HATCHERY REFORM SCIENCE

Recovery Implementation Science Team
April 9, 2009

Introduction:

The following quotes are taken from a recent scientific review of hatchery reform to protect wild, native salmonids. A page number for easy reference in the complete report identifies each quote. Conclusions that have been reached by fish managers and by those scientists involved in hatchery reform are being applied, but this independent science review shows clearly that this application is pre-mature. It is customary for fish managers to apply hatchery reform measures before they are tested and verified as effective measures to protect wild salmonids. These reforms are promoted by federal funding and a concern that hatcheries will not be funded unless wild, ESA-listed salmonids are protected. The standard procedure is to promote hatchery modification, apply it as if it were the solution prior to scientific evaluation. In this way the new hatchery concept is fundable even though it is not proven to work as described. By continuing to change hatchery operations, goals, and function, the fish managers are assured that politicians will secure the public dollars. Consequently, hatchery reform is a politically driven process not a science based one.

"About half a dozen recent studies have examined correlations between the abundance of hatchery fish and various measures of wild salmon survival, abundance or productivity. All have found significant negative associations between hatchery fish abundance and wild population abundance or productivity. These estimated effects can be substantial – in some cases suggesting a >50% reduction in estimated wild population productivity. Reductions in hatchery production have also been found to be effective at increasing natural productivity. For example, reductions in hatchery coho releases on the Oregon coast have been estimated to be responsible for a ~23% increase in the productivity of natural Oregon coast coho populations." (page 6)

"…the RIST agrees with the HSRG (Hatchery Scientific Review Group) that the risks of extensive straying by hatchery fish into natural spawning areas are real and need to be considered if the region is to achieve recovery of wild salmon." (page 8)

"We agree with the HSRG that the available scientific information, both theoretical and empirical, indicates that gene flow from hatchery populations into natural populations is likely to reduce natural population productivity. Limiting natural spawning by hatchery origin fish will be an effective way to reduce these risks." (page 8)

"Some of the specific thresholds recommended by the HSRG, such as limiting the proportion of hatchery strays from segregated programs to 5-10%, may or may not be sufficiently protective to allow full recovery." (page 9)

"Similarly, the "proportionate natural influence" (PNI) goals of 50% - 70% for integrated hatchery programs may or may not be insufficiently protective to ultimately contribute fully to recovery of natural populations…" (page 9)

"We agree with the HSRG's assessment that the current proportion of hatchery fish in many Lower Columbia River Chinook salmon populations are inconsistent with the goal of ESA recovery for this ESU as defined by TRT viability goals and existing recovery plans. Based on our review, we agree with the HSRG that current hatchery practices pose a long-term risk to natural Lower Columbia River salmon populations." (page 9)

“It remains to be seen whether weirs or other fish sorting barriers can be an effective tool for threading the needle of conflicting policy goals…we suggest that more passive measures – such as geographic isolation of hatchery programs from key natural populations or reducing hatchery production – would be preferable to weirs if such measures can be effectively implemented. There may be cases where controlling hatchery fish through the use of weirs is the best management alternative, however.” (page 9)

“One limitation of the “maintain production and control straying using weirs” approach is that it does not address risks from ecological interactions between hatchery and natural fish that occur downstream of the weirs. The continued release of millions of hatchery produced salmonids in the Lower Columbia River and nearby coastal areas therefore may have a significant negative effect on natural salmon productivity even if the HSRG’s recommendations are implemented.” (page 9)

“Obtaining good estimates of the relationship between natural population survival and total Lower River hatchery releases should therefore be a high research priority.” (page 9)

“Adequately addressing threats from hatcheries and harvest is particularly relevant for ESUs that have been historically subject to large scale hatchery production and high harvest rates, such as Lower Columbia Chinook and coho salmon, and Puget Sound Chinook salmon.” (page 11)

“Developing strategies for reducing hatchery and harvest impacts while attempting to meet sustainable fisheries and treaty rights stewardship objectives that depend upon high hatchery production has been a huge challenge for regional fishery managers and policy makers.” (page 11)

“In addition to considering the potential impacts of hatchery introgression on natural production characteristics of a target population, managers need to assess other potential hatchery risks, such as ecological impacts on target and non-target taxa.” (page 12)

“…constructing or adapting existing mainstem weirs are an option recommended by the HSRG reviews for limiting the number of hatchery origin fish accessing natural spawning areas.” (page 12)

“Selection in the hatchery has the potential to disrupt natural adaptations related to spawning migrations.” (page 31)

“Hatchery breeding clearly has the potential to select for sexual traits different from those that are optimal in the wild, since salmon in hatcheries are almost always spawned artificially with no opportunity for the expression of mate choice, intersexual selection, redd construction, or any other type of natural breeding behavior.” (page 33)
“Hatcheries also have the potential to alter the selective balance between survival and fecundity.” (page 33)

“It seems reasonable to assume that, because hatchery rearing typically completely replaces this critical portion of the life-cycle for stream-type (such as steelhead, coho, and spring/summer chinook that depend on rivers for maturation and rearing) fish and does so to a much lesser degree or not at all for ocean-type fish (such as fall chinook, chum, pink that migrate to the sea shortly after emergence), the potential for domestication effects during this life-stage will be considerably greater for stream-type fish than for ocean-type fish.” (page 35)

“Even if such alterations in life-history patterns are predominantly environmentally induced, because natural selection acts on phenotypic variation, such environmental induced changes in trait variation, if consistent over time, are expected to change the way populations are molded by natural selection.” (page 35)

“…wild and hatchery fish may be experiencing the same environment, but the resulting natural selection is different for hatchery and wild fish because the fish are different. Because differences in size between hatchery and wild fish can persist for a period of several months in the ocean environment (Chittenden et al. 2008; Riddell et al. 2008) hatchery and wild fish are likely to continue to experience different patterns of selection long after release from the hatchery.” (page 38)

“To the degree that the trait distributions seen in wild salmon populations are adaptations to their environments, selection imposed by the hatchery environment could result in reduced fitness of hatchery fish in the wild.” (page 38)

“Nearly all studies of steelhead have found low relative fitness of hatchery fish, even in situations involving local broodstocks that were propagated for few generations.” (page 43)

“Ecological impacts of hatchery programs include the changes in abundance, productivity, diversity and spatial structure of populations that arise from altering environmental conditions and species interactions by capturing, rearing, and releasing hatchery fish. Such effects are wide ranging and have been shown to occur even when genetic impacts are not thought to exist…” (page 45)

“Importantly, these effects are not necessarily restricted to the immediate areas in which hatchery fish are released. These effects can be found in tributary, mainstem, estuarine and even ocean environments (Kostow 2008; Pearsons 2008; Ruggerone & Goetz 2004). In addition, some species may have life histories that make them particularly susceptible to realizing these impacts – steelhead, for example, are prone to residualize, increasing the time during which hatchery and wild fish can interact. Moreover, these interactions can be exacerbated when hatchery fish have a physical advantage – being larger, more aggressive or in better condition, for example – over wild fish…this means that the effect of releases of all salmonids – not just those of the same species as the ESU or population of interest – should be considered in any assessment of ecological impacts, although niche partitioning may tend to limit competitive interactions among some species” (page 44)

“Most information available indicates that artificially-propagated fish do have ecological impacts on wild salmonid populations under most conditions (e.g. a 50% reduction in productivity for steelhead in an Oregon population).” (page 45)

Predation: “…evidence suggests that hatchery releases in areas of high wild density, particularly when the hatchery-origin fish are larger than the wild juveniles, have the potential to exert predation pressure.” (page 47)

“Releases of hatchery fish can help to support an increased predator population, thereby increasing predation rates on wild fish…” (page 48)

“Available evidence indicates, however, that predators appear to be attracted to large concentrations of salmonids, such as those that occur at hatchery releases…” (page 48)

“…since nearly 90% of the salmonid juveniles in the lower mainstem and estuary of the Columbia River are of hatchery origin, it is possible that the large population of Caspian terns is supported by these fish, and that the rate of predation on wild salmonids is higher than it would be with lower inputs from artificial propagation programs.” (page 48)

“Mixed-stock fisheries can be regarded as a special case in which a predator population (fishers) is supported at levels that impose a greater mortality rate on wild fish than would be experienced if only the wild population were in existence.” (page 49)

“Nickelson (1986) compared stocked and unstocked streams utilized by coastal coho and found that although the total abundance and density of fish was higher in stocked streams, the density of wild fish was 44% lower in stocked streams than in streams without stocking. This suggests that competition between wild and hatchery fish exerts a negative effect on wild fish production.” (page 49)

“A life-cycle study of steelhead examining adult-to-adult returns, and factoring out ocean and genetic effects (thus targeting freshwater ecological effects, and particularly competition) showed a 50% decline in…productivity and a 22% decline in recruits in streams with high levels of hatchery fish (Kostow & Zhou 2006). (page 49)

“Together, these results suggest that competition among juvenile salmonids in the freshwater life stage (expressed through density-dependent mortality) is present and that when hatchery fish increase the density of a juvenile population, wild fish may suffer greater mortality than they would have without the supplementation.” (page 50)

“A negative association between number of hatchery Chinook salmon released in the Columbia Basin and marine survival of wild fish (Chinook salmon) in years of relatively poor ocean conditions (Levin et al. 2001) also suggests that competition in marine habitats exists.” (page 50)

“This body of evidence supports the existence of competition in the ocean when large numbers of salmonids are present. It suggests that competition may occur, decreasing survival and growth in the presence of large numbers of hatchery releases, potentially with the greatest effect in years of relatively poor ocean conditions (low upwelling) when prey abundance is lowest, conditions that could be exacerbated by climate change (Schindler et al. 2008).” (page 50)

“When returning hatchery-origin spawners spawn earlier than wild fish, their progeny hatch earlier and become large sooner than the progeny of wild fish. This, in turn, can set in motion the competition among juveniles.” (page 50)

“Hatchery-origin spawners may also compete with wild fish for mates. In general, wild-origin spawners appear to be more desirable mates than hatchery-origin fish (e.g., Berejikian et al. 2001). Competition for mates (leading to interbreeding between wild and hatchery fish) may be a potential problem when the proportion of hatchery fish on the spawning grounds is high.” (page 51)

“The best documented transmission of a pathogen between cultured and wild stocks of salmonids is the case of whirling disease among rainbow trout and steelhead in both the US and Europe. The parasite causing this disease, *Myxobolus cerebralis*, was amplified among hatchery populations and then spread by stocking activities (Gilbert & Granath 2003). This parasite is currently spreading throughout the western United States.” (page 51)

“Transfer of sea lice (*Lepeophtheirus salmonis*) from farmed salmon to wild salmon is another example of how disease associated with aquaculture may impact wild populations.” (page 51)

Wild Fish Sanctuaries

“In response to concerns about the negative impacts of hatcheries, managers have established (and are proposing more) “wild fish sanctuaries” (WFS) that are intended to be mostly free of hatchery fish. There is no established definition of a WFS, but it is generally described as a watershed or part of a watershed from which hatchery juvenile releases and hatchery origin spawners are totally or largely excluded. By excluding hatchery fish, wild fish are expected to be protected from genetic degradation and harmful ecological interactions. Exclusion of hatchery fish in a WSF may not be absolute, and some descriptions of a WFS allow the fraction of hatchery origin fish to be in the 5-10% range (HSRG 2004).” (page 54)

“An obvious way to create many WFS would be by greatly reducing hatchery releases on a coastwide or regional basis, and some regions have taken steps in this direction (e.g. Oregon coast – Buhle et al. in press). However, in many regions hatcheries provide harvest opportunities that have significant economic, cultural and legal significance, and elimination or substantial reductions in hatchery production would come at a considerable economic and social cost. Therefore, fisheries managers have proposed strategies to create WFS while maintaining high hatchery production (HSRG 2004). If high hatchery production and WFS are to coexist, hatchery fish must be excluded from the WFS. The strategies proposed for excluding hatchery fish from WFS fall into four main non-mutually exclusive categories, 1) reduced hatchery production, 2) geographic isolation, 3) removal of hatchery fish by harvest , 4) fish sorting barriers.” (page 54)

“Reducing hatchery production sufficiently to reduce straying below a threshold or goal should conceptually be an effective way to create WFS, but may conflict with other societal goals… potential risks to wild fish associated with different WFS strategies includes issues such as the overharvest of wild fish in hatchery mark selective harvest programs, negative habitat effects of weirs created for sorting hatchery and wild fish, and ecological effects as wild fish interact with hatchery fish in mainstem and marine areas outside the WFS. (page 54)

"In its review of Lower Columbia River Chinook salmon hatchery programs, the HSRG noted that the current hatchery management situation is inconsistent with the recovery goals for many of the populations (HSRG 2004). In particular, a number of primary and contributing populations currently have fractions of stray hatchery fish among their spawning populations that are too high to be consistent with natural viability (Figure 16, lower panel). In addition, the HSRG noted that most of the Chinook salmon hatchery production in the Lower River is designed to maintain fisheries, and most of the programs are not managed in ways that promote natural population conservation." (page 73)

"Limiting natural spawning by hatchery origin fish should be an effective way to reducing these risks. The values of pHOS (hatchery origin spawners) of 5% and 10% for primary and contributing populations associated with segregated program are arbitrary, and at least theoretically there could be significant genetic impacts at these rates (Ford 2002; Lynch & O'Hely 2001)." (page 75)

"Similarly, the PNI (proportion of natural influence) goals of 70% or 50% for integrated programs are also arbitrary, and may or may not be ultimately sufficiently protective to contribute to recovery of natural populations." (page 75)

"…we believe the general thrust of the HSRG recommendations are scientifically sound, but do not think that model incorporates enough information to accurately predict the outcomes of specific hatchery or habitat actions in a quantitative way." (page 75)

"The idea of using weirs to control hatchery origin spawners largely stems from two conflicting policy goals: protecting natural salmon populations from the deleterious effects of straying from hatchery populations, and maintaining sufficient hatchery production to contribute substantial number of hatchery fish to fisheries. We agree with the HSRG's assessment that the current proportions of hatchery fish in many Lower Columbia River Chinook salmon populations are inconsistent with the goal of ESA recovery for this ESU as defined by TRT viability goals and existing recovery plans. Based on our review we also agree with the HSRG and other assessments (e.g., LCFRB 2004; Myers 1998) that current hatchery practices pose a long-term risk to natural Lower Columbia River salmon populations." (page 76)

"One limitation of the "maintain production and control straying using weirs" approach is that it does not address risks from ecological interactions between hatchery and natural fish that occur downstream of the weirs. As we discussed in the section on ecological risks above, there is some evidence for density dependent survival of salmon in the ocean. The continued release of millions of hatchery produced salmonids in the Lower Columbia River and nearby coastal areas therefore may have a significant negative effect on natural salmon productivity, although as far we know this effect has not been quantified. Obtaining good estimates of any relationship between natural population survival and Lower River hatchery releases should therefore be a high research priority." (page 76)