Hatcheries and salmon: comments on hatchery reform
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Salmon and steelhead hatcheries in California have two main purposes: sustain commercial and sport fisheries and assist in recovery of wild (naturally spawning) salmon. As far as I can tell, the present hatchery system accomplishes neither goal, when a long-term view is taken. The California Hatchery Scientific Review Group (CHSRG) report, while containing many useful recommendations (e.g. Section 3), largely concludes that we can work with the present system to accomplish both goals. A more likely result will be complete dominance of hatchery salmon and steelhead in most rivers. This will ultimately lead to wild swings in salmon numbers returning to California streams and the fisheries. This in turn will most likely lead to periodic shut-downs of the fisheries and extinction of most runs, even those supported by hatcheries. I suggest that the following lines of evidence indicate a much more radical reshaping of hatchery policy is needed than the CHSRG proposes, despite recognition of these factors by CHSRG.

1. Basic science. Extensive evidence from peer-reviewed papers shows that hatchery fish are adapted to a hatchery-based life history and have severe detrimental effects on wild salmon and steelhead populations when they spawn and rear in the wild.

2. History. There have been wide swings in salmon numbers in the past decades, reflecting the interactions of uniform hatchery fish with variable "ocean conditions" and conditions in the rivers. Increasingly, the fishery is dominated by genetically uniform fish of hatchery origin, especially where the fishery targets Central Valley Chinook salmon.

3. Native Fish Society et al. vs. Oregon DFW and NMFS (2013). An Oregon judge has ruled (in part) that the hatchery program on the Sandy River violates the ESA and NEPA because of its negative impacts on wild salmon and steelhead. Where this goes next is anyone's guess but this lawsuit is not likely to be the last lawsuit to try to force fisheries agencies to change hatchery practices to protect wild fish.

4. Hatchery fish increasingly dominate in runs, despite mandates such as the The Central Valley Project Improvement Act of 1992 (CVPIA) says the federal government must "implement a program which makes all reasonable efforts to ensure that, by the year 2002, ***natural production*** of anadromous fish in Central Valley rivers and streams will be sustainable, on a long term basis, at levels not less than twice the average levels attained during the period of 1967-1991." Last time I checked, even in the best of years the vast majority of fish were NOT naturally produced (e.g. CDFW proportional marking results). Likewise, in the Klamath Basin, the analyses of Rebecca Quinones and me indicate salmon runs in many streams having increasing numbers of adults of hatchery origin. They appear to be replacing, not supplementing, the wild runs.

5. ESA protections of salmon and steelhead in the Central Valley, North Coast, and Klamath are not leading to recovery. Hatchery fish directly (competition, predation) and indirectly (take in hatchery-supported fisheries) impact these runs.

6. Climate change and human population growth are making things even more difficult for wild salmon, as illustrated by the growing impacts of the current drought.

What can be done?

Despite the conclusions of the CHSRG, salmonid conservation should be segregated from the production function of hatcheries. Integrated management as advocated by the CHRSG will most likely lead to complete blurring of distinctions between of wild and hatchery fish (as indicated by the recent spate of peer-reviewed studies). The proposal to carefully control the proportion of salmon of hatchery origin in both hatchery and wild spawning populations has some potential to increase the effect of natural selection on the overall population, but it will not stop eventual total dominance by hatchery phenotypes.

Abandoning wild salmon and steelhead management in favor of hatcheries for some runs is a legitimate goal for fisheries agencies but the goal should be made clear, so other measures can be taken (if any are available) for runs maintained with wild fish. Abandonment of wild fish appears to be the unstated basic policy that governs management of Central Valley (CV) fall run Chinook salmon, for example. These fish support the salmon fishery of the central California coast and are genetically uniform, no matter what hatchery they come from. There is growing evidence (e.g., proportional marking studies) that naturally spawned fish contribute little if anything to returns to the hatchery or to the fishery. Meanwhile, hatchery returns have an erratic pattern. Another example: all CV steelhead (a listed DPS) below the dams are also genetically fairly uniform, and are closely allied genetically to north coast steelhead because of hatchery practices. The runs are declining while resident rainbow trout populations in the low elevation rivers with similar genetic affinities are thriving. Most trout with steelhead life history are produced by hatcheries although a few are also produced by wild resident rainbow trout populations. The steelhead life history does not appear to be sustainable by either hatcheries or natural production.

An alternative policy, one I am not yet ready to accept, is that espoused by Robert Lackey: Given increases in human populations and increasing water demand in a more and more uncertain environment, salmon are not a sustainable resource in California, especially in CV. The best we can hope for is 'boutique' (zoo-type) runs in a few places, supported by hatcheries. But this *is* likely to be the result of "integrated" hatchery management.

As the CHSRG report recognizes, a program of hatchery reform cannot really be independent of a program to improve or at least stabilize habitats (natural hatcheries) for wild salmon and steelhead. If wild fish are going to be encouraged, they need to have Salmon Sanctuaries, the best places left, to enhance the populations. The idea is not new; Livingston Stone recommended it for California in

1872. The Yurok Tribe, working with the Western Rivers Conservancy, has just established a tribal salmon sanctuary on Blue Creek.

Some first steps (not in order of importance)
1. Appoint a blue ribbon commission to work out strategies that will result in true segregation of wild fish from those of hatchery origin, such as rearing facilities in/near ocean, sterile hatchery fish, terminal fisheries, segregation weirs on some streams, etc.

2. Klamath: Stop the Klamath from sliding down the CV fall run Chinook and steelhead route, a route that goes to hatchery dominated runs in most rivers. Develop a segregation strategy for this system. As an experiment: close Iron Gate for ca.15 years, and mark all fish from Trinity with CWT +adipose fin clip. Then track the populations in the river and tributaries for 4-5 generations and re-assess how hatchery fish affect the populations. It is a reasonable hypothesis that total salmonid production would not be hurt by doing this.

3. Start a program to mark all production hatchery fish with CWT +adipose clip. Does not have to involve a mark selective fishery, although this might be a good idea for a terminal sport fishery. Alternatively, CWT all production hatchery fish but adipose clip only 25%, as recommended by the CHSRG

4. Develop and implement a hatchery release policy that takes into account both carrying capacity of the ocean and of the river into which the fish are released. Large releases of hatchery fish into a river *will* affect the behavior and reduce survival of wild fish, in part because of limits in food availability and cover. Releasing hatchery fish at the same size as wild fish will at best only partially reduce this problem.

5. Tie hatchery reform to development of tunnels in Delta and other proposals to enlarge dams and build new ones or to tear down dams on the Klamath. Water users should pay big time to keep fish going because they are responsible for blocking access to the best salmon habitats in many areas.

6. Formally establish, with funding, a salmon sanctuary program to protect and enhance the best wild salmon and steelhead streams left in California. Sanctuaries should be carefully monitored so only wild-origin fish are spawning in them.

7. Declare Central Valley fall run Chinook salmon to be extirpated as wild fish, so they can be managed purely as a hatchery fish, to support fisheries.

8. Delist CV steelhead so hatchery steelhead, wild steelhead, and associated rainbow trout populations in the rivers of the CV can be managed as one unit (which they are in any case). Then, manage them as a unit, include experimental cessation of hatchery production.