The Trouble with SALMON

Among the issues are deciding which salmon are in trouble, and in describing just what the trouble is.

BY PATRICIA KOSS AND MIKE KATZ

FOR decades the Pacific Northwest has been immersed in debate regarding the state of salmon runs in general — and lately, of wild salmon runs in particular. Since enactment of the Northwest Power Act in 1980, an estimated $4 billion has been spent to restore diminished Columbia River fish runs. Most observers consider the results disappointing. Except for a spasmodic burst of record-level runs last year and this year, many species of wild fish continue to decline or remain significantly below target levels of recovery.

Columbia River salmon runs once were reckoned the largest in the world. Before 1850, an estimated 10-16 million wild adult salmon returned from the ocean to the Columbia Basin each year. Today's runs are significantly reduced, something on the order of one-fifth to one-eighth of historic levels. Furthermore, only 20 percent or so of the present diminished runs are considered "wild fish;" the remainder come from hatcheries.

Declining fish runs in the Columbia Basin are not a recent phenomenon. Estimates indicate that 60 to 90 percent of the decline in salmon runs since the mid-19th Century occurred before the 1930s when Bonneville Dam, the first major dam across the Columbia River, was constructed.

There are many stakeholders — Indian tribes, industries, state and federal agencies, cattle grazers, power producers, industrial power customers, navigation interests, environmentalists, irrigators, sport and commercial fishers, timber operators, farmers, and recreational users — and controversy rages among them as to causes and remedies. More, there is debate as to who should bear the costs of restoration, full or partial, if indeed restoration is feasible.

Many factors, alone or in combination, have been nominated for blame. Not everyone agrees on the causes of the diminished fish runs, but no one disputes that a partial list of the putative fish killers would include: forestry, farming, cattle grazing, fishing (sport, commercial, and tribal, both in streams and at sea), industrial activities, road building, logging and forest clearing, urbanization, dams, hatcheries, deterioration of culverts , predatory birds and sea mammals, and variations in ocean conditions. All and more have been cited as principal causes of the slump in salmon stocks to unsatisfactory levels. Some of these "causes" are susceptible to policy intervention; others are not. Fishing can be curtailed or prohibited; ocean conditions are more or less beyond human control.

There is debate, too, within the scientific community. Some of this debate stems from the very real uncertainties regarding scientific, economic, and social values. More unsettling is that salmon experts and scientific "facts" may be susceptible to manipulation by proponents of particular policy positions. Some salmon scientists candidly admit that it is extremely difficult to obtain funding for objective research.

The Decline and Fall of Salmon Populations

The abundance of the salmon population is determined by three principal factors: the reproductive potential of adults returning from sea to spawn; the production of offspring from natural reproduction in streams and artificial propagation in hatcheries; and sources of mortality. Each major stock of salmon is made up of sub-stocks that display variations in spawning timing, feeding behavior, ocean migration patterns, and so forth. A small fraction of adult salmon do not return to their stream of origin but stray to neighboring streams. The resulting genetic diversity facilitates the species' survival of and recovery from disruptive events. Hence, preservation of diversity is a key to survival.

What events associated with the Columbia River Basin disrupted the salmon and their environment? We can identify five "encroachments" that impacted Columbia River salmon populations.

First, the advent of the commercial salmon fishery led to severe over-exploitation of salmon runs prior to the 20th Century. Second, salmon habitat began to suffer early in the 20th Century, when water diversion dams were built in sub-basins of the Columbia in order to irrigate agricultural land in the Pacific Northwest. Fish could no longer reach habitat upstream of barrier dams, and the dams altered the quality of habitat that remained accessible. A third encroachment was the introduction of non-native fish species during the 20th Century, which continue to occupy habitat and prey on salmon fry, fingerlings, and migrants.

Hydroelectric development imposes yet another adverse impact on native salmon populations. Between 1931 and 1984, a total of 61 major dams were built in the Columbia Basin for hydroelectric power and irrigation systems.

Hydropower has been successful, and has generated the cheapest electric power in the nation for the benefit of the Pacific Northwest. However, 60 percent of the Columbia Basin watershed became inaccessible to salmon and over 64 percent of the remaining mainstem has been changed into reservoirs, altering the migratory success of adults and juveniles. The reservoirs also changed the temperature profile of the Columbia mainstem corridor. These alterations of the river disrupted the relationship of the salmon with their habitat, which translated into reduced survival of those young salmon in the system unable to adapt.

The final encroachment on Columbia River salmon was the fisheries management process itself. An entire scientific discipline evolved for the purpose of determining the minimum number of fish that should not be harvested, but instead allowed to reach the spawning grounds to satisfy the replacement needs of the population. Management to minimize escape (and therefore maximize harvest) compromised the selective mechanisms that reinforced the genetic diversity essential to sustain a thriving salmon population.

How Many Salmon, and What Kind?

There have been numerous efforts to restore and enhance fish populations in the Columbia system, starting with the installation of fish ladders to assist returning adults when the first main-stem Columbia River dams were constructed. The primary response to the decline in natural or wild production has been to intensify hatchery programs. However, these programs were not designed around the biological needs of salmon. Therefore, the synchrony of the salmon with their native habitats was disrupted and the hatchery-produced fish did not always adapt to the streams into which they were released. The result was to further speed the decline in populations of wild salmon. At the same time, maintaining healthy stocks of wild salmon was not a priority. In fact, one of the reasons for the so-called lack of success in salmon recovery is that the objective has changed from salmon in general to wild salmon in particular.

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There are three broadly-stated visions of a desirable outcome: (1) more salmon, (2) more salmon in the right places, and (3) more wild salmon in the right places. The magnitude of the problem and the range of policy prescriptions depend in large part upon to the vision to which one subscribes. Because the dominant or popular vision has changed over time, the appropriate scientific questions have also changed. Moreover, the data and knowledge requirements to answer these questions are also different, depending upon which version of the problem is examined. Monitoring programs, and the institutions implementing these programs, originally evolved when the recovery of wild stocks was not a priority.

Congress enacted the Endangered Species Act (ESA) in 1973 and added amendments through 1996. Under the statute, the National Marine Fisheries Service (NMFS) has the responsibility to administer the ESA for anadromous and marine species. NMFS has focused on "natural" or "wild" fish. There has been confusion and disagreement regarding the definitions of the terms "wild" and "species," which has, to some extent, led to policy paralysis. Plainly, a "wild" salmon is one produced by natural spawning in fish habitat from parents that were spawned and reared in fish habitat. Conversely, a "hatchery" salmon is one produced by artificial spawning, usually accomplished in a hatchery.

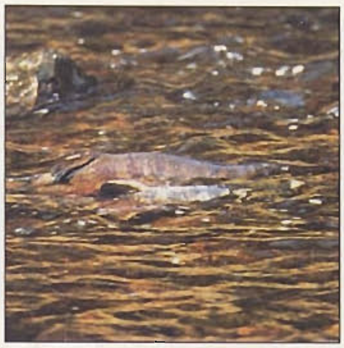
At the extremes, the difference between "wild" and "hatchery" is clear. Between the extremes, there is a very large gray area. For example, how are fish that use artificial spawning channels classified? How are salmon produced by lake fertilization classified? What about salmon stocks which, over many generations, have been able to adapt and survive in highly altered aquatic environments? NMFS excludes hatchery fish from salmon populations considered for listing under the ESA, unless they are critical to the preservation of genetic diversity. It is generally accepted by scientists that interbreeding between hatchery-raised and wild fish will have a negative effect on fitness; but there exists no reliable prediction of the magnitude of decreased fitness. Moreover, in the absence of tagging, we cannot differentiate naturally-spawned second generation hatchery fish from wild fish. Indeed, NMFS considers those progeny wild fish.

Each salmon "species" is composed of many stocks — defined as self-perpetuating populations that spawn generation after generation in the same location. Debate over the "extinction" of wild salmon is usually focused on decline or loss of salmon stocks, not salmon species. A sizable part of the Pacific Northwest no longer supports runs of wild salmon, but it is unlikely that any species of salmon will entirely disappear from the region in the foreseeable future.

There are ongoing scientific debates about the level of genetic distinctiveness appropriate to define a stock. The way in which we do so has major policy ramifications. Unfortunately, the ESA does not define or provide a means of assessing population "distinctiveness." That omission has fostered considerable confusion and debate in the Act's application to salmon policy.

Some scientists argue that protecting every stock may not be necessary to preserve sufficient genetic variation to sustain each species. For example, the concept of an "evolutionarily significant unit" (ESU) was fashioned to describe a salmon population unit whose loss would be significant for the genetic or ecological diversity of a given salmon species. Using ESUs as the unit of concern in salmon preservation has been criticized because there is no established amount of significant "difference" among populations or stocks that is necessary to identify ESUs.

It is clear that the vague objective of "restoration" takes a variety of meanings to the assortment of salmon scientists, decision officials, and policy advocacy groups. At one extreme, restoration may mean the rebuilding of wild salmon runs to levels that existed prior to 1850 (in other words, runs sufficiently large to support intense, but sustainable, fishing by commercial, recreational, and Indian fishermen). To others, recovery efforts would be deemed successful if we were able to maintain stocks at levels where extinction was unlikely. Some people argue that most salmon habitat has been altered beyond rehabilitation, and condone a significant role for hatcheries. Still others are willing — even eager — to eliminate commercial and recreational harvest, close all salmon hatcheries, and breach major dams. Without the articulation of a rational and realistic goal for wild salmon in the Columbia Basin, programs funded to recover wild salmon and steelhead have little or no basis on which to judge success.



One Thing Is Certain: There Is Much Uncertainty

Which solutions, alone or in combination, will enhance fish runs is surrounded by uncertainty. There are significant uncertainties as to the benefits of efforts to date in the areas of habitat restoration, harvest management, mitigation through hatcheries and modifications to hydropower production. Specifically, there is uncertainty regarding the relation between habitat restoration actions and habitat quality, the relation between habitat quality and fish production, appropriate levels of coordination and enforcement, and the appropriate decision-making structure. The key uncertainties about harvest management are how to limit the effects of mixed-stock fisheries on weak stocks, coordinate ocean and in-river harvests, coordinate interstate and international management actions, develop mechanisms to protect listed stocks, and accommodate scientific uncertainty about ocean effects on productivity, population dynamics, and genetic diversity.

The uncertainties underlying the mixed-at-best success of hatchery programs include incomplete knowledge about the effect of interbreeding of wild and hatchery fish, the extent to which genetic diversity must be protected, and the effect of habitat carrying capacity and numbers of hatchery releases on wild fish recovery. Finally, the key uncertainties about the effect of hydropower dams on salmon are how to manage the levels of indirect mortality induced by upstream and downstream passage, the effectiveness of measures taken to mitigate the harmful effects of dams, and the economic impacts of altering dam operations. Major questions surround the efficacy, not to mention the practicality, of dam breaching.

These uncertainties and the complex patterns of human activities in the Columbia River Basin make clear the complexity of the issue, and the difficulty of the coordination tasks. Actions on policy, regulation, and implementation for each of the restoration options are taken in many separate decision arenas, each with its own set of objectives and priorities.

Salmon in Sum

Proposed solutions to salmon recovery problems range over a broad spectrum. Different solutions impact different constituencies differently. The region has become increasingly polarized, and because no one sees how the issues will ultimately play out, stakeholders tend to stake out the most extreme positions at the outset. This atmosphere has been evident for years but seems to be intensifying.

Even if there was agreement among decision-makers as to the goal of salmon recovery efforts, and even if the aforementioned uncertainties were not so prevalent, the jurisdictions of agencies and organizations that are charged with making resource decisions are complex and fragmented. Decisions about marine salmon harvests, in-river harvests, power sales, dam operations, irrigation withdrawals, fish passage, hatchery production, and habitat protection are the responsibility of entities with overlapping boundaries, competing objectives, and incomplete authorities to accommodate the full scale of causes or effects.

Policy debates over salmon recovery tend to focus on narrow, relatively insignificant technical or scientific issues. For example, there are over 250 major dams in the Columbia Basin. Arguments over removal of a few dams, or the options for transporting smolts around dams, are interesting and controversial technical debates. However, it remains true that aquatic and terrestrial habitats have drastically changed in the Columbia Basin over the past 150 years. It is highly unlikely that the historically large runs of wild salmon can be supported in this modified environment. Society may well choose to make the trade-offs necessary to maintain a relatively small number of wild salmon, assuming such trade-offs can be identified, quantified and accurately communicated, but scientists should be realistic and candid about the actual number of wild salmon that can be expected from ventures such as dam-breaching and hatchery programs.

Adding markedly to the uncertainty is the recent unexpected robustness of Columbia River salmon runs. Runs in 2000 for several key species broke all records since fish counting began in 1937. Runs in 2001 are expected to be larger still. For example, adult spring chinook returning to the upper Columbia Basin in 2001 are expected to total 365,000 compared with about 100,000 when the Snake River dams were completed in the 1970s. Most of these fish are hatchery fish, but recent runs of wild fish are also dramatically improved.

Why? Speculation focuses on improved ocean conditions, which are not expected to persist, or to heavy spring runoff in 1998 and 1999. No matter. The important conclusion to be drawn is that uncertainty and lack of agreement as to what constitutes the desirable outcome with respect to numbers, species, and genetic diversity, are the issues, perhaps more than any others, which should dominate the Great Salmon Debate.

For More Information

This article was based largely on the following papers presented at the Portland State University Salmon Symposium, July 7-8, 2000: What We Don't Know About Pacific Northwest Fish Runs: An Inquiry into Decision Making Under Uncertainty.

Brannon, Ernest L. "The Salmon Crisis: A Lesson in Semantics."

Goodman, Daniel. "Managing Columbia Basin Salmon: the Facts, the Questions, and the Data."

Hanna, Susan. "Institutional Redesign for Pacific Northwest Salmon Ecosystems."

Huppert, Daniel. "Columbia River Salmon Recovery: Where are We Going? And How do We Get There?"

Katz, Mike, Patricia Koss, and Jennifer Shawcross. "Addressing Fish Uncertainty: The Quest for Rational Decision-Making."

Lackey, Robert T. "Restoring Wild Salmon to the Pacific Northwest: Chasing an Illusion?"

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