2012 regarding winter steelhead in Cedar Creek; 12) the filings by the parties in the preliminary injunction proceedings, including Federal Defendants’ Opposition (NMFS Brief), State defendants’ Opposition (ODFW Brief), First Declaration of Richard B. Turner, Declaration of Todd Alsbury, Second Declaration of Todd Alsbury, Declaration of Kirk Schroeder, Supplemental Declaration of Kirk Shroeder, Declaration of Richard Carmichael, Declaration of Mark Lewis; and 13) K. Arendt and G. Wanner, USFS Notes on the 2012 Spring Chinook Spawning Survey With Relation to Historic Trends, February 2013 (USFS 2013). Documents cited here and in the “Literature Cited” section below that were published after the NMFS decision to approve the HGMPs contained historical data that was available to NMFS prior to the decision. I also consulted available published scientific literature for pertinent information on selected topics, some of the more directly important scientific sources are cited below. I am familiar with the Sandy River basin through several field trips since about 2005 to visit streams, rivers, and watershed restoration projects around the basin. In 2010-12 I worked as scientific contributor to the report “Protecting Freshwater Resources on Mt. Hood: Recommendations for Policy Changes,” prepared by the Pacific River Council.

### **CONSERVATION CONTEXT OF THE SANDY HATCHERY OPERATIONS**

11. Because most directly affected species (three “ESUs” and a “DPS”) by the Sandy River Hatchery program--the Lower Columbia River Spring Chinook salmon, Lower Columbia River Coho salmon, Lower Columbia River Steelhead, and Columbia River Chum salmon--are

all listed as threatened species under the U.S. Endangered Species Act, actions such as hatchery operations involving these species within their range should not “jeopardize the continued existence” of the species nor “adversely modify or destroy designated critical habitat” (BiOp p.17). To meet this standard, ODFW has implemented a range of measures to modify the way fish are taken reared, and released in Sandy River hatchery operations.

12. However, as nicely discussed in the BiOp (p. 42-50), our present scientific understanding underscores that even the optimum hatchery practices inherently result in some level of adverse effect to wild or naturally-occurring salmon and steelhead, spelling out that these effects span several categories (genetic alteration through destruction of mate selection behavior and subsequent domestication selection, behavioral alteration, predation on or competition with wild fish, ancillary harm to wild fish from brood stock capture and other interventions, structures, or discharges, and other deleterious effects). These negative effects of hatchery fish on wild populations are well-documented in the scientific literature, including several studies cited in the BiOp.

13. Hatchery operations harm wild fish and their ability to recover natural populations. Within the first generation of their removal from the wild, hatchery fish have been reported to have a reproductive success rate that is only 60% to 80% of the reproductive success of wild fish (Araki et. al. 2008) and display characteristics of adaptation to captivity that make them significantly less suited for survival in the wild (Christie et. al. 2011). Accordingly, hatchery operations pose genetic threats to wild salmon and steelhead. When hatchery fish spawn with wild fish, the resulting offspring are less fit to survive and reproduce in the wild than fish which are wholly wild. Genetic threats include those caused by introgression of genetic material from hatchery fish into the native population through interbreeding, which leads to loss of reproductive

fitness and loss of the genetic diversity in the wild fish population. Deleterious genetic changes can occur within the first generation (Christie et al. 2011) or over several generations of hatchery breeding and rearing (Reisenbichler and McIntyre 1977; Chandler and Bjornn 1988; Reisenbichler and Rubin 1999, Araki et al. 2007, Araki et al. 2008). Emlen's (1991) modeling of a hypothetical salmon population scenario and showed that with 5% interbreeding of hatchery salmon in a natural population, deleterious genetic changes can reduce fitness in the resulting offspring, and recovery from even a single episode of interbreeding may take many generations.

14. Significant adverse genetic effects can manifest when the proportion of hatchery-origin fish among the natural-spawning population is 10 percent. Specifically for Chinook salmon, Chilcote et al. (2013, Figure 4) show that for river systems with in-basin hatcheries (fish do not originate from out-of basin hatchery stocks) and no dam influence on the migratory corridor (both reflect the present situation for the Upper Sandy where spring chinook primarily spawn), a ten percent incidence of hatchery-origin fish in spawning populations produced an estimated roughly 25 percent decline in reproductive success (expressed as intrinsic productivity, or next-generation recruits per this-generation spawner) compared to a population with no incidence of hatchery-origin fish. In fact the first 10 percent incidence of hatchery fish spawning imposes a larger absolute loss of wild population productivity than subsequent increments of hatchery fish occurrence (i.e., the per capita impact of a hatchery fish declines slightly at higher stray rates). From the standpoint of a threatened species, a 25 percent loss of productivity is of a magnitude that can cause dramatic declines of population viability under common circumstances.

15. Although Chilcote et al.'s curves translating hatchery stray rates into productivity losses have been available for two years now (and likely longer than that inside the agencies), it appears NMFS in the BiOp and EA, and ODFW in the HGMP, made no attempt to make a

transparent and plain English explanation or formal or informal assessment of the expected impact of its target of 10 percent hatchery stray rates on viability of listed spring Chinook salmon in the Sandy. The agencies' silence on this point leaves the impression in the public's mind that a 10 percent stray rate is either deemed nearly harmless, or has been through some formal and population-specific analysis determined to be acceptable or a level where benefits to the listed species outweigh the biological costs. As far as I can discern from the record, no such analysis has been done for Sandy River stocks. In my opinion, Chilcote's work (and other published research) raises grave doubts about the adequacy of the 10 percent stray rate as a conservation benchmark; it appears to be an arbitrary threshold picked as a generic recommendation with no specific assessment or reference to its likely biological effects in the Sandy Basin and its Chinook populations. Given that NMFS and ODFW in their briefs extoll the virtues of site-specific analysis, it appears strange that no such site-specific analysis was done to justify or evaluate their site-specific hatchery program stray rate targets in the Sandy basin, and that discussion of the implications of a 10 percent stray rate for the recovery of the species is absent from both the EA and BiOp. Furthermore, why cannot expected losses of reproductive success, estimated based on the best and readily available science such as Chilcote et al. (2011 and 2013), be considered a direct and robust measure of life cycle take caused by interbreeding with hatchery fish—the central issue, after all, of the HGMP? NMFS is silent on this question.

16. The presence of hatchery fish also poses ecological risks to wild fish, including competition with wild juvenile fish for local food resources and rearing space, competition with wild adults for spawning territory, predation of hatchery fish on wild fish, and delaying the migration of returning wild adults and causing them to spawn prematurely downstream of artificial barriers. The release of hatchery raised fish and operation of artificial barriers to migration cause

significant disruptions to the rearing, feeding, sheltering, and spawning behavioral patterns of wild fish and create the likelihood of injury or death to wild fish. The release of hatchery fish also poses a risk of introducing disease and parasites into the wild fish population. The combined effects of this slate of adverse ecological, behavioral physiological and genetic effects of exposure of wild to hatchery fish can be major observed declines in fitness and survival in the wild (e.g., Christie et al. 2012, Kostow and Zhou 2006, Chilcote 2003).

17. In some instances, fishery managers deem hatchery populations to be necessary to support or recover a dwindling listed population or ESU. Therefore the necessary rational context for consideration of a hatchery program for recovery of a listed species is to carefully account for and weigh the relative expected benefits against its known or likely adverse genetic, behavioral, and ecological effects.

18. Thus, the question naturally arises whether the Sandy Hatchery operations themselves contribute in any way to the recovery of threatened and endangered fishes in the Sandy River system. ODFW does not explicitly claim benefit to listed Sandy River salmon and steelhead from its hatchery stocks. Recovery goals are described in the BiOp for Sandy River spring Chinook salmon, Coho, and winter steelhead. In each case, the Sandy Hatchery program is not affirmed as necessary or contributory to recovery, and, except for coho, hatchery practices were identified as threats or “limiting factors” to recovery (BiOp, p. 25-26, and 33). The EA similarly identifies hatchery practices as limiting factors to recovery (EA, p. 3, 45-46, 53, 82, and 94). The BiOp (see Table 8, p. 51, and following) identifies the potential “safety net” benefit of broodstock collection, and the potential benefit of supplementing spawning numbers for severely depleted natural populations as the sole beneficial uses of hatchery programs, but does not make the case these are directly applicable to present Sandy River populations. The BiOp and the EA do not

evaluate whether, or how, the hatchery programs will contribute to the recovery of the listed species in the Sandy system. While the BiOp speculates there could be a potential future need to supplement wild winter steelhead in the Sandy, nowhere is this identified as an imminent conservation need. To the contrary, recovery planning has identified the potential for each of these listed populations to recover if hatchery programs and other threats were removed or substantially alleviated.

19. Therefore, while the Sandy hatchery program overall is being modified in ways that the ODF claims will supposedly “minimize” harmful effects—but in fact only reduces them relative to past levels that were deemed more threatening—and NMFS in the BiOp has projected that harmful effects should likely be small, it remains inescapable *there is no offsetting benefit identified that justifies the ongoing hatchery program as a conservation need*. Instead of considering whether the hatchery program is justified at all in the context of recovery needs of the species, the HGMPs and BiOp simply focus on reducing harmful actions. The Sandy hatchery program, therefore, benefits not Sandy River salmon, but two other groups: 1) those legally responsible for numerically mitigating for fish lost from historically blocked habitat in Bull Run watershed (and other effective, non-hatchery options would be available for this purpose, such as watershed restoration actions), and 2) those who participate in sport fishing opportunity for anglers (for whom fishing opportunities would also be available on wild fish if they were successfully restored).

20. The Sandy Hatchery programs continue to operate at the expense of risk or threat to naturally occurring salmon and steelhead populations in the Sandy River and its tributaries. In my opinion, a more informative, rational, and likely effective analysis and BiOp would consider a baseline recovery scenario as one without a hatchery program in the Sandy River Basin, and would

then consider incremental introduction of the proposed hatchery actions against the increment of harm (or risk of harm) to listed fish and their habitat that they introduce. I believe this form of analysis and disclosure would likely lead to a differently configured and scaled hatchery program—and a somewhat different and more effective set of reforms and practices to protect wild fish—than those now proposed.

21. The Sandy River and its tributaries offer an important opportunity for the recovery of wild fish populations that will contribute to the recovery of the ESUs and DPS to which they belong. The basin contains a significant amount of accessible habitat for all stages of salmonid life cycles including significant areas of high quality habitat, has had two dams that limited access to spawning habitat removed in the last five years, has a major habitat conservation plan in place to mitigate for blocked habitat in the Bull Run watershed, has newly-opened passage to steelhead and coho spawning habitat in Cedar Creek upstream of the Hatchery, and has access to the ocean that is not impeded by a dam on the Columbia River. Yet the wild fish populations in the basin do not yet show clear and consistent signs of recovery. In my opinion, the evidence suggests that operation of the Sandy Hatchery program is at present a major limiting factor preventing the recovery of these wild fish populations.

### **STRAY RATES OF HATCHERY FISH**

22. The approved HGMPs provide for the release of 300,000 spring Chinook, 500,000 coho, 165,000 winter steelhead, and 75,000 summer steelhead. With actions taken to increase the rearing to maturity, implement acclimation ponds, employ weirs to trap and sort spawning hatchery-origin fish, and alter the locations of spring Chinook smolts stocked by the hatchery program, ODFW hopes to reduce future stray rates of hatchery-origin returning adults into wild-spawning populations below the target of 10 percent hatchery fish. Despite these

actions, the large number of smolts stocked in the Sandy River (relative to naturally occurring spring Chinook smolt populations) are likely to still result in large numbers of stray hatchery fish throughout the river system in the future. The BiOp (p. 44-45) presents an excellent overview of the scientific literature on the factors known to influence the incidence straying of hatchery-origin salmon, stating that “One goal for hatchery programs should be to ensure that hatchery practices do not lead to higher rates of genetic exchange with fish from natural populations that would occur naturally.” Rearing and release practices, and ancestral origin are identified as playing a role in straying, and in reduced homing tendency by hatchery fish, based on past studies. Similar statements appear in the EA (p. 73-74).

23. However, one of the likely contributing causes to increased straying is the transfer of young fish across geographical locations during their hatchery lives, where they are exposed to different water supplies and other environments than their hatchery of origin. Experimental studies show the developing physiological and behavioral imprinting that affects later homing behavior of salmon and trout could be markedly influenced by such transfers. Because of rearing capacity limitations at Sandy Hatchery, spring Chinook are trucked from that location to hatcheries in two other basins for extended rearing before they are returned to the Sandy for final acclimation and release. In my opinion, unless this transport of hatchery fish from hatchery to hatchery and across drainage basins is curtailed, then ODFW has not taken all necessary and prudent measures to reduce harm from straying of hatchery Chinook salmon into natural populations. The problem, of course, is that ODFW would presumably have to greatly reduce the total number of hatchery smolts it rears and releases in the Sandy if it could not exploit these out-of-basin rearing facilities. However, since both reducing the number reared and released and reducing the transport of hatchery salmon should reduce straying, this would seem to be a prudent

choice, if the goal is truly to “minimize” impact to wild salmon. In the quest to maintain large numbers of released smolts, ODFW has chosen to dismiss reasonable and prudent measures that would further mitigate the impact of the hatchery program on wild fish. I could find no discussion of the implications of Sandy hatchery fish transport to out-of-basin rearing facilities in the EA or BiOp, despite the recognized importance attached to reduced stray rates.

24. ODFW’s own staff recommended at least twice (Schroeder 2010, 2011) that numbers of spring Chinook smolts stocked be reduced in order to bring down future hatchery fish stray rates on the spawning grounds. The Schroeder 2010 report (p.1), ODFW’s primary internal report on the numbers and incidence of hatchery fish in Sandy Basin spring Chinook populations for that year, states that previous attempts to reduce hatchery Chinook migration into the Upper Sandy system by releasing hatchery smolts into the lower Sandy River “...appear to have been ineffective in reducing numbers of hatchery fish migrating into the upper basin.” Schroeder (2010, p. 1) further concluded that “Immediate actions should be taken to reduce the number and proportion of hatchery Chinook in the upper Sandy Basin...Finally, reductions in the hatchery program should be seriously considered (at least in the short-term) until other measures have proven effective in reducing the number and percentage of hatchery-origin Chinook in the spawning population.” After a additional year of data showing that stray hatchery Chinook greatly out-numbered wild spawners in the upper basin, Schroeder and his colleagues (2011, p. 3) reiterated, “Because the effectiveness of alternative release will not be known until the adults return 4-5 years later, reductions in the hatchery program should be seriously considered (at least in the short-term) until other measures have proven effective in reducing the number and percentage of hatchery-origin Chinook in the spawning population.”

25. Because reported spring Chinook stray rates have ranged up to the extraordinarily

high levels over the four years preceding NMFS's decision to approve the HGMPs (45-77% in 2008-2011, reported in Schroeder et al. 2012), because of the likely ineffectiveness of slate of mitigation measures in preventing adverse interaction between hatchery fish and wild fish, and also because in my opinion the scientific literature indicates harm to wild fish could occur at stray rates well less than ODFW's stated goal of 10 percent, continued and potential long-lasting harm to wild fish and is likely to continue unless the release of hatchery fish is halted until ODFW can demonstrate that its mitigation can be successful. The only other options for attaining the ten percent goal rely on gains from rearing and trapping measures. (In my opinion, the expectation of such extraordinary gains from "tweaking" salmon rearing and trapping regimes are likely not reasonable, based on literature values from controlled experiments, geography of the river and past migration patterns of returning hatchery salmon in the Sandy system, and other considerations.) While it is always possible to ignore an opportunity for logical analysis by presuming that everything is too complicated for any analysis to suffice, it is not at all clear from the record why NMFS did not choose to conduct—or if it did, did not choose to disclose—some kind of simple and reasoned calculus informed with directly relevant, existing basin-specific data (data which were collected by ODFW for just this purpose) to inform its decision. Halting large-scale hatchery releases appears to be a biologically prudent and justified measure for protecting Sandy River salmon and steelhead, and fostering their recovery in the wild.

### **WEIRS AND THEIR EFFECTIVENESS**

26. To reduce hatchery spring Chinook straying into certain tributaries, ODFW has installed seasonal weirs, or constructed barriers that at least partially block upstream migration of adult salmon during the June through September migratory period. Blocked salmon that try to pass the weir are funneled into a trapping device. Hatchery-origin salmon, recognized by fin

clips (or other marks or tags), are removed from the trap, while wild-origin salmon are released above the weir to spawn upstream. While weirs were invoked in part because adult salmon returning for the next few years were not reared under the modified conditions of the new HGMPs, they also may be needed into the future because ODFW has chosen not to invoke the measures identified above to further reduce the propensity of hatchery fish to stray—namely reducing numbers of released smolts and curtailing out-of-basin transportation and rearing.

27. While some of the unintended adverse effects of weirs on fish were discussed in the BiOp (discussed in the next section of this declaration), the effectiveness of weirs for the purpose of screening fish was not given more than cursory mention. The effectiveness of the weirs is not discussed in the EA at all, which frankly acknowledges that it is “unknown” whether the weirs will be successful in removing enough hatchery-origin spring Chinook to meet the 10 percent stated goal and at the same time minimize impacts on natural-origin spring Chinook from the presence and operation of the weirs (EA at p.21 = AR 16538). NMFS simply stated that weirs are known to be useful and effective when appropriately applied, with the caveat there can be a “steep learning curve” associated with their maintenance and design.

28. My students and I have built several weirs and fish traps in research projects, and in my career I have visited and spoken with field and supervisory at many other weirs similar to those prescribed for the Sandy (most recently in 2012 to view a state-of-art fish weir constructed to trap Chinook and other salmon in the Hoh River, Washington). It is well-recognized that even the most expensive and elaborate weirs are variably effective at stopping fish, depending on the nature of the location where they are installed, appropriateness of design to the site, behavior of the fish in the locality of the weir, and variability of weather and water conditions, and other unexpected natural events or man-caused accidents. Equally important in

this application, weirs must not only effectively act as barriers to hatchery fish, but they must effectively trap and retain them for removal, while also safely trapping wild fish to allow their release upstream. Neither the EA nor the BiOp evaluate any of these factors, nor consider whether the weirs will be effective in reducing the stray rate to the 10 percent goal while minimizing adverse impacts to natural-origin spring Chinook.

29. While I will discuss some of the potential adverse effects of weirs on fish in the wild below, I first want to turn to the question of their effectiveness. Namely, few weirs are anywhere near 100 percent effective at stopping and trapping fish; some are more effective at stopping fish, but less effective at trapping them (because fish may behaviorally shy away from the weir altogether or avoid entering the trap location itself). Maintaining a single weir and trap on a salmon stream is a costly and time-intensive proposition; maintaining a flotilla of them is decidedly daunting. Even in the best circumstances, most weirs are only partially effective at stopping fish. Conditions occur when the weir partially fails and fish are able to find and pass through gaps. For example, a slight increase in stream flow during a storm can, at certain locations, result in a large increase in flow velocity, and the mesh size of the weir screens may be insufficient to pass the flow; the barrier is then overtopped (or, per some designs, automatically retracts upward) and fish are able to pass. Variations in streamflow can also cause traps to malfunction. Floating debris is an omnipresent problem. In the fall, screen mesh may be compromised by infilling with autumn leaves; unless cleaned, sometimes several times daily, flow stress on the structure greatly increases, and a breach can easily form, allowing fish to pass. In other cases, trees or large branches falling during windstorms—surprisingly common in forest settings—can damage and breach a weir. Bears and other mammals often tamper with traps, which can sometimes result in either injury to, or inadvertent release and passage of trapped fish.

Even at remote locations vandals are a constant threat, unless structures are attended 24 hours a day. Finally, the digging activity of salmon themselves can undermine the barrier. While there are design and maintenance measures that can reduce the risks of each of these problems, over the course of a season, to my knowledge, few weirs will not experience one or more episodes resulting in at least a partial breach. Fish that hold below a weir for days or weeks, avoiding the structure and its trap, will often seize such an opportunity to pass.

30. Not surprisingly, therefore, Schroeder and colleagues (2011, p. 3) reported that weir-trap arrays placed for a month in the lower Salmon River and lower Zigzag River in the upper Sandy during the 2011 season, coupled with removal of all fin clipped fish trapped, only marginally reduced the incidence of hatchery-origin spawners in Salmon river (from an estimated 73% hatchery fish without trapping to 62% with trapping) and ZigZag River (from an estimated 71% without trapping to 53% with trapping). In other words, in its first year, trapping reduced hatchery fish entry in to the upper reaches of Salmon River and ZigZag River by 15% and 25%, respectively. I've seen no evidence these ODFW estimates of trapping effectiveness were considered by NMFS in its analysis and decision, even though that decision rests largely on weirs and traps to reduce hatchery fish straying, and these were among the few direct data available. Extending the season of weir and trapping to 3 or 4 months will certainly improve their effectiveness for hatchery fish removal, but by how much is not discussed by ODFW or NMFS in either its EA or BiOp. The need to pull weirs because of increased streamflows and returning wild coho salmon (see below) in the fall results in an annual opportunity for hatchery Chinook holding downstream of the weirs to freely migrate into upper areas.

### **ADVERSE EFFECT OF WEIRS ON WILD FISH**

31. While they have beneficial uses, fish weirs and traps pose a wide variety of risks

to both target species and other species that may be inadvertently affected. Weirs are a temporary but significant alteration of habitat; their known adverse effects on salmon and steelhead are listed in the BiOp (p. 50). They include: 1) delayed upstream migration (and inhibited downstream migration); 2) behavioral aversion to the weir resulting in “forced” or premature spawning downstream of the structure where egg-laying conditions may be unfavorable (such accumulations of fish are also visible and vulnerable to predators and human poachers); 3) “fallback,” or the known but poorly understood behavioral tendency of some fish, once they do pass a weir or trap, to return back downstream through it and be captured and handled multiple times; 4) direct injury or mortality of fish that attempt to jump or otherwise pass through the barrier; 5) injury and stress to fish held in the close confines of the trap itself; 6) injury or stress that occurs when fish are held for extended periods of hours or days; 7) injury and stress to fish retrieved or netted within the trap and handled for identification and release, tissue sampling, or other biological sampling; 8) post-handling, stress-induced disorientation or exhaustion after release that makes the fish vulnerable to downstream displacement (hence passive “fallback” or possible injury if pinned against the weir) and predation or poaching. The BiOp (p.50) also briefly mentions a list of possible actions to remediate these effects, including personnel training, debris removal, guards posted against poaching, and frequent sampling to reduce the holding time of trapped fish. A range of other measures is often necessary too, before weirs become functional and “tuned” to reduce their most acute side effects (depending on case-specific post-installation factors such as hydrodynamic stresses in relation to the weir structure under fluctuating flows, local streambed and bank stability, fish behavior in response to the weir and flow fluctuations, and others).

32. After identifying these several sources of injury that are endemic to weirs and

traps, and recognizing that the operation of multiple weirs simultaneously affecting a large proportion of the naturally spawning populations of listed salmon and steelhead in the Sandy Basin, NMFS the BiOp (p. 57) summarily dismisses these concerns with the statements that "BMPs will be used to operate the weirs and handle fish," and that "weir technology has improved greatly over the previous couple of decades" and is now "widely applied." Moreover, the BiOp (p.57) further mentions that surveying spring Chinook salmon above and below the weirs by ODFW will allow them to monitor weir effects. No mention is made of how monitoring will establish that juvenile and adult coho and juvenile winter steelhead are not impacted by the weirs (with the exception that weirs will be removed when the first returning coho are caught in the traps; because this date typically overlaps with the spring Chinook migration in the fall, this measure is a critical factor that limits the possible effectiveness of weirs in removal of hatchery spring Chinook—see above discussion of potential weir effectiveness).

33. Any single weir and trap intrinsically poses a range of possible side effects, and these adverse effects—as well as the feasibility of mitigating them—must be carefully weighed against the benefit gained by weir and trap operation. Through manpower-intensive and constant effort, adverse effects can be reduced, but seldom or never to a level that can be arbitrarily deemed insignificant or negligible. Tradeoffs between desired and possible undesired effects should be very carefully evaluated. The risk that adverse effects outweigh beneficial effects grows as the number of weirs and traps increases, the habitat area and number of fish affected by them increases, and the duration of time they spend in the stream increases. The Sandy basin weir and trap array is one of the most extensive examples of I have heard of; the duration of trapping not only extends over many months within a year, but presumably will extend for many years—permanently or indefinitely. Because hatchery fish stray in large numbers to all quarters

of the basin, numerous weir sites are needed.

34. I examined preliminary numbers from spawning surveys above and below Sandy Basin weirs in 2011 and related information from ODFW (Schroeder and colleagues 2011, Schroeder and colleagues 2012) and the Forest Service (USFS 2012, USFS 2013). These sources provided some empirical evidence that adverse effects have been occurring; these include behavioral avoidance resulting in concentrations of hatchery and wild Chinook salmon below weirs, corresponding evident depletion of wild fish numbers above weirs, and likely forced spawning and probably increased interbreeding of wild and hatchery fish in the artificial aggregations of fish below the weir sites. For example, Schroeder and colleagues (2011, p.3), evaluating two weirs placed for one month in 2011, stated “Possible effects of traps on Chinook were suggested by distribution of redds,” and concluded that “Altered distribution of spawning Chinook could be caused by delay in upstream migration or reluctance of fish to enter traps resulting in displacement of fish to areas downstream of the traps or to other tributaries.” In my opinion, harmful effects of the nature reported above are endemic to weir and trap operations, and while they might be marginally reduced, they are likely to continue to occur at some biologically significant level into the foreseeable future.

35. Although NMFS acknowledges that the presence of a weir can result in “rejection of the weir” (EA p. 72, BiOp p. 49-50), NMFS does not address the magnitude or nature of the deleterious effects of weirs from concentrating spawning fish below the weirs. Because migrating adult salmon are on a fixed energy budget and must spawn prior to the depletion of energy reserves, delayed migration and altered migration timing can be harmful (Crossin et al. 2004). Quoting Donaldson (2008):

Prolonged delays that prevent salmon from reaching suitable resting or spawning

areas in time may obviously reduce their reproductive success ... This may especially be of importance in rivers with many migration barriers, which have a cumulative effect on the total delay. The fish may either have to spawn in unsuitable areas, or they may reach suitable spawning areas too late. Delayed arrival at spawning grounds results in fewer opportunities for selection of prime spawning sites, shorter time spent on spawning grounds, and fewer opportunities for reproduction (Smoker et al. 1998; Hodgson and Berg 1999; Crossin et al. 2004; Keefer et al. 2006).

Thorstad et al. (2008) reviewed the many ways that instream barriers, whether they are physically impassable or serve as behavioral deterrents to upstream passage, can cause migration delays and other anomalies, including displacement of spawning of Atlantic salmon.

36. In my own experience with Chinook and other salmonid species, concentrations of spawning fish, and relatively early spawning behavior is often observed below temporary barriers to upstream migration, whether these are natural or man-made. I have observed such aggregations below constructed weirs on multiple occasions, even where traps were actively maintained on a continuous or multiple-times-per day basis. (Biologists who work with weirs and other forms of traps routinely observe that many individual fish appear to consistently show “trap-shy” behavior.)

37. The actual act of salmon spawning in the wild is not purely a matter of “hardwired” physiological and genetic programming; once a measure of physiological maturity is achieved, environmental and behavioral factors such as stress, mate courtship and nearby spawning behavior of others of the species can trigger pairing and competitive spawning behavior. When a weir causes reluctance to migrate upstream, aggregations of fish below the

weir form, and if the “ripeness” window has opened for at least some individual fish, a spate of spawning activity commonly results. In my experience this often begins (and peaks) well before the peak of spawning is observed upstream. Because of the location *below* the trap, both hatchery and wild fish participate in these aggregations, and as a result there is likely to occur a very high incidence of interbreeding of hatchery and wild fish at such a location. Such a localized high concentration of interbreeding (or breakdown of the isolation of hatchery and wild fish that ODFW and NMFS are striving for under the HGMP) directly results from behavioral and habitat alterations caused by the weir. These disruptions can include “behaviorally premature” spawning in a location downstream of what might have been a preferred upstream site, impairment of mate selection and spawning segregation that wild fish might have exercised had they freely migrated, and increased likelihood of “sneaker male” matings and other mate selection distortions potentially associated with unusual crowding of hatchery and wild fish in proximity.

38. If fish that hold below a weir are subject to a thermal regime different than that they would otherwise have experienced in preferred habitat upstream, that can initiate a cascade of harmful physiological and developmental disruptions for the individual and its offspring. It has been shown to alter such fine-scale adaptations as timing of egg development and maturation, propensity or preparedness to spawn, spawning site selection, and subsequently on down the life cycle to the duration of egg incubation, the timing of emergence of fry from the gravel, and the survival of emerged fry in freshets or icing events. Such a cascade of changes at critical life stages triggered by changes in temperature exposure have been associated with declines of spawning success, survival, and productivity of affected wild salmon populations in careful life cycle studies (e.g., Holtby et al. 1989).

39. All of these effects can result in spawning at less suitable locations and with less selective mating behavior than fish might displaced had the obstruction not been present. It is most critical to note that this list of harms is not effectively measured by the monitoring protocol that ODFW uses and that laid out in the HGMP and which NMFS tacitly endorsed in the BiOp, except in the unlikely instance an extremely large and exceptionally consistent degree of crowding should persist downstream of a weir. To the contrary, harms and take associated with behavioral alteration and mate selection can be manifest in concentrated fashion over very short time frames and very short spatial distances when they occur in the proximity of spawning habitat. Many of these weirs, of course, are constructed in the midst of spring Chinook spawning areas.

40. Neither the EA nor BiOp evaluate whether the river reaches in which salmon spawning below the weirs are suitable or high-quality spawning habitat. The literature is replete with studies showing what the human eye discerns as suitable for spawning can in fact produce highly variable and often very low survival of eggs and emergent fry, depending on factors not readily apparent to us, including upwelling or downwelling of intragravel water, localized groundwater inflows, hydrodynamic stability of the specific gravel patch in the face of floods or drought conditions, and others (e.g., Geist and Dauble 1998, Baxter and Haurer 2000 Mull and Wilzbach 2007, McRae et al. 2012, Cram et al. 2012). While putative “good conditions” indeed do likely occur at some locations downstream of weirs, we also know that individual fish or pairs often seek out and select very specific microsite conditions to place their eggs, depending on the fine-scale features of those sites and on their own physical and physiological features (including both adaptive morphology and condition factors, e.g., body size, girth, current energy reserves and muscular ability to excavate redds in very fast flows, physiological adaption of eggs to

incubate in unusual groundwater-dominated temperature regimes) and other behaviorally-expressed preferences that reflect diverse individual biological needs. Because in this instance these factors are not measured and known, in fact fish that are displaced from their preferred spawning areas by a tendency to avoid weirs (or by the physical presence of a weir on top their preferred spawning site, or by delay caused by entrainment in a trap, or other behavioral effects) may be forced to spawn in locations that are far from their individual optima or preference. Moreover this appears to be a highly likely, and probably is an inevitable result of any action that disrupts adult migratory and spawning behavior of a wild population of salmon.

41. Any assumption or implication that artificially constructed weirs can be made to function perfectly without disrupting this fine-scale, interlocked and adaptive architecture of individual fish behavior and physiology interacting with microhabitat choice, strikes me as ludicrous—particularly when weirs are constructed in the immediate vicinity of spawning habitat. I think it's safe to presume this is among the reasons why NMFS and other state and federal state agencies routinely discourage other parties from the placement of potential migration-blocking structures in habitats critical for threatened and endangered salmon. Seamons et al. (2012) provide a recent example of weir inefficiencies and occasional lapses of function in a situation not unlike that of the Sandy River, where identification and separation of wild and hatchery fish was a paramount goal.

42. I do not see in the record evidence that a systematic analysis of past experience with weirs has been undertaken by ODFW or NMFS to evaluate and prescribe appropriate designs for the several prescribed Sandy River weirs. Rather, it appears that in the BiOp NMFS gave generic approval for “weirs” and mandated only a relatively crude monitoring protocol sufficient to ensure consistently disastrous biological outcomes are not evident.

43. For the reasons stated above, in my opinion NMFS' rather summary dismissal of side effects of an extensive, long-duration weir-and-trapping program is shoddy and not defensible. The trade off in the Sandy case is potential genetic integrity benefit from reduced numbers of hatchery fish spawning with wild fish above the weir locations, weighed against the potential impact of genetic integrity of increased numbers and interbreeding of wild and hatchery fish below the weir locations, as well as potential behavioral alteration and injury to wild fish that encounter and must pass through the weirs and traps to return to natal spawning areas. With such a balance of potential benefits and harms at stake, measurable performance criteria should be established to determine when undesired side effects are acceptable, and when they may exceed the potential benefits. Ensuring these adverse effects don't approach or exceed "acceptable" levels is equally critical to the well-being and recovery of wild salmon and steelhead in the Sandy Basin as is ensuring the desired beneficial effect is actually attained.

44. In the case of the Sandy, only a single formal criterion was established by ODFW and NMFS to determine "success" of the weirs—the reduction of hatchery spring Chinook to less than 10 percent of spring Chinook in spawning areas above the weirs. In the Incidental Take Statement, (BiOp page 67) NMFS imposed a single criterion for acceptable harm, that being "any change greater than 20 percent in spawning distribution above and below the weir and in pre-spawning mortality from what was measured during previous spawning ground surveys prior to the installation and operation of the weirs in 2011" NMFS's choice of this criterion for "take" associated with weirs and traps is not explained or reasoned relative to presumed biological benefit or net benefits to wild fish. In fact no rationale is provided. Moreover, it is unclear how the numerical standard is to be applied. Is it violated by a single date showing distortion of spawning distribution of this magnitude at one weir? Or does it need to be shown as an average

across all weirs? Or does it apply to all observations aggregated over the entire migration period? Further, Schroeder et al. (2012) pointed out that pre-2011 observations of fish and redds were compiled at stream section break that do not correspond to present weir locations, complicating any comparison across years (especially given that much of the observed distortion will likely occur in close proximity to the weirs). Moreover, does the language mean that *both* distortion of spawning distributions and an increase in pre-spawning mortality of the stated magnitude are necessary, or is one or the other sufficient to trigger a violation? Pre-spawning mortality is normally a highly variable factor, with observations dependent on vagaries of weather, streamflow, predators, scavengers, human egg poachers, and particular day of the survey. While a 20 percent increase in pre-spawning mortality is certainly a biologically significant harm, it may be very difficult to measure consistently in the field. In my view, the lack of precision and rigor in stating the terms of evaluation and their biological basis means that it could be very difficult for ODFW or NMFS to assess and substantiate whether the actions are in compliance.

45. In my opinion, in view of the intrinsic tradeoffs and limitations recognized above, even an extraordinarily well-funded and ideally executed system of weirs and traps could probably not reduce the occurrence of hatchery fish to less than 10 percent basin wide without risking undue and offsetting harm to wild fish in the Sandy Basin. Even if such were achieved above weir locations, only that limited part of the river system above the weirs would receive the benefits of reduced hatchery fish occurrence. In my opinion a weir and trap program, therefore, is little more than a partially successful remedial measure that fails to compensate for the causal threat: that is, the release of inordinately large numbers of hatchery fish in ODFW's Sandy River management program. And, in my opinion considering the data reported (cited above) on weir-

associated fish distributions which indicate distortions in the distribution of wild and un-trapped hatchery fish, it is highly likely that the 2012 operations of the weir have caused harm to wild fish. As stated above, because many of the effects are intrinsic to weirs and traps and difficult or impossible to do away with even with an extremely well-executed large-scale program, it appears most likely that these effects will continue at some level that causes harm to wild fish in future years.

#### **LIKELIHOOD OF SUCCESS FROM OUTPLANTING OF CHINOOK SMOLTS IN BULL RUN**

46. A principle measure emphasized in the EA (p. 8, 22–23) and BiOp (p. 58, 60–63, 66) intended to reduce future straying of hatchery spring Chinook is the use of off-site acclimation ponds and release of smolts into the Bull Run River, a tributary that meets the Sandy River downstream of the Sandy Hatchery location. ODFW is also seeking permission from the Portland Water Bureau to construct a weir and trap in the lower Bull Run River to capture returning hatchery adult spring Chinook and remove them from the system. There are several major reasons to not presume that this action will produce the desired result of greatly reducing the incidence of hatchery strays in to upper Sandy spawning areas. NMFS does not evaluate any of these factors, nor the likely effectiveness of the acclimation in reducing hatchery strays, in either the EA or BiOp.

47. While the term “acclimation” has a broader meaning in the literature of environmental physiology, fishery managers use “acclimation” of hatchery smolts as a term of art referring to the transport of juvenile fish at the time that they begin to experience physiological changes preparing them for eventual transition to saltwater, from some centralized hatchery rearing facility to “satellite” rearing ponds or impoundments located in other parts of the river basin. The duration of acclimation rearing may vary, and can depend on assumptions

about the physiological condition and health of the fish as well as limitations in water supply or other factors intrinsic to the capacity and stability of the ponds or impoundments. The premise is that fish transported at this stage will largely imprint on the water composition and other physical conditions they experience at the site of their translocation, rather than those they experienced earlier in their life, and will home with greater fidelity to the site of acclimation and release. Those who have studied homing and interbreeding of wild and hatchery salmon (e.g., Cram et al. 2012, Seamons et al. 2012, Kostow 2009, Donaldson 2008, Candy and Beacham 2000, Dittman and Quinn 1996) conclude while there is some evidence that acclimation procedures can influence the path taken by many hatchery fish when they return to freshwater to spawn, other physiological, behavioral, and engrained genetic factors also hold sway, and the extent to which salmon remain to spawn in at the site of acclimation and final release into the river, rather than elsewhere, remains uncertain and highly variable. While acclimation sometimes has been found to reduce stray rates, there are known tradeoffs that can hinder efficacy; transport during rearing has in some cases been associated with net *increased* straying of returning adults (Candy and Beacham 1999).

48. My foremost concern about so-called acclimation procedures proposed by ODFW in the Sandy is that the pattern of migration expected is utterly antithetical to the long-term evolutionary adaption of the Sandy River spring Chinook (we know that the wild stock and the hatchery stock derived from it originated largely if not wholly in the Upper Sandy Basin). Upper Bull Run spring Chinook were virtually eliminated early in the previous century with the construction of the Bull Run dams. Spring Chinook habitat in the accessible lower reaches of Bull Run River and the Little Sandy River is of limited quality and quantity, and sees some but limited use by wild spring Chinook (perhaps including descendants of displaced upper Bull Run

populations, but this is apparently unknown). Although it is not clear from the EA or BiOp how or why acclimation is expected to have beneficial results, it appears that ODFW expect short-term, pre-smolt acclimation to imprint hatchery fish released into the Bull Run to cause them to return there and avoid the Upper Sandy, but to accomplish this, behavioral imprinting will have to overcome several thousand years or more of strong natural selection for rapid migration into the Upper Sandy and its tributaries.

49. Migratory behavior of Pacific salmon has been intensively studied, and it is well-known to result from the interaction of imprinting and learning during juvenile life and a longer-term, genetically inherited, instinctive behavioral imprint (Dittman and Quinn 1996, and many others). Consequently, I doubt that brief exposure to Bull Run water will reprogram or overwhelmingly influence the migratory behavior of Sandy River Spring Chinook to the complete extent ODFW anticipates. If the stock of origin consisted of Bull Run fish or fish from another lower-Sandy tributary, there would not be such a vast discrepancy between the imprinting signal and the evolutionary template, and ODFW's expectation might be more reasonable. But given the ecological and evolutionary discrepancy, in my opinion ODFW's hopeful expectation is biologically untenable and therefore, not very reasonable.

50. A second and coupled concern is that when salmon home to less than optimal or crowded habitat, it is a plain fact that many of them choose to stray. Research demonstrates that homing and straying decisions are made (even by hatchery fish) based on a complex set of cues that includes the availability of habitat of higher quality in areas other than their point of acclimation or stocking (Cram et al. 2012). Habitat conditions in the lower Bull Run River simply do not appear to be particularly conducive to attracting and holding of adult spring Chinook in very large numbers (though I agree they are less hostile than Cedar Creek, which was

impossible for returning salmon to enter much of the time). The lower Bull Run River is relatively warm in summer and fall. A check of Portland Water Bureau and USGS water temperature data for the lower Bull Run River (USGS data for Bull Run River at Larson's Bridge near Bull Run, OR, as reported in the Portland Water Bureau's *Bull Run Water Supply HCP Compliance Report 2011*) indicates extended periods during July and August when flows are at their lowest and water temperature exceeds 17-18 degrees C. While this is below the absolute tolerance of adult spring Chinook salmon, it nevertheless can be considered stressfully warm for holding them over extended periods. In the Yakima River basin, for example, Berman and Quinn (1991) found that migrating spring Chinook sought out coolwater habitats that averaged 2.5°C cooler than the ambient 12°C-19°C temperatures of the river. Unless extensive coldwater thermal refugia exist there, and their availability is somehow detected by the fish, the thermal regime of Bull Run appears unlikely to naturally attract large numbers of migrating spring Chinook from the mainstem Sandy River, which appears to be somewhat cooler during than Bull Run much of the summer. The strongest attraction will continue to be the dramatically cooler Upper Sandy River tributaries. (For example, USGS stream record data for the summer of 2007 show that Sandy River below Marmot Dam site exceeded 18°C for only a few days in July, while the Bull Run River at Larson's Bridge exceeded 18°C for several weeks during August and September; further upriver at Brightwood the Sandy mainstem appears to generally run 2-3 °C cooler than Bull Run during most of the summer and fall months, and upper river tributaries can run much colder.) I can find no evidence in the record showing that ODFW or NMFS have undertaken a systematic review of the seasonal thermal template and other physical conditions in the Sandy system insofar they are likely to significantly affect migration and holding behavior of returning adult spring Chinook salmon.

51. A third and also coupled concern is the possibility that if large numbers of returning adult hatchery fish are attracted to Bull Run, prevailing temperatures and crowding in that system during low flow intervals could send the stage for disease outbreaks that propagate further to both hatchery and wild fish, adults and juveniles alike. Many forms of salmon disease become virulent at water temperatures above about 15.6°C (McCullough 1999 p. 97), and this is a particular challenge for spring Chinook adults that hold in freshwater for extended periods under prevailing temperatures. I have been unable to locate in the record consideration by ODFW or NMFS of this possible hazard of releasing large numbers of hatchery salmon into the lower Bull Run River, but records I examined (USGS data for Bull Run River at Larson's Bridge nr Bull Run, OR, as reported in the Portland Water Bureau's *Bull Run Water Supply HCP Compliance Report 2011*) indicate that temperatures exceeding 15.6°C prevail in lower Bull Run River during July and August, and may occur well into September.

52. Beyond mentioning that acclimation of spring Chinook would take place in the Bull Run River, neither NMFS (in the EA and BiOp) nor ODFW (in the HGMP) explain why it would be effective at reducing hatchery stray rates. NMFS in particular ignores the significant factors described above in failing to analyze whether or not the proposed acclimation would be successful. It is my opinion that, due to the factors described above, the acclimation of spring Chinook in the Bull Run River is not likely to drive the incidence of hatchery fish straying in wild spawning populations to levels that are biologically harmless, unless the numbers of hatchery fish released are also dramatically reduced, and other feasible measures taken as discussed in this declaration above.

### **INADEQUATE EVALUATION OF THE STEELHEAD AND COHO PROGRAMS**

53. I note that while the BiOp and ODFW's hatchery management and monitoring

plans provide much useful information about spring Chinook salmon, they acknowledge severe limitations in data for the other listed species. In particular, numbers of winter steelhead appear to be small and they are greatly outnumbered by hatchery-origin fish, but the BiOp and ODFW identify no monitoring program or performance criteria sufficient to resolve, track, and ensure a remedy for this situation. While wild coho appear to be increasing in number in the Sandy, ODFW and NMFS identify no clear performance measures or biological criteria against which to gauge coho population status and well-being against threats from massive hatchery fish releases and ancillary operations needed to manage hatchery fish in the Sandy system. In my opinion it is both feasible and necessary to develop such basin-specific performance measures and criteria if the promised but utterly undefined commitment to “monitoring” by ODFW is to have any assurance of protection and recovery of listed salmon and steelhead. Because genetically mediate impacts are a serious concern, in my opinion monitoring should include direct molecular genetic sampling of fish to determine the extent of recent hybridization between wild and hatchery stocks.

54. It appears the decision to permit hatchery stocking of steelhead in the Sandy was based on shockingly little information on current stray rates of hatchery fish in the Sandy system. This seems hard to justify considering that much of literature demonstrating harm to wild fish fitness, productivity or survival from interbreeding and otherwise interacting with hatchery fish in the wild is derived from studies of steelhead populations in nearby Columbia River tributaries (e.g., Kostow and Zhou 2006 in the Clackamas River, Araki 2007 and Christie et al. 2012 in the Hood River). I note that though recent data are scarce, the ODFW’s Recovery Plan (2010, Tables 4-8 and 6-31) reported stray rates of 52% for winter steelhead in the Sandy River (though a conflicting and unattributed statement in the same source [p.196] suggests unspecified actions

have reduced the rate to less than then 10%). Secondly, in 2012 ODFW allowed wild and hatchery fish to spawn together upstream of the Hatchery in Cedar Creek, apparently with a proportion of 90% hatchery fish passing the upstream to the spawning area (Todd Alsbury ODFW 6/25/12 email to Rich Turner, ODFW). These levels of hatchery-wild fish interaction would almost certainly harm winter steelhead in the same manner as I have described previously in this declaration. Given that the Sandy Hatchery is not sorting wild and hatchery fish except at the hatchery itself and ODFW apparently plans to continue to mix wild and hatchery steelhead in Cedar Creek, there is evidence to suggest that adverse effects from hatchery steelhead to wild winter steelhead will continue to occur.

55. ODFW's monitoring of the percentage of hatchery strays in spawning steelhead populations, as described in detail in the Lewis declaration, is problematic and in my opinion, even when very well executed is not adequately designed to ensure that stocked summer steelhead are not harming wild winter steelhead populations. I would note that this monitoring protocol is not described, or its efficacy evaluated, in either NMFS's BiOp or EA, even though it was apparently available to both agencies for at least the last several years. Harm could be occurring through several possible vectors: genetic introgression, behavioral interaction and competition for resources when they interact in the wild, and possible disease transfer. ODFW's current sampling design (as described in the Lewis declaration), is highly vulnerable to a major concern is that it seldom possible to visually observe the presence of a clipped adipose fin with certainty in a free-swimming fish in the wild, without capturing it or examining a recovered carcass (few steelhead die in spawning areas). When hatchery fish are in the minority, it is more likely that fin-clipped fish will be undercounted, rather than overcounted, and when these very small observed numbers are used as the basis of extrapolations (Lewis declaration p. 16, para

56), hatchery straying is highly likely to be systematically underestimated. A second concern is the unchecked assumption that no wild winter steelhead in the Sandy spawn prior to January. It is important to recognize that even a small incidence of wild fish spawning earlier than ODFW's arbitrary cutoff date winter steelhead spawning could result in a relatively large measure of genetic exchange between hatchery and wild steelhead, because the ratio of hatchery to wild fish would be exceedingly high at that time. Many wild winter steelhead populations in Oregon do, or historically did, support December and January spawning populations (particular rivers like the Sandy that apparently did not host a natural summer steelhead run), though these early spawners are (or were) nearly always less abundant than later-spawning population groups. (Under some natural conditions early-spawning wild steelhead may be favored by the same factors that favor hatchery juvenile steelhead—earlier emergence and growth to larger size [Reisenbichler et al. 2004], making them at least some years more productive *per capita* than later spawning fish.) Indeed, it has often been speculated that displacement by early-returning hatchery fish may be one reason why early spawning wild steelhead appear to have become more rare among coastal steelhead populations. Moreover, if earlier wild spawners do (or did) have higher per capita productivity, then harm caused by hatchery fish to such early wild spawners could exert a disproportionate negative impact on the overall productive capacity and fitness of the wild steelhead in total. The EA and BiOp provide no information on the past or present occurrence of early-spawning wild winter steelhead in the Sandy River, although the assumption that they do not exist is central to ODFW's monitoring effort.

56. Despite its limitations for tracking percent of hatchery strays, the design and data for steelhead monitoring described in the Lewis declaration is better suited to tracking overall basin-wide interannual population trends of steelhead observed in the wild. Therefore it would

seem that the fairly large drop in steelhead redd abundance reported by ODFW between 2010 and 2012 (Lewis declaration, p.16, table 2) is information that should be addressed in the EA and BiOp, but which was not. At a minimum, declining wild steelhead numbers mean that the potential genetic or behavioral, or other impacts of hatchery steelhead releases could be increasingly magnified, if the proportion of hatchery steelhead rises accordingly.

57. Taken together the above concerns illustrate a serious disconnect between the analysis in the BiOp and EA and the basis of ODFW's monitoring of steelhead in the Sandy. In my opinion there simply has been grossly inadequate consideration by NMFS of what information and what level of statistical rigor are needed to ensure that ongoing hatchery practices are not harming wild winter steelhead in the Sandy. In my opinion, given the well-known intrinsic difficulty and expense of extensively and precisely monitoring steelhead in the wild, use of molecular genetic methods to detect interbreeding between wild and hatchery fish in the Sandy would be the parsimonious and far more certain way to ensure harm has not occurred, or is not now occurring, from interbreeding. Molecular genetic analysis has already provided compelling evidence with clear implications for the Sandy; for example, Johnson et al. (2013) detected ongoing hybridization between wild winter steelhead and hatchery-origin summer steelhead (including the same so-called Skamania stock of origin as Sandy Hatchery summer run steelhead) in tributaries draining the Cascades in the upper Willamette River. Between 9 and 15 percent of juvenile steelhead showed introgression of hatchery summer steelhead genes, even in basins where returning summer-run stocks were thought to achieve little or no successful reproduction in the wild (Johnson et al. (2013).

58. It is important to note at this juncture that interbreeding of spawning adults—while appears to be the entire focus of ODFW's monitoring as described in the Lewis

declaration—is not the only pathway by which hatchery steelhead adversely affect wild steelhead. Stocked hatchery steelhead, because they often have a growth and size advantage over fish in the wild, can outcompete wild juvenile steelhead during the important freshwater rearing and migration phases. These interactions can involve both competition for food resources and differential ability to avoid predators. For example, smaller fish in a group are less likely to escape attacking predators than their larger cohorts, and this interaction may occur when released hatchery fish mix with wild fish during smolt migrations, well downstream of headwater rearing areas. Indeed such a (temporary but strong) competitive advantage at this key life stage may be the primary means by which hatchery steelhead can gain a foothold over wild fish in rivers with ongoing stocking programs (Reisenbichler et al. 2004). ODFW has not presented, nor has NMFS considered, information on the comparative sizes and other factors that may influence the potential competitive displacement of wild steelhead by hatchery steelhead in the Sandy River system. Because the hatchery summer steelhead are spawned much earlier, and reared in the hatchery where food is superabundant, it is likely they retain a size advantage in some or most years, and even though hatchery fish may be separated from wild fish until they are released as smolts, these interactions could affect competitive outcomes during the crucial time they come together in the river system and in the Columbia downstream.

## **CONCLUSION**

59. In summary, it is my opinion that the BiOp and EA for the Sandy River Hatchery program fail to consider, or fail to place in adequate context to assure reasoned consideration of, the following important factors: 1) the lack of evident conservation benefit from Sandy River Hatchery programs to listed salmon and steelhead in the Sandy River system; 2) the relative level of take or harm imposed by specific hatchery operations and alternative actions on wild salmon

and steelhead; 3) the relative conservation benefit of alternative actions that would be more robust and less dependent on speculative outcomes, such as greatly curtailing or halting hatchery releases in the Sandy River system; 4) biological and physical factors that could confound proposed actions such as moving hatchery Chinook releases to the Bull Run River have not been analyzed or assessed; 5) in general the effectiveness of proposed mitigation measures such as acclimation rearing and altering release locations of hatchery fish have not been rigorously considered in light of the best available scientific data; 6) potential specific ancillary harms likely to arise from heavy reliance on weirs and traps; 7) monitoring efforts for detecting harm to wild coho and particularly to wild steelhead that are not adequately designed to detect hatchery-wild interbreeding or determine the scope and impact of interactions during freshwater smolt outmigration.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

DATED this 5th day of July 2013.

s/ Christopher A. Frissell

Christopher A. Frissell

## LITERATURE CITED

- Araki, H., B.A. Berejikian, M.J. Ford, and M.S. Blouin. 2008. Fitness of hatchery-reared salmonids in the wild. *Evolutionary Applications* 2008 May; 1(2):342–355.
- Araki, H., B. Cooper, and M.S. Blouin. 2007. Genetic Effects of Captive Breeding Cause a Rapid, Cumulative Fitness Decline in the Wild. *Science* 318:100-103.
- Baxter, C.V. and F. R. Hauer. 2000. Geomorphology, hyporheic exchange, and selection of spawning habitat by bull trout (*Salvelinus confluentus*). *Canadian Journal of Fisheries and Aquatic Sciences*. 57: 1470-1481.
- Berman, C.H. and T.P. Quinn. 1991. Behavioral thermoregulation and homing by spring chinook salmon, *Oncorhynchus tshawytscha* (Walbaum), in the Yakima River. *Journal of Fish Biology* 39:301-312.
- Candy J.R., and T.D. Beacham. 2000. Patterns of homing and straying in southern British Columbia coded-wire tagged chinook salmon (*Oncorhynchus tshawytscha*) populations. *Fisheries Research* 47:41-56.
- Chilcote, M.W., K.W. Goodson, and M.R. Falcy 2013. Corrigendum: Reduced recruitment performance in natural populations of anadromous salmonids associated with hatchery-reared fish. *Canadian Journal of Fisheries and Aquatic Sciences* 10.1139/cjfas-2012-0542.
- Chilcote, M.W., K.W. Goodson, and M.R. Falcy. 2011. Reduced recruitment performance in natural populations of anadromous salmonids associated with hatchery-reared fish. *Canadian Journal of Fisheries and Aquatic Sciences* 68:511-522.
- Chilcote, M. W. 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.
- Chandler, G.L., Bjornn, T.C., 1988. Abundance, growth, and interactions of juvenile steelhead relative to time of emergence. *Transactions of the American Fisheries Society* 117:432–443.
- Christie M.R., M.L. Marine, R.A. French, R.S. Waples, and M.S. Blouin. 2012. Effective size of a wild salmonid population is greatly reduced by hatchery supplementation. *Heredity* 109, 254-260.
- Christie M.R., M.L. Marine, R.A. French, and M.S. Blouin, 2012. Genetic adaptation to captivity can occur in a single generation. *Proceedings of the National Academy of Sciences, USA* 109:238-242.
- Cram, J.M., C.E. Torgersen, R.S. Klett, G.R. Pess, D. May, T. N. Pearsons, and A.H. Dittman. 2012. Tradeoffs between homing and habitat quality for spawning site selection by hatchery-origin Chinook salmon. *Environmental Biology of Fishes*. Online, 14 p. DOI 10.1007/s10641-012-0026-1

Crossin, G.T., S.G. Hinch, S.J. Cooke, and nine others. 2008. Exposure to high temperature influences the behavior, physiology, and survival of sockeye salmon during spawning migration. *Canadian Journal of Zoology* 86: 127-140.

Dittman, A.H., and T.P. Quinn. 1996. Homing in Pacific salmon: mechanisms and ecological basis. *The Journal of Experimental Biology* 19: 83–91.

Donaldson, M.R. 2008. *The Physiology, Behaviour, and Fate of Up-river Migrating Sockeye Salmon (Oncorhynchus nerka) in Relation to Environmental Conditions in the Fraser River, British Columbia*. M.S. Thesis, Carleton University, Ottawa, Ontario.

Emlen, R. 1991. Heterosis and outbreeding depression: a multi-locus model and an application to salmon production. *Fisheries Research* 12:187–212.

Holtby, L.B., T.E. McMahon, and J.C. Scrivener. 1989. Stream temperatures and interannual variability in the emigration timing of coho salmon smolts and fry and chum salmon fry from Carnation Creek, British Columbia. *Canadian Journal of Fisheries and Aquatic Sciences* 46: 1396-1405.

Johnson, M.A., T.A. Friesen, D.J. Teel, and D.M. Van Doornik. 2013. The genetic structure of steelhead and spring Chinook salmon in the Upper Willamette River, Oregon. 2012 Willamette Basin Fisheries Science Review, February 5-7, 2013, Corvallis, Or. US Army Corps of Engineers, Portland, OR.  
[http://www.nwp.usace.army.mil/Portals/24/docs/environment/biop/2012\\_WFSR\\_abstracts.pdf](http://www.nwp.usace.army.mil/Portals/24/docs/environment/biop/2012_WFSR_abstracts.pdf)

Kostow, K.E. 2009. Factors that contribute to the ecological risks of salmon and steelhead hatchery programs and some mitigating strategies. *Reviews in Fish Biology and Fisheries* 19:9–31. DOI 10.1007/s11160-008-9087-9

Kostow, K.E., and S. Zhou. 2006. The Effect of an Introduced Summer Steelhead Hatchery Stock on the Productivity of a Wild Winter Steelhead Population. *Transactions of the American Fisheries Society* 135:825–841.

McCullough, D.A. 1999. A Review and Synthesis of Effects of Alterations to the Water Temperature Regime on Freshwater Life Stages of Salmonids, with Special Reference to Chinook Salmon. Columbia Intertribal Fisheries Commission, Portland, OR. Prepared for the U.S. Environmental Protection Agency Region 10. Published as EPA 910-R-99-010.  
[http://www.krisweb.com/biblio/gen\\_usepa\\_mccullough\\_1999.pdf](http://www.krisweb.com/biblio/gen_usepa_mccullough_1999.pdf)

McRae, C.J., K.D. Warren, and J.M. Shrimpton. 2012. Spawning site selection in interior Fraser River coho salmon *Oncorhynchus kisutch*: an imperiled population of anadromous salmon from a snow-dominated watershed. *Endangered Species Research* 16: 249–260, 2012.

Mull, K.E., and M.A. Wilzbach. 2007. Selection of spawning sites by coho salmon in a northern California stream. *North American Journal of Fisheries Management* 27:1343–1354.

Reisenbichler RR, Rubin S, Wetzel L, Phelps S. 2004. Natural selection after release from a hatchery leads to domestication in steelhead, *Oncorhynchus mykiss*. Pp. 371-384 in Leber, M., S. Kitada, H.L. Blankenshi, and T. Svåsand (editors) *Stock Enhancement and Sea Ranching*. Blackwell Publishing Ltd, Oxford, UK.

Reisenbichler, R.R., Rubin, S.P. 1999. Genetic changes from artificial propagation of Pacific salmon affect the productivity and viability of supplemented populations. *ICES Journal of Marine Sciences* 56:459–466.

Reisenbichler, R.R., McIntyre, J.D. 1977. Genetic differences in growth and survival of juvenile hatchery and wild steelhead trout, *Salmo gairdneri*. *Journal of the Fisheries Research Board of Canada* 34:123–128.

Seamons, T.R., L. Hauser, K.A. Naish, and T.P. Quinn. 2012. Can interbreeding of wild and artificially propagated animals be prevented by using broodstock selected for a divergent life history? *Evolutionary Applications* 2012 November; 5(7): 705–719. doi: 10.1111/j.1752-4571.2012.00247.x

Thorstad, E.B., F. Økland, K. Aarestrup and T.G. Heggberget. 2008. Factors affecting the within-river spawning migration of Atlantic salmon, with emphasis on human impacts. *Reviews in Fish Biology and Fisheries* 18:345–371. DOI 10.1007/s11160-007-9076-4. <http://www.lakseelver.no/Nyheter/2008/oktober/Thorstad%20et%20al%20migration%20review.pdf>

USGS, National Water Information System, Surface-Water Data, available at <http://waterdata.usgs.gov/nwis/sw>