OUTPLANTING AND NET PEN RELEASE OF HATCHERY-ORIGIN FISH

A large system of fish hatcheries exists in the Pacific Northwest for propagating Pacific salmon and steelhead (Oncorhynchus spp). A significant proportion of those released fish support commercial, Tribal, and recreational fisheries to specifically mitigate for fish and habitat losses associated with land- and water-use development. For example, approximately 85% of all returning adult salmon and steelhead in the Columbia River are of hatchery origin.

The vast majority of salmon hatcheries in the Pacific Northwest operate largely as adult spawning and juvenile rearing facilities through the smolt stage of development. Upstream-migrating adults are trapped and/or are diverted into adult holding ponds and then spawned when they reach sexual maturity. The fertilized eggs are incubated and hatched, and the resulting progeny are reared to the smolt stage prior to release into a freshwater stream. Age at release varies considerably among the various species of Pacific salmon (including steelhead), ranging from a few days or weeks after yolk absorption for pink and chum salmon (*O. gorbuscha* and *O. keta*, respectively) to approximately 15–20 months post-fertilization for steelhead, coho salmon (*O. kisutch*), and spring Chinook salmon (*O. tshawytscha)*.

The standard method of propagation is to release juveniles into the stream areas where returning adults can be recaptured for broodstock. The homing and recapture of returning adults may be further maximized if smolt releases and adult trapping occur "on-station" at the hatchery. Fish returning elsewhere where they cannot be trapped are known as "strays". The recapture and removal of unharvested, hatchery-origin adults reduces potential genetic and ecological risks to naturally spawning populations when the purpose of those hatchery-origin fish is strictly harvest.

On the other hand, smolts are often released from a site where adult collection facilities do not exist. In many situations, smolts are transported by hatchery truck—oftentimes into other watersheds and sometimes over relatively large distances (e.g. >100 km)—and then released. In general, salmon and steelhead return as adults to the areas where they are released, not where they are reared (reviewed by Quinn 1993).

Releasing smolts into streams geographically removed from a hatchery or adult collection facility is commonly called "outplanting." Steelhead programs in Washington state, for example, have often used outplanting to support recreational fisheries in a large number of small streams where no hatchery or adult collection facilities exist. More recently, saltwater net pens have been used increasingly to acclimate and release salmon smolts in marine areas where a targeted marine fishery on returning adults is desired. In these latter net pen releases, juvenile salmon are transferred to brackish or salt water (i.e., at a nearshore, estuarine location) at the early stages of smoltification and then fed in the net pens for one to three months prior to release. Significant harvests on returning adults can then occur in the near shore marine areas in the general vicinities of the net pens.

A common feature of outplanting and net pen programs is the release of smolts where no facilities exist to trap returning adults that escape target fisheries. In these latter situations, non-harvested adults may spawn unintentionally in streams far-removed from the source hatchery or geographic location where their parents were trapped for broodstock. Outplanting juvenile and/or adult salmonids also occurs in restoration and recovery programs where natural spawning by hatchery-origin adults is explicitly desired; however, these latter programs are not the subject of the discussion here.

Homing to natal streams is an important biological characteristic of salmonid fishes, allowing evolution of local adaptations in life history and other fitness traits (Quinn 1993; Altukhov and Salmenkova 1994; Quinn et al. 2001). Stock-specific, genetically-based adaptations include size and age at sexual maturity, adult return and spawn timing, pre-hatch developmental rate, length of freshwater residence prior to outmigration, and marine migration patterns (e.g., Smoker et al. 1998). Despite the biological importance of homing, natural straying also plays an important role related to colonization of new habitats and maintaining connectivity between geographically adjacent populations (Shapovolov and Taft 1954; Milner 1997; Quinn 1997).

Many studies have shown that salmon and steelhead seek alternative spawning habitats if no appropriate habitat is immediately available (Pascual and Quinn 1994). Such behavior is most apparent when natal streams are blocked by catastrophic, environmental events. For example, siltation resulting from the 1980 eruption of Mount St. Helens resulted in significant numbers of Chinook salmon and steelhead straying from the Cowlitz River to the Kalama and Lewis rivers (Leider 1989; Quinn et al. 1991).

Tagging and genetic studies have shown that outplanting and net pen programs promote stray rates that far exceed natural levels (Candy and Beacham 2000; Mackey et al. 2001). The absence of freshwater imprinting by fish released from saltwater net pens can lead to unpredictable straying by large numbers of unharvested adults to streams where natural spawning is not desired. Similarly, significant numbers of adults returning to outplanted streams typically escape targeted fisheries and potentially spawn with natural-origin fish. Consequently, outplanting and net pen releases can pose significant genetic risks to natural populations by promoting high stray rates to freshwater areas where interbreeding with naturally spawning populations is not desired.

Outplanted smolts may also outmigrate from freshwater at a much slower rate compared to smolts resulting from on-station releases (Hawkins and Tipping 1999; Pearsons and Fritts 1999). Such delayed outmigraton rates may result in increased predation on, and competition with, wild fish. Although side-by-side comparisons have not been done, outmigration rates of outplanted steelhead smolts have been documented at 2.9 km/day (Tipping and Byrne 1996) and 1.6 km/day (Tipping et al.1995), whereas on-station releases have documented 33 km/day (Dawley et al.1977; Harza 1998). This travel time difference could substantially increase smolt predation opportunities on wild salmonid fry. Also, the desired benefit of changing adult distributions within a river for supporting fisheries may be minimally affected by outplanting smolts in rivers downstream of a hatchery. Tipping and Hillson (2002) found that on the Lewis River—where steelhead smolts were reared near the upstream anadromous terminus—adult returns of winter steelhead were only slightly changed by downstream smolt release location, and summer steelhead were unaffected.

Outplanting and net pen releases from segregated hatchery programs[58] are especially problematic because of the potentially high level of genetic divergence between the hatchery stock and natural populations where straying and natural spawning may occur. Although the natural spawning success of hatchery-origin fish may be less than that of natural-origin fish when they occur in the same stream, those same data indicate that significant numbers of hatchery-origin fish from non-native or long-standing "domesticated" populations do indeed spawn successfully and can contribute significant numbers of progeny to naturally spawning populations (Chilcote et al. 1986; Campton et al. 1991; Mackey et al. 2001; Kostow et al. 2003; McLean et al. 2003). Kostow et al. (2003) presented data supporting a conclusion that hatchery summer steelhead adults and their offspring may have contributed to wild winter steelhead population declines through competition for spawning and rearing habitats.

Many studies have further indicated a genetic component to homing such that non-native fish, or their hybrid progeny, stray at higher rates than identically-reared native fish (Bams 1976; McIsaac and Quinn 1988; Pascual et al. 1995; Candy and Beacham 2000). This latter characteristic further confounds the genetic risks associated with straying of returning, outplanted fish by potentially increasing stray rates among natural-origin fish representing the progeny of hatchery-origin adults that reproduced successfully in nature. Consequently, based on the available scientific and fishery research data, both published and unpublished, the HSRG concludes that outplanting and net pen releases of hatchery-origin smolts pose significant, and potentially unacceptable, genetic risks to naturally spawning populations.

The HSRG has concluded that the simplest way to reduce risks associated with outplanting and net pen releases is to reduce the number and/or size of existing programs. However, the HSRG also recognizes that many of these programs support important tribal, commercial and/or recreational fisheries. As a result, significant trade-offs may exist between the fishery benefits of such programs and the risks they pose to naturally spawning populations. Consequently, the HSRG recommends that the biological risks of outplanting and saltwater net pen programs also be reduced by implementing the following actions:

- Mark all net pen released and outplanted fish each year, and tag a significant proportion of released fish with coded-wire tags, to assess the direct contribution of those fish to targeted fisheries and to assess stray rates and biological risks to natural populations. Systematically tagging a portion of the released fish each year, coupled with marking all outplanted and net pen released fish, will allow the co-managers to assess the degree to which these programs meet harvest goals while posing risks to natural populations.

- Conduct intensive harvest of hatchery-origin fish and/or use adult traps to reduce potential natural spawning of unharvested, hatchery-origin fish.

- Restrict releases of hatchery-origin fish to areas where adult collection facilities exist or can be easily developed. In some cases, adult traps can be added to existing smolt release ponds. In other cases, release sites can be restricted to streams with existing adult

[58] *See Emerging Issues section on Integrated versus Segregated hatchery programs.*

collection facilities. The wild steelhead management zones recommendations for steelhead would also help meet this recommendation (see below).

- Use locally-adapted and genetically integrated[59] hatchery stocks for net pen releases and outplanting wherever possible. That is, minimize—or eliminate—the use of "out-of-region" stocks and fish from genetically segregated hatchery stocks for these high-risk programs. Fish outplanted or net-pen reared for harvest-driven programs should be obtained from genetically integrated hatchery stocks and/or stocks native to the region or watershed where the net pen or outplanting programs occur. One possible exception to this latter recommendation would be hatchery populations that have been selectively bred, or otherwise manipulated genetically or phenotypically, for reproductive traits (e.g. spawn timing) that result in low probabilities of successful natural reproduction in the specific streams or geographic area where smolts are released. For example, hatchery-propagated populations of steelhead have often been selectively bred for early run and spawn timing, and these fish may have low reproductive success in watersheds driven hydrodynamically by snow-melt. However, these latter assumptions must be carefully tested and evaluated for such actions to be considered scientifically defensible.

- Implement the HSRG's recommendation for wild steelhead management zones to substantially reduce outplanting and thereby reduce risks to naturally spawning populations.[60] Similar region-wide guidelines and changes are needed to reduce biological risks of net pen releases and other outplanting programs, especially where no adult collection facilities are present for trapping non-harvested adults.

- Evaluate the benefits and risks of each program every two to three years. Programs imposing significant risks relative to benefits should be reduced or terminated.

- Monitor and evaluate high-risk programs annually to ensure that adverse effects to wild populations are minimal, that straying risks are appropriately managed, and that off-station releases are appropriately located such that non-harvested, hatchery-origin adults do not spawn in undesirable locations.

- Develop system-wide risk management guidelines and protocols for outplanting and net pen programs.

The HSRG believes these recommendations should be implemented as soon as possible as a first step alternative to terminating outplanting and saltwater net pen programs that are conferring significant fishery benefits. Many of the HSRG's specific recommendations within each region reflect the more generalized recommendations presented above.

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[59] *See Emerging Issues section on integrated versus segregated hatchery programs.*

[60] *See HSRG Hatchery Reform Recommendations, February 2003, System-wide Recommendations.*

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