<u>HATCHERY RISKS RECONSIDERED</u>

By Brad Halverson, Past Chair Oregon Hatchery Research Center Board

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Hatchery policy has long been influenced by peer reviewed scientific studies. Often, however, those studies contradict one another, making management practices based on select scholarship ambiguous.

Though hatcheries were first introduced to mitigate for declining natural abundance, they now are often implicated in that decline. Studies have associated ecological risks of hatchery releases causing greater predatory attraction[1] and competition for habitat[2], as well as the genetic risks of lost productivity and diversity due to interbreeding between hatchery origin stocks and natural origin fish[3]. But, let's reexamine those risks looking at the science as it is revealed in Courter et al.'s recent manuscript[4] as our guide.

With regard to hatchery program size specifically, long term productivity of natural origin (NO) fish is perhaps the fundamental consideration for the number of juveniles released. But, there is debate about whether those drivers of productivity are genetic or ecological? This distinction is important in order to achieve optimal hatchery scale, whereby harvest opportunities are not needlessly reduced for conservation effects. According to Courter, the most widely cited study in support of restricting hatchery program size is that done by Araki et al. (2007a) on Hood River steelhead, which demonstrated a 40.5% loss of productivity per generation in captivity. This is a ***<u>genetic</u>*** risk that is given abundant credence in hatchery policy.

But, Courter's recent manuscript demonstrated that the genetic effects of hatchery propagation to natural steelhead in the Hood River regarding productivity were no more undesirable than those caused by habitat demise or mortality due to predation. These are ***<u>ecological</u>*** risks leading to reduced productivity that have little or nothing to do with hatchery releases. Therefore, we must more precisely quantify the genetic effects, specifically reproductive success, of hatchery programs compared to environmental factors that may also impact natural spawning and recruitment in order to achieve optimal resource allocation.

The Christie scholarship cited above in footnote (3) evaluated several genetic parentage studies and came to the conclusion that fish with hatchery ancestry tend to produce fewer progeny in the wild, likely leading to depressed productivity for the entire population. Courter refutes this conclusion citing the Janowitz-Koch et al. 2019 long-term study on Johnson Creek Chinook salmon, demonstrating conversely that hatchery supplementation provided a demographic boost (productivity) to the population. He goes on to cite two other studies[5] that demonstrate spawning location (a behavioral effect rather than a genetic effect of hatchery programs) is critical to reproductive success; and therefore hatchery release protocols themselves may portend reduced hatchery yield. If part of a hatchery-origin adult spawning population utilizes suboptimal spawning habitat due to juvenile release points it stands to reason their relative reproductive success would be reduced.

Studies about relative reproductive success give us insight as to the influence of hatchery breeding on ***individual*** fitness loss, but the effect on ***population*** productivity in the naturally spawning population is less well quantified. This is the critical point I often hear well-respected professional Oregon fishing guide Jack Smith appeal for. Population-level appraisals are essential in order to differentiate the extent of influence hatcheries impute to wild fish relative to other drivers of abundance and productivity.

The importance of the Araki et al. 2007a study for constraining hatchery program size cannot be overstated. The immediacy (first generation) and magnitude (40%) in reproductive success cited therein are given considerable authority by program policy makers. However, this study was on individuals, and those results were extrapolated to deduce impacts on population productivity. The Courter study described in this manuscript[6] challenge those assertions and cite ocean conditions, minimum stream flow and pinniped abundance as all being associated with population productivity over the 27-year period of this research on Hood River winter steelhead. These are ecological conditions outside the influence of hatchery program size, and reduce the confidence warranted to individual, genetic reproductive success studies for policy formulation.

Another risk of hatchery propagation associates the number of hatchery smolt releases to lower natural origin recruitment[7] and productivity[8]. Courter, however, cites other studies[9, 10] that demonstrate that "predator swamping" leads to preferential predation on hatchery fish leading to increased survivability of naturally produced migrating salmonids.

Less is known about the marine life stage of salmonids and it's bearing on productivity versus the freshwater phases. But, Courter cites nine peer reviewed studies that support the positive correlation between ocean conditions and survivability and productivity. Again, these impacts to natural spawning yield are completely disassociated from hatchery propagation.

Stream flow is also shown to have an impact on out migrating juveniles, and therefore on returning adult recruitment. One year old juvenile steelhead (parr) actively rear in freshwater, but Columbia River basin interior stream flows are at their lowest during these crucial summer months of out migration. It is prudent, therefore, to infer that summer habitat inhibits juvenile steelhead production and hence adult steelhead recruitment in the Hood River. This important observation should be considered in conjunction with the Araki 2007 work.

Further, Courter suggests that if the rapid decline in fitness shown in Araki is indeed heritable, then it is also possible a rapid reappearance of wild genes also occurred, thus explaining the divergence between the Araki and Courter findings on fitness in Hood River steelhead. This is supported by Ho et al. 2020, which revealed captive-bred animals quickly adapt once reintroduced to their ancestral environments. Six peer reviewed scientific studies referenced by Courter in this manuscript assert that ***"Robust naturally-reproducing fish populations derived from highly-domesticated hatchery-origin salmon and steelhead stocks can be found throughout North and South America, indicating that anadromous hatchery-origin fish retain sufficient phenotypic and genetic diversity to reestablish extirpated runs, expand spatial distribution, and populate nonindigenous environments."***[11,12,13,14,15,16] That doesn't easily roll off the tongue, but we as sports anglers should become comfortable asserting it as others fault the value of hatchery propagation. In Ford et al. 2012 it was also observed that second generation hatchery fish spawning in the wild produced approximately one adult recruit, an RRS of 1 (the desired goal of productivity, and typical of NO/NO pairings in the wild). Courter interpreted this finding to demonstrate that reduced RRS of generation one HOS (hatchery origin spawners) was due to hatchery acclimation and release protocols leading to poor returning adult spawning habitat rather than maladaptive genetic traits selected in the hatchery environment.

As we stated in the opening, hatchery policy is greatly influenced by peer reviewed scholarship. But as we also noted, they often contradict one another. Why is that, and what determines which studies are considered for policy and which are marginalized? And, why are tribal studies mostly unheeded altogether?

Studies about ***population*** productivity are rare because of their reliance on long term time-series data. Even employing recent advancements in computing power to improve previously disregarded monitoring data divulges inconsistent outcomes between numerous studies. Factors that influence hatchery fish effects in the wild are complex and variable: such as the scale and purpose (supplementation, augmentation, integrated, segregated, etc.) of the programs; spawning, rearing and release protocols; broodstock source (HO or NO, local or out of basin); trapping and sorting facilities and techniques; and the size of the population in the wild. Add to these variables the inconsistency in experimental design, base assumptions, and methodology utilized to analyze datasets and we quickly see how the results may be asymmetrical one from the other.

To answer the query about which studies are used as a basis for hatchery policy and hence program size would require having a voice at agency planning meetings. Because I haven't had that opportunity, I will conjecture based on personal review of the scholarship as well as conversations with current and past agency staff (ODFW) and institutional (OSU) scholars and scientists:

The federal influence on state policy deriving from the Endangered Species Act of 1973, and subsequent litigation for being out of compliance with the ESA from conservation stakeholder groups cannot be exaggerated. It is immense. As I stated in an earlier article, the 2009 WDFW Hatchery and Fishery Reform Policy C-3619 governing hatchery practices in that state resulted from HSRG requisites focused profoundly on conservation, and adherence to the ESA. The goal was then and is now to make hatcheries compatible with ESA listings. In that policy paper they state that hatchery reform consists of "widespread, institutionalized changes to hatchery programs intended to reduce risk to natural populations." Observe the absence of value for harvest in that statement. How do we as individual anglers deal with that? Because this originates at the federal legislative level the undertaking must be dedicated there.

Certainly, federal authority exceeding state influence is a very big part of it. But, I believe there is also a local component to restraining hatchery program size. Disclaimer: I pause to state the following because I have developed a strong friendship and respect for the above staff and scientists. But, whether it is justified or not, there is undeniably a perception from sports and commercial anglers reliant on hatchery fish of an institutional bias against hatchery fish. Many years ago I had a conversation with a highly placed ODFW manager who stated "If not another hatchery fish was produced it wouldn't hurt my feelings." Much of this state's agency staff are comprised of graduates from OSU's Fisheries and Wildlife Department who participated in some of the studies footnoted here; and were themselves participants in peer reviewed studies used to influence hatchery practices in our state. So, the perception of this preference for conservation above harvest is not without merit.

In conclusion, because hatchery program size is constrained by <u>federal ordinance</u> and <u>local predisposition</u> toward conservation by those empowered to create policy, our role as a fully invested stakeholder group is to become better informed about the divergent science upon which that policy is shaped; and raise the level of our educated discourse with those responsible administrators and legislators as opportunities become manifest.

<u>FOOTNOTES:</u>

[1]Nickelson 2003

[2]Burke et al. 2009

[3]Christie et al. 2014

[4]Courter et al. accepted manuscript in Canadian Journal of Fisheries and Aquatic Sciences

[5]Williamson et al. 2010; and Ford et al. 2016

[6]Same as [4]above

[7]Nickelson 203

[8]Scheuerell et al. 2021

[9]Furey et al. 2016

[10]Collis et al. 2001

[11]Crawford 2001

[12]Pascual et al. 2001

[13]Soto et al. 2007

[14]DiPrinzio and Pascual 2008

[15]Gomez-Uchida et al. 2018

[16]Keefer et al. 2018