Lichatowich: Salmon Without Rivers 1999.

Chapter 8 A Story of Two Rivers

The Fraser and the Columbia Rivers are the two largest watersheds in the Pacific Northwest. Together they drain about 343,000 square miles—an area equivalent in size to the combined land masses of France and Germany. Each of these giants was the world's best at producing a species of Pacific salmon—sockeye for the Fraser and chinook for the Columbia.

The Fraser and the Columbia Rivers are very different ecosystems, characterized by different habitats. For example, the Fraser watershed contains an extensive system of large lakes, which are critical rearing areas for juvenile sockeye salmon. Their ecological differences notwithstanding, the story of their development and salmon management is instructive. Both rivers supported major salmon fisheries, and both showed signs of deterioration by the turn of the century and then rapid decline by the 1920s. The stories of these two great salmon rivers, the depletion of their salmon runs, and the subsequent attempts to restore them demonstrate that the current crisis has at least part of its roots in the failure of science to overcome nineteenth-century myths.

Key to this story are the major restoration programs initiated in each river within ten years of each other: the Fraser in 1937, the Columbia in 1947. Each effort took a very different approach to restoration, and over the course of fifty years—about twelve salmon generations—each has yielded very different results.

The Fraser River

The cornerstone of the Fraser River restoration program was the ratification of a treaty creating the International Pacific Salmon Fisheries Commission.

Before discussing what happened after the commission came into existence, some historical background on what led to the treaty is in order.

The Fraser is the largest river in British Columbia. With a catchment of 84,000 square miles, the Fraser (like the Columbia) penetrates the coastal mountains and drains a large part of British Columbia's intermountain interior. The Fraser starts its 850-mile journey in the Canadian Rockies and then flows northwest through the interior of British Columbia before taking a sharp turn to the south. As the river approaches the United States–Canada border, it takes a sharp turn to the west, eventually reaching salt water in the Strait of Georgia (Figure 8.1).

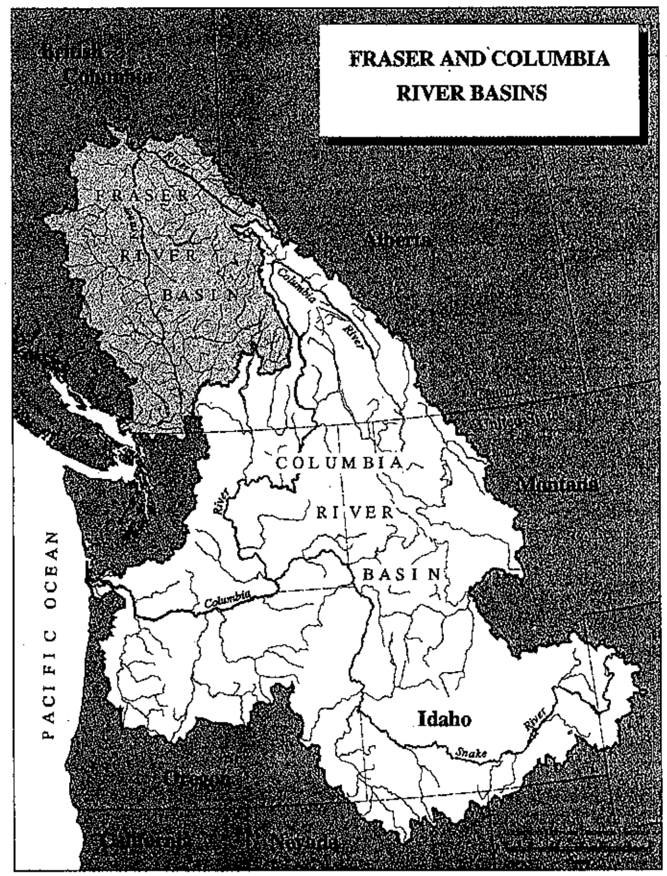

Figure 8.1. Fraser and Columbia River Basins. (Source: Dorie Brownell, Interrain Pacific)

Embedded in the Fraser's tributaries—including the Quesnel, Chilcotin, Thompson, and Harrison—are several large lakes that provide critical rearing habitat for juvenile sockeye salmon. Like the other Pacific salmon, adult sockeye deposit their eggs in the gravel of rivers, but they can also spawn on lake beaches where groundwater wells up through the gravel. No matter where the eggs develop, the juvenile sockeye nearly always spend their freshwater residence in a lake.[1] Because the Fraser River's extensive lake system makes ideal rearing habitat for young sockeye, the watershed is one of the two largest producers of sockeye salmon in the North Pacific (the other is the Bristol Bay watershed of southwestern Alaska).[2]

Before 1913, the Fraser River runs of sockeye salmon gave fishermen and canners every indication that they were truly inexhaustible. So as spring eased into the summer of 1913, the fishermen and cannery workers in north Puget Sound, the Strait of Georgia, the Strait of Juan de Fuca, and the lower Fraser River estuary waited with great expectations. Although no one knew exactly how many salmon would return that summer, they all expected the run to be particularly huge because every four years, like clockwork, an especially large run of sockeye came up the Fraser, and 1913 was the next big year in the four-year cycle.

The difference between the dominant, large-run years and the intervening three years was often striking. In the sockeye run that went up the Fraser to the Adams River, there may have been as much as a thousandfold difference between the largest dominant run and the smallest off-year run.[3] In the big year of 1901, fishermen caught 25 million sockeye salmon; in 1905 and again in 1909, 20 million sockeye were harvested.[4]

Thus, in the early summer of 1913, 4,000 fishermen in 2,500 boats waited for the next big run to begin. Down on Puget Sound, the Americans were also waiting. They had built huge traps across the known migration routes of the sockeye. The salmon's natural instincts would lead them into those meshed labyrinths from which there was no escape.

The size of the run four years earlier had caught the Fraser River canners unprepared. When the flood of sockeye came pouring into the canneries, the processors were so overwhelmed that excess fish had to be shipped south to be canned by Columbia River packers. This time the Fraser canners had built a large inventory of sanitary cans. Canneries that had been idle during the off-years between 1909 and 1913 were reopened, and their machines were oiled, tested, and put into good running order. The cannery workers rested, knowing that when the fish arrived, there would be little sleep until the last pound of pink flesh was sealed in tin.

Along the piers and wharves of the lower Fraser River, gillnetters mended nets and arranged gear in their small wooden boats. They looked out toward the salt water, beyond where they knew the salmon were massing for their run upriver. The fishermen waited. The seagulls, bears, and eagles waited. The fishermen, cannery owners, trapmen, butchers, can packers, warehouse workers, and cooks—all of them knew this was going to be a big year.

The four-year cycle of big runs held true. The catch exceeded all expectations, and despite the preparations, the canneries were again swamped with sockeye coming in faster than they could be canned. Fishermen tried to sell whole salmon on the docks at three for a quarter, but there were not enough outlets for the fish. Even a short-lived strike by some fishermen failed to slow the flood of fish into the canneries. As the catch overwhelmed the canneries' capacity, heaps of rotting salmon piled up everywhere.

When the season was over, the catch had broken all records. Thirty-two million sockeye were canned—22 million from the American traps and 10 million from the Canadian gillnetters. Adding an estimate of the wasted fish to those canned could push the total catch to about 50 million salmon. Despite that intensive harvest, about 6 million sockeye escaped the nets and traps and headed for the spawning grounds. The Pacific Salmon Commission's official statistics, which do not include waste, set the total 1913 run at 38 million sockeye.[5] In a recent report, however, Canadian biologist William Ricker reanalyzed the catch and escapement figures for the early years of the Fraser River sockeye fishery. Using a different but plausible set of assumptions, Ricker concluded that the size of the dominant runs in 1901, 1905, 1909, and 1913 might have reached 100 million fish.[6]

The frenzy of fishing and canning in 1913 reaffirmed the Fraser's status as the world's largest salmon producer. However, an incident in 1912, which went largely unnoticed at the time, would soon illustrate the vulnerability of the river and its salmon to the irresponsible use of technology. The sockeye run in 1913 would be the last large run for many decades.

From June 1911 until the end of 1912, the Canadian Northern Railroad laid tracks along the east bank of the Fraser River canyon. At a place known as Hells Gate, where water draining thousands of square miles funneled through a canyon only 110 feet wide, the construction crew blasted thousands of tons of rock into the river below the railroad grade. This constricted the channel even more, creating extremely turbulent conditions. Sockeye salmon that had escaped the gauntlet of traps and nets now found themselves blocked by the high-velocity currents at Hells Gate. A few fish got past Hells Gate early in the run, when the flows were more favorable, but most of the 6 million fish that escaped the fisheries could not surmount the obstruction.

Millions upon millions of sockeye salmon beat themselves to death in a futile effort to swim against the strong currents at Hells Gate. As the season advanced, the sockeye turned on their bright red spawning colors, which made the blockage and their futile struggle more evident. For ten miles below Hells Gate, millions of dead sockeye salmon filled every eddy and lined the banks of the river. Once people recognized the full extent of the disaster, action was taken to reduce the velocity of the river rushing through the narrow canyon. Work started in September 1913, and by the end of the year, workers had removed 2,000 cubic yards of rock from the river. Seeking to put a positive spin on the disaster, government officials declared that the blockage had been corrected, failing to note that it was already too late for the sockeye to reach their spawning grounds that year.

To make matters worse, the next year railroad workers triggered a massive landslide just upstream, squeezing the river into a seventy-five-foot-wide channel. This time the Canadian fisheries officials did not need millions of dying sockeye to spur them into action. Within a few weeks, they directed workers to remove the new obstacle. The men trying to remove the landslide had to contend with extreme conditions. Wet winter weather made work in the icy river difficult, and blasting from continued railroad construction sent rocks down the slope, injuring some of the men trying to save the salmon from another disaster. A year later, after workers had removed and redistributed about 60,000 cubic yards of rock, fisheries officials believed that the impassable conditions had been corrected, so work was suspended.[7]

Not everyone agreed that the situation at Hells Gate had been corrected. But believers and nonbelievers alike held their breath and wondered if the Fraser River would recover its tremendous fertility—if the huge sockeye runs would return, bringing back the enormous profits of previous years.

The full impact of the disruptions at Hells Gate was not recognized until 1917, when the adults produced from the 1913 run returned to the river. It was a disaster. Only 8 million fish returned to the Fraser in 1917, compared to 38 million in 1913. Of those, only 615,000 escaped the fishery to spawn. In the same cycle, four years later (1921) the total run dropped to only 2 million fish. Through the 1920s and 1930s, the catch in the "big" years plummeted to less than 10 percent of the harvests before the Hells Gate disaster. Hardest hit by the depleted runs were the Indians living above the blockage, who depended on the Fraser's salmon for their sustenance throughout the year.

Salmon depletion is nearly always the result of cumulative stresses on the fish's life cycle in the river, estuary, and ocean. In healthy, resilient ecosystems, stresses are absorbed with little discernible change in gross measures of production. As stresses accumulate, however, the resiliency of the ecosystem is slowly and invisibly lost. At some point, one more stress added to all the other stresses on an ecosystem triggers a major collapse. Debate may then ensue about which specific stress caused the catastrophe. For example, William Ricker believed that overharvest provoked the collapse of the Fraser River sockeye, while W. F. Thompson considered the blockage at Hells Gate to be the culprit.[8] In truth, the careless action of railroad construction crews triggered an avalanche of problems, only some of which were the rocks that fell into the river.

Although the blockage at Hells Gate posed a significant threat to the Fraser's sockeye, other types of habitat degradation and overfishing had already put increasing strains on the ecosystem. The runs of sockeye in the off-years had started to show a steady decline as early as the turn of the century.[9]

As in many rivers farther south in the United States, human activities had already degraded habitat and severely reduced the abundance of some salmon stocks in the Fraser River. For example, two of the most important sockeye runs in the Fraser system, the Quesnel-Horsefly River and Adams River populations, were devastated by environmental problems years before the Hells Gate disaster.

In the big years of the four-year cycle, the Quesnel-Horsefly system may have produced 10 million adult salmon.[10] Then, in 1896, a mining company built a dam on the Quesnel River, blocking access to the spawning areas in the Horsefly River and the rearing areas in Quesnel Lake. A few fish managed to pass the dam using an inadequate fishway, but the dam blocked most of the run. After building the dam, the mining company found it to be unsuitable and never used it; however, incredibly, it remained in place until 1921, even though the mine was closed in 1905.[11]

Similarly, a logging company built a dam across the Adams River in 1908. This dam also had an inadequate fishway that blocked salmon migration into the upper river, rendering useless thirty miles of the most valuable spawning gravel in the world.[12] The water and logs flushed downstream from the large splash dam gouged salmon eggs from the gravel and killed them. This occurred once a day, six days a week. In between each "splash" of water and logs, the flow was cut off, leaving the river below the dam nearly dry. The rich sockeye run below the dam was nearly exterminated, while the run above the dam was driven to extinction. This dam was not removed until 1945.[13]

In addition to habitat destruction, the intensive fishery also put tremendous stress on the Fraser River sockeye population. The amount and array of fishing gear used to harvest the big runs every four years overwhelmed the smaller runs in the off-years. Reconstructed harvest rates for the years before 1935 suggest that the fishermen may have taken 90 to 94 percent of the sockeye salmon in the off-years.[14] Harvest at that rate was not sustainable—it left too few fish to spawn and produce the next generation.

Traps set in U.S. waters were particularly effective in catching the salmon. The sockeye bound for the Fraser River generally followed predictable migration routes through the Strait of Juan de Fuca and the San Juan Islands to their home river. The Lummi Indians knew these migration routes well and had long used their knowledge to harvest salmon with reef nets.[15] When commercial fishermen in Washington State began harvesting the Fraser's sockeye, they used the Lummi's knowledge. But instead of reef nets, the white men built large traps—often placed directly in front of Indian reef net sites, effectively blocking the Lummi's access to the fish.[16] The Americans were soon catching more of the Fraser's salmon than were Canadian fishermen. In 1901, Washington State issued 149 licenses for traps to intercept sockeye salmon bound for the Fraser River, and the Americans canned 1,105,096 cases of Fraser River sockeye compared to the 928,669 cases canned by Canadians.[17]

The traps had quarter-mile-long leads, or fences, that crossed the migration route of the salmon. Once the salmon hit a lead, they moved along it, trying to find their way around the obstacle. But the lead guided the fish into large, corral-like enclosures that caught everything; one writer called them the fisheries version of clearcut logging.[18] A single trap operated by six men could catch as many fish as 150 gillnet boats operated by 300 men.[19] The Americans' traps caught nearly 60 percent of the Fraser River's sockeye salmon.[20]

When Washington's commercial fishermen entered the fishery with their massive traps, questions of fairness were quickly raised: Why should Americans harvest the largest share of Canada's premier fisheries resource?[21] This disparity led to discussions between the state of Washington and the Dominion of Canada and then between the two federal governments; the final result was the Bryce-Root Treaty of 1908. The next year, professors Edward Prince (for Canada) and David Starr Jordan (for the United States) drew up regulations to manage the Fraser River sockeye harvest so that each country

would receive a fair share of the fish. The Canadians quickly passed enabling legislation and gave the regulations the force of law, but there was a snag in the U.S. Congress. American lawmakers never approved the enabling legislation, and in 1914, tired of waiting, Canada abandoned the treaty.[22]

The treaty failed in part because of the difference in the way Canada and the United States manage their fisheries. Management of Canada's fisheries is largely centralized in the federal government, whereas in the United States, individual states control the fisheries in their waters.[23] So with Bryce-Root, the U.S. government essentially negotiated a treaty governing a fishery over which it had no jurisdiction. The state of Washington was keenly aware of its "states' rights" and successfully lobbied Congress against the treaty.[24] Because of Washington State's intransigence, it would take another thirty years to ratify a treaty and bring the harvest of Fraser River sockeye under sensible, unified management.

The decimation of the sockeye fishery in 1917 pushed the United States and Canada into new treaty talks. In the space of just a few years, a canning industry worth $30 million per year had been reduced tenfold, and people feared that it was on the verge of total collapse. In 1918, the Hazen-Redfield Commission, whose members included representatives of both Canada and the United States, drafted a report that called for the establishment of a new international commission to regulate the fishery and to conduct studies of the salmon's life history, hatcheries, and spawning-ground conditions. If approved, the new commission would include two members from each country. The Canadian House of Commons quickly approved the treaty, but once again, the state of Washington intervened and, through strong lobbying, convinced Congress not to ratify the agreement.[25]

For Washington State, more was at stake than the principle of "states' rights" over fisheries resources. When the Hazen-Redfield Commission drafted its treaty, salmon fishing in Washington State was regulated directly by the state legislature, which had apparently made little use of science in carrying out its management responsibilities.[26] As a result, the legislature was easily swayed by "selfishly interested" parties to defeat needed conservation measures.[27] For example, in 1913, there were 168 traps in Washington waters catching as much as 60 percent of the Fraser River sockeye salmon. Washington's battle against a rational management program for the Fraser probably had more to do with protecting special financial interests than with the principle of states' rights. The primary victim of Washington's intransigence was the salmon; but in the long term, the state's fishermen also paid a high price.

The sockeye stocks, badly damaged by the Hells Gate blockage, could not recover as long as overfishing prevented the salmon from reaching their spawning grounds in adequate numbers. Prior to the Hells Gate fiasco, the big-run years had sent as many as 12 million sockeye (in 1901) to the spawning grounds. The smallest number of spawners to escape the fishery was 4.7 million in 1909. But starting in 1917 and continuing through the 1920s, the distinctively large runs in the four-year cycle disappeared. In 1918, only 85,000 fish escaped the fishery and reached spawning areas, and from 1912 to 1929 an average of only 320,000 made it past fishermen to spawn. The low escapements created two problems. First, the depleted runs could not fully seed the Fraser's extensive lake system with juveniles. Second, the lack of spawners altered the ecological process, which determines the productivity of the Fraser's lake systems. Spawning salmon not only deposit eggs into the gravel but also fertilize the aquatic ecosystem with nutrients released by their decaying bodies. By dying after spawning, the adults nourish their offspring through the freshwater stage of their life cycle. Although the loss of nutrients from millions of decaying carcasses was invisible, it likely had a detrimental effect on the rearing juveniles and was probably a significant form of habitat degradation.[28]

Treaty negotiations continued unsuccessfully through the 1920s. Out of frustration, the Canadians even considered physically rearranging the mouth of the Fraser River—by cutting off the southern outlets—with the hope of redirecting the migration route of the fish away from American waters.[29]

When treaty negotiations resumed in 1930, a new development in the state of Washington gave politicians there even more incentive to oppose rational management. American purse seiners had begun fishing in international waters outside the Strait of Juan de Fuca, and within a few years the seiners had learned how to use their gear to hunt and catch sockeye salmon heading for the Fraser River. In 1930, the year a new treaty was drafted, the American purse seine fishery made its largest catch of sockeye. Predictably, the purse seiners disliked two provisions of the new treaty: the establishment of an independent commission that would be given jurisdiction over fisheries in international waters, and the stipulation of a fifty-fifty split in the harvest between the United States and Canada.[30] So to defeat the treaty, selfish economic interests employed power politics.

The point man for the political maneuvering against the treaty was Washington governor Roland Hartley. In a speech broadcast over radio to the citizens of Washington, he flatly refused to admit that the Fraser River salmon were in trouble. Hartley assured people that what they had heard was "untruthful propaganda," and he considered it his "duty to truthfully set forth the situation." Then he proceeded to manipulate statistical information to hide the collapse of the Fraser River sockeye stocks behind a thick layer of political fog. Although he did admit that the Fraser River salmon needed some help owing to the Hells Gate incident, he condemned the treaty as "sugar-coated for our public with that hackneyed word 'conservation,' behind which so many of the people's rights are being taken from them." Instead, Hartley promised that the state of Washington would take action by funding more hatcheries in the headwaters of the Fraser River.[31] Miller Freeman, publisher of *Pacific Fisherman* and a longtime advocate for the treaty, rebutted Hartley's misleading statements a few days later in a speech to the Seattle Bar Association. Hartley's obfuscation achieved its goal, however. The treaty sat in limbo for seven more years.

Then two unusual events—a political one in 1934 and a natural one in 1936—combined to rescue the treaty. In the fall of 1934, Washington voters approved Initiative 77, which prohibited the use of traps or any fixed-fishing gear in the state's waters and placed severe restrictions on commercial fishing in parts of Puget Sound. (Initiative 77 was not entirely motivated by a desire to conserve salmon; it was another battle in the "gear wars" that characterized the salmon fishery, which were described in Chapter 5.) After an unsuccessful challenge in the Supreme Court, the initiative became law, and the effect on the Fraser River sockeye fishery was immediate. Prior to Initiative 77, Washington's share of the harvest had risen to about 70 percent of the total catch. In 1935, the year after the traps were banned, Canada caught 57 percent of the Fraser-bound sockeye. Because Initiative 77 unwittingly shifted the catch in favor of Canada, the fifty-fifty sharing provision of the proposed 1930 treaty became more appealing to Washington fishermen. In 1936, when the Canadians caught a whopping 82 percent of the sockeye, American fishermen and cannery owners began to seriously reconsider the treaty.[32] Finally, Washington governor Clarence Martin indicated that his state was ready to cooperate.[33]

The big jump in Canada's 1936 catch probably resulted not from Initiative 77 but from a natural variation in the migration route of sockeye salmon. Sometimes the sockeye migrate down Johnstone Strait and approach the Fraser River from the north instead of using their normal southerly route through the Strait of Juan de Fuca. The sockeye appear to have taken the northern route in 1936, giving the Canadian fishermen a great advantage.

Happily, the fortuitous shift in migration and Initiative 77 were enough to push the state of Washington into supporting the salmon treaty, and it was finally ratified by both countries on August 4, 1937. With the adoption of the treaty, the joint Canada–U.S. program to restore the sockeye salmon in the Fraser River was under way, and the International Pacific Salmon Fisheries Commission would become the primary management agency for the Fraser's sockeye.

The Columbia River

The Columbia River drains an area about the size of France in its 1,200-mile journey to the sea. Historically, the Columbia produced more chinook and coho salmon and steelhead trout than any other river in the world.[34] Prior to the arrival of Euro-Americans, 10 to 16 million adult salmon of all species entered the river each year.[35] Though all five species of salmon spawned in the Columbia River, the royal chinook was by far the most abundant (Figure 5.1, Chapter 5). About 8 to 10 million chinook entered the river each year. Many of them, especially the "June hogs" of the summer run, weighed in at fifty to sixty pounds each.

In 1883, the Columbia River was full of the large spring and summer chinook; by the end of the summer, the canneries had processed 43 million pounds of the salmon. It was the largest harvest of Columbia River chinook ever recorded. Following that bonanza year, the catch declined to roughly 25 million pounds annually and then appeared to stabilize for about thirty years. After 1920, the harvest of chinook salmon went into a decline that continues today (Figure 5.1, Chapter 5).

The stable harvests over the thirty years from 1889 to 1920 created a numerical illusion that apparently fooled even experienced biologists such as Willis Rich. In a 1940 publication he remarked that "the chinook salmon catch has held up remarkably well" in spite of an intense fishery, "but the record since 1920 is one of constantly decreasing catches."[36] The raw harvest numbers hid important qualitative shifts in the annual runs of chinook salmon—shifts that signaled early depletion of the prime spring and summer chinook. The fishermen actually maintained an average harvest of about 25 million pounds between 1889 and 1920 by shifting from the spring and summer runs, once they became depleted, to the less desirable fall chinook. Figure 8.2 shows that in 1878 most of the harvest of chinook was taken from the spring and summer races, May through July. By 1919, most of the harvest occurred in August, when the fall race of chinook salmon was migrating through the river.[37]

If the Columbia River had a single-year turning point, an equivalent to

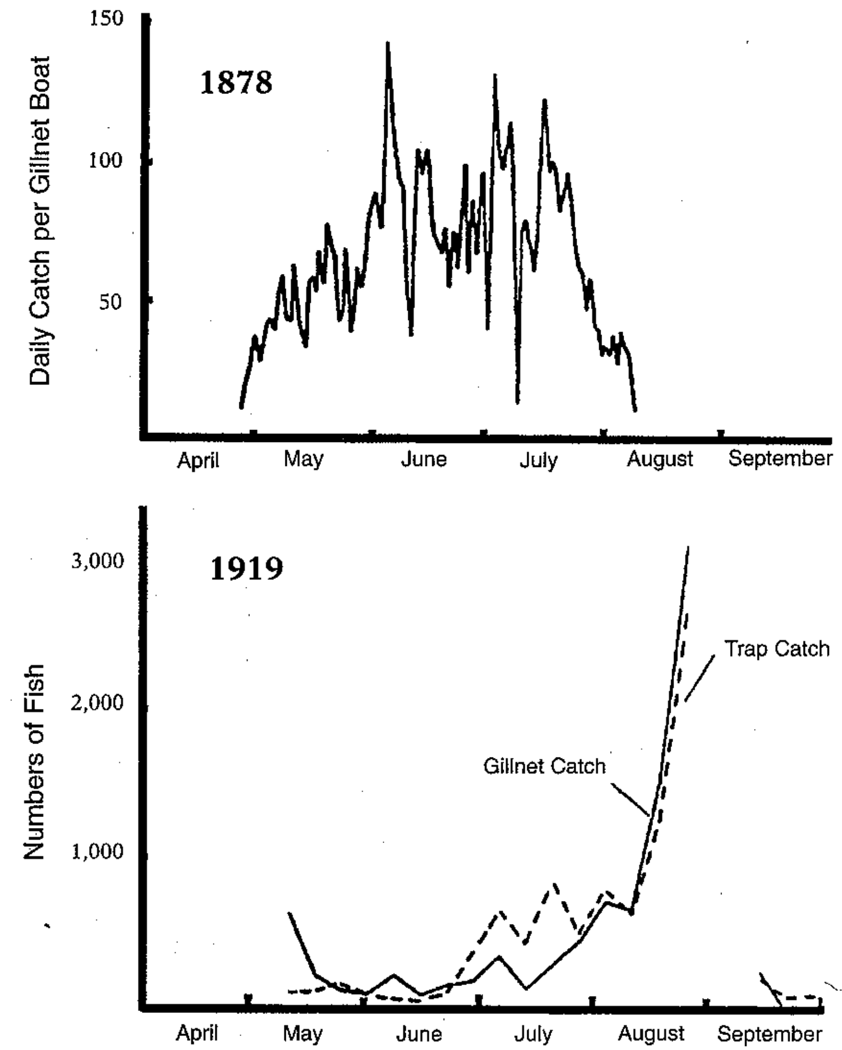

Figure 8.2. Comparison of the seasonal distribution of the chinook salmon harvest on the Columbia River, 1878 and 1919. (Source: Thompson 1951)

the infamous 1913 on the Fraser, it would be 1920. By that time, habitat degradation and overharvest had been reducing the productivity of the Columbia River's chinook salmon for over half a century, and the cumulative effects of poor stewardship and the gradual impoverishment of the watershed could no longer be hidden in the aggregated harvest statistics and shifting fisheries. Even the most die-hard optimists had to concur with a comment made twenty-six years earlier by Hollister McGuire, Oregon's first State Fish and Game Protector. "Oregon has drawn wealth from her streams," he said, "but now, by reason of her wastefulness and lack of intelligent provision for the future, the source of that wealth is disappearing and is threatened with complete annihilation."[38]

The depletion of the Columbia's spring and summer chinook salmon was not triggered by a single dramatic event like the rock slide at Hells Gate on the Fraser. The decline followed years of continuous attrition from several sources: excessive harvest, mining, logging, irrigation ditches that killed millions of juvenile salmon, and hatcheries that mined the eggs from wild populations. The spring and summer chinook were particularly vulnerable to habitat degradation because they migrated into the upper reaches of the Columbia and Snake Rivers and into the headwaters of the tributaries where habitat degradation was most intensive. By 1930, 50 percent of the best habitat for spring and summer chinook in the Columbia's tributaries had been blocked or severely degraded. The fishery was supported by fall chinook that spawned in the mainstem of the Columbia and Snake Rivers and in the lower mainstems of the larger tributary streams. Their mainstem habitat remained largely intact until the major dam-building era of the 1930s to the 1970s.

The problem created by overfishing and habitat degradation in the tributaries would soon be overshadowed by another major crisis. In the early 1930s, America was reeling from major economic and social disruption caused by the Great Depression and the environmental tragedy known as the Dust Bowl. With his New Deal, President Franklin Roosevelt set out to remedy the situation by relocating people from depressed areas to the Pacific Northwest. The Northwest would become the nation's escape valve, a place where the dispossessed and the down-and-out could start new lives and engage in productive work. Accomplishing this vision would require the full development of the hydroelectric power and irrigation potential of the Columbia River. As Roosevelt told the people of the region, "You have acreage capable of supporting a much larger population. . . . By proceeding with these great projects [Bonneville and Grand Coulee Dams], it will . . . give an opportunity to many individuals and many families back in the older, settled parts of the nation to come out here and distribute some of the burdens which fall on them more heavily than fall on the West."[39]

Massive development of the Columbia's hydroelectric and irrigation potential would eliminate the river's mainstem salmon habitat, the least

changed part of the watershed. Rock Island Dam was the first to span the mainstem of the upper Columbia River in 1933. That same year Congress authorized construction of Bonneville Dam, to be followed two years later by Grand Coulee Dam. These three dams, and the prospect of many others, compelled some state politicians and state and federal fisheries agencies to work together on the problems the mainstem dams would create for the Columbia River salmon.

With the authorization of Bonneville Dam in the lower river, state fish and wildlife agencies recognized that the design of adequate fish-passage facilities was critical. As one official explained, such work was "too great a task, and the ultimate results to be achieved of too vast importance, to be carried out by any one state department or individual."[40] Therefore, a committee of eleven was created with representatives from the state fish and wildlife agencies of Oregon, Washington, and Idaho; the U.S. Bureau of Fisheries; and the packers and fishermen from Oregon and Washington. The purpose of the committee, which called itself the Interstate Fish Conservation Committee, was to "consider the Bonneville project and to decide upon the general types of passageways and other safeguards for the protection, preservation and continued perpetuation of the Columbia River salmon."[41] This was the first, tentative step in organizing a comprehensive interstate salmon protection and restoration program for the Columbia. However, it was also the beginning of what would eventually become a complex maze of committees and subcommittees addressing the problems related to salmon and dams on the Columbia River.[42]

Rock Island, Bonneville, and Grand Coulee Dams were only the first dams to block the Columbia. Another twenty-four dams were slated for construction on the mainstems of the Columbia and Snake Rivers over the next forty-five years. By 1933, engineers had already designed many of the dams, and these plans were a source of grave concern for biologists as well as the fishing industry. At the time, engineers and biologists had not yet demonstrated that salmon could be moved past dams as high as those planned or already under construction. The threats of massive dams, together with the still-declining harvests, prompted political leaders in Oregon and Washington to take an interest in the fate of the salmon.

In Oregon, Governor Charles Martin asked the Oregon Planning Board to investigate the salmon fisheries of the Columbia River. In its 1938 report, the board observed that the responsibilities of salmon management were much broader in scope than one state could resolve alone, and it recognized that management fragmented among too many state and federal agencies was ineffective. In effect, the board rediscovered the problem highlighted in Theodore Roosevelt's 1908 State of the Union speech. It recommended that the Oregon, Idaho, Washington, and California legislatures enact an interstate compact to establish a joint Columbia River Fisheries Commission. The commission would be given the responsibility and authority to regulate the total catch, set the seasons, and proscribe types of fishing gear. The planning board also recommended giving the new commission the job of directing needed scientific research, including studies of the effects of pollution on salmon production, potential improvements in fish culture, the effects of harvesting sardines and other food fishes of the salmon, and the need to set aside tributaries to the Columbia as salmon sanctuaries.[43] The Oregon Planning Board's recommendation for an independent commission, which was modeled after the commission that had been created to manage the Fraser River salmon, was never implemented.

Oregon was not alone in its concern for the future of the Columbia River salmon-canning industry. In 1941, the Washington State Senate created a committee to investigate the salmon problems on the Columbia River—the Columbia River Fisheries Interim Investigative Committee (CRFIIC). The committee was to work with similar groups in Oregon and Idaho and report back with recommendations.

In its 1943 report, the CRFIIC viewed the condition of the Columbia River salmon with alarm. Just sixty years earlier, in 1883, the fishery had harvested 43 million pounds of fish, all from the prime spring run of the chinook salmon. But by the early 1940s, the average annual harvest had dropped to 16 million pounds, and most of that was from the less desirable fall run of chinook. The committee speculated that with adequate regulation, the salmon harvest could have approached 75 million pounds a year, thus calculating the annual loss at about 59 million pounds. From a wholly economic perspective, the CRFIIC explained, "by our negligence and refusal to meet the issues involved, we have sacrificed millions of dollars of revenue to the State of Oregon and the State of Washington and, in turn, to the United States."[44]

According to the committee, three fundamental factors had caused the depletion and prevented the restoration of the Columbia River chinook salmon. The first was overfishing. The CRFIIC estimated that fishermen harvested 90 percent of the summer-run chinook salmon. Incredibly, the committee laid the primary blame for overharvest on the Indian fishermen, who provided a convenient scapegoat for the deleterious effects of the industrial economy on the salmon and their habitats.[45]

The second factor was habitat degradation. After touring the Columbia Basin, the CRFIIC concluded that the Salmon River in Idaho was the only tributary stream not suffering from severe habitat problems. Even there, the sockeye run into Redfish Lake had been blocked by a mining dam, and mining pollution and irrigation had degraded several of the upper tributaries and headwaters. The gravest threats were to the mainstems of the Snake and Columbia Rivers, however—important spawning habitat for the late summer and early fall runs of chinook salmon, which supported the commercial fishery. The Army Corps of Engineers and the Bureau of Reclamation were already beginning construction of an extensive series of dams that would flood all the major spawning areas in the mainstems.

Finally, the committee warned that responsibility and authority for salmon management was fragmented among too many uncoordinated agencies and institutions. Like the Oregon Planning Board, the CRFIIC considered this a serious threat to the salmon industry because "our [salmon management] activities are too involved in inter-state problems and lack the cooperation and policies to permit an improved situation." The committee concluded, "We are hopelessly defeated in obtaining any solution to the Columbia River fisheries unless we simplify our administration over this resource."[46] Over the next fifty years, politicians and salmon managers would make hundreds of predictions regarding restoration of the Columbia River chinook salmon. Unfortunately, the CRFIIC's prediction was one of the few that has been realized.

Echoing the recommendations of the Oregon Planning Board, the CRFIIC also proposed an interstate compact that would establish a new commission with complete control of anadromous fish in the Columbia River watershed. The commission would have full power to regulate harvest, to carry out research, to build, to operate or close hatcheries regardless of ownership, and to require fish protective devices at all dams and diversions. The independent commission called for by Washington, like that recommended by the Oregon board, was modeled after the International Pacific Salmon Fisheries Commission on the Fraser.

In response to concern about fragmented management and calls for management by an independent commission, B. M. Brennan, director of the Washington Department of Fisheries, did something that few bureaucrats ever do. He volunteered to make the "considerable sacrifice" of relinquishing a major part of his agency's authority over the Columbia River fisheries to an independent commission because he could "see no other method of reaching the desired end"—the restoration and protection of the Columbia River salmon. Seemingly free of the suspicion many westerners had about federal involvement in their affairs, Brennan believed that Congress could set up a commission to create an "almost utopian situation wherein the salmon and steelhead runs of the Columbia River will be properly protected and built up towards their former magnitude."[47]

Regrettably, no such commission was ever established; despite their remarkable consensus, the recommendations of the Oregon State Planning Board, the Columbia River Fisheries Interim Investigative Committee, and Brennan were uniformly ignored. As a consequence, fragmented management has continued to hamper salmon protection and restoration efforts in the basin up to the present day.

The threat of mainstem dams on the Snake and Columbia Rivers not only pushed politicians to think more about the salmon but also prompted the few biologists working in the basin to synthesize the available scientific information concerning the salmon's biology and use it to predict the effects of the dams.[48] The results of their analyses led to a great deal of apprehension and pessimism. The proposed dams were much larger than any the biologists had experience with. No one could predict exactly what would happen when these massive concrete structures blocked the free flow of the Columbia and Snake Rivers, but one thing was certain, according to biologist Lawrence Griffin: "Dams are not going to do the fisheries any good."[49]

Although Grand Coulee, Bonneville, and Rock Island were just the first of many dams planned for the Columbia and Snake Rivers, the salmon were spared further construction and river development for several years while America directed all of its energy to fighting World War II. Still, salmon biologists knew that when the nation turned its attention to domestic matters once again, development of hydropower on the Columbia River would be a high federal priority. Before the end of the war, in 1944 the U.S. Army Corps of Engineers described its construction plans for the Columbia River at a series of meetings in Portland, Oregon. Four biologists from the U.S. Fish and Wildlife Service—Willis Rich, Federic Fish, Mitchell Hanavan, and Harlan Holmes—were invited to those meetings. For the first time, the engineers gave biologists advance warning of their plans. Rich and his colleagues believed that it was critical to take full advantage of the warning. They realized the Fish and Wildlife Service needed a policy or program to deal with the fish conservation problems that the new dams would create. So the four biologists wrote a lengthy letter to Elmer Higgins, their supervisor in Washington, D.C., in which they gave their professional judgment but also expressed their personal feelings about the fate of Columbia River salmon.[50]

The biologists were uncertain about what could be done to save the salmon, and they felt frustrated by the situation. For example, they questioned the ability of technology such as fish ladders to overcome the cumulative change in the ecosystem that would occur with each new dam. Eventually, they feared, the ecological change in the river would be too severe and the salmon would disappear. In the end, they believed the fish ladders and other engineered solutions would be only "monuments to a departed race."[51] Doubting that anything could actually be done to save the salmon, they wrote, "No competent fishery biologist is willing to assert that the salmon runs can be preserved if the full program of construction does go through." Yet they were not willing to give up. As they explained to Higgins, "It goes without saying that *some effort must be made to save the salmon runs.* We cannot take the stand that the situation is hopeless and that it is useless to put time and money into the effort" (emphasis in original). They suggested an all-out "frontal attack" on the construction program. But having proposed such a radical approach, they quickly retreated into the safe haven of the bureaucracy, explaining that it was "not a job for fishery biologists—it is something that must be handled higher up."[52]

In the end, the biologists decided to accept the dams as inevitable but to offer their best ideas for a program to save the salmon. Rich and his colleagues proposed to abandon the upper river to development and move the most important salmon runs from the upper basin to the tributaries of the lower river, below the proposed Umatilla (later named McNary) Dam. They recognized that the success of this massive transplantation of upriver stocks would wholly depend on artificial propagation, a technique that, they admitted, had not yet been proven effective.[53]

Though hatcheries had not yet proved that they could add to natural production or replace production lost due to habitat degradation or overharvest, the biologists believed that full hydroelectric development of the basin was inevitable and saw little choice but to recommend the use of artificial propagation to compensate for the effects of the dams. Rich hoped that hatchery research would eventually find ways to produce satisfactory salmon returns.[54]

A little over a year later, the same biologists helped to prepare the official proposal for a fisheries program to deal with the planned construction of forty dams, many on the mainstems of the Columbia and Snake Rivers. As their proposal passed through bureaucratic channels, the trappings of officialdom were added, and the passion of the earlier letter was watered down. For example, contrast the earlier declaration, "No competent fishery biologist is willing to assert that the salmon runs can be preserved if the full program of construction does go through," with the version in the official final proposal: "It appears that the losses incurred . . . might be serious enough to make continued propagation in the headwater tributaries impracticable." Moreover, the final report referred to the plan to transfer salmon stocks from the upper river to the lower tributaries as an insurance policy to protect the salmon industry in case "at some unpredictable time, the fish protective devices [fish ladders over dams] fail in their purpose."[55] Labeling the plan as insurance against failure of the fish ladders clearly implied more confidence in artificial propagation, stock transfers, and fish ladders than the original letter. In the official proposal, the discussion of the consequences of river development took on a much softer tone.

How did the biologists reconcile the mass relocation of salmon from the upper to the lower river, since they also understood that salmon returned to the same gravel where they were born and that they were adapted to the environment of their home stream? How could they rely on hatcheries to make the transfer from upper to lower river, when they acknowledged that hatcheries had yet to demonstrate their effectiveness? Were they just fatalistic? Did they believe that development was inevitable and that applying the new scientific understanding was useless? Or did this capitulation to the status quo demonstrate the power of the development ideology to bend science to its purpose? The answer to those questions cannot be found in the documents. As we will see later, however, there *were* other choices, such as the options followed on Canada's Fraser River. But before American biologists could even conceive of alternatives to artificial propagation, they would have to embrace a different worldview—one capable of challenging the conventional wisdom that humans had to manipulate and control ecosystems and that technology such as hatcheries could replace natural ecological processes. Even the threat of massive dams, it seems, could not change their deep-seated assumptions about man's relationship with nature.

In spite of their knowledge of the consequences and their personal opposition to the full development of the Columbia River, by proposing hatcheries the biologists handed politicians and federal construction agencies the leverage they needed to dam the Columbia River without making the hard choices between development and salmon. But they avoided those choices only temporarily. The listing of salmon under the federal Endangered Species Act in the 1990s has finally forced the region to confront the choices it avoided in the 1940s.

The plan to relocate upriver stocks to the lower river using artificial propagation was a straw that politicians readily grasped to promote the belief that power and salmon were compatible. The biologists' skepticism about hatcheries was pushed into the background, allowing optimism about the future to move to center stage.[56] For example, to win approval for its dams on the Cowlitz River, a tributary of the lower Columbia, the city of Tacoma, Washington, distributed an information packet whose cover showed an electric transmission tower, a salmon, and a cheery message in bold print: "power and fish / you *can* have *both*."[57] Having won World War II, Americans had supreme confidence that they could engineer a better environment. As historian William Robbins pointed out in his environmental history of Oregon, in the early decades of the twentieth century, some Americans had an almost "transcendental belief in the efficacy of the unlimited manipulations of the natural world."[58] There was no reason to doubt that technology could and would make salmon and dams compatible.

Despite the biologists' somewhat accommodating proposal to compensate for the effects of development, the fisheries agencies did not give up their fight against the dams. In fact, in 1945 they did indeed launch a "frontal attack" challenging the economic justification for the additional power, irrigation, and transportation the dams were supposed to produce, in a report titled "The Wealth of the River."[59] The agencies were joined by legislative committees from Oregon and Washington, as well as tribal organizations and fishermen, in opposing the dams.[60] But as Willis Rich and his colleagues had feared in 1944, the situation turned out to be hopeless. On March 6, 1947, the U.S. secretary of the interior signed a memorandum settling the battle between the salmon and the proposed construction program—in favor of the construction program. The memorandum, titled "Columbia River Salmon or Dams," reiterated in unambiguous terms the view that humans had to conquer and control the landscape and rivers of the Northwest. "It is, therefore, the conclusion of all concerned that the overall benefits to the Pacific Northwest from a thorough-going development of the Snake and Columbia are such that the present salmon run must be sacrificed. This means that the department's efforts should be directed toward ameliorating the impact of this development upon the injured interests and not toward a vain attempt to hold still the hands of the clock."[61] With that memorandum, the lower-river plan—the "insurance policy" proposed by the U.S. Fish and Wildlife Service—became the primary strategy for "ameliorating the impacts."

Prior to the "Salmon or Dams" memo, the fisheries agencies had invested heavily in hatcheries and had done little to understand the ecology of the salmon on the Columbia River. Thus in 1947 they faced a massive dam construction program with little information and a single management tool—artificial propagation—that didn't work. To give fish managers time to implement the lower-river plan, the Department of the Interior requested a ten-year delay in the construction program, but the Columbia Basin Inter-Agency Committee recommended against the delay and approved the lower-river strategy for immediate implementation.[62] The plan was renamed the Lower Columbia River Fisheries Development Program, and under it the states of Oregon and Washington became salmon management partners with the federal government. The first major salmon restoration program for the Columbia River was under way.

Different Roads to Restoration

Although major salmon restoration programs were launched on both the Fraser and the Columbia within a ten-year period, the different strategies followed in these two programs produced very different outcomes.

The International Pacific Salmon Fisheries Commission (IPSFC) began its work restoring the Fraser River sockeye in 1937. When Congress ratified the treaty bringing the commission into existence, however, it added to the treaty an understanding that prohibited the enforcement of any fishing regulations for two sockeye life cycles, or eight years. During that time the commission was directed to conduct research and use its findings to establish any necessary regulations, starting in 1945. This in itself was a major departure from the conventional approach to salmon management, which tended to be content with "groping in the dark."

Since the control of the harvest had been put on hold, the IPSFC focused on habitat and natural production. The commission notified the Canadian government that it wanted to be informed of all activities in the Fraser Basin that might modify spawning areas or pollute, dam, or divert water used by adult or juvenile sockeye salmon.

Although salmon fishermen and cannery owners pressured the IPSFC to use hatcheries to quickly rebuild stocks, the commission had other priorities and put off the hatchery issue. According to John Roos, the IPSFC's director of investigations in its waning years, "From the very beginning, a strong commitment was made to protect natural propagation from the detrimental effects of dams, logging, erosion, dredging, pollution and other human-induced changes in the environment."[63]

Long before the commission started its work, biologists suspected that there were many distinct races of sockeye in the Fraser watershed. Hatcherymen, who handled large numbers of salmon, noticed consistent differences in appearance and biology among salmon from different areas in the Fraser watershed.[64] Because W. F. Thompson, the commission's first director of investigations, had been one of Charles Gilbert's students, he knew about Gilbert's earlier discovery of distinct sockeye salmon stocks in the rivers of British Columbia. As a result, Thompson designed harvest management and habitat preservation programs around protection of the individual Fraser River sockeye stocks.[65] Regarding the stock as the basic management unit, Thompson immediately initiated research to learn more about the individual populations of sockeye, including the timing and route of their migration through marine and freshwater habitats and the location of their natural spawning areas. The commission also launched studies on the potential delays or blockages in migration that might still exist at Hells Gate.

The IPSFC's approach to salmon restoration reflected the scientific understanding of the salmon's biology at the time. For example, making hatcheries a low priority was consistent with Russell Foerster's 1936 study of the Cultus Lake hatchery, which had eliminated hatcheries as a scientifically valid option and led to the closure of all British Columbia hatcheries.[66] Instead, the commission emphasized natural production and the protection of the river reaches where spawning took place. The commission's focus on the individual populations of sockeye in the Fraser River was also consistent with the latest understanding of the Pacific salmon's stock structure.[67]

The Lower Columbia River Fisheries Development Program (LCRFDP), meanwhile, took a very different approach to salmon restoration. The program had six parts: removing obstructions to salmon migration in tributaries of the lower Columbia; cleaning up pollution in major tributaries such as the Willamette River; screening water diversions to prevent the loss of juvenile salmon in irrigation ditches and construct fishways over dams in the tributaries; transplanting salmon stocks from above McNary Dam to the lower river; revamping the Columbia River hatchery program by remodeling existing hatcheries and building new facilities; and, finally, creating salmon refuges by setting aside most of the tributaries below McNary Dam exclusively to maintain salmon and steelhead runs.[68]

As it was originally designed, the program contained strong provisions for habitat protection and restoration, but in implementation many of those provisions were given a low priority. For example, to create salmon sanctuaries in all Columbia River tributaries below McNary Dam, Oregon and Washington had to pass enabling legislation. The state of Washington passed its sanctuary bill by overwhelming majorities: 42 to 1 in the Senate and 79 to 18 in the House. But the Oregon House of Representatives voted 41 to 18 to build power dams on the Deschutes River, effectively killing the sanctuary provisions of the LCRFDP. Washington's sanctuary bill was later overturned in the state supreme court.[69]

The hatchery program was only one of the six parts of the LCRFDP, but within a few years it became the dominant part. In 1951, the fourth year of the program, the states spent 49 percent of the budget on hatcheries and used only 5 percent on habitat projects.[70] In 1986, hatcheries received 79 percent of the program's budget. The plan to transfer commercially valuable spring chinook salmon from the upper to the lower river, and then to maintain those fish through artificial propagation, ignored the stock concept and instead treated salmon management on the Columbia as a large agricultural enterprise, a massive extension of the earlier attempts to "till the waters" for the benefit of humans.[71]

On the Fraser, the IPSFC took advantage of the eight-year delay in enforcing harvest regulations and used the time to undertake research and gather the information needed to manage the sockeye on a stock-by-stock basis. Biologists working for the commission studied the migration of individual sockeye stocks through the Strait of Juan de Fuca and the San Juan Islands. Research at Hells Gate revealed that the obstruction there still impaired passage of specific stocks whose migration timing coincided with particular detrimental flow levels. The commission also developed methods to accurately estimate the number of spawning salmon, began collecting more-accurate estimates of the total harvest, and undertook studies to identify and describe the freshwater biology of individual races.[72]

While W. F. Thompson launched major research programs on the Fraser River to strengthen salmon management through sound science, the Columbia managers gave scientific research a low priority. This occurred in part because the salmon management agencies in Oregon and Washington were still dominated by fish culturists who continued to deny the need for research and critical evaluation. Instead, they promoted the LCRFDP as an "action" program that could be implemented immediately, without delay for lengthy research. Their key word was "action."[73] Research was eventually initiated later, but it focused on hatchery operations and fish passage through dams, putting little emphasis on salmon ecology.

The state fisheries managers did not have the same level of concern as the federal biologists regarding the ability of hatcheries to sustain the salmon fishery. Even in the face of massive development of the river, the managers believed they knew how to maintain the salmon through artificial propagation. The fact that their hatcheries had been in use for more than seventy years without documented success did not appear to concern them. They simply assumed that continued implementation of the same unsuccessful programs would somehow in the future produce different results.[74] The failure to use the latest science and to invest in research on salmon ecology was in part a tragic consequence of the failure to create an independent commission to manage and restore the Columbia River salmon.

The bargain that salmon managers had struck with the industrial economy three decades earlier on the Elwha River—wild salmon for dams and hatcheries—was about to pay off with big increases in agency budgets. But the resulting massive increase in spending on salmon only exacerbated the problem. As long as management remained fragmented among several institutions, too much attention would be focused on the competition for funds generated by turbines. The fate of the salmon would not be the center of attention until the Endangered Species Act shocked the institutions out of their complacency.

By 1951, it was apparent that the LCRFDP was in trouble. Funds for the program had been slow to reach the Northwest, and even the available funds were not being used on schedule. The original LCRFDP was designed to be completed in ten years—a schedule that was critical because the construction program was rapidly changing the river. Hatcheries had to be built or remodeled before the dams eliminated upriver populations of salmon altogether. The Korean War added another degree of urgency with calls to accelerate the construction of dams for national security reasons.

On June 14, 1951, Albert Day, the director of the Fish and Wildlife Service, came to Seattle to put the LCRFDP back on track. At a "meeting of great potential importance to the preservation . . . of the salmon fisheries," Day did most of the talking and delivered a strange mixed message of threats, pleas, science, and bribes. He told the assembled managers and biologists that the Northwest's rivers were going to be dammed and "we should not kid ourselves" about it. He did not limit that prediction to American rivers. In his effusive monologue, Day assumed that the Canadians shared American standards and values and that the Fraser River would suffer the same fate as the Columbia. He urged the group to "come up with something that may lead to some concrete results on this problem of dams versus salmon." Day was not bothered by the half-century of failure to stop the decline of salmon, which started before the mainstem dams had been constructed. He wanted the state and federal salmon managers and biologists to come up with a workable program before the end of the day. To give the audience an added incentive, Day laid his bribe on the table. The federal government was willing to speed up and increase funding for the LCRFDP, from $2 million to $5.5 million a year. He also proposed an additional $12.5 million for research on salmon passage at the dams. Sounding like a cheerleader, Day urged the group to "all pull together as one team."[75] The subtext of his speech was clear: The dams are inevitable; take the money, boys; join the team and quit complaining. The group established committees to work out a program.

In hindsight, it's evident that the meeting with Day was the first step in a voracious process that would trap the Northwest in costly salmon programs and actually accelerate the fish's downward spiral.[76] Optimism that a technological solution could ensure salmon survival in "engineered" rivers has not diminished—not even in the face of persistent failure. For the past forty years, the response to continued salmon declines has been to invest in more technology. Through the years, more and more money has been thrown at the problem, but the approach remains rooted in the nineteenth-century myth of universal benefit from human control over natural ecological processes—in the myth that humans could have salmon without healthy rivers.

Columbia River salmon managers became trapped in what historian Paul Hirt has called the "conspiracy of optimism." The goals of stewardship and conservation were displaced by techno-optimism—the belief that it was possible to maximize salmon production through technology, even in a watershed simplified and degraded by a series of continuous impoundments. Salmon managers stuck with their technological fixes even in the face of obvious failure. As Hirt pointed out, when programs based on techno-fixes fail, the technology is never blamed for the failure; rather, the fault is said to lie with the politicians who did not provide sufficient funds to buy enough of it.[77] On the Columbia, the result of this kind of thinking has been a spiral of escalating costs with few tangible results (Figure 8.3).

At first it may appear that Albert Day, an American, erroneously included the Fraser River in his prediction that the hydroelectric potential in every Northwest river would be developed. Day was not just superimposing American values on Canadian rivers, however; the Fraser did not escape the dam-building engineers. In a book on the Fraser River published in 1950, a year before Day's meeting, Canadian Bruce Hutchison left no doubt that the Fraser would be fully developed. Hutchison argued that the government had to weigh the value of the salmon against the value of electricity and the industrial development it would promote, and to him, "The choice is obvi-

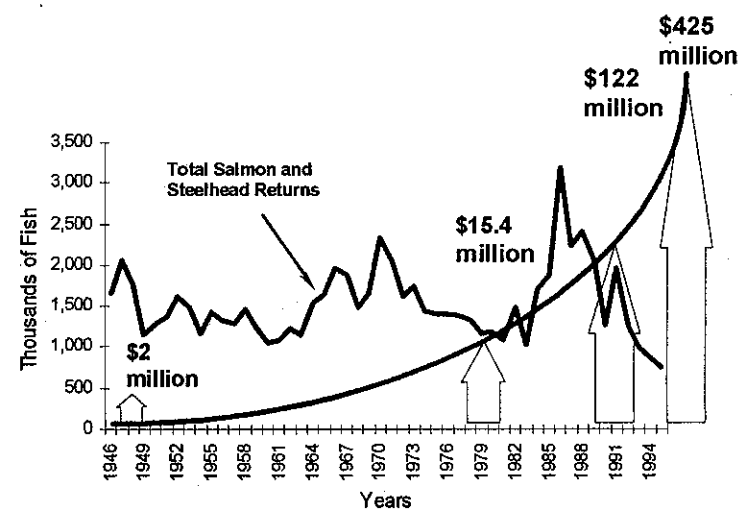

Figure 8.3. Total adult salmon and steelhead returns to the Columbia River and the cost of the salmon restoration program. Initially the program expended $2 million per year. From 1949 to 1981 the average annual cost was $15.4 million per year; from 1982 to 1991 it was $122 million per year; and it could reach $425 million per year in the near future. Note that the first data on the chart are from 1946, when the number of salmon entering the river was about one-tenth their level of historical abundance; the total salmon abundance then was less than half the region's current goal of 5 million fish. (Sources: Laythe 1948, General Accounting Office 1992, Northwest Power Planning Council 1994)

ous." The Fraser would follow the same path as the Columbia. Artificial propagation would be used to maintain the salmon if engineering could not make dams and salmon compatible.[78]

Although the engineers had plans for dams on the Quesnel, Adams, Chilcotin, and Chilko Rivers, the biggest threat to the Fraser River sockeye came in the 1950s in the form of Moran Dam, a 720-foot-high structure that would have been built on the mainstem about twenty miles above Lillooet, British Columbia—roughly 200 miles from the river's mouth. Canadian biologists, together with the IPSFC, concluded that the dam would eliminate all the salmon and steelhead above it. Furthermore, it would eliminate half the salmon in the lower river by changing the river's ecology.[79] This dire prediction was similar to those made by American biologists regarding McNary Dam on the Columbia River. Like the Americans, the Canadians looked for opportunities to have the best of both development and salmon—and they too looked for ways to mitigate the effects of the dams using hatcheries.

Consistent with its commitment to maintaining a scientific basis for its plans and programs, the IPSFC undertook an exhaustive scientific review of salmon mitigation programs. The resulting report concluded, "At the present time, artificial propagation is not a proven method of maintaining even small localized stocks of Fraser River sockeye and pink salmon."[80] The commission also pointed out that the economic cost of destroyed salmon runs would make the power produced by Moran Dam too expensive. Commissioner Roderick Haig-Brown asserted that the salmon's value went beyond economics: the whole attempt to have an "objective" discussion of salmon and dams, he said, "was a betrayal of the salmon and their meaning." To balance the salmon against human "needs" that could be met in other ways revealed an "insensate arrogance that has no place in modern thinking," he argued, that preserving the salmon was "an act of faith in the future."[81]

As a consequence of the commission's research, Moran Dam was not built. The empty claims of success made by hatchery programs did not convince the Canadians to risk their Fraser River salmon. Science clearly showed that intensive artificial propagation did not make dams and salmon compatible. As Canadian biologist Ferris Neave explained, "A natural stream is a complex organization . . . not a specialized farm for the intensive production of one or a few species."[82]

While American biologists turned toward technology to find a way to accommodate the "inevitable" Columbia River dams, commission biologists working on the Fraser effectively used science to halt the construction of mainstem dams. Although development did take place on the Fraser River, the construction of dams was largely limited to upper tributaries that were beyond the limits of salmon migration, as the Canadian biologist John Babcock had once predicted. The mainstem of the Fraser remained free flowing.[83]

Although the commission resisted the hatcheries' false promise of a quick fix, it did experiment with the use of spawning channels adjacent to the river. These artificial stream channels provided a seminatural, protected environment where adult sockeye could spawn naturally and eggs could incubate. The resulting fry left the channel to rear in nearby lakes. Biologists located spawning channels in areas where there was excess rearing capacity in a nearby lake. Of the three spawning channels constructed, the Weaver Creek channel was an immediate success, but the Gates and Nadina channels showed disappointing results.[84]

Inspired by the success of the Weaver Creek channel, the commission developed a comprehensive program to construct twelve additional spawning channels to increase the production of weak stocks. A major purpose of this enhancement program was to avoid additional harvest reductions. When the IPSFC submitted its proposal to the American and Canadian governments for funding approval, the United States quickly agreed, but Canada refused, thereby killing the program. Canada's refusal stemmed from its dissatisfaction with the U.S. position in ongoing negotiations about regulating U.S. fisheries that caught Canadian salmon.[85] This action by Canada was a blessing in disguise, forcing the commission to increase production by cutting the harvest, despite the short-term hardship on the fishermen, and allowing the weak stocks to rebuild naturally. Techno-fixes would not play a large role in the recovery of Fraser River sockeye salmon.

This situation contrasted starkly with that of the Columbia River, where the long-term health of the ecosystem and its salmon were repeatedly sacrificed for short-term economic gains from development or excessive harvest. The sacrifice of long-term ecological health for short-term economics could be made acceptable only by the unfounded optimism invested in techno-fixes—the "conspiracy of optimism." Deprived of the opportunity to rely on technology, the IPSFC was forced to manage the Fraser based on the fundamentals of salmon ecology and good stewardship. And it worked. Except for a small contribution from the three spawning channels, all of the increases in production on the Fraser River occurred through natural processes.[86]

While the IPSFC was concluding that hatcheries could not mitigate for habitat destroyed by dams, the U.S. government was having second thoughts about its own hatchery program. By then twenty hatcheries had been rebuilt or newly constructed with LCRFDP funds. When Ross Leffler, assistant secretary of the interior, reviewed the program, he concluded that habitat improvement needed more attention, especially above McNary Dam. He further recommended that new spending on hatcheries be deferred until the existing program was evaluated and treatments were developed for the diseases that were attacking the salmon in hatcheries.[87] After eighty-seven years of undocumented claims of success, federal authorities finally mandated an evaluation of the effectiveness of the hatchery program.

To carry out the evaluation, federal and state biologists marked hatchery-reared fall chinook salmon from thirteen hatcheries in the Columbia Basin from 1961 to 1964. Then they intensively monitored fisheries from southeast Alaska to northern California to recover the marked fish. Analysis of the data showed that 14 percent of the chinook salmon caught in all the fisheries were hatchery-reared fall chinook from the Columbia River. This level of contribution from hatcheries was a relatively recent phenomenon. Research on nutrition, disease control, and fish-culture practices through the 1950s had yielded positive results in the 1960s, increasing the survival rate of juvenile salmon after release from the hatchery. Changing ocean conditions also contributed to the boost in survival. The results were encouraging: the economic benefits of the surviving hatchery-reared chinook outweighed the costs of operating the hatcheries by as much as seven to one.[88] The evaluation came up with positive results only because it examined a very narrow set of questions, however, and avoided the most important question of all.

The researchers asked two primary questions: Do hatcheries make a contribution to the fisheries (number of fish caught), and is the economic value of the catch greater than the cost of producing it (cost of hatchery operations)? Although these were important questions, they were too narrow to serve as the sole criteria for evaluating the success of hatcheries. Not only were hatcheries supposed to add fish to the fishery at a reasonable price, but they were also supposed to maintain the total level of production by replacing the wild salmon lost as a result of habitat degradation. So the researchers should have also asked, Did hatcheries replace the production lost as a result of habitat destruction in the tributaries and construction of mainstem dams? The obvious answer to that question would have been a resounding "no." As habitat in the tributaries was degraded by grazing, irrigation, mining, and logging, and as the mainstem salmon habitat was engineered into a series of reservoirs, hatcheries clearly failed to compensate for the loss of wild salmon.

Thus the success of the hatchery program was measured by a flawed statistic. As the total number of wild salmon in the Columbia Basin declined, salmon from the hatchery program began to make up a larger and larger percentage of the total run. Today, as proof of their success, hatchery advocates note that artificially propagated salmon make up 80 percent or more of the total number of salmon on the Columbia, but they fail to mention that the total run has crashed to less than 5 percent of its historical abundance. Measuring success by the percentage of hatchery fish in a shrinking production base not only was scientifically invalid but also insidiously enhanced the illusion of hatchery success. At the same time that the percentage of hatchery fish in the run increased, hatcheries were contributing to the decline of wild salmon—by inappropriate stock transfers, egg mining, encouraging overharvest, and allowing managers to ignore habitat degradation.[89] This situation created a deadly extinction spiral that managers, with their myopic evaluation methods, failed to detect.

Nevertheless, the positive results of the federal study gave a green light for further expansion of the hatchery program on the Columbia River. Between 1960 and 1990, the number of juvenile chinook salmon released from hatcheries in the basin nearly tripled, from about 60 million to over 150 million juveniles a year. At the same time, the total abundance showed no sustained increases, failing to even partially recapture historical production levels.

The philosopher and sociologist Max Weber once remarked that man is an animal suspended in a web of ideas he himself has spun.[90] That certainly describes how people have clung to the use of hatcheries to compensate for the effects of dams in the Columbia Basin. Salmon managers became entangled in a web of their own assumptions about nature, the human manipulation of it, and the ability of technology to replace ecological processes. They reinforced their assumptions with studies that were designed not to objectively evaluate but to support their myopic worldview. Caught in the trap of techno-optimism, salmon managers became so committed to their worldview that they never questioned its basic assumptions.

The eminent physicist Freeman Dyson offers an explanation for the increasing commitment to a failed technology. According to Dyson, ideologically driven technology is never allowed to fail; instead, its proponents will ignore signs of failure until it is too late and great damage has been done.[91] And throughout their history, hatcheries have been ideologically driven. Beginning with Spencer Baird's recommendation in 1875 and continuing with the Columbia River program in the 1940s, hatcheries have been promoted not because they were scientifically justified but because they supported the prevailing development ideology. They enabled canneries to have unrestrained access to fish, and they permitted nearly complete development and control of the rivers—that is, nearly complete destruction of the salmon's habitat. To acknowledge that artificial propagation has failed would call into question not only the hatcheries but also the ideology from which they were derived. It has been far easier to construct and maintain a "conspiracy of optimism."

As a result, management costs have rapidly accelerated, with no tangible results; salmon runs on the Columbia have continued to decline and have reached record lows in recent years. About $3 billion has been spent attempting to restore salmon on the Columbia River over the past fifty years, and management institutions are now calling for an additional $50 million for new hatcheries and over $1 billion to improve the passage of juvenile salmon over the dams. In contrast, over roughly the same period (from 1937 to 1985), the International Pacific Salmon Fisheries Commission spent $21.3 million.

More important, the commission's program was successful. From 1917 to 1949 the average Fraser River sockeye salmon run was 3.3 million fish. Under commission management, the average annual run gradually increased to 5.6 million from 1949 to 1982, then to 7.8 million from 1983 to 1986, and finally to 10.2 million in recent years.[92] In 1990, 22 million sockeye returned to the Fraser River to spawn. On the Columbia, in contrast, the 1993 harvest of prime chinook salmon dwindled to 50,000 fish out of a run of about 450,000, a pitiful fraction of the 8 to10 million chinook that once returned to the river.

Why did the management of salmon runs on the Columbia and Fraser Rivers turn out so differently? For one, the focused authority of the IPSFC on the Fraser carried more weight in protecting the river's habitat and preventing the construction of mainstem dams than could the fragmented management practiced on the Columbia. The restoration of salmon on the Columbia River never did come under a central authority, fulfilling the prediction made in 1943 by the Washington State Senate that the states would be "hopelessly defeated in obtaining any solution to the Columbia River fisheries unless we simplif[ied] our administration over the resource." Instead of the five or so agencies the Washington senators were worried about, today a salmon leaving the Lochsa River in Idaho will make the round trip to the ocean and back while passing through a tangled web of seventeen management jurisdictions.[93] Had a central authority been established to manage the Columbia, the development of the river's hydroelectric potential probably would have proceeded anyway, but such an authority might have relied more on science and tempered the worst destruction. Some of the most damaging dams might not have been built, or their design might have been more fish-friendly.

The Americans may have defeated themselves from the beginning. As early as 1925, at the Seattle meeting, American biologists were resigned to the idea that their rivers would be fully developed. Their mood was in sharp contrast to that of the Canadian, John Babcock. There was no question in his mind that no dams would be built on the Fraser's mainstem. Did Babcock's sentiment reflect a broader cultural difference between the American and Canadian attitudes toward the management of natural resources? Maybe, but the Canadians have destroyed far too many salmon streams through logging and development for me to claim that they are fundamentally better conservationists. And recently, Canadian biologists have argued

that the problems in the Pacific salmon and Atlantic cod fisheries stem from political or economic influences that interfere with research and dissemination of scientific information.[94]

But from 1930 to 1980, the Canadians and later the IPSFC certainly sought out and accepted the findings of science more readily than the Americans. The Canadians closed all their hatcheries in British Columbia in 1936 after Russell Foerster's study found that they were no less effective than natural propagation. This decision removed the option of mitigating for dams with hatcheries, an option that seems to have been so readily and unjustifiably accepted by the Americans. Even when faced with the threat of Moran Dam in the 1950s, the Canadians still relied on science and did not allow the hatcheries' promise of a quick fix to lure them into trading away the Fraser's mainstem. The commission's restoration program was based on the latest science, which stressed the importance of the salmon's stock structure and the importance of habitat.

On the Columbia, this scientific understanding was ignored until recently. Instead, the Columbia River restoration program invested in a "conspiracy of optimism," clinging to the unfounded hope that hatcheries could restore the salmon. As a result, wild coho in the lower Columbia River have disappeared, and populations of salmon and steelhead in other parts of the basin have become severely depressed. The Canadians and the IPSFC did not do everything right; the Fraser does have its share of environmental tragedies, and some salmon stocks have declined in recent years. But for the period of time when it counted most—the major dam-building era of the 1940s to the 1970s—the International Pacific Salmon Fisheries Commission and its biologists used the science they had to ask the right questions, and then mustered the courage to live with the answers. That, I would argue, made all the difference.