

Northwest Science Forum

Northwest Science Forum provides an opportunity to articulate and discuss scientific issues in a less structured format than peer-reviewed articles. The Forum publishes short articles, opinion pieces, and letters with a focus on science and natural resource issues in the Pacific Northwest. Although the Forum is not peer-reviewed, it is edited for format and clarity. Articles should generally be less than 2000 words and contain minimal literature citations. Letters in response to articles are particularly encouraged; the original author will normally be given a chance to respond to the letter as well. There are no page charges or reprints associated with the Forum, and participants need not be members of the Northwest Scientific Association. Please send all submissions, including two hard copies and an electronic copy (any recent version of Word or WordPerfect) to the Editor.

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The Future of Washington Salmon: Extinction Is Not an Option but May Be the Preferred Alternative

Introduction

Puget Sound and much of the northern half of Washington on both sides of the Cascade Range had essentially no anadromous fish 15,000 years ago because the entire area was glaciated. When humans first arrived in the Pacific Northwest, following glacial retreat, salmon were abundant. The fish runs were in dynamic equilibrium with their habitat. They went through periods of abundance, scarcity, local extinction, and re-invasion. Now, due to the impact of humans and the changes they have brought to the area, these populations are threatened with extinction.

The recent and potential future listings of Pacific Northwest salmonids under the United States Endangered Species Act (ESA) have required regional planners, politicians, and the public to examine ways to continue to encourage and maintain development while advocating restoring wild salmonid populations to harvestable levels. In Washington, the response in the press from leaders and the public at large is that extinction of wild salmonids is not an option; the state will take whatever actions are necessary to preserve and restore wild salmonid populations. In this paper, I present a distillation of discussions with

fellow biologists—people directly involved with the daily management of salmonid runs, habitat protection and restoration, and recovery programs for specific populations.

In these discussions, I found widespread consensus that society has made a series of essentially irreversible land- and resource-use decisions which have altered the landscape to such an extent that some streams and watersheds can no longer produce anadromous salmonid populations large enough to support harvest if they are able to maintain a self-sustaining wild population at all. There is little likelihood that society will accept, support, or pay for the removal of the infrastructure and industries which have been so damaging to salmonid habitat. Because of these landscape changes, resource managers should concentrate habitat restoration efforts on those watersheds with the highest probability of maintaining anadromous salmonid production and productive habitat. Society should retain anadromous salmonid habitat wherever it exists, and develop fish culture and selective harvest techniques which will provide the levels of harvest demanded by society. The aquatic habitats we preserve or restore will differ significantly from the habitats that were there in the past. The fish populations

will, likewise, be different, but, if allowed to naturally reproduce, the fish populations will adapt to the existing environment. Given the choices already made by our society, our goal should be to restore naturally spawning salmonid populations wherever possible, then accept that the fish will either evolve to be genetically, physiologically, and behaviorally fit enough to survive in the environment in which it finds itself, or it will go extinct. Reestablishing anadromous salmonids means providing suitable habitat for all life stages and in all areas used by salmonids. For example, a pristine headwater spawning stream is useless to anadromous fish if the lower reaches of the watershed are so deficient in oxygen that adults can not pass through on their upstream migrations or if there are man-made barriers which prevent migration.

Habitat Issues

Water is the most critical component of the salmonid environment. If the water is not the proper temperature, or does not have the proper chemical makeup, the fish can not survive. Water is just as critical to humans. The current human population of Washington needs water for domestic use, for irrigation, for manufacturing, and for the generation of electricity. As the human population grows, it will demand more water. Surface water removal directly diminishes the amount of water available to support and produce fish. As flows decrease, the stream habitat changes, resulting in different relative abundances of the various salmonid species because each species occupies a different niche within a stream. At low enough flows, some species will be eliminated.

In Washington, the solution most commonly offered to the water quantity problem is to set a minimum flow for a stream and then prohibit withdrawals when that minimum is reached. This minimum flow is normally established to meet some critical aspect of a fish's life history such as rearing during the summer, spawning in the fall, or migration in the spring. While setting a minimum flow does set a floor value it also sets a target for users to hit. Any water in excess of the identified minimum is seen as available for out-of-channel uses. The real purpose of setting a minimum flow is to define the level of water-supported growth and industry which will be allowed in a watershed. A possible compromise that would

benefit aquatic organisms would be to require that all diversions where water is not consumed through evaporation, evapotranspiration, uptake by plants, animals or humans, or inclusion in a manufacturing process, must be returned to the point of diversion with the same quality as when it was removed. Why is so much freshwater used once and discharged in marine waters and why is wastewater not returned to the point of diversion?

A second problem associated with water is not too little but too much. Floods have a profound effect on in-stream habitat. Periodic over-the-bank flooding, under a natural hydrologic regime, is necessary to maintain high quality in-stream habitat. But under the altered hydrologic regimes brought about by logging and development in a watershed, floods are almost always detrimental to salmonid fish. Impervious surfaces do not allow water to infiltrate the soil. Logged hillsides and associated road systems similarly produce runoff rather than infiltration such that a storm generates more runoff and generates it more quickly than historically.

What do we do with floodwaters? We try to confine them between levees, rock armor the banks, straighten the channels, place streams in underground culverts, and clear out the streams so that the water will pass by quickly. These actions lead to higher velocities which increase movement of streambed gravels which kills eggs. The ability of a stream to move material increases with increases in velocity. As velocity increases both the size of particle moved and the total amount of material moved increases. For example, if the velocity is doubled, the volume of the largest rock fragment that can be transported may be increased by as much as 64 times. If the velocity of the water at the surface of the streambed can be reduced, the redds and their incubating eggs would be protected. If a stream's floodway is widened the velocities can be kept lower, improving egg survival. Setting back levees will substantially reduce stream velocities. There is, however, a downside to widening the stream channel. If water withdrawals lower summer flows, and development increases winter flows, then the resulting stream will have summer flows that are low, warm, and perhaps intermittent, because the channel necessary to carry the flood flows is so much larger than that necessary to carry the summer flow. This increased channel width may place riparian trees well away from the summer watercourse limiting

their ability to provide shade to keep the water cool. The stream then becomes more suited to the production of species which only incubate eggs in the stream (pink (*Oncorhynchus gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*)) rather than those species with extensive summer and winter rearing in the stream (chinook (*O. tsawytscha*), coho (*O. kisutch*), steelhead (*O. mykiss*), cutthroat (*O. clarki*), native char (*Salvelinus malma* and *S. confluentus*)).

In order to return a watershed to a more natural hydrology, it will be necessary to remove levees away from streams in order to increase the flood plain, relocate flood plain houses and businesses, replace road and railroad fills with causeways, and develop methods to slow runoff in developed areas, agricultural areas, and in industrial logging areas so that flooding is proportionate to that which would occur if the ecosystem were intact. Will this be done in Washington?

Any decisions about streamflow issues in Washington will establish a new hydrologic cycle and therefore a new environment to which anadromous salmonids must respond, just as earthquakes, volcanic eruptions, and glaciation challenged them in the past. If enough fish are allowed to spawn, I believe they will successfully adapt in those new environments which meet their overall needs. These fish will be different from those present 200 years ago. No law, no matter how well intended, can alter the biological reality that if the habitat is not suited for a particular species, that organism will not survive. This happens when volcanoes erupt or when new shopping centers, subdivisions, and highways are built. Once the stream reaches some sort of stability, fish may re-invade if there is a population in connected waterways, if migratory paths are not blocked, and if there is sufficient high quality water.

A critical component of salmonid habitat is the estuary. Estuaries provide a gradient between fresh and salt water that helps fish make the physiological adjustment between the two, and they are food rich areas where juvenile salmonids grow rapidly before moving to the high seas. Washington's estuaries are quite different than they were in 1750. They have been filled, tidelands have been turned into uplands, shallow areas have been dredged, and freshwater input patterns have been changed. The resulting estuary will support entirely different animal and plant communities because the habitat is different. Are we going to

restore the highly industrialized estuaries of the Duwamish, Puyallup, and Snohomish estuaries or the agriculturally developed Stillaguamish, Skagit, and Nooksack estuaries to a more hospitable environment for salmonids?

Harvest

Salmonid harvest management in Washington is complicated because there are more demands for fish than there are fish available. Sport, commercial, and subsistence fishing have played a large part of Washington's history and economy. There is a strong emotional connection to the harvest and consumption of salmonids that often blocks dispassionate management. This passion for harvest means that survival of salmonids is insufficient; salmonid populations must be robust enough to withstand large harvests.

Recent studies of the relationship between anadromous salmonids, the nutrients they carry in their bodies, and the function of terrestrial and aquatic ecosystems in the Pacific Northwest show that salmon and other anadromous fishes at one time provided the nutrients that were used extensively by many plants, birds, animals and other fish in the ecosystem. These studies show that Washington's recent spawning escapements have been anywhere from one half to one tenth (or less) of the number required to meet the needs of the ecosystem. Will fisheries be restricted sufficiently to allow for this level of spawning?

In some cases, fisheries have been restricted and the result has been large spawning escapements. These escapements have been well above the identified escapement goal. These streams should be intensively studied to determine the overall impact of these large escapements on the entire ecosystem. Will we invest sufficient time and money on these questions in order to provide decision makers with scientifically defensible answers?

Hydropower

The hydropower system is the biggest impediment to anadromous salmonid population recovery in the Columbia River watershed. Even if it were possible to engineer dams so that migrating adult and juvenile fish suffered little mortality when passing through the reservoir and dam, construction of the dam and reservoir has destroyed spawning and rearing habitat through inundation. In the

mainstem Columbia and Snake rivers alone, more than 90% of the spawning habitat upstream of Bonneville Dam has been inundated. It can be recovered only by dam removal. Not only are the fish themselves lost, but the nutrients which they transported from the ocean to fuel the ecosystem are also lost. The same can be said for any dam that blocks anadromous fish migration.

Hatchery Management

Hatcheries, their existence, and the manner in which they are used are the centerpiece of debate in Washington. Arguments range from hatcheries being the source of all current salmonid problems to hatcheries being the answer to all problems. A key to understanding the debate is to recognize that the management of hatcheries (how fish are actually cultured) and hatchery management (how the fish are used in fisheries) are two entirely different topics. My primary intent here is to discuss hatchery management. It is unfortunate that we have been unable to appropriately manage the ease with which salmonids can be cultured. We have used this ease of culture to justify inherently poor fisheries and habitat management decisions. Ease of culture of salmonids has allowed society to justify decisions to destroy habitat or overharvest naturally produced fish populations. Habitat destroyed by dam construction is mitigated by building a hatchery. The hatcheries on the Cowlitz, Lewis, and Columbia rivers demonstrate this. Hatcheries also produce fish to create fisheries. It is particularly destructive when brook (*Salmo fontinalis*), brown (*S. trutta*), rainbow, and lake (*S. namaycush*) trouts, and a plethora of Centrarchids, Percids, and Esocids are stocked into waters accessible to native salmonids because the native fish were deemed to be not as desirable as the introductions.

Hatcheries are much more efficient than nature at producing salmonids for harvest. Fewer spawners, less water, and less land base are needed by a hatchery to produce an equivalent number of fish. The Hood Canal Hatchery has produced, catch plus escapement, chum salmon runs in excess of 300,000 fish. This hatchery has a water right for 0.5 m³/sec of freshwater from Finch Creek. This freshwater is used to produce a run of chum salmon that in the last decade or so has generally been about twice as large as the chum salmon run produced by the entire Skagit River watershed (8,000 km²). The Hood Canal Hatchery water

supply occupies a fraction of the area occupied by the Skagit watershed. From a pure benefit/cost analysis, producing chum salmon at a hatchery as successful as Hood Canal frees up the whole Skagit watershed for the production of wood fiber, hydroelectric generation, agriculture, and whatever other uses society decides are more valuable than wild chum salmon. Another advantage of artificially produced runs is that they are inherently more stable than a naturally produced run. Most of the mortality on naturally produced salmonids occurs in freshwater. A hatchery, by providing technological fixes to problems of flooding, predation, disease, and loss of habitat can produce a relatively stable annual return. In contrast, a wild run subject to the vagaries of nature will vary over a much wider range of abundances. Again, this is demonstrated by comparison of the Hood Canal Hatchery chum salmon run to the Skagit River watershed. In only one year out of four (basically representing a single brood year) the return of chum salmon to the Skagit is greater than the return to the Hood Canal Hatchery.

It is this success that leads to problems. In order to harvest a high percentage of the Hood Canal hatchery chum at their highest economic value, the decision was made to deliberately overfish the naturally spawning chum in Hood Canal. In the 1970s, the Washington Department of Fisheries found that managing for the identified wild escapement goal of chinook salmon in Puget Sound resulted in surplus fish at the hatcheries and wild escapement goals being unmet due to an effort to catch the hatchery fish. The solution was to lower the wild escapement goal in those systems with hatcheries to a level that could be met under the desired fishing regime, and surpluses of fish at the hatcheries were reduced.

There are alternatives. Fish can be harvested in terminal area fisheries after they have separated from other stocks. Fish can be selectively harvested using specially designed gear that allows fishermen to separate and keep hatchery fish and release naturally produced fish. To accomplish this, hatchery produced fish would have to be externally marked for easy identification, and non-selective gears would have to be eliminated. A major problem of using selective gear in commercial fishing operations is that each fish must be handled and examined. Holding fish awaiting examination in an uncrowded environment will increase the cost per fish.

Conclusion

By our actions, society has already decided that anadromous salmonids in the Pacific Northwest will exist in lower numbers and less diversity than historically. The Duwamish River has had the White River and Lake Washington watersheds removed from it, plus the diversion of water to meet Tacoma's domestic needs. The White and North Fork Skokomish rivers have had large bypass reaches created in order to generate electricity. The estuaries of the Duwamish and Puyallup rivers have been extensively industrialized to where there is little of the functional estuary remaining. Almost every stream in the Puget Sound lowlands has been in some way straightened, diked, or leveed so that the floodplain can be put to agricultural, housing, or industrial use. Most of the mainstem Columbia and Snake Rivers has been converted to reservoirs. Realistically, none of this will change. There is too much money invested, and too much in tax revenues and economic power to remove what is now in place. Consider the difficulty being faced by the proposal to remove the two dams on the Elwha River. The electricity is available elsewhere, they provide essentially no flood protection, and their removal offers the opportunity to restore anadromous salmonid production to an essentially protected watershed. If it is so difficult to act in a situation where the benefits to the natural resources are great and the costs to society small, how can we ever consider restoration of the Columbia or any other developed watershed?

Similar decisions have already been made for other species. Will marshes in the Dakotas, Minnesota, and other parts of the Great Plains be restored to allow whooping cranes (*Grus americana*) to nest in their historic range? Will the Sacramento Valley be restored for pronghorn (*Antilocapra americana*), tule elk (*Cervus elaphus nannodes*), and grizzly bear (*Ursus arctos horribilis*)? Will the key deer (*Odocoileus virginianus clavium*) be restored to all of the Florida Keys? Will we restore the great northern and southern herds of bison (*Bison bison*) to the Great Plains? The policy decisions are plain: species will be maintained in areas where sufficient habitat exists, where that habitat can be preserved, and where existing infrastructure is protected.

In taking a realistic look at the ability of Washington's watersheds to produce anadromous salmonids it is apparent that some difficult choices must be made, and those that have been made

must be publicly confirmed. The first is to admit there will be certain watersheds and certain species that cannot be maintained at levels that will support harvest, if they can be maintained at all. The provision for harvest is important because in most of Washington, there are Indian Tribes with treaty rights to harvest anadromous salmonids. The second decision is to make a firm commitment to preserve and restore those watersheds which still offer the opportunity to produce fish. These streams will be where wild anadromous salmonid populations will be restored to levels which will support fisheries. The rest of the state will need protection, but any substantial harvest will come from cultured fish.

I mentioned the need to provide harvestable fish. The goal of the ESA is to simply restore and maintain a species so that it will not go extinct. The rights of Washington Treaty Indians require more. The Boldt Decision held that Treaty Indians are entitled to catch fish. The loss of fish through the loss of habitat did not diminish this right. Because most of the causes for the decline in harvest by Washington Treaty Indians can be laid to societal decisions such as water diversions, hydro-electric dams, development, reduction in hatchery programs, and management disagreements with Canada and Alaska, it can be argued that Washington and the Federal Government must operate a hatchery system to replace these lost fish in the Treaty Indian harvest.

The resulting scenario is that some areas of Washington will be retained for wild fish production to protect evolutionarily significant units of a particular species. In the developed areas of Puget Sound and the Columbia Basin, we will recognize that the habitat has been so altered that the cost of producing meaningful numbers of wild anadromous salmonids is too high and that wild anadromous salmonids may become essentially extinct. In these areas there will be extensive artificial-production programs designed to provide desired levels of harvest. Further, the artificially produced fish will all be externally marked so that naturally produced fish can be released when appropriate. These programs, because they are in place to meet a treaty right, will need to be assured of funding. The production of additional fish to allow non-Indians the opportunity to harvest anadromous salmonids can remain a discretionary option for the state and federal budgeting and management authorities.