DECLINING SALMON FISHERIES

James C. Barron and James J. Anderson

Salmon have migrated up and down the rivers of the Pacific Northwest for millions of years. The young salmon journey from upstream spawning areas to the ocean, where they mature. Adult salmon then travel upstream to spawn another generation. The Columbia River and its many tributaries drain an area of 260,000 square miles in seven states of the U.S. and two Canadian provinces. Virtually all of this region is east of the Cascade Mountains and consists of deserts, prairies, and about a dozen different mountain ranges. Great variation in climate, topography, elevation, vegetation and economic activity exists over this area. Salmon once populated the entire stretch of the Columbia and Snake River systems. The loss of one-third of the salmon's habitat, and a series of dams that must be negotiated on their trip to and from the ocean, have caused wild native salmon populations to decline dramatically over the last 50 years.

Since the overall ecosystem within which salmon live is so large and diverse, there is no single factor or reason for the decline in numbers of fish in recent years. Hence, there is no single solution for their revival. To complicate the situation further, there are large gaps in the biological database available to public agencies, private organizations, and the public. Scientists discuss the mechanism in salmon that drives them to salt water and then forces them to return to the precise spot they were born to spawn three to five years later. But no one clearly understands what that mechanism is in the salmon, how it works, and what things can cause it to go awry. Biologists know some of this information, but far too little to be able to provide accurate solutions. Even with some of the proposed solutions that have been discussed, there are natural limits of water quantities and other factors that may prevent them from being successful on a regular basis.

The Columbia River system probably has a greater influence on the economy of the Pacific Northwest than does any other river in the world. It is the source of over three-fourths of the electric power consumed by residents, it provides water to irrigate about 8 million acres of farmland, it provides barge transportation between Lewiston, Idaho and the Pacific Ocean, it provides a wide range of recreational opportunities, and is the habitat for anadromous salmon and steelhead along with many other species. The river system is clearly a major economic force in the region. How it is managed to balance the provision of those goods and services influences jobs, incomes, distribution of population, and public finance. Until recently, the river was viewed as an almost inexhaustible resource but the time has long since arrived when any increased use of the river for one use will be at the expense of some other use. It can no longer meet all the demands that have been placed upon it.

The historical salmon habitat extended far into Canada on the main stem of the Columbia and via the Snake River to Wyoming, Utah, and Nevada. Tributaries throughout that region provided spawning beds. In the 1930s, Bonneville Dam was built, ushering in a half century of dam building to create facilities for barge transport, power production, irrigation water, and flood control. Coulee Dam in northcentral Washington was built without fish ladders and eliminated thousands of miles of habitat upstream. The Snake River was blocked off above Hells Canyon Dam, thus wiping out thousands of miles of stream formerly used by migrating salmon.

It has been estimated that 100 years ago there were between 10 and 16 million salmon a year moving out to sea. Today that number is about 2.5 million and over 2 million of those are hatchery produced fish. When the dams were built it was assumed that hatchery production would effectively substitute for the former wild runs of salmon and not harm or unduly compete with remaining native stocks. The wild fish numbers have continued to decrease, however, and there is a growing recognition that hatchery production has not been the solution as expected. Hatchery fish do not have the genetic vigor of the wild stocks and there is much more danger of disease in the heavy concentrations associated with hatchery production.

The Endangered Species Act was invoked in response to a 1990 petition to list the Snake River Sockeye as endangered. This particular stock spawns only in Red Fish Lake, high in the Salmon River drainage, and the number of returning fish in the last half dozen years has been in the single digits. Later, the National Marine Fisheries Service listed Snake River Spring/Summer Chinook and Fall Chinook as threatened. These listings have led to much concern by many private and public organizations about possible adverse economic consequences stemming from recovery efforts that have still not been fully developed.

UPSTREAM HABITAT

In addition to the loss of much of the salmon spawning habitat closed off by dams without fish ladders, there is increasing concern about the quality of the remaining habitat. The fish need a river environment in which they can lay their eggs to be left undisturbed until the fry emerge and grow to the point where they can move on their own. Gravel beds, pools in the stream for protection, and sufficient flow of quality water are required. Land uses in the riparian zones along streams can have an effect on the quality of the stream habitat. Cattle trampling stream banks, road building, some forest harvest practices, and other uses can result in sediment runoff into the stream and ruin

Published in proceedings of "Ecosystem Management in Western Interior Forests" held May 3-5, 1994, Spokane, WA, USA.
Compiled and edited by Richard L Everett and David M. Baumgartner, Washington State University Extension, Pullman, WA.
(Bulletin Office, WSU, PO Box 645912, Pullman, WA 99164-5912.) MISC0228. 245 pp

spawning areas. Removal of streamside cover also can lead to higher water temperatures.

Evidence of deteriorating habitat quality is beginning to accumulate, but it is slow. The U.S. Forest Service, in cooperation with other agencies, is surveying and assessing stream conditions to determine if changes have taken place and the extent of those changes. Two examples are cited here.

Overton, Radko and Nelson (1993) studied two streams in Idaho that flow into the Little Salmon River and have similar elevation, climatic conditions, parent geology, and upland and streamside vegetation. Rapid River has been largely unaffected by forest development while Boulder Creek has been intensively managed for timber production. The streams were compared in terms of habitat variables for fish. Table 1 shows comparisons of selected variables on the two streams from comparable areas of the streams.

Table 1.—Comparisons of selected variables on Boulder Creek and Rapid River from comparable areas of the streams.

	Rapid River	Boulder Creek	Sig*
	mean		
Pool vol. (m3)	63.03	35.59	0.005
Pocket pools (n/100 m)	11.12	5.00	0.005
Pool depth (m)	0.46	0.37	0.0001
Single LWD/100 m	7.04	3.53	0.0001
% Fines	9.66	12.23	0.0001
% Gravel	19.02	22.29	0.0001
% Rubble	20.64	25.93	0.0001
% Cobble	21.19	17.81	0.0001
% Boulder	27.23	19.55	0.0001

*T-tests for equal variances were used.

Rapid River, which was not subjected to timber management for harvest, had significantly better mean values of the habitat characteristics listed. Pools were more numerous and deeper. There was more large woody debris in the river to provide protection and help form pools. Rapid River also had less fine material in the stream bed than Boulder Creek.

A separate Forest Service study done by McIntosh et al. (1994) focused on changes over 50 years in the number and size of large pools available in streams of various river basins east of the Cascades. Pools were defined as areas of 20 or more square meters and over 0.8 meters deep. The streams surveyed in the late 1930s were resurveyed in 1991 to determine differences in stream habitat conditions for fish. Data are available for the main stem and selected tributaries of the Grande Ronde, Yakima, Wenatchee, and Methow rivers.

Table 2 shows the 50 year comparison for the Grande Ronde. Eight of the eleven observations show dramatic declines in large pools available for fish. The overall basin suffered a drop of two-thirds of the pools. All the observations were for watersheds that have been managed for forest production and grazing. The latest survey also showed high levels of fine sediments throughout the Chinook salmon spawning habitat.

Table 2.—Large Pools per Kilometer in Grande Ronde River Basin, 1941 to 1990.

Watersheds	1941	1990	% Change
Managed			
Rock Creek	0.00	0.9	90
Jordan Creek	0.00	0.00	-
Five Points Creek	1.8	1.8	-
Meadow Creek	2.5	2.0	20
Sheep Creek	14.6	6.8	53
Catherine Creek	9.2	3.6	61
N. Fk Catherine Creek	4.7	1.7	64
Grande Ronde River	4.0	1.1	73
McCoy Creek	9.1	1.7	81
Beaver Creek	10.0	1.5	85
S. Fk. Catherine Creek	11.2	1.5	87
AVERAGE	6.1	2.1	66

The Yakima River basin habitat characteristics are shown in Table 3. The river has been managed similarly to the Grande Ronde with grazing dating back to the 1800s and later forest management. Overall, the number of large pools increased by 111%, with only the American River showing a decline. The one unmanaged watershed surveyed showed an increase of 144%.

Table 3.—Large Pools per Kilometer in Yakima River Basin, 1935 to 1990.

Watersheds	1935	1990	% Change
Managed			
Taneum Creek	0.5	3.4	580
Little Naches River	1.7	4.6	171
Rattlesnake Creek	1.9	4.6	142
American River	3.3	2.4	27
TOTAL	1.8	3.8	111
Unmanaged			
Rattlesnake Creek	1.6	3.9	144

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The Wenatchee River basin, Table 4, contained one managed and three unmanaged watersheds. All had increases in pool numbers, but the increase was much larger on the unmanaged areas.

Table 4.—Large Pools per Kilometer in Wenatchee River Basin, 1935 to 1991.

Watersheds	1935	1991	% Change
Managed			
Nason Creek	4.9	7.7	57
Unmanaged			
Jack Creek	1.9	8.1	326
Icicle Creek	3.8	10.3	171
Chiwawa River	1.8	4.2	133
AVERAGE	2.5	7.5	200

The Methow River shown in Table 5 had increases in number of pools on all reaches. The increase on the one unmanaged watershed was more than double the overall average on the managed watersheds.

Table 5.—Large Pools per Kilometer in Methow River Basin, 1935 to 1991.

Watersheds	1935	1991	% Change
Managed			
Chewack River	1.0	3.5	250
Methow River	1.4	3.0	114
Twisp River	2.8	3.9	37
AVERAGE	1.7	3.4	100
Unmanaged			
Chewack River	1.0	3.4	240

The two studies cited here do not provide a comprehensive review of habitat quality on the wide range of inland Northwest streams used for spawning by salmon. The evidence is not reassuring, however. It appears that economic and recreational use of riparian areas over the last half century has had an adverse effect on stream habitat for fish propagation in many areas. Even where the number of pools increased on managed watersheds, the increase was greater for unmanaged watersheds.

INSTREAM MIGRATION

Salmon have to navigate the river system twice in order to complete the life cycle. The first one is getting out to salt water safely so they can mature. Downstream migration poses a series of challenges to young fish. The first is mixing with hatchery stock, which increases the chances of disease among the native strains which spawned in the wild.

For Snake River fish, there are eight dams to be crossed on the trip downriver whether they go through the turbines, over the dam, or are screened through bypass facilities there is some mortality at each dam. The estimates vary, but anywhere from 5 to 15% mortality may occur at each dam. Assuming 10% mortality, that would mean for every 100 fish beginning the trip only 43 would be expected to make it below Bonneville Dam where they still have over a hundred miles yet to go to the ocean. At 15% mortality per dam, there would be 27 survivors out of 100 after eight dams.

Improved screening and bypass facilities are under study and construction at some dams where they have not previously been in place. Even though salmon may successfully get past a dam, they still face the threat of predators in the reservoirs on their journey. Squawfish and other species eat the small salmon and gulls eat as many as they can. With the stress that the fish experience in the transit through a dam, they may emerge disoriented or injured which makes them even easier prey for predators.

Not all the fish go through the dams, however. For over 20 years the Corps of Engineers has collected salmon and steelhead on their downstream migration at Lower Granite (the first dam on the downriver trip) as well as Little Goose and McNary dams. From there they are transported by barge in constantly circulating river water to below Bonneville where they are released to make their way on to salt water. There is considerable controversy about this transportation program. It does get more live fish past the dams, but it is unclear what happens to them after release and how many succumb to injury, disease or predation before completing their trip. It is known that not enough are returning upriver as adults. Whether they succumb to river problems, ocean predators, or harvesters is not entirely documented. Some organizations oppose the barging of fish just on the grounds that it is not a natural solution to the migration problem.

Upstream migration also poses hazards to returning salmon. Dam passage via the fish ladders is strenuous and there are eight to climb over. Water temperatures in the reservoirs can reach higher levels in the summer than would be the case in a free flowing river and may delay or impede the adults returning to spawn.

HARVEST ISSUES

Among the dangers to adult salmon, a major one is harvest by sport or commercial interests. Commercial fishing takes place both in the ocean and the river. Sport fishers also seek salmon in the river and the ocean. When the fish are in the ocean they mix with other fish from different rivers and travel great distances out to sea before returning. Commercial fishers several hundred miles offshore cannot very well separate the fish by point of origin for spawning. Treaties dating back well over a hundred years give Indian Tribes the right to catch fish in the river as well. Each of these interests does not wish to see their rights reduced

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or eliminated, and have sought to encourage other types of strategies to restore salmon runs.

MAJOR POLICY ISSUES

While the National Marine Fisheries Service has not yet released a recovery plan for the salmon stocks under ESA listing, the broad nature of the issues have taken shape.

Downstream Migration

The first issue revolves around how best to get young salmon downstream and out to sea. Two very different approaches have been suggested. The first is to release larger amounts of water from upstream reservoirs during the critical time period when young salmon are moving downstream. The larger flow will "flush" the fish through the river faster to enable them to pass through the reservoirs more quickly. A "water budget" has been identified to be used for this purpose in order to reach flows of 85,000 cubic feet per second (cfs) at Lower Granite dam. Many biologists argue that a flow of up 145,000 cfs is needed to move the salmon most effectively. The problem is that the Snake River does not have enough water every year to meet the 85,000 cfs target, much less the higher flow. The only source for this water in the Snake River is from Idaho and agricultural users who are not keen on giving up irrigation water for the salmon.

To deal with this limited availability of water, some research has been conducted on contingent water markets which could be activated in low flow years (Peterson et al. 1994). It has been estimated that because of the power generation from increased flows, there could be a self-sustaining market in dry years that would require no more than 50% of consumptive water use in agriculture to provide for salmon needs. Farmers would receive fair market compensation for the water and the market would only be needed about three years out of ten years.

The second approach, commonly known as the "Andrus plan" (for Gov. Cecil Andrus of Idaho), would provide for drawdowns of lower Snake River reservoirs during the spring migration of salmon to as low a level as possible to increase the river flow. Before dams were constructed, it is estimated the salmon were able to move out to sea in less than two weeks, but now it takes one to two months. The closer the flow could approximate the free flowing natural river, the faster the salmon could travel through the system, thus shortening the time they would be subject to predation. This would also spare them from dangers of the dams operating at normal pool levels.

The drawdown plan is strongly opposed by a variety of interests, principally those who use the river for barge transportation of grain, lumber and paper products, and petroleum. There are alternatives to barging, but the longer the drawdown, the more severe would be the consequences for firms requiring alternative transportation (Hamilton et al. 1992). There would also be significant modifications required in the dams and water bypass facilities at each of the dams for the drawdown to work effectively. It would also cost the region a considerable amount of electric power generation.

The drawdown plan is strongly favored by some sports fishing interest groups, as well as the state of Idaho because it would move in the direction of a more natural river environment for downstream fish migration. An important drawback to the plan, in addition to the costs mentioned above, is that there is no consensus among biologists that it would work as claimed.

In March, 1994 a federal court ruled that the continued operation of the river system for power production and barging was detrimental to the fish and not in accord with the Endangered Species Act. It directed federal agencies to come up with alternative plans. This action has several immediate and major implications. First, it increases the probability that reservoir drawdowns may be required, even though there is insufficient biological data and understanding to say conclusively that this would be good for the fish. Second, this begins to move the decision making to micro-management by the courts. It could very well lead to decisions based on legal maneuvering rather than on science.

Riparian Land Management

Another major policy issue is riparian land management along streams where salmon return to spawn. This can affect cattle grazing, forest management practices, mining, road building and residential uses of streamside environments. The evidence is beginning to show that there has been significant degradation of the instream habitat for salmon resulting from various economic activities and some changes may be required. What those changes may be, who will bear the costs, and how they will be regulated or managed are questions yet to be resolved.

Harvest

A third policy issue is salmon harvest. Should sport and/or commercial harvest of salmon be curtailed or eliminated in certain areas to aid in salmon recovery? This year (1994) there is a total ban on sport salmon fishing off the coasts of Washington and Northern Oregon. Some coastal communities will feel severe adverse economic consequences of this policy. What should be done, if anything, about river fishing by sport or commercial interests? Should the Native American tribes be expected to cut back or cease salmon harvest they have come to expect from the treaties?

CONCLUSIONS

The decline in salmon populations in eastside rivers has taken place over a long time and results from a mix of factors. The development of the river system for the production of economic goods and services has clearly not been in the long-term interests of native salmon stocks. Biological understanding is not complete and there is uncertainty over the correct mix of recovery measures. Henry Mencken once said, "For every complex public problem there is an answer that is simple, cheap, and wrong!" For salmon there is no quick fix, but there is clearly a danger that measures will be taken that fit Mencken's description.

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(Bulletin Office, WSU, PO Box 645912, Pullman, WA 99164-5912.) MISC0228. 245 pp

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Authors

James C. Barron, Chair
Department of Agricultural Economics
Washington State University
Pullman, WA 99164-6210

James J. Anderson, Associate profesor
School of Fisheries
University of Washington
Seattle, WA 98195

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