DEDICATION

This work is dedicated to all life on this earth,
before our time and long after we are gone.

We did not inherit this earth or its natural resources from our ancestors, we are only borrowing them from our children's children; therefore, we are duty bound and obligated to protect them and use them wisely until such time that they get here, and then they will have the same obligations.

— Eugene Greene, Sr., Chairman
Columbia River Inter-Tribal Fish Commission

WY-KAN-USH-MI
WA-KISH-WIT

Spirit of the Salmon

The Columbia River Anadromous Fish Restoration Plan
of the
Nez Perce, Umatilla, Warm Springs,
and Yakama Tribes

VOLUME I

PREFACE

The salmon's spirit — Wy-Kan-Ush-Mi Wa-Kish-Wit — is sacred life. The salmon was provided a perfect world in which to enjoy its existence. For thousands of years, the salmon unselfishly gave of itself for the physical and spiritual sustenance of humans. The salmon's spirit has not changed; the human spirit has.

Today the perfect world of the salmon is in total disarray. Even its very existence and worth are being debated. Human arrogance has brought the salmon to the brink of extinction.

Rather than a dignified cultural icon, the salmon is being redefined as a problem, as something that makes unacceptable the human laws designed to protect the environment. In spite of the state of crisis, crude science and perilous politics have reduced the salmon and its habitat to a struggling species living in a polluted and life-threatening home.

The four Columbia River treaty tribes, who are keepers of ancient truths and laws of nature, employ the depths of their hearts and the expanse of their minds to save the salmon.

Respect and reverence for this perfect creation are the foundation for this plan.

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It was known that the passage conditions in the mainstem Columbia River were inhospitable to salmon. Yet changes in river operation were minute, especially given the prevailing drought conditions. It was also known that many salmon runs and stocks had declined to such an extent that their best hope was the application of artificial propagation strategies. But hatcheries were eschewed without regard to the best available science. Instead some of the stocks that might have been helped by enactment of the fish program measures became listed under the Endangered Species Act. And it was known that many environmental laws have been ignored, exacerbating the crisis in the Columbia River Watershed.

Wy-Kan-Ush-Mi Wa-Kish-Wit is the culmination of the leadership and wisdom of the Nez Perce, Umatilla, Warm Springs and Yakama fish and wildlife committees and the technical work of reservation fisheries and the Columbia River Inter-Tribal Fish Commission staffs. This tribal salmon restoration plan outlines the cultural, biological, legal, institutional and economic context within which the region's salmon restoration efforts are taking place. This long-term plan addresses virtually all causes of salmon decline and roadblocks to salmon restoration for all anadromous fish stocks: chinook, coho, sockeye, steelhead, chum, eels (Pacific lamprey) and sturgeon, above Bonneville Dam. This area, encompassing about three quarters of the Columbia River Basin, is where most of the tribes' treaty-reserved fishing places and fish resources are located.

The Columbia River treaty tribes take a holistic "***gravel-to-gravel***" approach to the management of the salmon, which differs from approaches of many other groups in a variety of respects. This approach focuses on the tributary, mainstem, estuary, and ocean ecosystems and habitats where anadromous fish live. This focus on passage, habitat, harvest and production requires substantial changes in current practices and specific actions to recover from historical destructive impacts.

Wy-Kan-Ush-Mi Wa-Kish-Wit integrates this gravel-to-gravel approach into an ***adaptive management framework***. The tribes agree with others who advocate an adaptive approach that requires action even in the face of uncertainty. According to adaptive management principles, that action must be carefully monitored and evaluated so that natural resource managers learn and change their actions on the basis of what they have learned. Using an adaptive framework, this plan identifies the survival changes in current water, land and fish management needed to produce the necessary survival rates. The actions endorsed in this plan are designed to measure whether or not survival levels are being achieved. Should the recommended measures not attain sufficient rates of survival, the plan calls for modifications and additional actions.

This plan goes far beyond those plans currently offered by other sovereign governments — the federal plan for endangered Snake River salmon by the National Marine Fisheries Service and the Idaho, Montana, Oregon, and Washington fish and wildlife mitigation plan by the Northwest Power Planning Council (NPPC). The plan not only makes recommendations, but more importantly begins to provide a context for decision making: scientific and legal justifications, directions for implementation, and analyses of expected outcomes are provided.

Unlike other plans, this plan establishes a foundation for the United States and its citizens to honor their treaty and trust obligations to the four tribes. If implemented, it would at least begin to meet ceremonial, subsistence, and commercial needs of tribal members and to return fish to many of the tribes' usual and accustomed fishing places, as guaranteed in the 1855 treaties. If these obligations were met, the non-Indian public would be a beneficiary, enjoying its legal allotment of harvestable salmon and sharing a healthier, more natural river system.

What often sets policy development apart from other decision-making is the tribal conviction that not all societal decisions can be properly weighed in terms of costs and economics. The

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EXECUTIVE SUMMARY

We, the Indians of the Columbia River Inter-Tribal Fish Commission, recognize that our fisheries are a basic and important natural resource and of vital concern to the Indians of these states and that the conservation of this resource is dependent upon effective and progressive management. And it is further recognized that federal court decisions have specifically established that the tribes have treaty rights to an equitable share of the Columbia Basin fishery resource. We further believe that by unity of action we can best accomplish these things, not only for the benefit of our own people but for all the people of the Pacific Northwest.

Preamble to the Constitution and Bylaws of the Columbia River Inter-Tribal Fish Commission

The Columbia River Watershed is world renowned for its salmon populations. Historical estimates of average annual salmon runs exceeded 5-11 million fish in the portion of the watershed now above Bonneville Dam. When Lewis and Clark reached the Columbia River, they were amazed by the abundance of the salmon. Yet today, fewer than 500,000 fish return above Bonneville and approximately 80% of these are produced in hatcheries. Some stocks have already been lost, three have been listed as endangered under the Endangered Species Act by the National Marine Fisheries Service, and the majority of the remaining stocks are declining. These reduced runs of salmon are surely cause enough for alarm, yet the issue comprises far more than salmon. Tribal culture, the identity of all the people, and many of the species that constitute the Pacific Northwest—essentially the integrity of the entire Columbia River Watershed—are at stake.

If salmon are to survive in the Columbia River Watershed, we must face the challenges before us with our goals clearly in mind, in heart, and in spirit. We must now begin to respect, to reestablish, and to restore the balances that once enabled this watershed to perform so magnificently.

Wy-Kan-Ush-Mi Wa-Kish-Wit: The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes provides a framework to restore the Columbia River salmon, simply stated: ***put the fish back into the rivers***. Yet making this happen has become increasingly difficult because of the decades of poorly guided and deeply entrenched fish management policies. More than science and its limits, the problems have almost always involved people and their institutions — whether government, business or otherwise.

Much of what is recommended to benefit salmon is what has been needed and known for a long time. More than 50 years ago, federal biologists warned that the consequences of continued habitat degradation and additional hydroelectric development would be devastating to salmon populations. They were joined by tribal leaders and through the years, by government commissions and citizen groups.

However, until the enactment of the Pacific Northwest Power Planning and Conservation Act of 1980 and its fish and wildlife program, there was no comprehensive salmon restoration program for the Columbia Basin. Had the Northwest Power Planning Council's salmon plan been implemented, the people of the Northwest would not be today facing a salmon crisis.

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Goals and Objectives of Tribal Fish Restoration

• PUT THE FISH BACK INTO THE RIVERS ! •

GOALS

- Restore anadromous fishes to the rivers and streams that support the historical cultural and economic practices of the tribes. (These are generally areas above Bonneville Dam.)
- Emphasize strategies that rely on natural production and healthy river systems to achieve this goal.
- Protect tribal sovereignty and treaty rights.
- Reclaim the anadromous fish resource and the environment on which it depends for future generations.

OBJECTIVES

- Within 7 years, halt the declining trends in salmon, sturgeon, and lamprey populations originating upstream of Bonneville Dam.
- Within 25 years, increase the total adult salmon returns above Bonneville Dam to 4 million annually and in a manner that sustains natural production to support tribal commercial as well as ceremonial and subsistence harvests.
- Within 25 years, increase sturgeon and lamprey populations to naturally sustainable levels that also support tribal harvest opportunities.
- Restore anadromous fishes to historical abundance in perpetuity.

EX5022-000006-TRB

costs of restoration must be at least equated with the value of restoration. That value includes the spirit of the salmon (*Wy-Kan-Ush-Mi Wa-Kish-Wit*). Tribal peoples can feel the yearning of salmon to serve its life purpose. There is no model that can factor in spirituality nor the ultimate value of living creatures.

The tribes would hope that those who read, study and use this plan, consider it a work-in-progress and invite readers to join in refining it. The tribes believe that the plan's approach can help give direction to a region whose salmon recovery is floundering without real political vision and genuine scientific guidance.

If the reader can reconcile the truths of the past with the dreams for tomorrow, then today's work can be found. This plan calls on the collective human spirit to bring cultured and hereditary strengths to bear upon the need for salmon restoration.

Specific Contents of the Plan

If the actions outlined in the plan are taken, the four tribes believe the salmon decline can be halted within seven years and salmon populations rebuilt to annual run sizes of four million above Bonneville Dam within 25 years. Based on adult return goals for each subbasin and species (Table 1.1), and allowing for additional escapement needs and anticipated passage losses, over two million salmon will be available for harvest in mainstem fisheries. Goals in this plan will be reviewed periodically as part of the adaptive management process.

To accomplish these objectives, the first volume of the plan sets out 10 proposals for institutional change, along with 13 scientific hypotheses and the recommended actions associated with each. The second volume contains subbasin-by-subbasin return goals and the restoration actions that must be undertaken to achieve them.

Tribal Culture and History

To understand the approach the four Columbia River tribes have taken to anadromous fish restoration, key aspects of tribal culture and history are described, including the importance of salmon, tribal governmental structures and the traditional tribal management philosophies that continue to guide the tribes as they have since ancient times.

Biological Perspective

Outlined in this section are the survival requirements for salmon and measures to improve survival of Pacific lamprey and white sturgeon. While their requirements, such as cool, clean water and complex stream systems, remain virtually the same as they have for hundreds of years, the conditions under which these anadromous fish must now live have been dramatically altered in a relatively short time. These changes and their consequences are summarized here and are the bases for many of the recommendations presented in this plan. The tribes have set survival standards by life history stage required to meet restoration goals for spring and fall chinook (Table 1.2).

Legal and Institutional Context

The tribes in the Northwest have a unique place in the legal and regulatory scheme of natural resource management. To provide some understanding of why this is so, tribal sovereignty, treaty-reserved rights, trust responsibility and other legal matters pertaining to the governmental status of the tribes are explained. This section also describes the institutional structures already in place which recognize the tribes as resource co-managers and that can serve as the framework for accomplishing most restoration actions. An analysis of the successes and failures of these institutions and of numerous legislative initiatives is offered.

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Table 1.1. Adult return goal to each subbasin. Most goals represent a combination of spawning needs plus tributary harvest opportunities; exceptions are footnoted.

SUBBASIN	CHINOOK Spring	CHINOOK Summer	CHINOOK Fall	COHO	SOCK-EYE	STEELHEAD Summer	STEELHEAD Winter	TOTAL
LOWER COLUMBIA RIVER MAINSTEM (Bonneville Dam → McNary Dam)								
Wind River[a]	5,000			200		2,000	200	7,400
Little White River[a]	2,000		200	200				2,400
Big White River[a]	500		100	100		4,800	800	6,300
Klickitat River[b]	20,000		40,000	50,000		25,000		135,000
Hood River[b]	1,700					8,000	5,000	14,700
Deschutes River[b]	10,250		11,000		5,000	19,000		45,250
Fifteenmile Creek[c]							300	300
John Day River[b]	7,000					45,000		52,000
MID-COLUMBIA RIVER MAINSTEM (McNary Dam → Chief Joseph Dam)								
Umatilla River[b]	11,000		21,000	6,000		9,670		47,670
Hanford Reach[c]			40,000					40,000
Walla Walla River[b]	5,000					11,000		16,000
Yakima River[b]	26,300	12,000	4,700	5,000		29,700		77,700
Wenatchee River[b]	21,000	10,000			35,000	6,410		72,410
Entiat River[a]	750					3,000		3,750
Methow River[a]	2,000	3,000				10,000		15,000
Okanogan River[a]	1,000	2,000			15,000	10,000		28,000
LOWER-SNAKE RIVER MAINSTEM (Ice Harbor Dam → Hells Canyon Dam)								
Snake River[b]			18,300					18,300
Tucannon River[b]	3,000	2,000				2,200		7,200
Clearwater River[b]	60,000	48,000	6,000	4,500		93,100		211,600
Grande Ronde River[b]	16,000		10,000	3,500	2,500	27,500		59,500
Salmon River								NA
Imnaha River[b]	5,740		1,150			4,315		11,205
TOTAL	198,240	77,000	152,450	69,500	57,500	310,695	6,300	871,685

[a] Harvest goal only

[b] Harvest and spawning goal

[c] Spawning goal only

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Table 1.2. Survival rates of Snake River spring and fall chinook under NMFS and Tribal restoration plans. *From Table 5C.2.*

LIFE HISTORY STAGE OR MORTALITY SOURCE	SPRING CHINOOK		FALL CHINOOK	
	NMFS 1995 Plan	Tribal 25-yr Strategy Option 3	NMFS 1995 Plan	Tribal 25-yr Strategy Option 3
Egg→Smolt	.045	.10	.50	.50
Juvenile Passage	.24	.71	.19	.36
Early Ocean	.16	.16	.20	.20
Ocean Natural	.50	.50	.50	.50
Ocean Harvest	1.00	1.00	.79	.85
In-river Harvest	.90	.61	.85	.28
Adult Passage	.70	.91	.55	.83
Pre-spawning	.85	.85	1.00	1.00
Lifetime Total ($x10^{-3}$)	**.46**	**2.69**	**3.51**	**3.56**
Spawner/Spawner Ratio	***1.16***	***6.74***	***6.04***	***6.13***

failure of these existing mechanisms is *a failure to act* by responsible parties. The success of these existing institutional frameworks requires true co-management by the tribes instead of unilateral decisions by the state and federal governments.

The institutional recommendations propose, for the most part, modest changes to the procedures adopted under the authority of *U.S. v. Oregon* and the Pacific Northwest Electric Power Planning and Conservation Act to improve harvest and production management and to coordinate policies and resolve disputes, particularly for hydro operations, public lands management and research. The recommendations attempt to join accountability with responsibility for fish restoration by shifting the funding prioritization process to the tribes and agencies and transferring certain federally funded hatcheries to the tribes. The recommendations seek to limit policy barriers to the use of artificial propagation as a tool for restoration. The institutional changes also address private land management by recommending support for watershed initiatives and for enforcement of environmental laws.

Tribal Recommendations

The tribal plan generally offers three types of actions within the recommendations section: institutional, technical, and watershed- or sub-basin-specific. Recommendation descriptions and highlights follow.

Institutional

The tribal salmon restoration plan urges that existing institutional frameworks be used to manage and achieve anadromous fish restoration. The framework provided by the Columbia River Fish Management Plan, Pacific Salmon Treaty, Northwest Power Planning Act, and the Federal Energy Regulatory Commission provides the structure for the sovereign governments of the Northwest to plan, coordinate and direct major restoration actions. The tribes contend that the

Institutional Recommendations

1. Rather than create a new federal bureaucracy, use the Columbia River Fish Management Plan, the Northwest Power Planning Council's Fish and Wildlife Program, and orders of the Federal Energy Regulatory Commission as a basis for management.

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2. Plan and implement production called for in the Columbia River Fish Management Plan.
3. For public lands and water project management, implement a dispute resolution process similar to Columbia River Fish Management Plan and Federal Energy Regulatory Commission processes.
4. Establish a new state and tribal fish and wildlife entity using Bonneville Power Administration funding.
5. Support ongoing and implement new subbasin planning through a Columbia Basin watershed trust program.
6. Base Endangered Species Act listing on the status of species throughout a significant portion of its spawning and rearing range. In the absence of scientific proof, the National Marine Fisheries Service should withdraw its Evolutionarily Significant Unit (ESU) interim policy as a basis for Endangered Species Act listings.
7. Transfer federally funded hatcheries located on reservations and at other upriver sites to tribal control.
8. State, tribal and federal fish agencies coordinate and set priorities for research, monitoring and evaluation programs.
9. Continue development of and make research and monitoring data available through a coordinated information system.
10. Update provisions of the Pacific Salmon Treaty and the Columbia River Fish Management Plan based on the latest survival rate and catch level information.
11. Continue coordinated harvest law enforcement; develop habitat protection law enforcement.

Technical Recommendations

1. Begin improving in-channel stream conditions for anadromous fish by improving or eliminating land-use practices that degrade watershed quality.
2. Protect and increase instream flows by limiting additional consumptive water withdrawals, using the most efficient irrigation methods, preventing soil compaction and riparian vegetation removal and wetland destruction; where necessary, restore soil, restore riparian vegetation and re-create wetlands.
3. Actively restore watersheds where salmon populations are in imminent danger of extirpation. Use "Coarse Screening Process" to develop demonstration projects.
4. Use supplementation to help rebuild salmon populations at high demographic risk of extirpation.
5. Use supplementation to reintroduce salmon to watersheds from which they have been extirpated.
6. Use flow, spill, drawdowns[1], peak efficiency turbine operation, new turbine technology, and predator control projects to improve inriver juvenile salmon survival; avoid fluctuations caused by power peaking operations.
7. Protect and restore critical estuary habitat.
8. Establish Alaskan and Canadian ocean fisheries based on chinook abundance.
9. Use stored cold water, additional ladders, ladder improvements and ladder maintenance to enhance mainstem adult passage; incorporate 24-hour video fish counting.
10. Improve water quality by eliminating sources of toxic pollution that accumulates in fish tissue and by reducing discharges of other contaminants to meet water quality criteria for anadromous fish.
11. Closely monitor tributary production and escapement to improve management.
12. Conduct research on Pacific lamprey and design artificial propagation strategies to supplement natural production.
13. Develop artificial propagation and management strategies for white sturgeon populations above Bonneville Dam.

Technical

The tribal technical recommendations are presented in sets of hypothesis statements that summarize various restoration problems. The

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hypotheses are organized by salmon life cycle stages. Individually, they propose near- and long-term actions, identify expected results and name the institutional and decisional processes required to carry out the recommended actions.

Habitat Restoration

To protect and recover tributary habitat, the plan proposes that land and water users and managers meet a series of habitat conditions associated with survival rates, for example, 10% egg-to-smolt survival for Snake River spring and summer chinook. The use of the "Coarse Screening Process," where applicable, will determine the allowable level of watershed impacts. This process requires federal and state land and water managers to maintain or improve fish habitat. If they do not meet the habitat standards — for example, water temperatures can be no higher than 60°F — land and water managers must take action that will achieve compliance. Other important Coarse Screening standards include limits on the amount of sediment in spawning habitat and in streams generally, and the establishment of riparian reserves to protect vegetation and soils. So that anadromous fish are able to again thrive in their natural environment, other necessary measures are recommended, including reconnecting habitat areas that support salmon. Badly degraded habitat may be directly downstream or upstream of salmon-supporting habitat. As migratory fish, salmon require decent habitat throughout their life-cycle range.

Production

The tribal goal to put fish back in the rivers means literally putting the fish back. To do that requires returning more of the basin's fish production to the rivers and streams where they come from. Young salmon, if released at the proper time and manner, will return as adults to spawn in the same area they were released as juveniles. Rather than continuing current hatchery rearing and release methods, the plan outlines the development of new propagation strategies to reestablish naturally spawning salmon runs. With so many Columbia basin stocks at such low numbers, supplementation, which is what the tribes call their propagation proposal, is now an indispensable part of any restoration plan. While accounting for genetic concerns, the tribal plan asserts that increasing likelihood of further extirpations is in fact the far greater genetic risk.

Passage

In the mainstem Columbia and Snake rivers where more than a dozen massive dams dominate riparian habitat, the plan also calls for putting the fish back in the river: Young migrating salmon are now being transported in trucks and barges. Stop collecting them for transport, the plan urges, and let them swim down the river to the ocean on their own. To support anadromous fish, mainstem habitat must be returned to natural conditions which are linked to a 71% downstream passage survival rate, closer to those that existed prior to construction of the dams. This can be done by providing additional spill and water flows, among other measures. The plan recommends actions that can begin restoration of mainstem habitat, including provisions to address toxic pollution as well as provisions for additional spill and water flows. The plan also addresses estuary and ocean problems.

Harvest

Plan recommendations include proposals for reducing chinook mortalities in North Pacific fisheries and the adoption of abundance-based salmon management in ocean fisheries. The plan addresses the problem of incidental mortalities and other harvest issues.

Watershed Actions

In Volume II of this plan, the subbasin plans that were part of the earlier Northwest Power Planning Council fish and wildlife program have been updated and are included as a key part of this plan. Detailed recommendations are provided for 23 major watersheds above Bonneville Dam. The measures focus on habitat protection and rehabilitation and on returning fish to these streams using supplementation techniques. It is envisioned that these actions will be accom-

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plished through a watershed restoration trust fund, under the leadership of the Columbia River treaty tribes.

Economic Context

In this section, the tribes' plan acknowledges the cost of salmon restoration but provides a different look at valuation. The tribes contend that the people of the Northwest can afford salmon restoration and that calculating foregone hydroelectric cost is not the only measure of the salmon's worth. The annual costs of salmon restoration measures are estimated to be half a percent of the region's annual personal income. The loss of salmon has also meant the loss of revenue for tribal economies historically dependent on salmon with an estimated loss for tribal economies of billions of dollars so far. The estimated annual cost of the plan, $195-$325 million, is similar to the cost range of the Northwest Power Planning Council's Columbia Basin Fish and Wildlife Program and the National Marine Fisheries Service's Snake River Recovery Plan.

In conclusion, the tribes urge the region to adopt a single plan for Columbia Basin anadromous fish—one that is mutually acceptable to the four tribes, the United States and the states of Washington, Oregon and Idaho. The tribes ask citizens and their government representatives and officials to use this plan and its framework as the basis for salmon restoration.

BPA energy-related subsidies. *From Table 6.1*

BPA DISCOUNTS	ANNUAL SUBSIDY (1994)
Bureau of Reclamation irrigation pumping	$32. million
Private irrigation pumping	$13.5 million
Direct Service Industries (primarily aluminum smelting)	$179. million
Residential loads of Investor Owned Utilities	$210. million

1. Short term: Draw down John Day to minimum operating pool and Lower Granite to 705' mean sea level;
   Long term: Option 1: John Day and Lower Granite to natural river level;
   Option 2: John Day to spillway crest; Ice Harbor and Lower Monumental to natural level;
   Option 3: John Day and four lower Snake dams to natural river level.

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SECTION 2

CULTURAL CONTEXT

CULTURAL CONTEXT

The Columbia River Treaty Tribes

The Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warms Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Indian Nation (Figure 2.1) are the only tribes in the Columbia Basin to have reserved rights to anadromous fish in 1855 treaties with the United States.

The people of these tribes have always shared a common understanding — that their very existence depends on the respectful enjoyment of the Columbia River Basin's vast land and water resources. Indeed, their very souls and spirits were and are inextricably tied to the natural world and its myriad inhabitants. Among those inhabitants, none were more important than the teeming millions of anadromous fish enriching the basin's rivers and streams.

Despite some differences in language and cultural practices, the people of these tribes shared the foundation of a regional economy based on salmon. To the extent the resource permits, tribal people continue to fish for ceremonial, subsistence, and commercial purposes employing — as they always have — a variety of technologies. Tribal people fish from wooden scaffolds and from boats, use set nets, spears, dip nets, and poles and lines. Tribal people still maintain a dietary preference for salmon, and its role in ceremonial life remains preeminent. Salmon is important and necessary for physical health and for spiritual well-being.

Today, perhaps even more than in the past, the Columbia River treaty tribes are brought together by the struggle to save the salmon and by shared spiritual traditions such as the first salmon feast.

The Nez Perce Tribe

The Nez Perce homeland once consisted of 13 million acres in what is now Idaho, Oregon, and Washington. The original land base included significant portions of six different drainages. Today, the reservation consists of 750,000 acres, of which 13 percent is owned by the tribe.

The management of land and natural resources continues to be paramount for the Nez Perce. The tribe is trying to buy back some of the 7.5 million acres originally reserved in the 1855 Treaty with the Nez Perce. The tribe's strong fish program employs nearly 50 full-time and part-time workers. Nez Perce co-management responsibilities extend to the Columbia, Snake, Tucannon, Grande Ronde, Imnaha, Clearwater, and Salmon drainages. Tribal members fish on the Clearwater River, which runs through the reservation near its northern and eastern borders, and on the Columbia, Rapid, and Selway rivers.

The General Council, which includes all voting-age members of the tribe, elects the nine-person Nez Perce Tribal Executive Committee (NPTEC), the tribe's governing body. The tribe's fish and wildlife committee is made up of appointed members of NPTEC. The tribe, whose enrolled membership is about 3,000, is headquartered in Lapwai, Idaho.

The Confederated Tribes of the Umatilla Indian Reservation

When the leaders of the Walla Walla, Cayuse, and Umatilla peoples signed a treaty with the United States in 1855, they ceded 6.4 million acres of homeland in what is now northeastern Oregon and southeastern Washington. Today the three-tribe confederation numbers 1,500. The 172,000-acre reservation, almost half of which is owned by non-Indians, includes significant portions of the Umatilla River watershed.

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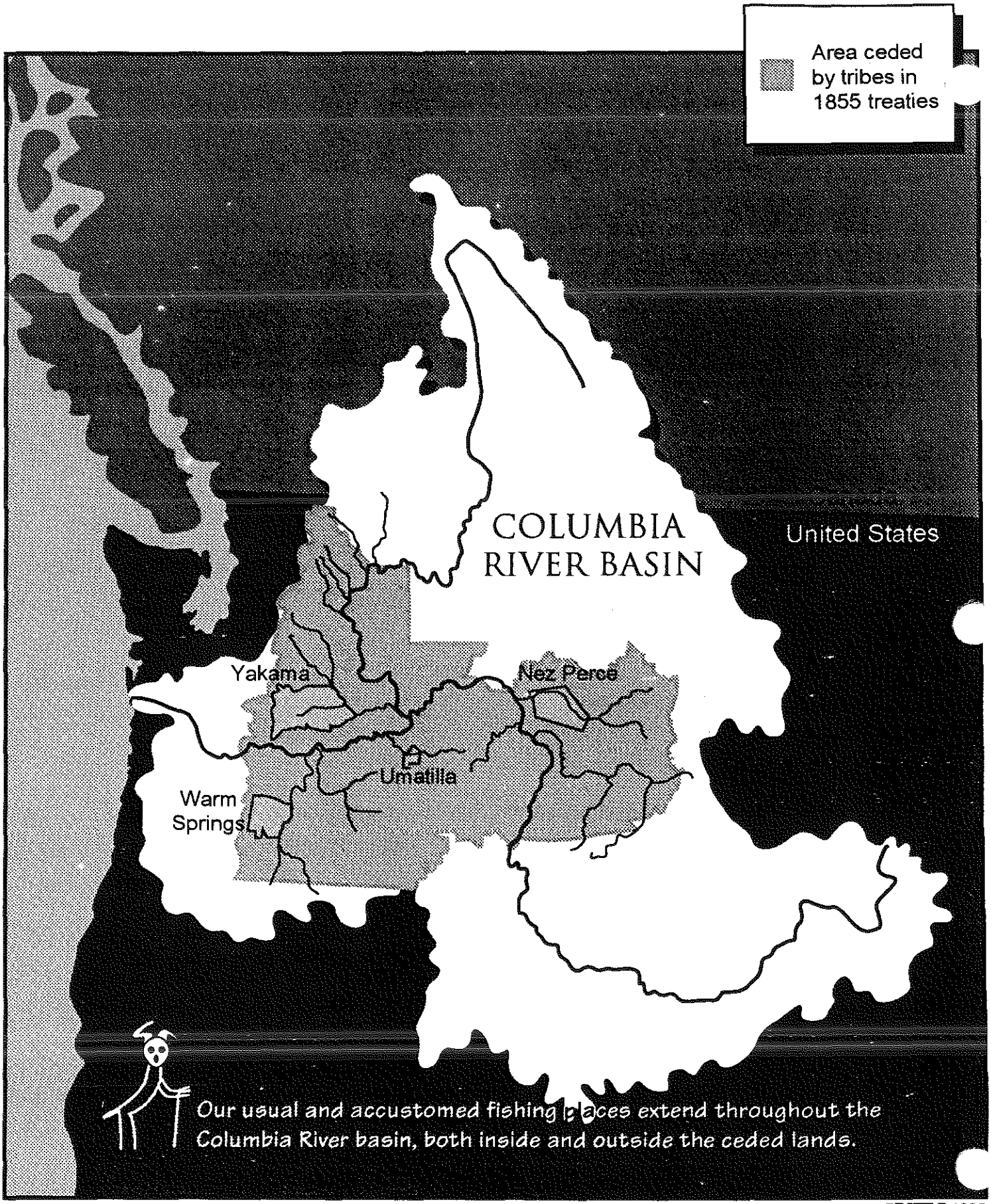

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Figure 2-1. The Columbia River basin, the four Columbia River treaty tribes and their ceded area.

The Umatilla and Grande Ronde rivers have been the focus of the tribe's fish restoration activities for more than a decade. Under the tribe's leadership, salmon were reintroduced in the Umatilla river in the early 1980s. The tribe, along with the state of Oregon, operate egg-taking, spawning, and other propagation facilities that are helping restore salmon runs. The first fall chinook, spring chinook, and coho salmon in some 70 years returned to the Umatilla River in 1984.

In the Grande Ronde watershed, the Umatilla and Nez Perce tribes along with state and federal agencies developed a state-of-the-art salmon habitat restoration plan for the USDA Forest Service. Other river basins in which the tribe has co-management responsibilities are the Columbia, Snake, Walla Walla, Tucannon, Grande Ronde, John Day, and Imnaha. In recent times, tribal fisheries have occurred only on the Umatilla and Columbia rivers.

The Umatilla are governed by the Board of Trustees composed of nine members elected by the General Council. Tribal headquarters are located in Mission, Oregon.

The Confederated Tribes of the Warm Springs Reservation of Oregon

A 640,000-acre reservation in north central Oregon is home to a confederation of three tribes: the Warm Springs, Wasco, and Paiute tribes. The Warm Springs Tribe is made up of the Upper Deschutes (Tygh), Lower Deschutes (Wyam), Tenino, and John Day (Dock-spus) bands. The Wasco tribe is made up of The Dalles (Ki-gal-twal-la) and Dog River bands. Several Paiute bands from southeastern Oregon were removed to the Warm Springs Reservation in 1869. In 1855 the Warm Springs and Wasco tribes treated with United States in the Treaty with the Middle Oregon Tribes of Oregon. In the treaty, 10 million acres of aboriginal lands were ceded to the United States. Today, the enrolled membership of all three tribes totals nearly 3,000. Most members reside on the reservation.

The reservation government is led by an 11-member tribal council. Three are chiefs who serve life terms, and the remaining eight are elected from reservation districts for 3-year terms. The Warm Springs Tribe co-manages the Columbia, Deschutes, Fifteenmile Creek, John Day, and Hood River watersheds. The U.S. Fish and Wildlife Service operates a chinook hatchery on the reservation. Tribal headquarters are in Warm Springs, Oregon.

The Cascade Mountains flank the reservation on the west, and the Deschutes River forms its eastern border. The river now supports spring chinook, fall chinook, and steelhead. Tribal members still fish with dip nets and set nets from wooden scaffolding at the falls near Sherars Bridge.

The Confederated Tribes and Bands of the Yakama Indian Nation

Mount Adams, the Klickitat River, and the Yakima River are among the defining features of the 1.2 million-acre Yakama Indian Reservation in south central Washington. In the 1855 Treaty with the Yakama, 14 bands and tribes ceded 11.5 million acres to the United States. The bands and tribes in the Yakama confederation are the Kah-milt-pah, Klickitat, Klinquit, Kow-was-say-ee, Li-ay-was, Oche-chotes, Palouse, Pisquose, Se-ap-cat, Shyiks, Skinpah, Wenatshapam, Wishram, and Yakama.

Today, representatives of the 14 bands and tribes make up the Yakama Tribal Council. A general council includes all tribal members over 18 years of age. The tribe, which uses an interdisciplinary and sustainable approach to care for the land and natural resources, operates a fisheries program with approximately 40 employees. Among its fisheries projects is its unique work with the US Department of Energy to use abandoned intake settling ponds at the Hanford Nuclear Reservation to acclimate about 500,000 fall chinook juveniles before releasing them into the Columbia. (The concrete pools were tested and found to have no contamination.) The Yakama Indian Nation co-manages the Columbia, Wind,

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White Salmon, Klickitat, Yakima, Wenatchee, Methow, Entiat, and Okanogan rivers.

The tribe has usual and accustomed fishing places in many locations in the Columbia River Basin and some outside the basin. Salmon continue to be the lifeblood of the nearly 8,400 Yakama tribal members.

The Importance of Salmon to the Tribes

- Salmon are part of our spiritual and cultural identity.
- Over a dozen longhouses and churches on the reservations and in ceded areas rely on salmon for their religious services.
- The annual salmon return and its celebration by our peoples assure the renewal and continuation of human and all other life.
- Historically, we were wealthy peoples because of a flourishing trade economy based on salmon.
- For many tribal members, fishing is still the preferred livelihood.
- Salmon and the rivers they use are part of our sense of place. The Creator put us here where the salmon return. We are obliged to remain and to protect this place.
- Salmon are indicator species: as water becomes degraded and fish populations decline, so too will the elk, deer, roots, berries, and medicines that sustain us.
- As our primary food source for thousands of years, salmon continue to be an essential aspect of our nutritional health.
- Because our tribal populations are growing (returning to pre-1855 levels), the needs for salmon are more important than ever.
- The annual return of the salmon allows the transfer of traditional values from generation to generation.
- Without salmon returning to our rivers and streams, we would cease to be Indian people.

A Tribal Tradition of Sound Fish Management

The native peoples of the Columbia River Basin have always revered the way the Creator took special care of nature and the way nature obeyed the Creator. This was a perfect mystery. For that reason, Columbia River tribes found it easy to embrace the concept of stewardship. For them, stewardship extends respect for life beyond the dignity of the human person to the whole of creation. That respect involves the responsibility to honor what the Creator provides. As long as nature is taken care of, nature will take care of the people. The tribes continue to acknowledge this traditional wisdom.

The tribes developed "gravel-to-gravel" management principles from this traditional wisdom. Gravel-to-gravel management acknowledges the relationship between the biology of the fish, the degree of human pressures on them, and the condition of their physical environment throughout all life history stages. It is an ecologically sound approach that is at the same time sacred and regulatory.

In non-Indian parlance, traditional wisdom is *systems thinking*. It is a discipline for seeing wholes, recognizing patterns and interrelationships, and learning how to structure human actions accordingly.

This way of thinking is the foundation of the recommendations for salmon restoration. The recommendations are intended to harmonize what Indian people know about the basin's natural environment, what humans have imposed on that environment, and what can be done to create a balanced and sustainable existence.

Tribal management begins with a recognition of nature's bounty as a gift from the Creator. They are humbled by the salmon's faithful return to the rivers to serve human and other needs. Tribal people celebrate nature's preeminence and the need for human society to harmonize itself with the structures and rhythms of nature. They believe that everything in nature has a purpose,

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whether or not humans know the purpose. Today tribal respect for nature is evidenced in time-honored ceremonies such as the seasonal first-food feasts held each year, when the human world stops to honor the return of nature's gifts.

In the native cultures of the Columbia Basin, food and water were never taken for granted, as they often are in today's society. Tribal society recognized that food and water are always matters of survival and of spiritual well-being.

Today people are often far removed from the sources of their food and drinking water. Very few are engaged in growing or gathering food for the table, and a growing number are no longer even involved in food preparation at home. Under such circumstances, it becomes difficult to appreciate our place in the natural cycles of life. Contemporary society is removed from what traditional native thinkers of the Columbia Basin called the "connectedness" or "connection of all life."

Indian culture and religion are attentive to the human place within nature. A drink of water, the aroma of roasting salmon, or a bite of the crispy kouse (root) are ordinary reminders that all humans are dependents of nature. As we are served, we must also serve.

The complexity of human minds was simplified in the indescribable beauty of songs that expressed a culture based on the fundamentals of love, purity, respect, and worship which sustained life for natives before the time of Christianity, Judaism, or any other of the great world religions. This strength should not be lost.

Many laws and rules were the subject of the hundred or more songs that the people knew. In them were instructions on how to live, expressed in "a way that opens your mind up." Some explained that as "the givers of life," the salmon, the deer, the roots, and the berries must be enjoyed as food and in ceremony. How water and the four great foods are to be honored and cared for are also prescribed in the songs.

Non-Indian attempts to subjugate nature and the resulting spiritual bankruptcy are what many Indian people and others believe are among the root causes for many current environmental and social problems, including the salmon crisis.

Perhaps nowhere are the differences in the Indian and non-Indian ways of relating to nature more evident than in the treatment of water. The tribes have always regarded water as a medicine because it nourishes all of life. Water flushes poisons out of humans, other living creatures, and the land. Traditional culture teaches that to be productive, water must be kept pure. When water is kept pure and cold, it takes care of the salmon. It takes care of humans as well. Water that cannot take care of salmon cannot take care of humans.

Non-Indians, on the other hand, have used the water without fully understanding that it must be treated with respect to remain powerful. By causing the water to warm, by restricting its flow and by putting pollutants in it, they have made the water sick. It can no longer be used as a cleansing agent. The water is so inhospitable that at times it can no longer take care of the salmon.

After European-introduced diseases took their toll, after treaties and the reservation system were firmly installed, and as non-Indian cultural domination spread, a great deal of tribal "encyclopedic" knowledge of the natural and spiritual world was lost. What is known comes from tribal elders, from the study of the language and culture, from records, and from other analytical sources.

What is known, for example, is that hundreds and hundreds of plants, animals, and geographic locations were identified. Each of these plant and animal species had a particular purpose or use. Tribal people knew their characteristics and properties, the habitat and environmental conditions in which they could be found, and the ritual and practical methods for using and preserving them. For animals, tribal people also understood migration, nesting, and mating

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habits. For plants, they knew when, where, and which varieties could be picked.

Different types of biogeographic formations (of water and land) were distinguished. Plants, animals, and especially places were also repositories for historical, social, and spiritual lessons. This knowledge and more was transmitted to succeeding generations as part of their inheritance.

With regard to fish, each species was known by its shape, size, color, taste, and swimming and jumping abilities. Tribal people differentiated between anadromous and non-anadromous fish. In their taxonomy, steelhead are considered one of the salmon (nusux) by virtue of their anadromous habits, their size, and other characteristics.

Traditional tribal experts could distinguish among stocks of salmon. That is, they could tell for which tributary a run of salmon was destined. Tribal experts could predict the arrival of salmon by observing, for example, the new growth of grasses and shrubs.

Within the context of their systems frame of reference (i.e., their ecological and spiritual values), tribal people applied this extensive knowledge to fisheries practices and management. Today, tribal people use some of the same methods that were used for thousands of years. Rules and regulations, management areas, law enforcement, and research and analysis (the accumulated observations and interpretations described above) were all integral parts of tribal resource management. The result was that for thousands of years, and until the arrival of non-Indians, tribal leaders managed their resources successfully. The people fished, and the salmon returned.

The mainstem Columbia River was divided into territories, each with its own regulatory body. For example, on either side of the Celilo Falls fishing area were important territories. Downstream were Big Eddy and the Great Cascades, and upstream, a fishery was centered around what was later called John Day Falls. Among the tribes and bands who fished the river there was general recognition of each other's areas, who fished there, and when. Although fishing rules varied according to area, they were similar and were usually enforced by a headman (sometimes referred to as a salmon chief) and his committee.

More is known about the Celilo Falls fishery because it was in continuous use until 1957. It was the last major fishing area in the Basin to be inundated by backwaters from dam construction. At Celilo, the headman was responsible for conducting an orderly fishery in compliance with the traditional laws of his people so that the salmon returned year after year.

Following the traditional law, the headman determined when and how long fishing occurred. For example, no fishing could take place until the first salmon feast was held. The headman determined when the feast would occur. To prevent over-harvest, fish were caught at their prime. A fisherman was to catch only what was needed for food or for trade. Wasting fish or parts of fish was prohibited. Even the head and backbone were used; they were, for example, made into a soup. Night fishing was prohibited to allow upstream-destined salmon to continue to spawning grounds.

To maintain an orderly fishery, a headman, along with his committee, enforced other regulations. They often dealt with matters such as property rights, standards of behavior, polluting the water, or safety. Fishing sites were individually owned and were inherited. Owning a site did not mean that only one family would benefit. Unwritten but understood ethics of sharing dictated an owner allow another the opportunity to catch at least one fish or might require that preference be given to elders. However, a nonowner always sought permission to use another's site. For rule breakers, there were punishments, often involving banishment from the fishing area for a day, a fishing season, or in extreme causes, longer.

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It is important to note that tribal people did not rely exclusively on salmon. Such a reliance would not have been very practical. Fishing was mostly an intermittent spring-to-early-fall activity. Most places were fished only during certain times of the year.

Rather than being permanently located in fishing villages, most of the people of the Columbia Basin made the seasonal round. At each place, they carefully appropriated nature's abundance and moved on. Seasonal movement avoided overuse of resources and abuse of the environments that supported them. A typical seasonal round took village members from their winter lodges near the rivers, to root-digging fields, to fishing areas, to the mountains for summer recreation and berry picking, to the big river for fishing and other activities, and back again to the winter lodge.

During winter, village leaders made what we now call resource management plans. Based on accumulated knowledge and current observations such as weather, water conditions, animal behavior, and other data, they planned for the next year's seasonal round. Evolving over thousands of years, the seasonal round — with significant dependence on fisheries — was a successfully managed, sustainable lifestyle compatible with the basin's environment.

Table 2.1. A summary of significant events affecting Columbia River Basin anadromous fish resources and the tribes' rights to fish.

Time Immemorial	Indian people lived in the Columbia River Basin for thousands of years, with salmon as a foundation for their culture, economy, and religion.
1800s	During this period, the Priest Rapids prophet Smohalla leads a revival of the traditional Indian religion in which the salmon feast is a vital part.
1805	The Lewis and Clark expedition travels down the Columbia River. Indian society comprised at least 100,000 mostly Sahaptin- and Chinookan-speaking peoples. According to conservative estimates, salmon harvest approximated 42 million pounds annually with average yearly run sizes of 10-16 million fish.
1855	Treaties are signed with the Columbia River tribes in which the tribes (Nez Perce, Umatilla, Warm Springs, and Yakama) cede most of their lands, but reserve exclusive rights to fish within their reservations and the right to fish "at all other usual and accustomed places."
1872	Congress passes the Mining Laws Act, which leases mining claims on public lands for annual fees of $2.50-$5.00 per acre, regardless of the amount of environmental damage incurred or profit made. In the John Day, Salmon, and other river basins, mining in the late 1800s so devastated salmon habitat that it has still not recovered.
1877	The first hatchery (of about 100 propagation facilities today) is established in the Columbia River Basin on the Clackamas River.
1905	The first major fishing rights case reaches the Supreme Court. In *U.S. v. Winans*, the Justices hold that treaty Indians have the right to cross non-Indian lands to fish at "usual and accustomed" places, and that the treaties are to be interpreted the way Indians had understood them.
1910	Over two million acres of farmland are irrigated. Missionaries in the early half of the nineteenth century were the first to withdraw water for irrigation. Today 28 million acre-feet of water are diverted for irrigation each year.

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Table 2.1. *(continued)*

1918	The Washington/Oregon Columbia River Compact is formed by Congress to regulate commercial fishing activities on shared waters of the Columbia River.
1924	Congress grants Indians United States citizenship and the right to vote.
1933	Rock Island Dam, the first dam on the mainstem Columbia River, is completed.
1934	Congress passes the Taylor Grazing Act in response to extremely poor conditions on Western rangelands caused by decades of overgrazing. Sixty years later the Bureau of Land Management and the U.S. Forest Service conclude that riparian areas in federal rangelands remain highly degraded, but the Clinton administration's rangeland reform is dropped because of political pressure by the cattle lobby.
1938	Bonneville Dam, the farthest downstream dam on the Columbia River, is completed. Congress authorizes formation of the Bonneville Power Administration to market power from Bonneville and other federal dams on the Columbia. Congress also passes the Mitchell Act, which promises that fish lost because of the dams would be mitigated with the help of hatcheries.
1940-60	Passage barriers were installed to prevent lamprey (eels) from using fish ladders at Bonneville Dam. However, lamprey continue to migrate upstream through navigation locks.
1941	Grand Coulee Dam is completed. This structure blocks salmon access to 1,100 miles of spawning areas, including most of the areas used by sockeye in the upper Columbia River Basin.
1942	In *Tulee v. Washington*, the Supreme Court decides that Indians with tribal treaty rights cannot be required to buy state fishing licenses. The state could, however, regulate treaty fisheries for conservation.
1944	The Department of Defense begins using the Columbia to cool eight nuclear reactors at the Hanford Nuclear Reservation, an area adjacent to the Columbia above the confluence with the Snake. While the cooling ended in 1971, the contamination continues as the legacy of accidental spills, intentional dumping, and routine discharges from nuclear materials processing facilities. So far, 1,400 contaminated sites, including 120 square miles of groundwater, have been identified.
1948	State and federal agencies begin implementing the Mitchell Act. In doing so, they place or fund almost all the hatcheries (36 of 38) below The Dalles Dam (26 of these are below Bonneville), where non-Indians fish, rather than in the upriver areas where Indians fish and where salmon were being destroyed by dams.
1957	The Dalles Dam, which floods the major Indian fishing area on the Columbia — Celilo Falls, is completed.
1963	Affirming the federal district court's ruling in *Confederated Tribes of the Umatilla Indian Reservation v. Maison*, the appeals court found that the state could not restrict off-reservation treaty fishing unless the restrictions were *indispensable* to conservation.
1964	The last treaty commercial fishery for summer chinook occurs.

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Table 2.1. *(continued)*

1964-65	During a series of winter storms, massive landslides from logging roads and clearcuts inundate the South Fork Salmon River watershed with sediment, drastically reducing salmon survival in the South Fork, which was until then the single largest producer of summer chinook in the Snake River Basin.
1967	With the completion of Hells Canyon Dam, it and seven other dams on the upper Snake River block 600 miles of tributary and mainstem salmon habitat.
1968	Fourteen members of the Yakama tribe file suit (*Sohappy v. Smith*) against Oregon's regulation of off-reservation fishing. The United States and Yakama, Warm Springs, Umatilla, and Nez Perce tribes file a related lawsuit, *United States v. Oregon*. The federal court hears the two cases together and then, in 1978 closes *Sohappy v. Smith*. The court, however, continues its jurisdiction in *U.S. v. Oregon* to the present day.
1969	In deciding *Sohappy v. Smith/U.S. v. Oregon,* Federal District Judge Robert Belloni recognizes the rights of the tribes to fish at all usual and accustomed places and rules that the tribes are entitled to a "fair share" of the fish runs. The Belloni decision holds that the state is prohibited from discriminating against treaty fishing and that state power is limited in regulating treaty Indian fisheries, i.e., the state can regulate only when "reasonable and necessary for conservation." U.S. Army Corps of Engineers conducts its last year of lamprey counts at mainstem dams. At Bonneville the count is 380,000.
1970	With the continuing decline in salmon runs, commercial sturgeon fishing becomes vital to many tribal fishers.
1972	Congress authorizes the Clean Water Act to restore the biological, physical, and chemical integrity of the nation's waterways.
1973	The Endangered Species Act, which defines protection for species that are threatened or endangered, as defined by the Act, is passed.
1974	In *U.S. v. Washington* (Boldt decision), Judge Boldt mandates that a "fair share" was 50 percent of the harvestable fish destined to pass the tribes' usual and accustomed fishing places and reaffirms tribal management powers. In *Settler v. Lameer*, the federal court rules that the treaty fishing right is a tribal right, not an individual right, and that tribes reserved in treaties the authority to regulate tribal fishing on and off the reservations.
1975	Judge Belloni applies 50/50 principle to Columbia River fisheries in *U.S. v. Oregon*. Army Corps of Engineers completes the last (Lower Granite Dam) of four lower Snake River dams, bringing to 13 the total number of Columbia and Snake river dams that salmon can still pass. The dam's completion enabled Lewiston, Idaho to become the most inland port (465 miles) on the West Coast.

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Table 2.1. *(continued)*

1976 The National Forest Management Act passes. This requires national forests to develop plans to manage forests consistent with protection of soils, vegetation, water quality, and aquatic habitat needed to provide viable fish and wildlife populations.

The Magnuson Fishery Conservation and Management Act asserts exclusive U.S. management authority and establishes regional management councils to oversee ocean fisheries 3-200 miles offshore.

The Lower Snake River Compensation Program authorizes mitigation for losses caused by the construction of the four federal dams on the lower Snake River. Spring chinook, summer chinook and steelhead are the focus of artificial production programs; fall chinook are moved downstream into Washington; and coho and sockeye are ignored.

1977 Under the jurisdiction in *U.S. v. Oregon*, the federal court orders a five-year plan to set up an inriver harvest sharing formula between non-Indian and Indian fisheries. The plan failed, however, because it did not include specific controls on ocean harvests or measures to replace runs destroyed by development.

The Nez Perce, Umatilla, Warm Springs and Yakama tribes form the Columbia River Inter-Tribal Fish Commission (CRITFC) as a forum to coordinate their actions and to provide fisheries technical services.

The last treaty commercial fishery for spring chinook occurs. Because of declines, treaty fishing on spring chinook has since been limited to ceremonial and subsistence fishing.

1979 The Supreme Court upholds *U.S. v. Washington*.

Columbia River, Puget Sound, and Washington coastal tribes sue the Secretary of Commerce over ocean fishing regulations because a large percentage of treaty fish were being caught in waters managed by the Department of Commerce. Columbia River tribes also sued in 1980, 1981, and 1982 (*Confederated Tribes et al. v. Kreps*; *Yakima et al. v. Klutznik*; *Hoh v. Baldrige*; and *Yakima et al. v. Baldrige*). The federal government was shown to have a legal obligation to regulate the ocean fishery to ensure that a reasonable number of salmon reached tribal fishing places on the Columbia River.

1980 Congress passes the Pacific Northwest Electric Power, Planning and Conservation Act, establishing the Northwest Power Planning Council with members from Oregon, Washington, Idaho, and Montana. The act requires the Council to develop a fish and wildlife protection and restoration program.

The Federal District Court issues the *U.S. v. Washington* (Phase II) decision that affirmed a right to protection of fish habitat subject to treaty catch and a right to fish produced by artificial production.

Congress passed the federal Superfund law in response to concerns over abandoned toxic waste sites. In the 15 years since, at least 43 sites in the Columbia River Basin have fallen under the act. Other pollution problems exist at pulp and paper mills, metals production facilities, lumber mills, food manufacturing facilities, and power-generating plants.

1981 The Nez Perce, Umatilla, Warm Springs, and Yakama tribes establish their own inter-tribal law enforcement arm, the Columbia River Inter-Tribal Fisheries Enforcement, in Hood River, Oregon.

In their recommendations for the Northwest Power Planning Council fish and wildlife program, the Nez Perce, Umatilla, and Yakama tribes propose building their own salmon production facilities. Of the three facilities, only the Umatilla project, in partnership with the Oregon Department of Fish and Wildlife, has been funded. The Nez Perce and Yakama projects are still being studied and planned while at least 20 other hatchery facilities have been built since the tribal proposals.

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Table 2.1. *(continued)*

1982	The Northwest Power Planning Council adopts the Columbia River Basin Fish and Wildlife Program, drawing heavily on recommendations made by the four Columbia River tribes. (The program has been amended numerous times since its inception, however, and many of the tribes' recommendations have been filtered out.)
1983	Nez Perce, Umatilla, and Yakama tribes initiate challenges to forest plans and timber sales in the basin's national forests when those plans and sales threaten to damage fish habitat. Since then, more than 30 have been filed.
1984	Salmon released from Umatilla Hatchery facilities in 1981 return to the Umatilla River. These are the first salmon to return since passage was blocked by an irrigation dam in 1914.
1985	The United States and Canada sign the U.S.-Canada Pacific Salmon Interception Treaty, which Congress later ratified. The treaty sets up a process for managing ocean salmon fisheries according to conservation and equity principles and includes the tribes with other government fish managers. For several years, the treaty resulted in reduced Canadian and Alaskan catches of Columbia River chinook.
1986	Total salmon run size to the Columbia River is 2.9 million. One million upriver salmon are counted at Bonneville Dam.
1988	The Columbia River Fish Management Plan is adopted by the federal court, and includes a detailed harvest and fish production process under the authority of *U.S. v. Oregon*.
1990	The four tribes and CRITFC enter into a cooperative agreement with the Environmental Protection Agency to survey tribal fish consumption. The survey, released in October 1994, determined potential health impacts to tribal members from consumption of contaminated fish. A second phase, scheduled to begin in 1996, involves sampling fish tissue to determine the level of toxins in Columbia Basin fish. Regional leaders, convening a Salmon Summit to find solutions to salmon crisis, fail to come up with any agreement.
1991	Sockeye from the Columbia's largest tributary, the Snake River, are the first salmon to be listed as endangered by the National Marine Fisheries Service under the Endangered Species Act as a result of a petition from the Shoshone-Bannock tribe. Umatilla tribe submits first lamprey restoration proposal to Northwest Power Planning Council fish and wildlife funding process. The Environmental Protection Agency orders eight of the 19 pulp mills in the Columbia River Basin to reduce dioxin discharges by 85 percent. The eight, bleach-kraft pulp mills, produce dioxin as a result of using chlorine bleach.
1992	Snake River spring, summer, and fall chinook are listed as threatened under the Endangered Species Act.

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Table 2.1. *(continued)*

1993 The U.S. State Department puts the U.S. Section of the Pacific Salmon Commission on notice that it is in jeopardy of not meeting its international requirements under the U.S./Canada Pacific Salmon Interception Treaty with regard to chinook salmon. This is in response to the failure of the two sides to reach a harvest agreement on chinook in 1992. The two sides have failed to reach harvest agreements on any species since.

The Columbia's total salmon run size drops to 900,000. The upriver portion, counted at Bonneville Dam, amounts to 600,000 salmon. The tribes now have only one remaining commercial fishery: the fall season.

Federal Judge Dwyer holds that Environmental Protection Agency and Idaho Department of Environmental Quality acted arbitrarily and capriciously in failing to list many Idaho streams as "water quality limited" under the Clean Water Act. Subsequently, more than 900 streams were added to Idaho's list of streams that fail to fully support beneficial uses, such as salmon spawning and rearing.

1994 In *Northwest Resources Information Center, et al. v. Northwest Power Planning Council,* the federal appeals court rules in favor of the Yakama Tribe's claim that the Council violated the power act in developing its Strategy for Salmon and remands the salmon plan back to the Council.

In *Idaho Department of Fish and Game v. National Marine Fisheries Service,* the federal court rules that the National Marine Fisheries Service's biological opinion of "no jeopardy" regarding hydrosystem operations on the Columbia and Snake rivers violates the Endangered Species Act. The judge orders the parties to develop appropriate changes in dam operations.

The Northwest Power Planning Council publishes its 1994 amendments to the *Columbia River Basin Fish and Wildlife Program.*

At 9,800 fish, the upriver spring chinook run is the lowest on record. None of the tribal longhouses (places of traditional Indian worship) have enough salmon for their ceremonies.

1995 The National Marine Fisheries Service released its proposed Recovery Plan for Snake River Salmon. The recommended actions will not result in salmon restoration, according to tribal analysis.

Nez Perce, Umatilla, Warm Springs, and Yakama tribes release their own fish restoration plan: *Wy-Kan-Ush-Mi Wa-Kish-Wit.*

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SECTION 3

BIOLOGICAL PERSPECTIVE

BIOLOGICAL PERSPECTIVE

The Problem

Before the treaties were signed, the tribes enjoyed the bounty of a land blessed with abundant resources upon which their culture depended. Some of the most important were the rich assemblage of anadromous fish populations in the rivers of the basin. Salmon populations were numerous and represented five species: chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), steelhead and rainbow (*O. mykiss*), sockeye and kokanee (*O. nerka*), and chum (*O. keta*). The Columbia Basin supported the Pacific's largest run of chinook, or king salmon, known to weigh as much as 125 pounds and measure more than five feet in length (Brown 1982). Other important native anadromous species included the lamprey (*Lampetra tridentata*) and white sturgeon (*Acipenser transmontanus*). Other fish species were also utilized.

This lifestyle, and the fisheries upon which it depended, were reserved by the tribes when they signed treaties with the United States. While yielding control of vast tracts of land, the tribes retained ownership of the salmon runs so vital to their culture. These treaties, though challenged often, have been reaffirmed repeatedly as legally binding documents in numerous court decisions.

Now the salmon are disappearing. The eels cannot be found in much of their former territory. Sturgeon are less abundant and populations have become fragmented. What could not be done legally in the past, is now being done in practice by the widespread mismanagement of natural resources. The treaties are being ignored and broken.

Current Status of Anadromous Fish in the Columbia River Basin

As long as the resources on which salmon, Pacific lamprey, and white sturgeon depended were maintained — i.e., the cool, clear waters, complex stream systems, and the interconnectedness of the parts — these anadromous species prospered and enabled the Indians of the Columbia River Basin to prosper as well. As indicated below, much of this has changed drastically in a relatively short time.

Salmon

During the last century in the Columbia River Basin, salmon runs, once the largest in the world, have declined over 90%. The 7.4-12.5 million average annual number of fish above Bonneville Dam has dropped to 600,000. Of these, approximately 350,000 are produced in hatcheries (ODFW and WDFW 1990-1994).

Spawning salmon populations in the Columbia River produced enough offspring historically to replace themselves fivefold; now, however, the magnitude of cumulative mortality impacts is so large that these species are biologically unable to compensate, and populations cannot replace themselves on a consistent basis. Many salmon stocks have been extirpated from major portions of their historical range (Table 3.1). Furthermore, the majority of Columbia River Basin natural salmon populations are on a downward trend, and many are approaching extirpation (CRITFC 1992a). Snake River chinook and sockeye have been listed under the federal Endangered Species Act. What is considered to be a local population today may simply be a fragment of what was once a larger, continuous historical population. Declines in natural production are indicated generally by declining numbers of redds in tributary streams.

Pacific Lamprey

Since the completion of the hydropower system in the Columbia Basin, numbers of Pacific lamprey have declined dramatically compared with historical levels of abundance and distribution. For example, the name of the ancestral Nez Perce village Hasotino (located on present day Asotin Creek), means "the great eel fishery" (Spiden 1908). Counts at Bonneville Dam have

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Table 3.1. Extirpated (■) or badly damaged and declining (□) Columbia River salmon populations above Bonneville Dam. Revised from CRITFC 1992.

SUBBASIN	TRIBUTARY	SOCK-EYE	CHINOOK Spring	CHINOOK Summer	CHINOOK Fall	COHO	CHUM
***LOWER COLUMBIA RIVER MAINSTEM** (Bonneville Dam → McNary Dam)*							
Wind River	Wind R.		□				
Hood River	Hood R.		■		□	■	
Klickitat River	Klickitat R.		□				
Deschutes River	Deschutes R.				□		
	Shitike Cr.		□				
	Suttle L.	■					
John Day River	Middle Fk J.D. R.				□	■	
***MID-COLUMBIA RIVER MAINSTEM** (McNary Dam → Chief Joseph Dam)*							
Walla Walla River	Walla Walla R.		■		■	■	■
	Touchet R.		■		■	■	
Yakima River	Yakima R.			■		■	
	Teanaway R.		□				
	Rattlesnake Cr.		□				
	Cle Elum L.	■					
	Keechelus L.	■					
	Kachess L.	■					
	Bumping L.	■					
	Naches R.					■	
Wenatchee River	Wenatchee R.					■	
	L. Wenatchee R.		□				
	Icicle Cr.		□			■	
	Nason Cr.					■	
Entiat River	Entiat R.		□	■		■	
Methow River	Methow R.					■	
	Early Winters Cr.		□				
	Lost R.		□				
	Twisp R.					■	
Okanogan River	Okanogan R.					■	
***LOWER-SNAKE RIVER MAINSTEM** (Ice Harbor Dam → Hells Canyon Dam)*							
	Snake R.				□		
	Asotin Cr.		□				

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Table 3.1. *(continued)*

SUBBASIN	TRIBUTARY	SOCK-EYE	CHINOOK Spring	CHINOOK Summer	CHINOOK Fall	COHO	CHUM
Clearwater River	Clearwater R.		■		□		
	Selway R.		□				
	Bear Cr.		□				
	Fish Cr.					■	
	Clear Cr.					■	
	Orofino Cr.					■	
Grande Ronde River	Grande Ronde R.		□		□		
	Spring Cr.		■			■	
	Bear Cr.		□				
	Sheep Cr.		■				
	Hurricane Cr.		□				
	Indian Cr.		■				
	Wallowa R.		□				
	Wallowa L.	■				■	
	Lookingglass Cr.		□				
	Wenaha R.		□			■	
	Minam R.		□			■	
	Lostine R.		□			■	
	Catherine Cr.		□			■	
	Prairie Cr.		□			■	
Salmon River	Lower Salmon R.		□				
	Little Salmon R.		□				
	Upper Salmon R.		□				
	Upper Yankee Fk.		□				
	Upper Valley Fk.		□				
	Lower Valley Cr.		□				
	Upper East Fk.		□				
	Lower East Fk.		□				
	Herd Cr.		□				
	Panther Cr.		■				
	Rapid R.		□	□		■	
	Pahsimeroi R.		□				
	Loon Cr.		□				
	Pettit L.	■					
	Yellowbelly L.	■					
	Stanley L.	■					
	Alturus L.	■					
	Redfish L.	■					
Imnaha River	Imnaha R.		□	■	□		
	Big Sheep Cr.		□				
	Lick Cr.		□				

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exceeded 300,000 lamprey in the past (Starke and Dalen 1995). These counts include only those fish that passed the counting station during the 18 hours of counting, i.e., they do not include lamprey that passed through navigation locks or at night. Counts of Pacific lamprey returning over lower Snake River dams were in the thousands in 1969, but declined to hundreds by 1978 (Hammond 1979) and numbered only 40 individuals total in 1993 (L. Basham, Fish Passage Center, Portland, personal communication 1994). Although tribal proposals for lamprey recovery have been submitted since 1991, lamprey were not considered high priority when compared to salmon stocks. At this time no active studies have been funded for lamprey research.

White Sturgeon

Colonization of the Columbia Basin by white settlers profoundly affected the sturgeon populations and habitat. Like other North American sturgeon populations, Columbia Basin white sturgeon were commercially exploited for their flesh and eggs (Bajkov 1949; Smith 1990). Prior to purposeful commercial harvest, vast numbers were simply killed because they damaged gear of commercial salmon fishers. Once a market was established, white sturgeon were commercially harvested from the lower Columbia River by 1894 (Galbreath 1985).

White sturgeon populations today are considerably reduced, even though they are still found throughout much of their historical habitat (PSMFC 1992). Hydroelectric development on the Columbia and Snake rivers has created a series of reservoirs, which trapped and separated the single historical white sturgeon population into a number of separate land-locked (reservoir) populations (North et al. 1993. Populations above Bonneville Dam are characterized by the following river reaches: (1) Lower Columbia River above Bonneville Dam, (2) Mid-Columbia River, and (3) Lower Snake River.

(1) The area located between Bonneville and McNary dams, contains three reservoirs. Bonneville Pool has a stable population with good recruitment. The Dalles and John Day pools contain depressed populations, with the John Day population the poorer of the two. The three reservoirs in Zone 6 support tribal commercial and subsistence fisheries, and a popular sport fishery (Hale and James 1993). Annual harvest of sturgeon populations between Bonneville and McNary dams ranged from 3500 to 4600 for the period between 1991 and 1993; the bulk of the harvest came from Bonneville Pool.

(2) The Mid-Columbia River reach contains reservoirs and the longest free-flowing section of the Columbia River (the Hanford Reach) upstream from Bonneville Dam. All reservoirs within this section are subject to point and nonpoint source pollution, which may affect the reproductive success and recruitment of larval sturgeon (Anders and Beckman 1993; Glubokov 1990). Tribal subsistence fisheries occur within this reach, as well as consumptive sport fisheries.

(3) The Lower Snake River contains three reservoirs (behind Ice Harbor, Lower Monumental, and Little Goose dams), and one reservoir with the free-flowing section of the Snake River at the upper end. The Lower Granite Reservoir appears to be a rearing area for white sturgeon, and adults are prevalent in the free-flowing Snake River downstream from Hells Canyon Dam (Coon et al. 1977; Lukens 1985). The population in the free-flowing section of the Snake River appears to be stable.

Past Attempts at Restoration

Past attempts to maintain or restore declining salmon numbers all made, and relied upon, the assumption that technology could "fix" the damage caused by disregard for the underlying, interconnected processes of nature which gave rise to and sustained the great salmon runs of the Columbia Basin — that a relatively simple solution could replace the complexity of nature. Naturally these attempts failed.

EX5022-000034-TRB

As the Columbia Basin was progressively developed to reap the full benefits of hydropower, agriculture, forestry, mining, and urbanization; periodic attempts were made to ameliorate the resultant declines in salmon production. Dams were equipped with fish ladders for returning adult salmon, and bypass facilities for outmigrating smolts. Large scale hatchery programs were funded to replace production lost from areas flooded or blocked by dams. Screens were required on irrigation diversions. Laws were promulgated, but not enforced, to restore and maintain water quality and quantity and to protect ecosystems on which imperiled species depended for survival. Additional water was spilled to assist smolts over dams. Smolts were collected and barged around dams. Billions of dollars have been spent over the years to maintain salmon production in the Columbia River Basin.

Nevertheless all these efforts have proven inadequate to maintain anadromous fish numbers and productivity. The lesson is inescapable: technical solutions cannot maintain salmon populations in the face of massive disregard for, and destruction of, the ecosystems within which salmon evolved. If the remaining salmon are to be preserved and restored to tribal goal levels, the natural structure and functions of the salmon's ecosystems, combined with wise use of technical expertise, must be foremost. Accomplishing this requires a common understanding of habitat requirements of salmon relative to the present conditions they face in the Columbia River Basin.

Toward a Solution

The various salmon species pass through vast expanses of geography during the course of their life cycles (Figure 3.1, 3.2). A typical salmon starts life as an egg in the gravel of a stream, often hundreds of miles from the Pacific Ocean where they graze and gain the majority of their adult size. Between stream bed and ocean, salmon need a wide variety of quality habitats in order to grow and develop from a small freshwater fish into a large marine feeder. Because salmon depend on the health of several different ecosystems for their survival, and because so many different cultures in the Pacific Northwest hold them in such high esteem, the salmon are both a bellweather and a lightening rod in the struggle which now rages to retain the ecological and cultural integrity of this vast region. The biological context for the tribal recovery plan consists of the habitat within which the salmon live, the rich collection of biological strategies which the salmon have evolved to prosper in these habitats, and the connections of land, water, plants, and animals which scientists call the ecosystem.

Habitat of Anadromous Fish in the Columbia River Basin

The Columbia River Basin

The Columbia River Basin encompasses nearly 260,000 square miles. The river drains most of Washington and Idaho, half of Oregon, Montana west of the Continental Divide, small portions of Wyoming, Utah, and Nevada, and 40,000 square miles of British Columbia (Figure 2.1). The 1,214-mile-long river begins at Columbia Lake, high in the Rocky Mountains of British Columbia, Canada. It initially flows northwest for 218 miles, then turns south for the next 280 miles. After crossing the United States-Canada border into northeastern Washington, the Columbia River flows south, west, and south again across central Washington in a broad curve commonly known as "Big Bend." Just below the mouth of the Snake River, the Columbia turns west for its remaining 210 miles. It cuts through the heart of the Cascade Mountains, thus forming the Columbia River Gorge; flows into the Columbia River Estuary; and finally empties into the Pacific Ocean at Astoria, Oregon.

The Columbia's largest tributary, the Snake River, begins in Wyoming, Utah, and Nevada and flows westward through the southern part of Idaho. It then turns north and forms the boundary of today's Oregon and Idaho. Near Lewiston, Idaho, the Snake River turns west-

EX5022-000035-TRB

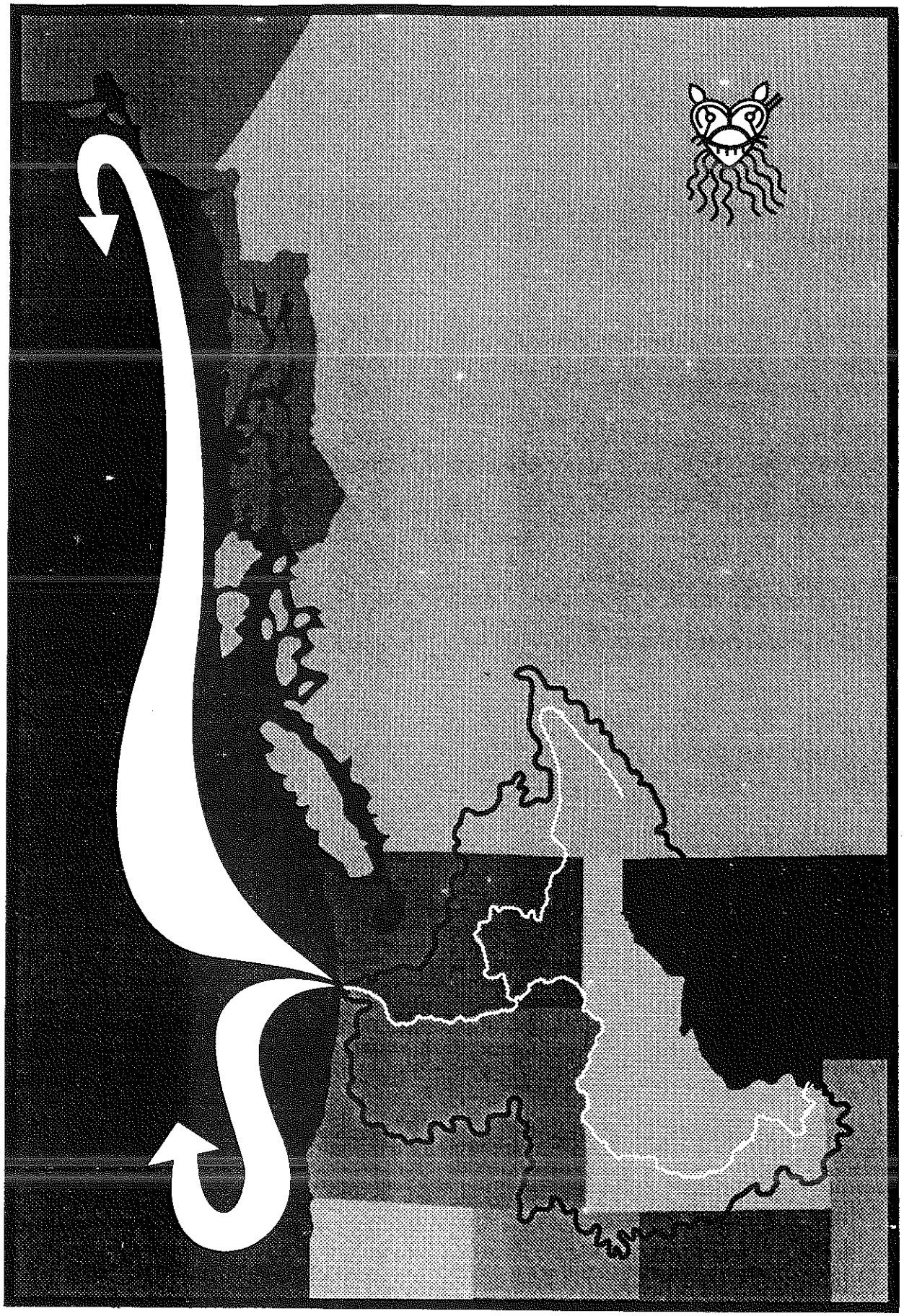

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Figure 3.1. Habitat and range of Columbia Basin anadromous fishes.

EX5022-000036-TRB

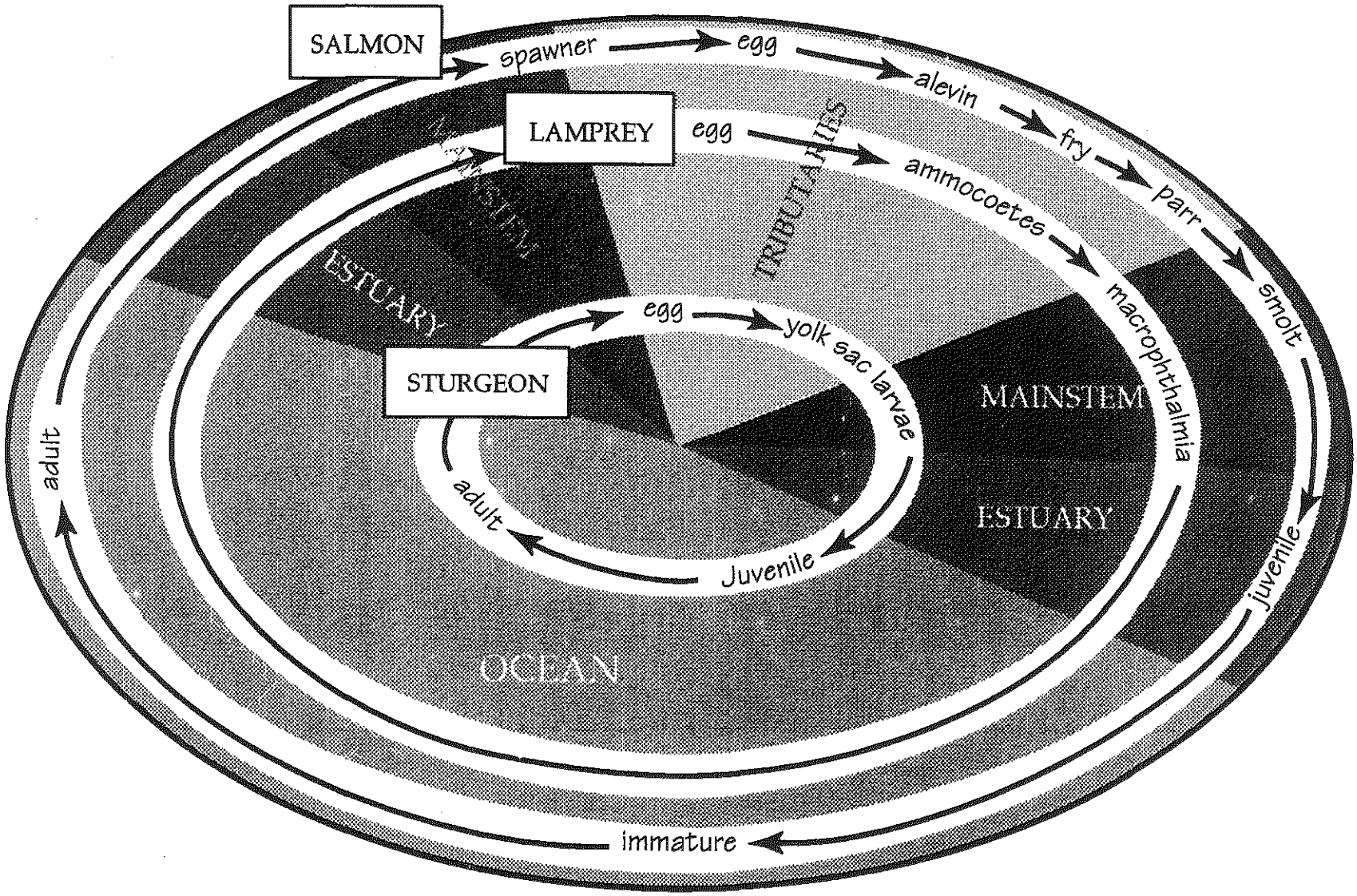

Figure 3-2. Life cycles of salmonids, Pacific lamprey, and white sturgeon in the Columbia River Basin. White sturgeon above Bonneville Dam are no longer anadromous.

ward and flows through eastern Washington until it enters the Columbia River near Pasco, Washington.

The land mass over which much of the Columbia River now flows did not exist until the Tertiary period (30-60 million years ago). Although the Columbia River Basin is relatively young in terms of geologic time, it comprises portions of eight physiographic provinces: Northern Rocky Mountains, Columbia Mountains/Okanogan Highlands, Cascade Mountains, Columbia Plateau/Columbia Basalt Plain, Snake River Plain, Blue Mountains, Willamette Lowland, and Coast Range. This rich variety of landforms has been determined by geology, past and present climate, and such processes as erosion and sedimentation.

Regional differences in climate and elevation have created a unique range of environmental conditions. For example, annual precipitation averages 10-20 inches in central Washington, eastern Oregon, and southern Idaho, and 40-140 inches between the Columbia River Gorge and the mouth of the Columbia River.

Periodic massive disturbances are an integral part of the natural environment that forms the basis for the ecology and evolution of anadromous fish in the Columbia River Basin. Natural events of large magnitude, such as the Mount St. Helens eruption which impacted steelhead runs on the Toutle River in Washington, have often occurred in localized regions.

Climatic cycles, such as *El Niño* which results in below-average snowpack and rainfall are a part of the North Pacific region to which the salmon have adapted. The distribution pattern of warm and cold ocean currents and associated nutrient upwellings, which affect salmon production, are also cyclical in nature. Salmon populations (coho and tule fall chinook) which rear primarily south of Vancouver Island appear to have lower natural survival during *El Niño* events; whereas populations (bright fall chinook, upper Columbia summer chinook, and sockeye) that rear in the Gulf of Alaska seem to have better than average survival (PFMC 1985).

Columbia River Subbasins

Numerous subbasins compose the Columbia River Basin east of the Cascade Range. These watersheds share many hydrologic features including snow as the dominant form of precipitation, dry summers punctuated by thunderstorms, seasonal peak flows in the spring during snowmelt, and seasonal low flows during the summer. Both seasonal peak and low flows are a function of climate as mediated by soils, geology, vegetation, and terrain as modified by land and water uses. Salmon have evolved to migrate downstream during high springtime flows that facilitate downstream movement. The effects of major flooding and/or peak flows on channels vary with stream conditions, soils, vegetation, geology, and terrain as modified by land and water use. The quantity and quality of summer low flows, the period when most salmon populations spawn, is determined by climate and groundwater inflow as mediated by stream conditions, soils, vegetation, geology, and terrain as modified by land and water use.

Salmonids and Pacific lamprey, similar to other anadromous species, have evolved with high spring flows as a mechanism to facilitate passage to the ocean for the adult phase of the life cycle. Although the frequency and magnitude of rainfall-dominated stream peak flows in any part of the Columbia River Basin is a function of the long-term climatic regime of that locale, their effects in stream channels (e.g., sediment loads, and frequency and intensity of channel scouring) vary according to topographic and geologic structure of the watersheds and channel morphology. Soils and topography also determine the inherent ability of a given watershed to provide stable, cool summer flows during the low-flow period.

The primary subbasins of interest to the Columbia River treaty tribes are those located upstream from Bonneville Dam. The tribes share management responsibilities in these basins with state and federal governments. These subbasins (Figure 3.3; descriptions provided in Appendix A) are numbered from 1 to 20, beginning at the point furthest downstream, in the order in which

EX5022-000038-TRB

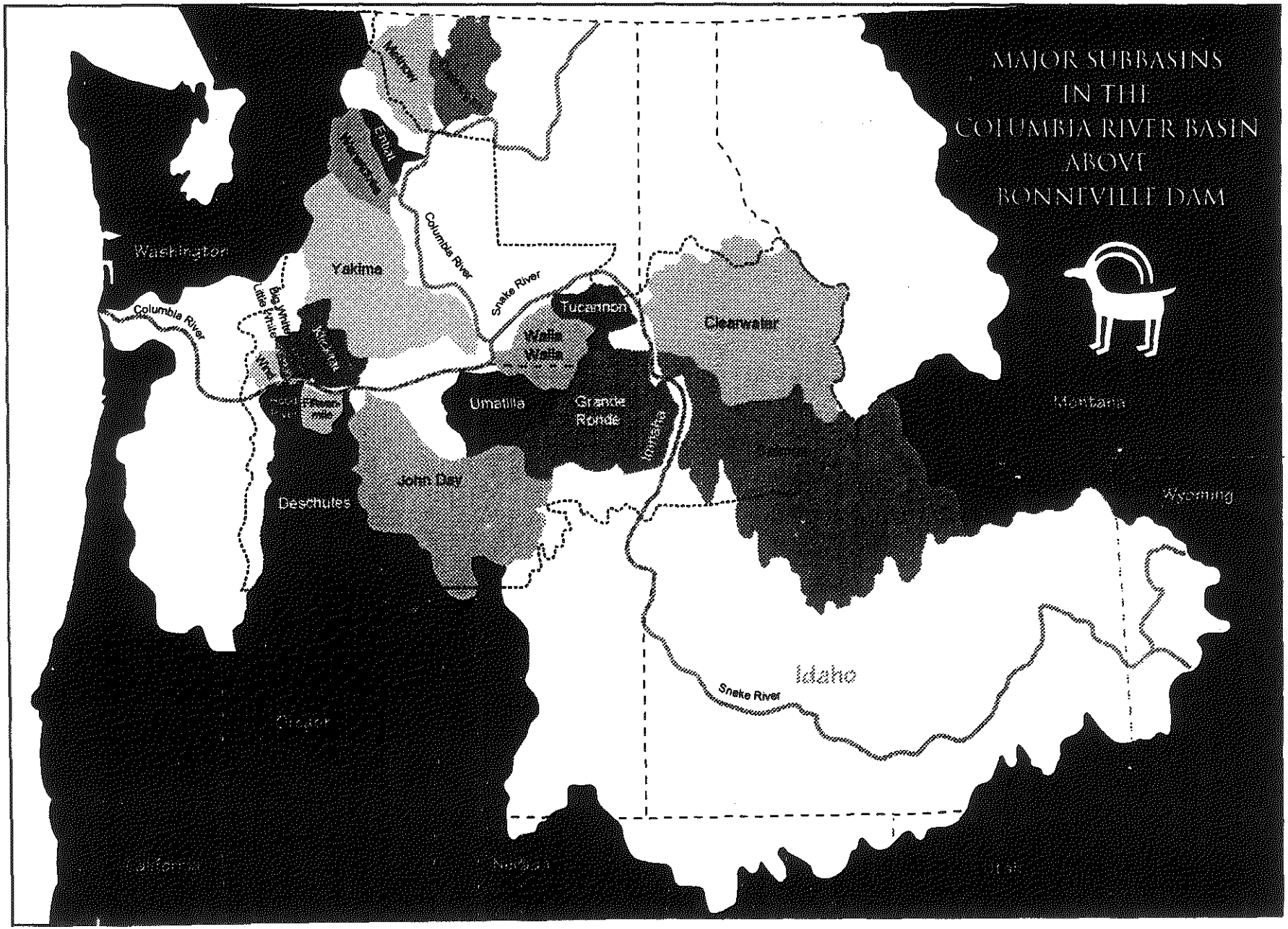

Figure 3.3. Major subbasins above Bonneville Dam for which the tribes have co-management responsibilities.

EX5022-000039-TRB

their major tributaries enter the Columbia, and then the Snake river mainstems. The number of stream miles historically utilized by salmon species in each subbasin compared to the amount of habitat currently suitable for salmon species is provided in Table 3.2.

The Columbia River Estuary

The Columbia River Estuary is a variable mixture of fresh and salt water and sediments at the coastal end of the Columbia River Basin. The estuary, which now has a surface area of approximately 41,200 hectares (101,750 acres), has been formed over geologic time by the forces of volcanism, glaciation, hydrology, and the erosion and deposition of sediments. Circulation of sediments and cycling of nutrients within the estuary are driven by river hydrology and coastal oceanography. Sea levels have risen since the late Pleistocene, with the result that coarse and fine sands have been deposited in submerged river channels.

The Pacific Ocean

Three major current systems in the North Pacific Ocean affect Columbia River Basin salmon: the Alaska Gyre, Subarctic Current, and California Current (Ware and Thompson 1991). Upwelling events off the Oregon and Washington coasts are correlated with coho survival rates (Nickelson 1986). In addition, periodic *El Niño* events bring in warmer water with fewer nutrients, and negatively affect salmon production (Pearcy 1992).

Environmental variation in the ocean has always been a feature of the salmon life cycle. Salmon have been able to survive through these variations by natural compensatory survival mechanisms that act as a buffer (Foerester 1968). Increased stress in other aspects of the life cycle has reduced buffering capacity and the salmon's ability to cope with environmental variation. Fluctuations in the ocean environment must be evaluated in order to understand the entire life cycle. Indices of ocean surface temperature, coastal upwelling, and weather patterns provide insight to changes in ocean productivity. Ocean growth patterns as recorded in salmon scales will provide biological measurements of the changes in ocean productivity. However, the best way to restore the buffering mechanisms and thus increase the probability of long-term survival of naturally reproducing populations is to reduce the stresses in the other stages of the life cycle.

Adaptation of Anadromous Species

Anadromous fish have developed a complex set of behaviors that are useful in adapting to change in the Columbia River Basin, as well as to the individual watershed conditions under which they have evolved. The salmon's life history can be described as a series of biological functions (e.g., spawning, feeding, and migration) that are carried out in a series of temporally and geographically connected environments (Thompson 1959; Rothschild 1986). Within each of these physical environments, individual fish from a single population may exhibit different patterns of use of available habitat to express different biological functions, such as feeding, resting, and avoiding predators. A population may produce some fish which smolt in their first year and others which smolt in their second or even third year of life. Salmon parr may use both upper and lower portions of watersheds to rear prior to smolting. These kinds of life stage-habitat interactions are more fully discussed by RASP (1992).

The characteristic anadromous life cycle and strong tendency for homing to streams and rivers of origin have contributed to the evolution of numerous stocks of salmon (Groot and Margolis 1991).

EX5022-000040-TRB

Table 3.2. Change in the amount of habitat available to anadromous fish in Columbia River subbasins upstream of Bonneville Dam.

	ANADROMOUS FISH HABITAT[a] (stream miles or %)					SPECIES PRESENT							
	Available	Lost to Development			%	Chinook			Steelhead				
SUBBASIN	Pre-1855	Blocked[b]	Degraded[c]	Remaining	Lost	Spring	Summer	Fall	Summer	Winter	Coho	Sockeye	Chum
LOWER COLUMBIA RIVER MAINSTEM (Bonneville Dam → McNary Dam)													
Wind R.	83.7	0.0	19.4	64.3	23	✓		✓	✓		✓		
Little Wht. Salmon R.	2.0	1.5	0.0	0.5	75	✓	✓	✓	✓		✓		
Big Wht. Salmon R.	104.9	101.6	0.0	3.3	97	✓	✓	✓	✓		✓		✓
Hood R.	95.0	5.0	19.0	71.0	25	✓		✓	✓	✓	✓		
Klickitat R.	132.0	12.0	15.0	105.0	20	✓		✓	✓	✓	✓		
Fifteenmile Crk.	141.0	0.0	56.0	85.0	40					✓			
Deschutes R.	605.0	220.0	95.0	290.0	52	✓		✓	✓			✓	
John Day R.	1551.1	N/A[d]	N/A	N/A	N/A	✓		✓	✓				
Umatilla R.	543.0	50.0	179.0	314.0	42	✓		✓	✓		✓		
MID-COLUMBIA RIVER MAINSTEM (McNary Dam → Chief Joseph Dam)													
Walla Walla R.	207.9	N/A	N/A	N/A	N/A	✓			✓				
Yakima R.	1006.0	317.0	408.0	299.0	72	✓		✓	✓		✓	✓	
Wenatchee R.	203.3	37.9	21.7	143.7	29	✓	✓		✓			✓	
Entiat R.	50.5	1.0	4.0	46.0	10	✓			✓				
Methow R.	257.0	45.0	11.0	201.0	22	✓	✓	✓	✓		✓		
Okanogan R.	290.0	175.0	100.0	15.0	95	✓	✓	✓	✓		✓	✓	
SNAKE RIVER MAINSTEM (Ice Harbor Dam → Hells Canyon Dam)													
Tucannon R.	55.0	N/A	N/A	N/A	N/A	✓		✓	✓				
Clearwater R.	1975.0	627.0	N/A	N/A	N/A	✓		✓	✓				
Grande Ronde R.	647.0	N/A	N/A	N/A	N/A	✓		✓	✓				
Salmon R.	1992.0	88.0	N/A	N/A	N/A	✓	✓	✓	✓				
Imnaha R.	223.0	0.0	N/A	N/A	N/A	✓		✓	✓				

[a] Adequate habitat conditions for spawning and/or rearing.

[b] Habitat los due to blocked passage (e.g., construction of impassable dams).

[c] Habitat lost due to degradation (e.g., loss of instream flows, high temperatures).

[d] N/A = data not available.

The evolution of different life history types has occurred in part because of the characteristic differences in individual streams to which the animals have homed as well as the capacity of these organisms to stray and thus colonize (or recolonize) new areas after disturbance. Thus, salmon have inherent resilience as a result of their anadromy, life span, and life history characteristics that help compensate for environmental fluctuations in freshwater habitats.

Such characteristics take advantage of spatial and seasonal variations in resource availability, lessen the risk that all populations would be extirpated by a single disturbance, or would react identically to the same set of environmental conditions (Reiman and McIntyre 1993). This has helped to buffer salmon populations against catastrophes (Steward 1993; Stearns 1976; Wootton 1990; Healey 1991). For example, large numbers of Toutle River fish strayed to the other streams and fish migrations were delayed after the 1980 Mount St. Helens eruption (Martin et al. 1984). Subsequently, recovering vegetation helped to create the physical, chemical, and trophic base necessary for the recovery of salmon stocks impacted by Mount St. Helens eruptions (Martin et al. 1986; Bisson et al. 1988). The behaviors which are important in colonization and recolonization are influenced substantially by habitat quality and quantity. For example, chinook introduced to New Zealand in 1905 from a single population in California have successfully colonized different river basins, and now exhibit differences in life history traits which could be the result of environmental factors.

Information about homing and straying behaviors is not available for Pacific lamprey (Beamish 1980). Because lamprey are a primitive species with fossil records dating back nearly 300 million years (Bardack and Zangerl 1968) and wide distribution throughout the northern hemisphere, they have no doubt been resilient to changing environmental conditions.

Anadromous Fish of the Columbia River Basin

The anadromous species of particular interest to the Columbia River treaty tribes are salmon and steelhead, Pacific lamprey, and white sturgeon. These species share a common anadromous life cycle, yet differ in specific life history characteristics and requirements.

Salmon

The evidence available suggests that salmonids appeared between 20 and 100 million years ago, and have evolved in the Pacific Northwest over the last 10 cycles of glaciation (Stearly 1992). There are five species of salmon prevalent in the Columbia River Basin. These include chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kisutch*), sockeye and kokanee (*Oncorhynchus nerka*), chum (*Oncorhynchus keta*), and steelhead and rainbow (*Oncorhynchus mykiss*). Chinook, coho, sockeye, chum, and steelhead are anadromous species (Figure 3.2); kokanee and rainbow are resident — i.e., do not migrate. Adults of all Columbia River salmon species die after spawning, except for steelhead which may spawn more than once. Predominant life history characteristics, such as areas required for spawning and rearing, timing of adult migration back to spawning grounds, and number of eggs produced for each of these species are provided in Table 3.3.

EX5022-000042-TRB

Table 3.3. Comparative lifecycle characteristics of Pacific salmon species (genus *Oncorhynchus*) found in the Columbia River Basin. Sources: Olsen *et al*. 1992a, 1992b; Hymer *et al*. 1992a, 1992b; Kiefer *et al*. 1992.

SPECIES	SPAWNING AREA	REARING AREA	AGE		OCEAN DISTRIBUTION	RETURN TIME	ADULT		FECUNDITY
			FW	Ocean			Age	Size (cm)	
Chinook									
Spring	tributaries	mainstem, tributaries	2	1-3	?	Apr-Jul	3-6	25-40	4700-6000
Summer									
Mid-Columbia R.	mainstem, tributaries	mainstem, tributaries	0-1	1-4	AK-WA	May-Jul	3-5	41-92	4900
Snake R.	mainstem, tributaries	mainstem, tributaries	0-1	1-3	?	Jun-Jul	3-5	24-36	3500-4300
Fall	mainstem	mainstem	0	1-5	AK-WA	Aug-Sep	2-6	42-101	4400-5200
Coho	small tributaries	tributary	1	1-2	WA-OR	Aug-Oct	2-3	40-99	2500-3500
Steelhead									
Summer	tributaries	tributary	1-3	1-5	Gulf of AK	May-Sep	3-5	61-73	5000-6400
Winter	lower river tributaries	tributary	1-2	1-5	Gulf of AK	Nov-Jan	3-5	45-70	2200-4000
Sockeye	streams above lakes	cold lakes	1-2	1-3	Gulf of AK	May-Jun	3-5	35-57	2600
Chum	lower river tributaries	estuary	0	3-5	?	Oct-Nov	3-6	63-75	2200-2300

All of the salmon species, including steelhead, may be divided into three basic life history types for the purposes of description. The life history types of salmon are stream, lake, and ocean, referring to where the young reside at the end of the first year of life. Chum salmon and the fall race of chinook salmon are ocean type, in which the young enter salt water some time during the year following their deposition as eggs. A typical ocean type, taking the fall chinook salmon for example, starts life as an egg in the gravel of the Columbia River above Richland, Washington in October of the year, emerges from its gravel nursery the following calendar year in February or March, moves down river, and enters the Columbia River estuary, in the vacinity of Astoria, Oregon from June through September. The typically ocean type fall chinook spends its second, third, and sometimes fourth, winters of life in the ocean and returns to spawn on its fourth or fifth birthday.

The stream and lake types of salmon have the same basic life cycle, except that the second winter of life is spent in stream or lake, respectively. The coho salmon, the spring race of chinook salmon, and steelhead are all stream types, while sockeye salmon are lake types. As is the case with any teaching model, this "three types" life history explanation can not capture the rich diversity of ages and types which are present in most healthy salmon populations. For example, some chinook populations may have both stream and ocean types within the same race. But the basic concept is that most biological species (e.g chinook, coho, sockeye, chum, steelhead) exhibit a diversity of strategies which allow them to adapt to different biological and physical circumstances, and these strategies are shared across species.

Life history strategies of salmon are often identified by the season of the year in which the adults return to freshwater on their way to the spawning grounds. Prior to the entry of western culture in the early 19th century, adult salmon were likely to have entered the Columbia during all seasons of the year. It is probable that human development, in conjunction with harvest, acted to reduce the number of life history types of salmon in the Columbia River Basin; hence, there are now times of the year when practically no adult salmon can be found in the mainstem Columbia River.

Salmon once occupied nearly 13,000 miles of Columbia River Basin streams and rivers. According to conservative estimates, the Columbia River Basin, both above and below Bonneville Dam, once produced between 10 and 16 million salmon annually (NPPC 1986). Historically, salmon runs in the Columbia River Basin consisted of 16% fall chinook, 12% spring chinook, 30% summer chinook, 11% coho, 23% sockeye, 8% steelhead, and less than 1% chum. These runs extended from March through October generally (Figure 3.4), though steelhead runs extended through the winter.

Habitat Requirements of Salmon

Tributary

Tributary habitat for salmon must be available for adult migration from the ocean, as well as holding and spawning, egg incubation, juvenile rearing and overwintering, and smolt migration to the ocean. Salmon, in general, spawn in gravel beds in rivers, streams, or lake shores in late summer and early winter. Watersheds tributary to the mainstem Columbia and Snake rivers are the primary nursery and rearing areas for anadromous fish. Juvenile fish production is a function of the quantity and quality of available habitat. Factors that contribute to high-quality salmon habitat include: well-oxygenated cold water; spawning and rearing areas with low levels of surface fine sediments in the stream bed; abundant amounts of large woody debris in the channel; frequent large pools greater than 1 meter in depth; off-channel aquatic habitats fed by groundwater; stable stream beds; banks that overhang stream margins; and natural levels and types of riparian vegetation occupying the floodplain area.

Deep pools in streams supplied by cool groundwater shelter returning adults until they are ready to spawn. Clean, stable gravel beds with continuous subsurface flow protect developing

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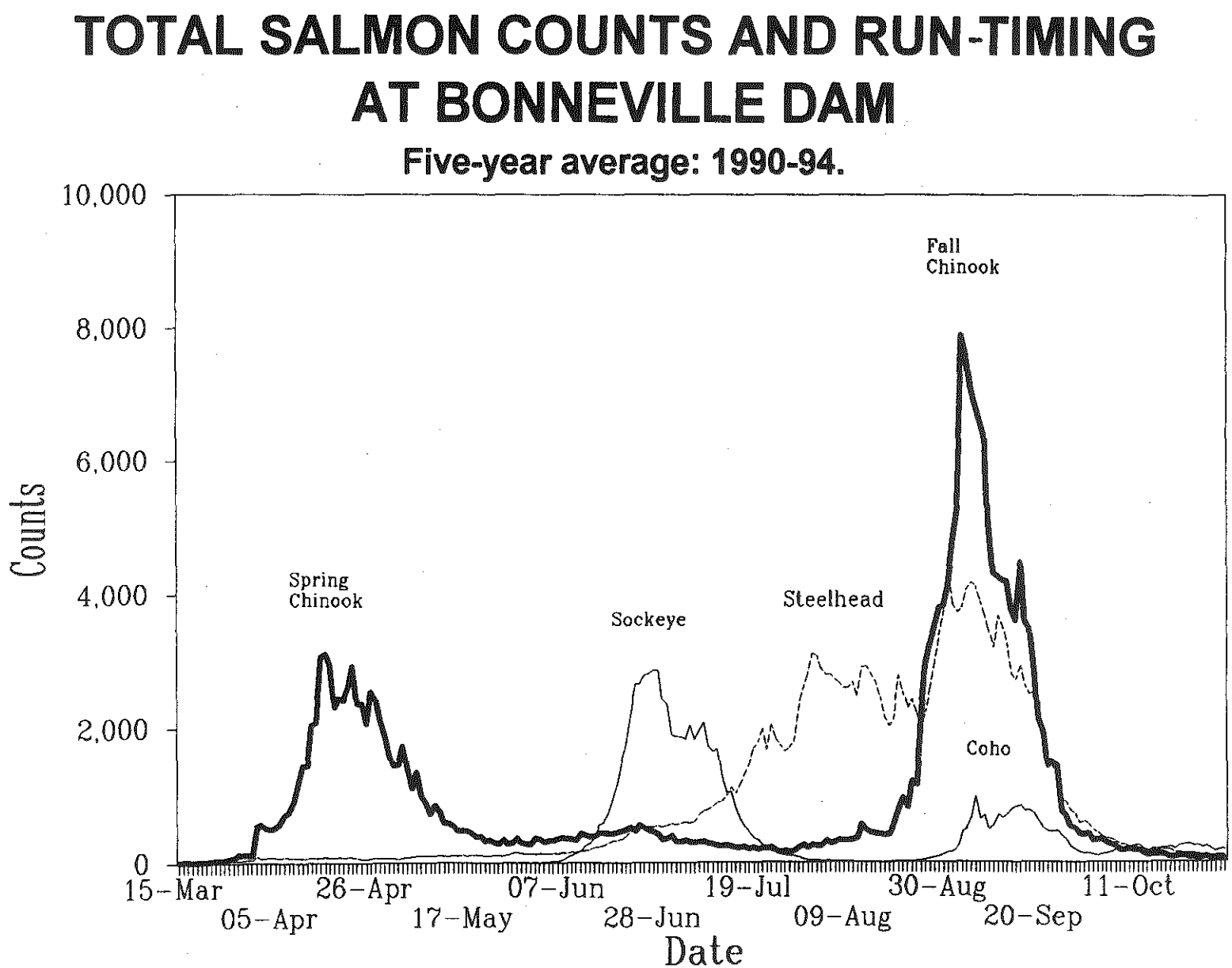

Figure 3.4. Timing of salmon and steelhead runs at Bonneville Dam.

eggs through the winter months. As juveniles hatch, emerge from the gravel, and grow, they use a succession of habitat types, but prefer areas with both protective cover and access to a reliable food supply. Intact adjacent wetlands and subsurface aquifers cool and maintain flows during hot summer periods of reduced rainfall. Undisturbed floodplains with numerous side channels expand the amount of available rearing area and provide shelter during cold winter months.

Mainstem

Mainstem Columbia and Snake Rivers provide critical adult holding, spawning, incubation, and rearing habitat, and are migration corridors for migrating and emigrating salmon. Over time, the Columbia basin streamflow has largely defined freshwater salmon productivity and has a major influence on ocean survival, which is largely dictated by the quantity and quality of smolts that enter and mature to adults in the ocean. Successful completion of salmon life history stages is dependent on critical physical and chemical habitat factors, including hydrological regimes driven by routine meteorological sequences, maintenance of hydraulic geometry factors, and continual organic and inorganic nutrient cycling (Hynes 1970; Heede and Rinne 1990).

Specific requirements include temperature ranges from 7.2-15.6°C (EPA et al. 1971), dissolved oxygen normally saturated at levels greater than 7 mg/l (Reiser and Bjornn 1979), turbidity ranges from 10-25 nephelometric units (Lloyd 1987) and nitrate-nitrogen ranges from 0.02-0.03 mg/l. Also critical for different life stages are diversity in river velocities, which range from 15-100 cm/s, and diversity in substrate size and river depth (Groot and Margolis 1991).

Large, small, and particulate organic matter provide structure and diversity to channel morphology (Maser et al. 1988). Large debris traps organic and inorganic sediment, which in turn provides niches for primary and secondary producers and provides habitat diversity for anadromous salmon (Lisle 1986). In order for salmon populations to proliferate, diversity in secondary production is important. Rearing salmon depend upon different populations of macroinvertebrates at different times (Waters 1969), and drift insects provide high levels of nutrient levels necessary for successful growth and migration.

Estuary

The importance of estuary residence for rearing juvenile salmonids and for adults preparing to migrate upstream is crucial (Healy 1982; McDonald et al. 1987; Wissmar and Simenstad 1988). Juvenile salmon spend days or weeks in the estuary gradually acclimatizing themselves to increasing concentrations of salts and adjusting to new food supplies. During this period they use aquatic vegetation and channel structures as cover from predators. Adults use estuary areas to readjust their body chemistry to a freshwater environment.

Ocean

An area of marine waters off the mouth of the estuary has been identified as an important transition habitat used by juveniles before they migrate further into the ocean (Figure 3.2). All free-ranging anadromous fish use the ocean as a feeding ground, where they grow to maturity. The ocean habitat provides feeding opportunities and conditions necessary for salmon to attain adulthood. Salmon are generally distributed over the northern Pacific Ocean and Bering Sea (some populations or subpopulations remain in coastal waters or freshwater), where they stay for 1-7 years until they mature. Rates of growth and mortality for populations caught in ocean fisheries (e.g., fall chinook and coho) are reasonably well known (Groot and Margolis 1991). Less is known, however, about spring chinook, sockeye, and steelhead.

Pacific Lamprey

Pacific lamprey (*Lampetra tridentata*) or "eel" are restricted in North America to the Pacific Coast and coastal islands from the Aleutians to Baja, California. Pacific lamprey were once widely distributed throughout the Columbia

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River Basin, in the present-day states of Oregon, Washington, and Idaho (Kan 1975; Wydoski and Whitney 1979). Distribution was likely a function of access to suitable spawning and rearing areas (Kan 1975).

Estimates of predevelopment populations of Pacific lamprey runs are not available, but some counts at Bonneville Dam have exceeded 300,000 lamprey annually (Starke and Dalen 1995). These counts include only those fish that passed the counting station during the 18 hours of counting, i.e., they do not include lamprey that passed through navigation locks or at night. Night time passage can be equal to or greater than the numbers migrating during daylight hours. Data from the commercial harvest of Pacific lamprey at Willamette Falls indicate that 116.6 tons on average were harvested from 1943 to 1949 (Mattson 1949). An indication of predevelopment abundance of Pacific lamprey in the Snake River Basin is reflected in the name of the ancestral Nez Perce village, Hasotino, (near present day Asotin Creek) which means "the great eel fishery" (Spiden 1908).

Habitat Requirements of Pacific Lamprey

Tributary

The life cycle of Pacific lamprey is similar to that of salmonids (Figure 3.2). Although they reach the spawning grounds in mid-summer (Kan 1975; Beamish 1980), Pacific lamprey generally spawn the following spring. Thus, adult lamprey spend approximately 1 year in freshwater. Spawning generally occurs in small tributary streams, where both sexes construct a crude redd (Scott and Crossman 1973), generally located in the center of the stream near the tailout of a pool, and immediately upstream of shoreline depositional areas (Beamish 1980). Mating is repeated several times in the redd, with each mating followed by actions that move substrate over newly laid eggs. Water temperatures of 10-15°C have been measured in Clear Creek, a tributary of the John Day River, during spawning (Kan 1975). Adults die soon afterwards, and provide valuable nutrients to small tributaries where salmon fry rear (Kan 1975).

Eggs typically hatch into ammocoetes in less than 2 weeks; these newly hatched larvae, which are filter feeders, then drift downstream and bury themselves in silt, mud, or fine gravel along the margins and backwaters of streams and rivers (Scott and Crossman 1973; Hammond 1979). Ammocoetes generally spend 5-6 years in freshwater (Scott and Crossman 1973); they metamorphose into the adult form — macrophthalmia — in the fall of the last year of this period. This transformation process is generally completed by early winter.

Mainstem

Downstream migration of macrophthalmia appears to be stimulated by and dependent on late winter and early spring floods (Hammond 1979; U.S. ACE, unpublished data). Because they are not strong swimmers, lamprey appear to be dependent on spring flows to carry them to the ocean (Kan 1975; Beamish 1980). The upstream, spawning migration of adults generally begins in early spring. Adult lamprey use the mainstem in returning to their spawning grounds, but do not feed during this period. They were once an important food source for juvenile and adult sturgeon (Kan 1975).

Estuary

Pacific lamprey appear to travel directly into the open ocean, rather than feed in the estuary of nearby coastal waters (Kan 1975; Beamish 1980), as do other lamprey species.

Ocean

Pacific lamprey primarily rear in the ocean habitat for an average of 3.5 years (Beamish 1980), and range in excess of 100 km offshore, often in areas of considerable depth (up to 800 m) (Kan 1975; Beamish 1980; Figure 3.2). Adult lamprey in the ocean are parasitic on many fish species, including salmon. They attach themselves to fish and other animals and feed on blood and body fluids through a hole rasped in the flesh of the host.

White Sturgeon

White sturgeon (*Acipenser transmontanus*) are a large, long-lived species, commonly reaching 70 years of age and weighing in excess of 1,000 pounds (Bajkov 1949; Scott and Crossman 1973; Beamesderfer et al. in press). Today the only population in the Columbia River Basin that migrates to the ocean is downstream from Bonneville Dam. Dams have effectively trapped and separated the historical single population of white sturgeon into a number of separate reservoir populations, and thus created a number of functionally isolated nonanadromous populations upstream from Bonneville Dam (North et al. 1993). Remaining populations are thus considered to be landlocked or resident in the reservoirs upstream from Bonneville. They do not migrate to the ocean. Rather, they complete their life cycle in the mainstem Columbia River (Figure 3.2).

Historically abundant populations of white sturgeon occupied the Columbia River Basin and millions of pounds were harvested commercially during the turn of the century (Craig and Hacker 1940; Reiman and Beamesderfer 1990). Prior to hydroelectric development white sturgeon were

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semi-anadromous throughout much of the Columbia and Snake river basins, with the exception of the geographically isolated Kootenai River population (Northcote 1973).

Habitat requirements of White Sturgeon

Mainstem

White sturgeon spawn in areas of high water velocities (greater than 0.8 m/s) over areas of bedrock, rubble, and large boulders (Anders and Beckman 1993). Historical spawning areas were probably located at the downstream end of falls, cascades, and rapids. Today these conditions are met in the tailrace areas immediately downstream from hydroelectric dams. Sturgeon begin spawning when water temperatures are 10-18°C, with optimal temperatures between 13 and 15°C. White sturgeon are broadcast spawners, and thus spawn in small groups consisting of a single female and several males. Newly laid eggs are extremely sticky, and drift to the river bottom where they adhere to bottom substrates. Hatching generally occurs within 7-12 days (Anders and Beckman 1993). Eggs can be killed if temperatures rise above 18°C. Newly hatched white sturgeon have an internal yolk sac. These yolk sac larvae disperse by swimming vertically into the current and drifting downstream. The larvae metamorphose within a 25- to 30-day period, after which they grow rapidly. Females require an average of 23 years before they spawn. These fish continue to grow throughout their life cycles.

Estuary

Although reservoir populations do not have access to the Columbia River Estuary, the estuary is an important rearing area for juvenile and adult white sturgeon downstream from Bonneville Dam (DeVore et al. in press). The estuary provides access to the ocean, other drainages, and a variety of seasonally abundant prey. In addition, the estuary facilitated restoration of white sturgeon after commercial fisheries decimated populations at the turn of the century (DeVore et al. 1993; McCabe and Tracy 1993). Salinities greater than 16 parts per thousand are known to be lethal to larvae and fry (Brannon 1985).

Ocean

White sturgeon use the ocean for rearing and as a migration route to other drainages along the Pacific Coast (Scott and Crossman 1973; DeVore and Grimes 1993). White sturgeon residing in the ocean have been found to be in superior condition relative to those in the estuary or freshwater (DeVore and Grimes 1993).

Changes in Habitat in the Columbia River Basin

The varied habitats required by anadromous fish have been altered extensively since European settlement of the region, and attempts to manage these habitats have become increasingly complex (see, e.g., Figure 3.5). Generally, the impacts of these alterations are experienced in more than one habitat — e.g., impacts of altered flow regimes, blocked access, and water quality and quantity — beginning in the tributaries and continuing in the mainstem, estuary, and potentially the ocean. For example, mainstem dams and their operation have created a series of reservoirs along the mainstem, and led to altered flows, higher temperatures, and related changes in habitat conditions in the estuary.

Destruction of habitat required by anadromous species has occurred in a variety of ways throughout the Basin. For salmon, human impact in the Columbia River Basin is often categorized as the "4 Hs" — those related to the Hydrosystem, Habitat, Hatcheries, and Harvest . Because the needs of anadromous organisms encompass habitats in different ecosystems, any break in the habitat chain becomes a problem for these species. Weakening of a given link similarly reduces the ability of these organisms to cope with environmental stress. Among the major changes addressed by this plan for restoration in the Columbia River Basin are those involving reductions in available habitat, habitat degradation, water quality impacts, mortalities related to passage, and harvest.

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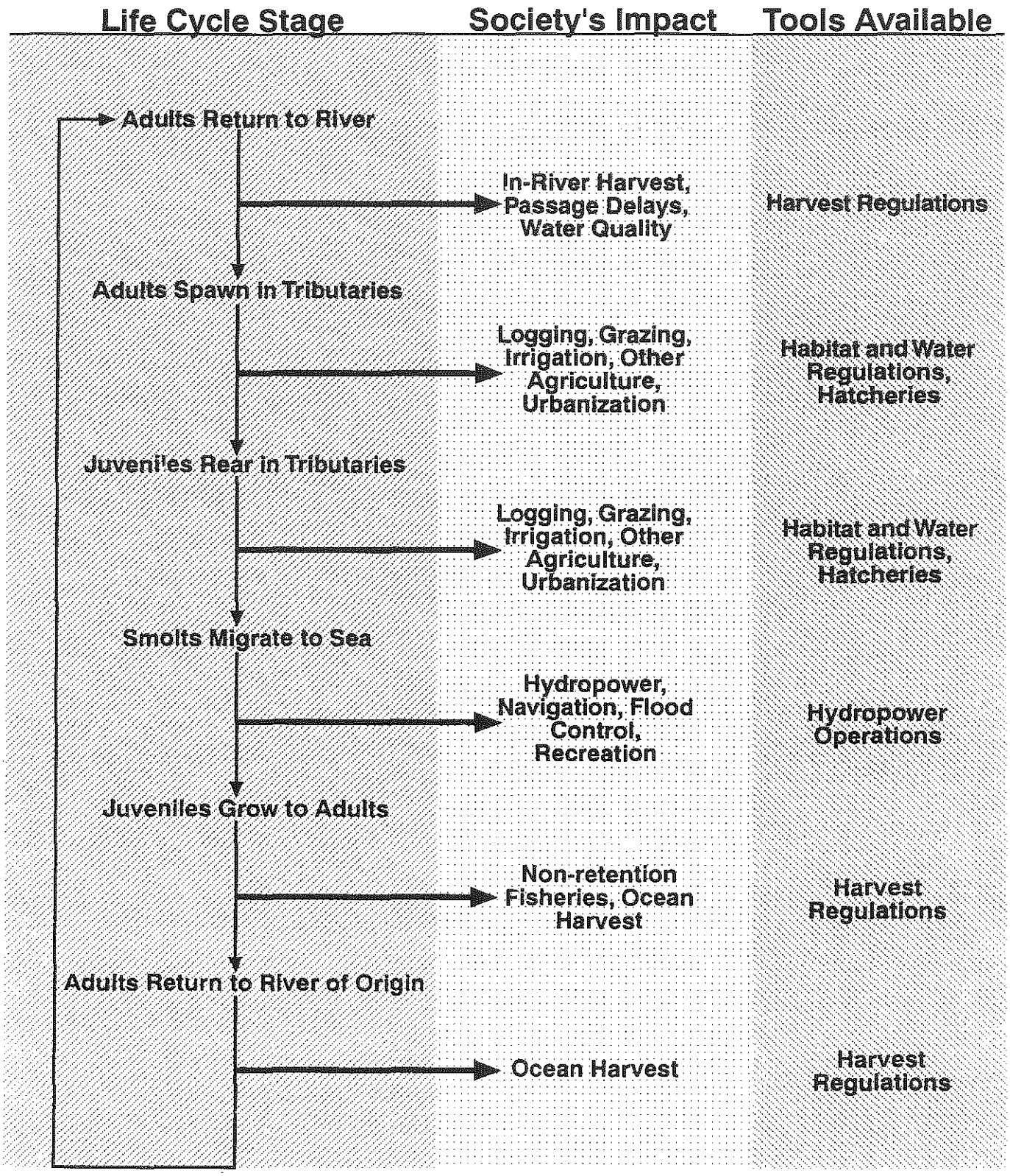

Figure 3.5. Modern society's impacts on anadromous salmon, by lifecycle stage, and tools available to control those impacts.

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Reductions in the Amount of Available Habitat

Critical tributary habitat functions and processes have been limited, and in some cases eliminated, by direct blockage of access (tributary and mainstem) by hydropower and irrigation projects. Chief Joseph, Hells Canyon, and Dworshak dams are high head projects that are impassable to anadromous species from the Upper Columbia, Snake, and Clearwater rivers, respectively. Chief Joseph Dam blocks access to 1100 miles of Columbia River mainstem and tributary habitat, and Hells Canyon Dam blocks access to 600 miles of Snake River mainstem and tributary habitat. Together Chief Joseph, Hells Canyon, and Dworshak dams in the Columbia River Basin block more than 55% of historical tributary and mainstem habitat for anadromous fish (NPPC 1986; Figure 3.6). In addition, tributary dams which are impassable and block hundreds of miles of habitat include Condit in the White Salmon Basin and Enloe in the Similkameen River, located in the Okanogan River Subbasin. Additional reductions in habitat have occurred in the mainstem. Many chinook salmon populations historically spawned in the mainstem Columbia and Snake rivers. Except for the Hanford Reach, the Snake River between Lower Granite Pool and Hells Canyon Dam, the Lower Clearwater River, and a few other locations, these mainstem spawning areas have been considerably reduced by the construction of hydroelectric dams.

The amount of habitat available to chinook, coho, and sockeye before water developments blocked access to streams and before habitat was degraded relative to the present is shown in Table 3.3.

Habitat has also been eliminated by excessive water withdrawals for irrigation, which effectively de–waters portions of watersheds. Habitat has also been eliminated by elevated temperatures which have forced fish to rear only in the cooler waters of the upper portion of watersheds.

In addition, passage is impeded by poorly designed, maintained, and operated structures and facilities and by reductions in the amount of water available for passage. Although both Oregon and Washington require screens at diversions on fish-bearing streams, surveys of the pumping stations in the Columbia River Basin indicate that 70-80% of Oregon sites and 50% of those in Washington are poorly maintained, damaged, oversized, or entirely absent (ODFW 1994; CBFWA 1994). Tens of thousands of salmon smolt can be lost at these sites (e.g., an estimated 58,000 juvenile salmon were annihilated at a small, private hydropower facility near Hermiston, Oregon, where a torn screen allowed fish to pass through turbines in March 1994. Idaho has even less compliance.

Where access to tributaries has been blocked or constrained, anadromous fish populations often become fragmented. Fragmentation of these historically interconnected salmon stocks resulted in the development of numerous smaller subpopulations that have an increased risk of becoming extinct. In much of the remaining high-quality habitat, stream systems are often punctuated with segments of poor or unsuitable habitat. This effectively relegates both anadromous and native resident native fish to disconnected areas of good habitat. Overall survival is further reduced by overwintering habitat that is either nonexistent or poor in quality.

Extensive losses of habitat have occurred in the Columbia River Estuary as a result of dredging, filling, diking, and channelization. Estimates from 1870 to 1970 indicate that 20,000 acres of tidal swamps (with woody vegetation; 78% of estuary littoral area), 10,000 acres of tidal marshes (with nonwoody vegetation), and 3000 acres of tidal flats have been lost. Further, major projects of the U.S. Army Corps of Engineers to aid the annual navigation of more than 2,000 ocean vessels continue to alter the shape of the estuary (Simenstad et al. 1990).

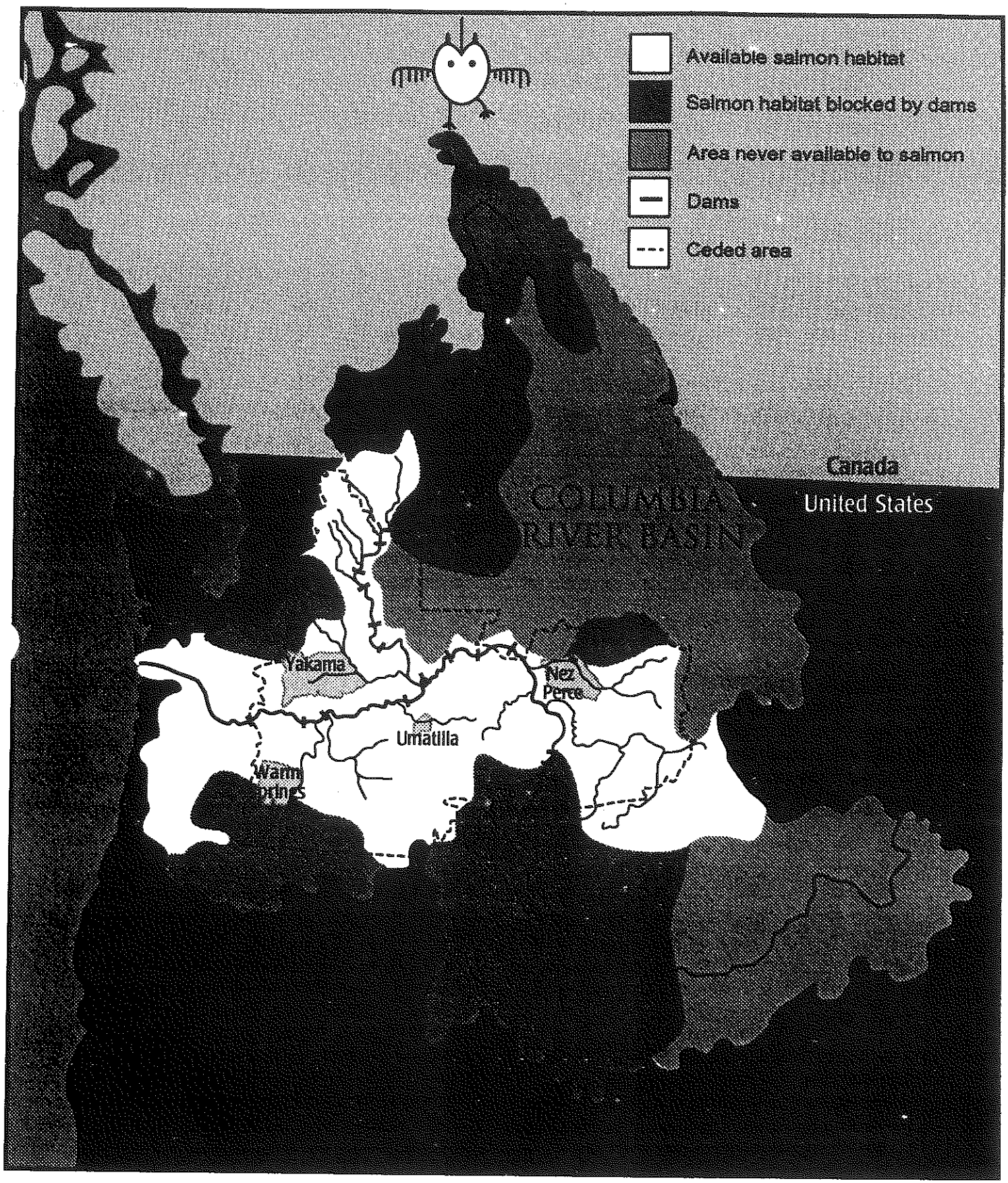

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Figure 3.6. Available and blocked salmon habitat in relation to tribal ceded area.

Habitat Degradation

Construction and operation of numerous mainstem hydroprojects (Figure 3.7) have altered remaining habitat and caused substantial passage problems as well. Free-flowing habitat has been replaced with reservoir habitat to the extent that only 50 miles of the Columbia River (the Hanford Reach) and 100 miles of the Snake River (Hells Canyon) still accessible to anadromous fish above Bonneville Dam flow freely. Anadromous fish in Columbia River Basin tributary habitat are affected by a wide variety of land use practices, which are subject to a range of jurisdictions. These activities include logging, road construction, grazing, agriculture, irrigation, flood control, navigation, electric power generation, and urbanization. General impacts resulting from these activities on tributary systems, as well as agencies responsible for their management, are listed in Table 3.4. Land use management is particularly difficult, because effects and impacts of activities are interrelated, and the results of improving one type of land use practice may be offset or reversed by detrimental changes in others.

Historically, the majority of high quality spring chinook habitat was located on what are now privately owned lands, where degradation has been most severe. However, most of the remaining cooler streams that provide habitat for spring chinook and steelhead and contribute cool water to additional downstream habitat for anadromous fish are located on U.S.D.A. Forest Service lands. Approximately 50% of the current anadromous fish habitat in the Columbia River Basin is federally owned. Thus, wilderness and roadless areas on federal lands serve as increasingly important areas, where much of the salmon production in the subbasins co-managed by the tribes is concentrated.

Land use practices in most tributary watersheds have increased the frequency and intensity of numerous natural disturbance regimes. Building roads on steep terrain, creating high-density road networks, constructing culverts with an inadequate capacity, clearing riparian vegetation, removing large woody debris from stream channels, and grazing livestock in ways that affect stream banks act in concert to destabilize natural processes and amplify the impacts of such natural events as storms. Storms with similar intensity result in surface and mass erosion events more frequently in intensively managed watersheds (e.g., logged, roaded, farmed, grazed, and mined) than in unmanaged ones (e.g., wilderness and roadless areas) (Chamberlin et al. 1991; Furniss et al. 1991).

Current land use practices commonly impact all freshwater habitats and have pervasive and widespread impacts on aquatic species (Chamberlin et al. 1991; Hicks et al. 1991; Platts 1991). They may also affect side channels and oxbow lakes, which are often some of the more productive of remaining fish rearing and refuge areas. In some terrain, grazing tends to break down stream banks and create wider and shallower channels. This reduces the area available for rearing, and contributes to faster increases in water temperature during the summer months. In other areas, grazing can lead to entrenchment, where streams form a steep sided gully, cause increased erosion, and reduce available habitat. In turn, the water table is lowered, and this reduces summer flows and riparian productivity. Problems with decreased water quantity resulting from permitted irrigation withdrawals are further exacerbated by the practice of water spreading.

Impacts on watershed and in-channel habitats during the developmental history of an anadromous species may contribute proportionately little to the overall level of habitat degradation taken singly. Taken in aggregate, however, these impacts may be highly influential. Cumulative effects may result from repeated impacts of the same type, or from an aggregate of impacts of different types. These effects can occur as a sequence of impacts through time, or as a combined set of impacts occurring at a single point in time. Further, they may be additive, synergistic, or significant past a critical threshold (Stull and Emery 1985). Activities such as forestry, urbanization, agriculture, mining, and grazing each create impacts that may lead to similar negative trends in habitat quality. Needs

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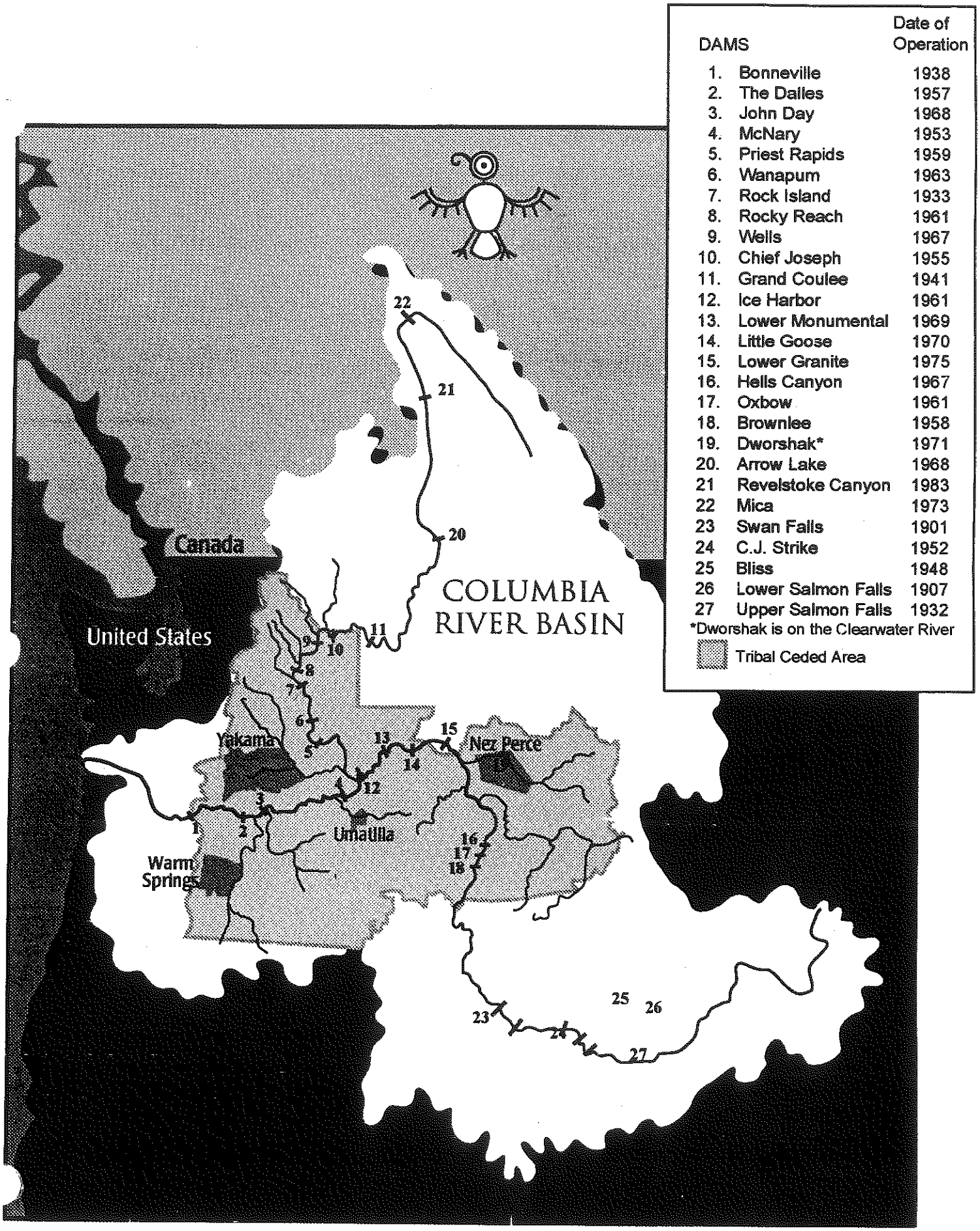

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Figure 3.7. Mainstem dams on the Columbia, Snake, and Clearwater rivers.

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Table 3.4. Major activities that reduce the quality of anadromous fish habitat and parties responsible for them.

ACTIVITY	HABITAT FACTORS IMPACTED	
PARTIES RESPONSIBLE	Increased ↑	Decreased ↓
Grazing		
U.S. Forest Service U.S. Bureau of Land Management U.S. Environmental Protection Agency Various state agencies Private land owners	Channel cross section Surface fines Cobble embeddedness Water temperature Organic pollution Runoff Wetland destruction	Bank stability Riparian vegetation Pool volume Groundwater base flow
Logging		
U.S. Forest Service U.S. Bureau of Land Management U.S. Environmental Protection Agency Various state agencies Private land owners Timber companies	Channel cross section Mass failure & surface erosion Surface fines Cobble embeddedness Water temperature Runoff	Riparian vegetation Large woody debris Pool volume Groundwater base flow
Road Building		
U.S. Forest Service U.S. Bureau of Land Management Various state agencies Timber companies Private land owners	Mass failure & surface erosion Surface fines Cobble embeddedness Water temperature Peak flow Migration blockages	Pool volume Groundwater base flow
Mining		
U.S. Forest Service U.S. Bureau of Land Management U.S. Environmental Protection Agency Various state agencies	Surface fines Cobble embeddedness Inorganic pollution	Pool volume
Agriculture		
U.S. Bureau of Reclamation U.S. Soil Conservation Service U.S. Environmental Protection Agency U.S. Agricultural Stabilization and Conservation Service Various state agencies Private land owners	Surface fines Cobble embeddedness Water temperature Organic pollution Inorganic pollution Runoff Migration problems Wetland destruction	Riparian vegetation Pool volume Groundwater base flow Summer low flow

EX5022-000055-TRB

assessed generally for each of the subbasins for which the tribes share management responsibility are provided in Table 3.5.

Water Quality Impacts

Water quality problems are the result of land use practices that affect streams basinwide, flows altered by dams and irrigation withdrawals, and discharge of pollutants from point sources. The major water quality issues related to anadromous fish production in the Columbia River Basin involve temperature, silt and sediment, dissolved gases and chemical pollution.

Temperature

In portions of many rivers and streams throughout the Columbia River Basin, water temperatures commonly exceed lethal levels for salmonids during August (Collins 1963; Thompson 1974; Liscom et al. 1985; Vigg and Watkins 1988; Meyer 1989; Karr 1992). Water temperatures now commonly exceed 21°C (70°F) in the mainstem (Collins 1963; Shew et al. 1985; Meyer 1989). Systems affected (refer to Figure 3.3) include the Deschutes, John Day, Umatilla, Walla Walla, Yakima, Wenatchee, Entiat, Methow, Okanogan, Tucannon, Clearwater, Salmon, and Grande Ronde rivers; the Columbia River mainstem from the mouth to Chief Joseph Dam; the entire Snake River mainstem; and the Columbia River estuary.

These increased water temperatures equal or exceed levels that are lethal for Columbia River Basin salmon stocks which migrate during this time (Karr 1992). Duston et al. (1991) noted that increases in water temperature interfere with the ability of juvenile salmon to achieve smoltification. In addition "ecological death" as a result of loss of equilibrium occurs at even lower temperatures (Coutant 1970). Existing mainstem temperatures may also explain some of the variation in conversion rates (the difference in numbers at two consecutive dams after accounting for known losses) of steelhead stocks migrating through the lower reaches of the Snake River (Filardo 1990), and the failure of radio-tagged fish to pass upstream (Trefethen and Sutherland 1968; Stabler 1981; Shew et al. 1985). Migration delays caused by high temperatures have been observed often, particularly where tributary temperatures exceed those of the mainstem Columbia River (Major and Mighell 1966; ODFW 1977; Johnson et al. 1982; Liscom et al. 1985). Adult salmon may be further stressed by warmer waters in the reservoirs, and suffer prespawning mortalities (McGie 1992).

Silt and Sediment

The amount of silt and sediment entering streams and rivers can be increased by several orders of magnitude above background levels, as a result of human disturbance in the watershed (through logging, road construction, grazing, mining, and agriculture). Silt settles into coarse gravels, and decreases water circulation needed by salmon eggs in the gravels.

Dissolved Gases

Hydroelectric projects in the tributaries and mainstem have altered concentrations of dissolved gases in the basin. During periods of high runoff, entrainment of gases into dam tailraces caused by large volumes of water over dam spillbays can lead to gas bubble trauma. During warm periods, dissolved oxygen levels can become critically low in the bottom portion of reservoirs.

Pollution

Runoff from agricultural fields, feedlots and urban areas, sewage treatment plant discharges, combined sewer overflows, and heavily grazed tributary streams contains nutrients that lead to excessive plant growth. This growth reduces the amount of oxygen available for aquatic life, and can create fatally anoxic conditions.

Toxic pollutants enter streams and rivers through industrial waste discharges, surface runoff from urban areas, and runoff from agricultural and forested land where herbicides and pesticides are applied. Heavy metal pollution may be generated by active or abandoned mining sites. These pollutants often reduce the supply of food available for salmon, and heavy metals directly decrease the survival of eggs and rearing fish.

EX5022-000056-TRB

Table 3.5. Habitat needs[a] for salmon-bearing subbasins above Bonneville Dam. See Volume II, Appendix D, for detailed information.

SUBBASIN	INSTREAM FLOWS	PASSAGE FACILITIES	RIPARIAN RESTORA-TION	WOODY DEBRIS	CONTROL OF: Mining	Grazing	Logging	Pollution	LAW/CODE ENFORCE-MENT
LOWER COLUMBIA RIVER MAINSTEM									
(Bonneville Dam → McNary Dam)	■	■	■						
Wind River		■	■	■		■	■		
Little White Salmon River		■	■				■		
Big White Salmon River		■	■	■		■	■		
Hood River	■	■	■	■		■	■	■	■
Klickitat River		■	■	■		■	■	■	■
Fifteenmile Creek	■	■	■	■		■	■	■	■
Deschutes River	■	■	■	■		■	■	■	■
John Day River	■	■	■	■	■	■	■	■	■
Umatilla River	■	■	■	■		■	■	■	■
MID-COLUMBIA RIVER MAINSTEM									
(McNary Dam → Chief Joseph Dam)	■	■	■						
Walla Walla River	■	■	■	■	■	■	■	■	
Yakima River	■	■	■	■		■	■	■	■
Wenatchee River	■	■	■			■	■		■
Entiat River	■		■			■	■		■
Methow River	■		■	■			■		■
Okanogan River	■	■	■			■	■	■	■

[a] ***Instream Flows:*** requires the states to establish and adopt instream flows adequate for fish.
Passage Facilities: requires facilities for downstream migrants (e.g., fish screens) or upstream adults (e.g., fish ladders).
Riparian Restoration: requires reductions in or elimination of such land use activities as logging and grazing, or use of such restoration methods as replanting, zoning, or creating riparian reserves.
Large Woody Debris: requires that large trees that create fish habitat be left in place when they fall.
Mining Controls: requires restoration or prevention of further damage to streams in which past or ongoing mining activities have damaged fish habitat.
Grazing Controls: requires temporary suspension of grazing in riparian areas to allow for recovery of habitat destroyed by overgrazing livestock.
Logging Controls: requires that logging be eliminated or restricted in riparian areas to allow for recovery.
Pollution Controls: requires elimination of pollution sources, e.g., industrial and agricultural.
Laws/Codes Enforcement: require that federal, state, county, and tribal laws and codes protecting fish and fish habitat be adopted or enforced.

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Table 3.5. *(continued)*

SUBBASIN	INSTREAM FLOWS	PASSAGE FACILITIES	RIPARIAN RESTORA-TION	WOODY DEBRIS	CONTROL OF: Mining	Grazing	Logging	Pollution	LAW/CODE ENFORCE-MENT
Snake River Mainstem									
(Ice Harbor Dam → Hells Canyon Dam)	■	■	■						■
Tucannon River	■		■			■	■	■	■
Clearwater River	■		■	■	■	■	■	■	■
Grande Ronde River	■	■	■			■	■	■	■
Salmon River	■	■	■	■	■	■	■	■	■
Imnaha River	■		■			■	■		

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According to the State of Oregon, all of the Columbia River within the state's borders (river miles 0-309) is in violation of the state water quality standard adopted for dioxin (ODEQ 1994). Washington State has specifically identified the Columbia River mainstem downstream of Priest Rapids Dam and the entirety of the Snake River within Washington State as violating the dioxin water quality standard (WDOE 1992).

Organochlorine compounds can disturb the endocrine systems of exposed organisms adversely affect the development of the organism's reproductive system and create immunological deficiencies. Contaminant exposure and uptake by fish can occur even when fish are in a contaminated area for a brief time and such exposure can trigger changes in enzyme levels and DNA damage (McCain *et al.* 1990). The effects of these chemicals may be exacerbated by near-lethal water temperatures which exist in the mainstem Columbia and Snake rivers at times during the summer (Collins 1963; Meyer 1989; Karr *et al.* 1992).

Problems Related to Water Resource Project Development

The operation of the series of Columbia Basin dams and storage reservoirs and the diking and development of structures for flood control has served to disconnect key productive areas from the river flow continuum. Impacts include the loss of floodplain vegetation and loss of nutrient capital essential for fish production (Sedell and Frogatt 1984). Welcomme (1979) and Ward and Stanford (1989) investigated large floodplain rivers worldwide and found that the loss of floodplains was the greatest reason for the loss of productive fisheries. For example, the loss of 67% of floodplain habitat in the Missouri Basin was accompanied by a greater than 80% reduction in fish catch (Whitley and Campell 1974).

The loss of downstream organic and inorganic nutrient cycling from dam construction and operation has been profound. In reviewing ecological impacts of dams in major rivers worldwide, Petts (1987) and Regier et al. (1989) found that the accumulation of nutrients behind dams has lowered the diversity of trophic orders necessary to support higher orders of biota and that this is a continuing process over time.

The loss of nutrient cycling upstream from dam passage losses has also been profound basinwide. Dams have both reduced the widespread distribution of salmon carcasses into mainstem and tributaries by direct means and by contributing to the loss of energy reserves. The importance of salmon carcasses in providing a trophic base for subsequent year classes was documented by Cederholm et al. (1989), who also found that the carcasses were utilized by 22 species of birds and mammals.

Sources of mortality to anadromous fish in mainstem areas that are not directly blocked include passage through turbines, inadequate adult and juvenile bypass systems, indirect effects of power peaking, slackwater reservoir passage, and migration delays resulting from the altered hydrologic regime. Estimates of passage mortalities through the series of mainstem dams average 15-30% per dam for juveniles and 5-10% per dam for adults (NPPC 1986; Raymond 1988; Kaczinski and Palmisano 1992). Thus, cumulative mortality through the nine-dam mainstem system may be as high as 98% for juveniles and 37-51% for adults during low-flow years (Raymond 1988). Further, salmon must pass additional barriers in many of the tributaries (e.g., the Yakima River).

After 1970, with the completion of huge Canadian storage reservoirs and the construction of John Day Dam, four public utility dams in the Mid-Columbia, and three Lower Snake River dams, large and consistent declines, from about 4% to about 1%, occurred in average smolt-to-adult survival rates (Raymond 1988; Petrosky and Schaller 1992). Numerous alternatives were developed with much expense and effort to address juvenile passage — mechanical bypass, juvenile barging and trucking, and spill (Anderson 1988; Raymond 1988). Yet each of these alternatives has met with confounding drawbacks. For example, spill, if not carefully controlled, can cause nitrogen supersaturation (Ebel

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et al. 1975; Ebel and Raymond 1976; Ebel 1979; Weitkamp and Katz 1980). Mechanical bypass systems may divert only 8-30% of subyearling chinook and sockeye from turbines (Gessel et al. 1989, 1990; U.S. ACE 1993; Brege 1992). Twenty years of transportation have not stemmed the steady decline of Snake River chinook stocks (Congleton et al. 1985). Adult salmon, accustomed to working with natural river hydraulics to move upstream, are confused by flows at the base of dams. This leads to delay in moving expediently through adult fishways (Muir 1957; Bjornn and Peery 1992). Further, lack of proper hydraulic cues in dam forebays can cause adults to "fall back" over dams spillways and through turbines. For example, during one week, nearly 800 steelhead have been documented to fall back through McNary Dam (WDF 1991).

An additional impact related to changes in the system's hydrograph involves travel time for migration. Whereas juvenile salmon historically took an average of 22 days to reach the estuary from the upper reaches of the Snake River, the trip today requires over 50 days. This prolongs the period during which migrants are exposed to heightened predation, disease, and increased water temperatures, and interferes with essential physiological development (Li et al. 1987; Raymond 1988). Average peak flows at The Dalles have been reduced from 400-500 kcfs to less than 200 kcfs. Concurrent impoundment of organic sediments in reservoirs behind mainstem dams has produced large blooms of phytoplankton (Sherwood et al. 1990), which has benefited exotic species such as shad.

Since the last of the basin's large storage reservoirs was created in Canada less than 20 years ago, it is likely that the Columbia basin ecosystem is still in a period of ecological adjustment. Because of the complexity of the cumulative changes and the time lag in which ecosystems attempt to stabilize to environmental disturbances, it is not known at this time what the final ecosystem of the Columbia River will contain with respect to trophic assemblages. However, the historical record from other major rivers in the world indicates that unless major management changes are instituted to restore riverine physical and chemical habitat processes, the Columbia River ecosystem will not likely continue to support anadromous salmon into future centuries.

Estuary Habitat

Impacts from human activities during the last 150 years have significantly affected essential estuary habitat. As a result of construction of hydroelectric and irrigation diversion dams, lower river and estuary habitat has been degraded, with changes in basin sedimentology, hydraulic geometry, and temperature. Although mean annual discharge has not substantially changed since 1878, Simenstad et al. (1990) estimate that the peak annual discharge has decreased from 17,500 to 12,000 cubic meters per second. The greatest change has occurred in the past 30 years, with significant changes in estuary circulatory patterns, flushing, and bathymetry.

Damping of peak and sustained flood flows by hydrosystem operations has not only resulted in the loss of critical estuarine habitat, but also has altered the trophic structure that supports salmonid production, and enhanced the accumulation of pollutants from the entire Basin in estuarine sediments (Sherwood et al. 1990). Changes in the littoral ecology of the Columbia River Estuary have been drastic. Emergent plant production has been decreased by 82% and benthic macroalgae by 15% (Sherwood et al. 1990). The large blooms of phytoplankton from mainstem reservoirs are washed into the estuary, where they alter food webs to the benefit of such exotic species as American shad, and to the disadvantage of anadromous salmon (Bottom and Jones 1990). Prior to the construction of the dams, organic debris, ranging in size from fine particulates to old-growth logs, washed down the river, and were carried to the estuary and deposited in the ocean. Estuarine turbidity has decreased dramatically, and this has allowed for increased predation on juvenile salmon (Junge and Oakley 1966; Bottom and Jones 1990). Petts (1980) and Sherwood et al. (1990) suggest that

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Table 3.6. Major activities affecting ocean habitat and the agencies that regulate them.

ACTIVITY	REGULATORY AGENCIES
Fishing	North Pacific Fisheries Management Council Pacific Salmon Commission Pacific Fisheries Management Council
Mining and Oil Exploration	Minerals Management Service
Oil Spills	U.S. Coast Guard U.S. Environmental Protection Agency
Pollution	U.S. Environmental Protection Agency

Columbia River estuarine ecological communities may be experiencing a considerable "lag time" in adapting to rapid and profound physical changes. Because of the magnitude and rapidity of physical changes in the Columbia River estuary, ecological communities may be unable to fully adjust until conditions have stabilized.

Increases in human activity in the Pacific Ocean (Table 3.6) result in reduced populations of all species.

Harvest

Historically, Indian fisheries included the harvest of chinook, coho, sockeye, chum, and steelhead, as well as Pacific lamprey and white sturgeon. These fisheries were extensive and diverse, and fish were harvested throughout the year with a wide array of gear. These fish not only served as the tribes' primary food source, but also were an integral and essential part of their cultural and spiritual existence. Further, these fish were a primary commodity in an extensive economic system with a vast trade network.

Non-Indian fisheries for anadromous fish in the Columbia River Basin began operating in 1866, and expanded rapidly. As the technology used in the fisheries became more elaborate, and because regulation was sparse, salmon stocks were already showing a rapid decline in abundance by the late nineteenth century. In addition, sources of mortality other than fishing began to have an impact on fish populations.

Fisheries on Columbia Basin stocks range from Alaska to California in the ocean, and throughout the Columbia River and its tributaries. Although in-river harvest has been regulated for decades, historical ocean fishery management did not attempt to achieve any particular chinook conservation objective. Direct management of chinook harvest in ocean commercial and recreational fisheries has occurred only recently. Beginning in the early 1980s, management of chinook stocks has attempted to address conservation of upper Columbia River spring, summer, and fall chinook runs (the aggregate of upriver stocks), and court-ordered treaty harvest allocation requirements.

In response to competing jurisdictional interests, a complex system of regulatory processes evolved to address this need (see Institutional Context section). Present management involves a number of regulatory agencies established to manage commercial fisheries on the west coast of North America. (1) The Pacific and North Pacific Fishery Management Councils were established pursuant to the Fishery Management

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and Conservation Act to manage ocean fisheries in U.S. waters from Alaska to Mexico. (2) The Pacific Salmon Commission was established pursuant to the Untied States-Canada Pacific Salmon Treaty, and regulates fisheries in waters off southeast Alaska, northcentral British Columbia, and western Vancouver Island to the U.S.-Canada boundary according to catch ceilings intended to stabilize harvest impacts on stocks of concern. (3) The Columbia River Fish Management Plan, formulated by the parties to *U.S. v. Oregon* and adopted in 1988, sets run-by-run criteria to meet allocation, conservation, and rebuilding goals.

No catch guidelines are available for Pacific lamprey. They are now used by tribal elders for subsistence. The general management goal is to increase populations so that they can be used for subsistence by tribal people

Columbia River Basin white sturgeon have been exploited for commercially for their flesh and eggs (Bajkov 1949; Smith 1990). They are especially vulnerable because of their longevity, slow growth, and relatively old age at which they become mature. The goal is to maintain healthy, stable populations, and increase commercial catches over the long term.

Operation and Location of Hatcheries

Hatchery operations have been generally limited to increasing total salmon numbers in the system as a whole, without regard for sustaining the historical geographic distribution of the species present. Further, hatchery operations have not effectively considered the biology of the organisms reared. Thus, salmon reared in hatcheries may learn behaviors which may hinder them after release. Juveniles are often released at a single point and all at one time. Some of these juveniles may not be ready to migrate. Further, they may be released without proper acclimation and imprinting, and into streams with environments to which they are not particularly well suited.

Federal statutes such as the Federal Power Act and the Fish and Wildlife Coordination Act of 1934 and its amendments were designed to provide mitigation for damages caused by water and other federal projects. The prevailing notion behind mitigation was to move fish production from natural areas to federally and power-company funded hatcheries as hydropower development, irrigation, forestry, and mining swept across the Columbia River Basin. However, mitigation provided did not necessarily take place where the damage occurred, or for the same species that had been damaged. As a result, an imbalance was created by the geographical redistribution of individual stocks in the Columbia River Basin to areas downstream from Bonneville Dam. Subbasins that might be appropriate for reintroduction (where salmon populations have been extirpated) or supplementation (where populations are at high risk of extirpation) programs are summarized in Table 3.7.

Salmon Population Structure

Healthy salmon populations have complex population structures characterized by the return of multiple age classes and by limited mixing between neighboring populations. This variety in life history patterns allows them to persist through periodic disasters and unfavorable environmental conditions and to colonize newly available areas.

The complex structure of salmon populations most likely functions as a metapopulation. A metapopulation is a subdivided population, with each subdivision having its own internal dynamics, yet connected to other subdivisions by dispersal (Hanski and Gilpin, 1991). The ability of naturally reproducing populations to persist and flourish in a fluctuating environment depends on demographic factors, genetic factors and interactions between local populations. Properly describing this population structure and the interrelationships is a complex task based upon examining the statistical properties of a number of phenotypic, genetic, and behavioral information (NRC 1995). While a multi-attribute approach to describing stock structure is a difficult task, it has the advantage of avoiding the shortcomings of any single approach and more accurately

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Table 3.7. Production assessments designated by species and according to Columbia River subbasins of primary interest to Columbia Basin treaty tribes. N = Natural production present; A = Artificial production present under current hatchery system; S = Potential candidate for supplementation; ■ = Extirpated; — = Not known to be present.

SUBBASIN	CHINOOK Fall	CHINOOK Spring	CHINOOK Summer	COHO	SOCK-EYE	STEEL-HEAD	CHUM
***LOWER COLUMBIA RIVER** (Bonneville Dam → McNary Dam)*							
Mainstem and minor tributaries	N	—	—	N	—	N	■
Wind River	NS	NAS	—	NS	—	NAS	■
Little White Salmon River	■AS	—	■AS	—	■	—	—
Big White Salmon River	NS	■AS	—	N	—	NAS	—
Hood River	N	NAS	—	N	—	NAS	—
Klickitat River	NAS	NAS	—	NAS	—	NAS	—
Fifteenmile Creek	—	—	—	—	—	N	—
Deschutes River	N	NAS	—	—	—	NAS	—
John Day River	—	N	—	■	—	N	—
Umatilla River	NAS	NAS	—	NAS	—	NAS	■S
***MID-COLUMBIA RIVER** (McNary Dam → Chief Joseph Dam)*							
Mainstem and minor tributaries	NAS	AS	—	—	—	NAS	—
Walla Walla River	—	■S	—	■	—	NAS	■S
Yakima River	NAS	NS	■S	■NAS	■S	NAS	—
Wenatchee River	N	NAS	NAS	■S	NAS	NAS	—
Entiat River	N	NAS	NS	■S	—	NAS	—
Methow River	N	NAS	NAS	■S	—	NAS	—
Okanogan River	N	—	NAS	■S	NAS	NAS	—
***LOWER SNAKE RIVER** (Ice Harbor Dam → Hells Canyon Dam)*							
Mainstem and minor tributaries	NAS	■	—	■	—	NAS	—
Tucannon River	NS	NAS	—	■	—	NAS	—
Clearwater River	NS	NAS	■S	■S	—	NAS	—
Grande Ronde River	NS	NAS	—	■S	■S	NAS	—
Salmon River	N	NAS	NAS	■	■AS	NAS	—
Imnaha River	NS	NAS	—	—	—	NAS	—

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describes the important traits which have allowed these fish to persist for thousands of years.

The lack of data necessary to describe metapopulation structure has led to management uncertainty. This has been particularly true when developing management strategies to conserve small local populations. Current strategies often rely heavily on one aspect such as genetic factors, while not accounting for extreme demographic risk.

Lack of information has also led to speculation and disagreement about the impacts of using hatchery technology as a tool to increase natural salmon populations. Certainly, traditional production hatchery practices have resulted in behavioral and genetic changes in the cultured fish compared to the original population. Radically different hatchery practices, as proposed by the tribes to deal with the immediate risks of further extirpations, will be designed to minimize potential genetic effects. On the other hand, the use of captive breeding practices using all of the few remaining adults from a population might keep the population from being extirpated, but would almost certainly have a greater genetic and behavioral impact than earlier intervention using a low impact supplementation approach. In either case, there is a need to track the medium and long-term genetic and behavioral effects of hatchery technology on naturally spawning populations. The information obtained over time will help describe the population structure for salmon and evaluate the effects of hatchery techniques, so that natural and hatchery production can be wisely managed over the long term.

Genetic Considerations

The tribal approach to using artificial propagation for supplementation and reintroduction is based on scientific principles and practicality. This approach minimizes genetic risks to the natural populations by applying specific protocols for spawning, rearing, release and disease prevention (Cuenco et. al 1993). Whenever possible, salmon spawning in a given stream will serve as the source of the artificially propagated fish planted in that stream. Source populations for all supplementation efforts will be chosen to best match the characteristics of the natural population. The intention of tribal supplementation proposals is to increase the abundance of naturally reproducing populations through outplanting while keeping genetic risk at acceptable levels. The increase in survival and reproductive capacity gained through the use of artificial propagation in supplementation and reintroduction programs is necessary to recover stocks in a timely fashion.

Many salmon populations are at such a small fraction of their historical size, that the risk of losing a whole population outweighs the risk of losing genetic variation. In the case of small populations, factors related to demographics, survival rates, and spatial structure become more important than genetic factors in determining the long-term viability of the population. Increasing the size of a population to permit it to breed effectively for that population to survive environmental changes.

Restoring the spatial structure through supplementation and habitat actions will help reestablish the natural gene flow between adjacent spawning populations and reduce the risk of localized extirpations. In comparison to other organisms, the "stray" rate for salmon is relatively high (Quinn et. al 1991) and therefore the inherent rate of gene flow is relatively high for salmon. In the past, salmon habitat, which was continuous, provided links between local populations, creating a metapopulation. But, human activity partitioned the habitat and fragmented the populations, increasing the possibility of inbreeding depression by reducing natural gene flow and effective population size. The links between local populations have been broken, and they must be reestablished.

It is important to evaluate changes resulting from supplementation actions and the tribal plan includes monitoring for genetic change. Although not meaningful by itself, the level of heterozygosity will be tracked and evaluated. For anadromous fish returning to natal areas to spawn, levels of heterozygosity would be expect-

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ed to be low (Nevo 1978). Population fragmentation due to land use practices and other ecological and genetic factors also can alter the character of fish populations. These factors will also be considered in determining the consequences of enhancement actions. Should there be significant loss of heterozygosity, alternative restoration actions can be applied.

Supplementation is a short-term solution that would not be necessary over the long-term if other factors such as habitat restoration and passage improvement were to promote salmon survival. Unless the high mortality levels throughout the life cycle of salmon are reduced, losses of salmon populations and their associated genetic diversity will continue. Then, the survival advantage provided by supplementation efforts will simply delay the demise of salmon populations in the Columbia basin.

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SECTION 4

LEGAL AND INSTITUTIONAL CONTEXT

LEGAL AND INSTITUTIONAL CONTEXT

The treaty promises of the United States to protect the aboriginal right of our tribes to take fish at all of our usual and accustomed fishing places precedes all other laws affecting the Columbia Basin and were not diminished by those laws. The laws regarding operations that may affect treaty fisheries are subject to the treaties and need to be read consistent with them.

The decline of many Columbia Basin anadromous populations has been observed for over a century. Departing from the policies that produced the Mitchell Act and the Lower Snake River Compensation Plan (LSRCP), the last twenty years produced the *US v. Oregon* Columbia River Fish Management Plan (CRFMP), the Northwest Power Planning Council's (NPPC) Fish and Wildlife Program (FWP), and mid-Columbia orders under the Federal Energy Regulatory Commission (FERC); plans for in-place, in-kind rebuilding and restoration using habitat and propagation techniques to increase naturally spawning populations.

Our tribes first proposed a realistic, authoritative program for recovery of damaged upriver salmon in 1982. In the instances where our proposals were implemented, the tribes demonstrated that recovery is possible when the uses of the river are balanced to increase survival at all salmon life stages, not just at the time when fish pass our fishermen. In other instances, new institutions lacked the authority to overcome the imbalance of a century of development built on the backs of upriver anadromous fish.

In 1986, our biologists estimated our cumulative salmon losses due to hydropower development at 140 to 340 million fish, and the taking continues. By this proposal, the tribes are not asking for repayment of this debt in dollars. We are simply asking that the region utilize our knowledge and modify regional institutions to support our methods for restoring our fish and fisheries so the debt stops mounting.

The Legal Context: Rights, Trust Responsibility and Trust Resources

Since time immemorial the Columbia River and its tributaries were viewed by the Columbia River Basin tribes as "a great table where all the Indians came to partake."[1] The tribal peoples' sustainable culture and the natural resources upon which it depended — including, but not limited to, land, water, natural foods and medicines — were reserved by the tribes when they signed treaties with the United States. The fisheries resources of the Columbia River, including all salmon stocks, are part of the tribes' treaty protected fisheries. The treaties, though challenged often, have been affirmed repeatedly as legally binding documents by numerous court decisions.

The right of the tribes to govern their members, and manage their territories and resources flows from tribal sovereignty as recognized by treaty. In general, tribal governmental powers are described as "inherent powers of a limited sovereignty which has never been extinguished."[2] The tribes' status as one of three sovereigns is recognized in the Constitution and has been upheld by the courts since the early years of the Republic. Treaties made with Indian tribes, indeed the fact that treaties were made at all, reflect the federal government's recognition of tribal sovereignty.[3]

The fishing right means more than the right of Indians to hang a net in an empty river.[4] However, Columbia River runs of sockeye, coho, and spring, summer, and fall chinook have declined drastically since the mid-1800's. Where once the Columbia produced annual runs of at least 10-16 million salmon, its runs are now diminished to approximately 600,000. In negotiating the treaties, the tribes did not envision nor sanction the U.S. government using or allowing the use of the resource common to each

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sovereign in a manner that would diminish its availability to the other. The devastation of fish runs is inimical to Indian treaties and the United State's trust responsibilities to the tribes.

In 1855, representatives of the United States government negotiated separate treaties with the tribes and bands that now compose the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakama Indian Nation, and the Nez Perce Tribe. Retaining the right to continue traditional fishing practices was a primary objective of the Columbia River tribes during treaty negotiations.[5] In addition to reserving hunting, pasturing, and gathering rights, each treaty contained a substantially identical provision reserving to the tribes the right to take "fish at all usual and accustomed places in common with citizens of the United States." The fishing clause is the heart of the Columbia River tribes' treaties. The Columbia River tribes each reserved the right to take fish: (1) within their respective reservations, (2) at all usual and accustomed fishing sites on lands ceded to the United States government, and (3) at all usual and accustomed fishing sites outside the reservation or ceded areas.

The right to take fish is integral to the Columbia River tribes' subsistence, culture, religion and economy. The Supreme Court recognized the importance of fish to the tribes early in the development of treaty interpretation:

> *The right to resort to...fishing places...was a part of larger rights possessed by the Indians, upon the exercise of which there was not a shadow of impediment, and which were not much less necessary to the existence of the Indians than the atmosphere they breathed.*[6]

Winans stands as an explicit recognition that Columbia River tribes retain an aboriginal fishing right that has resided with these tribes since time immemorial. The *Winans* reserved rights doctrine is the law today.

In the 90 years since the Court's opinion in *United States v. Winans*, the treaty fishing clause has been the subject of no fewer than six additional written opinions by the United States Supreme Court. All of the Court's decisions have upheld the basic rights of the treaty tribes to take fish at all usual and accustomed fishing places. In addition, the fishing clause has been the subject of dozens and dozens of federal district court and court of appeals opinions. The federal court opinions have confirmed that the tribes are entitled to 50% of the harvestable number of fish destined to pass usual and accustomed fishing places. In their interpretations of the treaties, the federal courts have established a large body of case law setting forth certain fundamental principles.

In accordance with these established principles, also known as the conservation standards, for government regulation of fishing rights to be permissible, it must be demonstrated that the regulation is a reasonable and necessary conservation measure ... and that its application to the Indians is necessary in the interests of conservation."[7] The regulation must not discriminate against Indians exercising treaty rights, either on its face or as applied.[8] And, all measures must be taken to restrict non-Indian activities before treaty rights may be regulated.[9]

Conservation in the context of fisheries management often includes "wise use" considerations. However, in the context of regulation of treaty Indian fishing rights, conservation is a term of art whose meaning is limited to maintenance of a reasonable margin of safety against extinction.[10]

Although the tribes' rights to take fish and regulate the fishery resource have been clearly upheld in numerous courts, these rights are meaningless if there are no fish to be taken or resources to be managed. As described in Section 3, fish runs passing through usual and accustomed fishing places have been severely diminished by environmental degradation. In the most general terms, this degradation has profoundly impacted the quality and quantity of the waters that sustain the fish.

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In the realm of treaty fishing rights, the tribes, states, and federal government share the responsibility to protect and enhance fish habitat as cotenants.[11]

To protect fish habitat and tribal fisheries, courts have grounded their decisions on reserved water rights and treaty fishing rights in situations where certain uses of water impact fish habitat.[12] In 1985, for instance, the Ninth Circuit affirmed a federal district court order which required that water be released from a dam in the Yakima system to protect 60 spring chinook salmon redds from destruction.[13]

In addition to the concept of a cotenancy regarding the fishery resource, the United States stands in a trust or fiduciary relationship to Indian tribes. The trust relationship is a legal doctrine which embodies the many political promises made by the federal government to Indian tribes. The trust doctrine governs all aspects of federal government actions that affects Indian tribes. Because the federal government and its agencies are subject to the United States' fiduciary responsibilities to tribes, all federal actions and the implementation of federal statutory schemes affecting Indian people, land or resources must be "judged by the most exacting fiduciary standards."[14] Because the trust doctrine permeates every aspect of the federal government's relations with Indian tribes, the United States' trust obligations extend to all federal agencies that manage fisheries, water projects, hydroelectric projects, and federal lands. Thus, the federal government and its implementing agencies owe a duty to not only recognize the impacts of their activities on the tribes, but also a duty to safeguard natural resources which are of crucial importance to tribal self-government and prosperity. In addition, the trust responsibility imposes an affirmative duty upon a federal agency to use its particular expertise, in meaningful consultation with the tribes, to protect tribal resources. As discussed later with regard to *US v. Oregon* and the other major institutional structures affecting Columbia basin anadromous fish, procedures exist that provide such meaningful consultation.

For the last thirty years, treaty fishing rights cases and the federal trust responsibility toward Indian tribes have been major factors in the evolution of institutional structures for the management and protection of Columbia Basin salmon fisheries. From a tribal perspective, the development of management institutions in the basin reflects and must continue to reflect the implementation of treaty promises through the development of joint or co-management strategies by the tribes, the states and the federal government.

The Institutional Context: Management Structures for Columbia Basin Anadromous Fish

During the past twenty years, the region has established institutions to manage restoration of anadromous fish in the Columbia Basin in addition to structures used for managing fisheries. Using the authorities of their participating governments, these structures are intended to focus personnel and resources on the tasks of restoration in an efficient and effective manner. Restoration of Columbia Basin anadromous fish requires procedures that are authoritative, efficient, goal-oriented, and can effectively resolve disputes. Where existing processes meet these standards, their most useful aspects should be retained. Where they fail, they should be modified, replaced, or eliminated.

The tribal recommendations for institutional change reflect the need to manage activities affecting anadromous fish in a manner that implements restoration and recovery through adaptive management, or "learning by doing." This document proposes a series of hypotheses that are designed to lessen human-caused mortality at all stages of the life cycle of the species in question. The institutional recommendations are aimed at managing the implementation of the hypotheses, evaluating outcomes and modifying the hypotheses to reflect knowledge obtained. In general, these recommendations utilize existing structures but modify them to provide increased accountability for the parties with direct respon-

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sibilities for increasing survival and meaningful participation for the tribes whose very existence is dependent upon restoration and recovery.

There are currently five major institutional structures governing anadromous fish restoration in the upper Columbia Basin. They include: the Columbia River Fish Management Plan under the jurisdiction of the Federal District Court of Oregon[15] (CRFMP); the Pacific Salmon Treaty[16]; the FWP adopted under the authority of the Pacific Northwest Power Planning and Conservation Act of 1980 (Northwest Power Act)[17]; the orders of the Federal Energy Regulatory Commission (FERC)[18], and the processes authorized under the Endangered Species Act[19]. Each of these structures addresses important aspects of the life cycle of upriver anadromous fish and each, to varying degrees, coordinates recovery efforts among necessary parties and authorities and provides an authoritative planning process, appropriate goals and objectives, and dispute resolution for restoring Columbia Basin anadromous fish. The first four programs, however, are based upon the concept of co-management recognizing, especially, the unique authorities and functions of the federal, state, and tribal governments in managing salmon resources. Implementation of the ESA, however, centralizes authority for recovery in one federal fishery agency that has demonstrated neither the capacity nor the intent to rebuild upriver salmon runs.

The Columbia River Fish Management Plan

In 1977, after eight years of litigation, the federal district court in *US v. Oregon* approved a five-year management and allocation agreement regarding upper Columbia fish runs.[20] That first management plan established an in-river harvest sharing formula and included an agreement by the parties (the United States, Oregon, Washington and the Warm Springs, Yakama, Nez Perce and Umatilla tribes) that they would "diligently pursue and promote through cooperative efforts upriver maintenance and enhancement of fish habitat and hatchery rearing programs...." The plan also established a technical advisory committee to develop and analyze biological information.[21] However, the plan relied upon the federal district court as its sole means of policy dispute resolution.[22]

In 1982, two of the tribes gave notice of their intent to withdraw from the original plan based upon the lack of a connection between plan objectives and ocean fishing regulations, and the vague objectives of the plan regarding enhancement. The court then ordered the parties to attempt to agree upon a modified agreement.[23] Negotiations among the parties continued from 1983 until 1988. During that period, the court allowed both the State of Idaho and the Shoshone-Bannock tribes to intervene.[24] In October 1988, the federal district court approved the Columbia River Fish Management Plan (CRFMP).[25]

The CRFMP is an agreement among the tribal, state, and federal parties with jurisdiction over Pacific salmon originating in the Columbia Basin that provides procedures whereby the parties co-manage anadromous fish harvest, production and habitat. The CRFMP is similar to the 1977 Plan by its inclusion of inriver runsize allocations[26] but the resemblance ends there. At the core of the CRFMP is the goal "to rebuild weak runs to full productivity and fairly share the harvest of upper river runs."[27] The preamble continues:

> As a means to accomplish this purpose, the Parties intend to use (as herein specified) habitat protection authorities, enhancement efforts, and artificial production techniques as well as harvest management to ensure that Columbia River fish runs continue to provide a broad range of benefits in perpetuity. By this Agreement, the Parties have established procedures to facilitate communication and to resolve disputes fairly. It is the intent of the Parties that these procedures will permit the Parties to resolve disputes outside of court and that litigation will be used only after good faith efforts to settle disagreements through negotiation are unsuccessful."[28]

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The CRFMP calls for "agreed-to production orientated actions to achieve the goal of rebuilding upriver anadromous runs ... within 15 years" and stated that "[p]resent and future artificial production programs shall be integrated with natural production" as described in the Plan.[29] The CRFMP further calls for the development of subbasin plans for all upriver tributaries and assigned responsibility to the states and tribes with management jurisdiction for specific subbasins,[30] a provision that paralleled elements of the NPPC's 1987 FWP.[31] The CRFMP also includes a table of specific production actions utilizing artificial propagation that are to be undertaken during the plan's tenure.[32]

Dispute resolution is a key element of the CRFMP. The parties to the CRFMP, in light of their experience with *US v. Oregon*, recognize the need for expeditious judicial review but also realized that an opportunity to review positions and supporting data is required for successful resolution.[33] In this regard, the parties established a technical advisory committee to make technical recommendations regarding harvest[34] and a production advisory committee to review artificial and natural production programs and make recommendations to the management entities.[35] The CRFMP further provides procedures whereby these technical committees are to deliberate with assistance from the court's technical advisor and submit consensus recommendations or a "consensus description of unresolved technical issues."[36]

Under the CRFMP, a Policy Committee composed of representatives of the parties was established to "facilitate cooperative action by the Parties with regard to fishing regulations, policy disputes, coordination of the management of fisheries on Columbia River runs and production and harvest measures."[37] Detailed dispute resolution rules are provided for the technical committees and the Policy Committee concerning notice, additional issues, confidentiality of proceedings, and judicial action.[38] In the harvest area, dispute resolution processes evolved from the initiation of the 1977 Plan and now take place on a scheduled basis that provides systematic consideration. On the production side, dispute resolution has focused on specific disputes concerning the use of hatchery-bred fish to increase natural production rather than on production policy objectives, a key requirement to effective case-by-case dispute resolution.

In contrast to the 1977 Plan, the CRFMP also addressed the linkage between ocean harvest and inriver fisheries by setting a schedule for determining ocean harvest allocations.[39] This effort linked with the operations of the Pacific Salmon Treaty considered below. The major limitation of the CRFMP, however, was that the federal parties to the plans were limited to the Bureau of Indian Affairs, the US Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration, agencies without the authority to regulate use of public lands or water projects.

The U.S. - Canada Pacific Salmon Treaty

The U.S. - Canada Pacific Salmon Treaty, which established the Pacific Salmon Commission, was adopted in 1985.[40] It provides for the conservation and equitable allocation of north Pacific salmon stocks originating from Canada and the United States. The treaty was preceded by fourteen years of negotiations; its signing was finally caused by the drastic decline of chinook stocks in Southeast Alaska, Canada and the Pacific Northwest in the early 1980s.[41] The treaty's chinook rebuilding program, with a goal of rebuilding naturally spawning chinook stocks coastwide by 1998, is a cornerstone of the treaty and serves as a base for management actions in other salmon fisheries.[42]

The Pacific Salmon Commission, in carrying out the parties' obligations under the treaty, is guided by two principles: conservation and equity, which are described by the treaty as follows:

> With respect to stocks subject to this Treaty, each Party shall conduct its fisheries and its salmon enhancement programs so as to:
>
> (a) prevent overfishing and provide for optimum production; and
>
> (b) provide for each Party to receive benefits equivalent to the production of salmon originating in its waters.[43]

These principles are based on the Law of the Sea Convention,[44] which recognizes that a nation has a primary interest in the stocks that originate in its waters. This is because the country of origin must protect the spawning, rearing, and in-river migratory habitat of these stocks, at times sacrificing their ability to maximize other river uses; or expend funds to restore stocks and healthy fisheries lost to habitat destruction and degradation, as is the case with the Columbia River Basin stocks.

The Pacific Salmon Commission itself is composed of a Canadian Section and a United States Section of four members each.[45] Each section has one vote and a decision may only be made with the approval of both sections.[46] Within the United States Section there are three votes that must be cast on a consensus basis before the U.S. may agree to a recommendation of the Commission.[47]

With regard to chinook salmon, the treaty included specific annex language to halt the decline in spawning escapements in depressed chinook salmon stocks and, by 1998, to attain escapement goals to restore production of naturally spawning chinook stocks based on a 1984 rebuilding program.[48] This was designed to be a dual track approach: first, implementing harvest restrictions for immediate reductions in impacts on depressed stocks; and, second — and perhaps more importantly — addressing habitat and production problems that were critically limiting the productive capability of naturally spawning stocks.[49]

Unfortunately, the region and the federal agencies are still struggling to meet this second commitment. Stock abundances continue to decline, hastened by recent poor ocean survival conditions, forcing fishery managers to further restrict ocean and terminal fisheries. These restrictions cause further economic disruption and dislocation for communities and businesses dependent upon healthy fisheries.

Under the Pacific Salmon Commission, the Parties are developing abundance-based approaches for harvest management with the goal of addressing conservation concerns during periods of poor survival while meeting domestic and international equity objectives as well. In addition, the Commissioners acknowledge that harvest management will become only more contentious as more stocks collapse along the coast, unless habitat and production problems are addressed by management agencies in both countries.[50]

The Columbia River Basin Fish and Wildlife Program

Prior to 1980, with the passage of the Pacific Northwest Electric Power Planning and Conservation Act (Northwest Power Act) and its mandate to "protect, mitigate and enhance," the prevailing notion of mitigation in the Columbia Basin was to make the habitat safe for development by moving fish production to federal hatcheries in the lower river as mitigation for hydro, timber, mining and irrigation development in the watersheds of the upper Columbia.[51] Federal statutes such as the Federal Power Act[52] and the Fish and Wildlife Coordination Act of 1934[53] were designed to provide mitigation for the damage caused by water and other federal projects but not necessarily in the place where the damage occurred or for the same species that were damaged.

Mitigation for federal mainstem dams is illustrative. The Mitchell Act[54] was passed in 1938 as

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companion legislation to the Bonneville Project Act of 1937[55] to mitigate for fishery damage caused by Bonneville and Grand Coulee Dams as well as other federal water projects. The Mitchell Act was implemented by state and federal agencies through development of hatchery programs that resulted in taking upper Columbia and Snake River salmon as broodstock for downriver hatcheries.[56] Less than 5% of Mitchell Act production is now released above The Dalles Dam.[57] Placement of Mitchell Act facilities resulted in mixed-stock fisheries that focused on the abundance of lower river hatchery production rather than the protection of the naturally-spawning stocks of the upper river that were being diminished by the combined effects of water withdrawals, land management activities, and hydroelectric projects.[58]

To address the impacts of the four federal hydro projects on the Lower Snake River,[59] Congress included the Lower Snake River Compensation Plan in the Water Resources Act of 1976.[60] This series of hatchery programs, though located in the general area of damage caused by the Lower Snake dams, failed to mitigate for Snake River coho, sockeye or fall chinook in Idaho.[61] Snake River coho were extirpated from the Snake during the late 1980's[62] while Snake River sockeye[63] and fall chinook[64] are listed under the ESA.[65]

Since the 1968 passage of the National Environmental Policy Act with its provision for environmental impact statements[66], federal conservation statutes have shifted from earlier policies of off-site mitigation for damage to fisheries to protecting fish and wildlife in their habitats. The Endangered Species Act[67] and the National Forest Management Act[68], among others defined a new federal policy that shifted from the mitigation/substitution concept to a habitat-based policy.

The Northwest Power Act[69] is an example. In this legislation, Congress incorporated the notion of protecting anadromous fish in their habitat by providing for a "program to protect, mitigate, and enhance fish and wildlife, *including related spawning grounds and habitat,* on the Columbia River and its tributaries".[70]

The Act required the NPPC to adopt a fish and wildlife program that would deal with the Columbia Basin as a system and that would rely upon the recommendations of the region's State fish and wildlife agencies and appropriate Indian tribes. The Act also specified that the Bonneville Power Administrator was to use the funds and authorities of BPA to "protect, mitigate, and enhance fish and wildlife *to the extent affected by the development and operation of any hydroelectric project of the Columbia River and its tributaries. ...*[71]

The 1982[72] and 1987[73] FWPs adopted by the NPPC consisted of measures required to be funded by the Bonneville Power Administration and established the foundation for carrying out congressional intent.

Throughout implementation of the program, BPA funding processes were a cause for concern. As early as 1983, the tribes and NMFS found it necessary to intervene as parties to the BPA wholesale power rate adjustment proceedings (rate case) in order to assure adequate funding to implement high priority projects in the 1982 FWP.[74] Though the Administrator denied the rate adjustments sought by the tribes and NMFS, Congress subsequently directed BPA to implement the high priority projects in the BPA appropriation bill.[75]

During the rate case and in the following year, BPA was reluctant to fund projects adopted by the NPPC until a programmatic assessment of BPA's mitigation obligations was carried out.[76] Completed in 1986, the NPPC's assessment found that development and operation of the hydroelectric system accounted for annual losses of 5-11 million salmon from pre-development run sizes of 10-16 million salmon.[77]

The NPPC's losses assessment was incorporated into the 1987 FWP and the NPPC adopted an interim goal of doubling adult salmon run sizes, with emphasis on protecting genetic diversity,

monitoring and evaluation, and the restoration of salmon runs above Bonneville Dam that were impacted by the dams.[78] The program was to be implemented by using adaptive management methods whereby carefully designed projects would improve knowledge of restoration techniques. The 1987 FWP called for an extensive subbasin planning effort carried out by the agencies and tribes that would assess the opportunities for rebuilding. In concert with the production policies and process of the CRFMP under *US v. Oregon*, and the rebuilding goals of the Pacific Salmon Treaty, the 1987 program included elements of the first major workplan for Columbia basin salmon rebuilding. However, pending completion of the subbasin plans, the NPPC agreed to only support limited priority habitat and production measures.

Over a period of three years, the agencies and tribes met with subbasin stakeholders and fashioned plans designed to rebuild salmon runs consistent with the NPPC's doubling goal opportunities.

By 1991, when the completed plans were submitted to the NPPC, the prospect of ESA listings of Snake River chinook and sockeye populations diverted its attention. Instead of completing the subbasin planning process that addressed salmon needs in thirty-one subbasins and was an integral part of the CRFMP, the NPPC attempted to guide, if not foreclose, application of the ESA.[79] However, in its 1994 amendments to the FWP, the Council revisited subbasin planning and included measures designed to encourage watershed approaches to salmon restoration and the updating of subbasin plans.[80]

The BPA, in response to the listings, also de-emphasized the rebuilding goal and directed its budget priorities in the direction of ESA recovery activities.[81]

Since the adoption of the first Fish and Wildlife Program in 1982, BPA Fish & Wildlife Division management of implementation has proven highly problematical. As stated in a recent report of the BPA Task Force, House Committee on Natural Resources:

> *BPA's administration of the fish and wildlife program has been criticized by both power users and environmental advocates. BPA's customers, conducting a "function by function review" of BPA's programs, presented draft recommendations to streamline and possibly restructure the administration of the fish and wildlife program. Environmental advocates have argued that BPA commits excessive program resources to activities that are better implemented by fish and wildlife specialist agencies, and that BPA has failed to implement all of the actions required by the Strategy for Salmon on the schedule set by the NPPC.*[82]

The alternative to direct BPA management is a lump sum transfer of fish and wildlife funds to a combined entity of fish and wildlife agencies and tribes. This method is currently used to fund the NPPC's wildlife program.[83] As stated by the House Task Force:

> *A lump sum transfer could allow Bonneville to substantially reduce its fish and wildlife staffing level, which now stands at 77 full-time equivalent positions. Many of Bonneville's critics complain that the BPA's fish and wildlife program is at best redundant, and in some cases operates at cross purposes with other federal, state, and tribal fish and wildlife agencies.*[84]

A transfer could alleviate the substantial but unquantified transaction costs incurred by agencies negotiating with BPA for detailed program costs. An additional benefit of a lump sum transfer would be to transfer accountability for meeting FWP objectives to the agencies and tribes who have the legal responsibility to maintain salmon resources.

The agency and tribal members of the Columbia Basin Fish and Wildlife Authority (CBFWA), beginning in 1989, initiated a process for prioritizing FWP expenditures. However, BPA ignored CBFWA priorities. Permitting the agencies and tribes to determine priorities and methods for FWP implementation is not only a

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means for greater accountability, it is also consistent with the Regional Act which states in §4(h)(1)(C)(iv)(1) that measures in the program shall:

(1) complement the existing and future activities of the Federal and the region's State fish and wildlife agencies and appropriate Indian tribes;

Because the measures in the Program are to complement existing and *future* activities of the agencies and tribes, it is crucial that the agencies and tribes are actively involved in the direction of implementation under the oversight of the Council as FWP developer.[85] Furthermore, because the NPPC is also responsible for preparing a regional power plan, there is a critical need for the NPPC to develop a longer-term, expansive vision for Northwest power options that accommodates the need for salmon restoration.

The Federal Energy Regulatory Commission

The Federal Energy Regulatory Commission (FERC), under the authority of the Federal Power Act,[86] licenses non-federal dams on navigable waterways.[87] In 1985, Congress passed amendments to the Federal Power Act that mandated greater consideration of fish and wildlife in licensing proceedings.[88] By these amendments, FERC must give equal consideration in licensing proceedings to "the protection, mitigation of damage to, and enhancement of, fish and wildlife (including related spawning grounds and habitat), the protection of recreational opportunities, and the preservation of other aspects of environmental quality."[89] FERC is further required to make its determination upon whether the project will be best adapted to a comprehensive plan for improving a waterway, for the improvement of water-power development, "for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat), and for other beneficial public uses, ..."[90] FERC is required to consider the recommendations of Federal and State agencies "and the recommendations (including fish and wildlife recommendations) of Indian tribes affected by the project."[91] In addition, FERC is required to adopt conditions for fish and wildlife recommended by state and federal agencies received pursuant to the Fish and Wildlife Coordination Act,[92] and to prepare findings as to why the recommendations were rejected based upon inconsistency with applicable law.[93]

Five mainstem dams, owned and operated by public utilities traverse the mid-Columbia in the state of Washington.[94] On the Snake River, the Idaho Power Company owns the Hells Canyon Project which consists of three dams: the Brownlee, Oxbow and Hells Canyon developments.[95] The licenses for these projects include "reopener" clauses permitting FERC to require "reasonable modifications" of project structures and operations in the interest of fish and wildlife resources. Article 39 of the Wanapum and Priest Rapids license, for instance, provides that:

> *39. The licensee shall ... comply with such reasonable modifications in project structures and operations in the interest of fish life in connection with the project as may be prescribed hereafter by the Commission upon recommendations of the Secretary of the Interior, the Washington State Departments of Fisheries and Game and the licensee.*[96]

In response to a fish kill at Priest Rapids, Mid-Columbia FERC license modification proceedings were initiated between 1976 and 1978 in response to petitions invoking article 39 filed by the Yakama and Colville Indian tribes, the Oregon and Washington fish and wildlife departments, and the USFWS.[97] On March 7, 1979, FERC consolidated the proceedings and ordered hearings to determine what long-term studies and interim measures were necessary for protection of migrating salmon.[98] Over ten years, the parties developed a series of five interim agreements prior to agreements establishing long-term modifications.[99] The Wells Dam Settlement Agreement (Wells Agreement) reflects a positive, long-term outcome of those proceedings.[100]

The substance of the Wells Agreement addresses the elements of adult and juvenile fish passage

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including flows, spills, bypass, and operational requirements.[101] The Agreement also includes a detailed hatchery-based compensation program composed of adult collection sites; a central hatchery facility for incubation, early rearing, and adult holding; and acclimation facilities in the tributaries above Wells Dam for final rearing and release.[102] This production program includes funding for studies relating to the potential for establishing new sockeye populations in the Okanogan and Similkameen systems in a manner consistent with the NPPC's FWP.[103]

During the next twenty years, each of the PUD dams on the mid-Columbia, except Rock Island, and the Idaho Power Company projects on the Snake will be subject to relicensing.[104] In light of the mid-Columbia proceedings and the 1985 amendments to the Federal Power Act, non-federal dam licensing has clearly evolved into an authoritative process with dispute resolution and clearly defined responsibilities for the protection of anadromous fish. It remains to be seen whether the FERC processes will be integrated with the other major institutional structures to facilitate recovery.

The Endangered Species Act

With regard to Snake River chinook and sockeye, it would seem that the purposes of the ESA and the tribes' treaties could be read consistently with one another and with the laws of nature. But application of the ESA to treaty fisheries demonstrates otherwise.

The purpose of the Endangered Species Act is to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation[105] of" such species, "and to take such steps as may be appropriate to achieve the purposes of "various international treaties and conventions."

The ESA is a process for listing, protection, and recovery of certain species, subspecies, and distinct populations. In 1991, NMFS listed Snake River sockeye and chinook under the ESA. Unfortunately, administration of the ESA by the federal government has impeded the protection and rebuilding of treaty fish resources by shifting regional priorities away from basin-wide rebuilding and restoration, by limiting necessary recovery actions and by failing to proscribe certain harmful activities. Federal implementation under the leadership of NMFS has been inconsistent with the major structures that were developed by the region during the last twenty years to guide Columbia Basin anadromous fish management.

The Listings

NMFS decision to list Snake River salmon populations hinges on its application of the ESA's provisions defining "species," which allows the listing of species, subspecies, and distinct population segments.[106] Snake River chinook and sockeye are neither species nor subspecies, they are, according to the listing, "distinct population segments" (DPS). Under the NMFS Interim Policy, NMFS will find a DPS when a population's characteristics meet the standards of an "Evolutionarily Significant Unit." In order to meet these standards, the population must exhibit reproductive isolation and "represent an important component in the evolutionary legacy of the species."[107]

The NMFS Interim Policy on Artificial Propagation of Pacific Salmon requires that once a population is found to be an ESU, its adaptive genetic differences are to be protected from interbreeding with other non-ESU populations as defined by NMFS.[108] But this policy is at odds with nature: a proportion of a salmon population will home to their natal streams while the remainder will stray to other streams where they will spawn with the local population and produce hybrids that can add to the ability of the population to cope with changed conditions in the habitat.[109]

In a healthy metapopulation, like upriver chinook or sockeye in 1855, straying and introgression occur frequently. In a damaged/declining population, isolated from other populations, the beneficial effect of straying is diminished because the population gene flow is

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limited by the respective sizes of the populations and the fragmentation of their habitat. By limiting straying to arbitrary limits by either limiting populations that may stray or destroying adult fish that may stray into the spawning areas of a listed population, NMFS is limiting normal biological activities that may strengthen listed populations.

The NMFS ESU policy, as applied to fragmented, isolated populations would separate those same populations from basin populations in adjoining subbasins and hatcheries that could render assistance.[110] Thus, the ESU policy is at odds with the plans and programs of CRFMP, FERC, and FWP, which rely upon specific watershed programs that utilize habitat protection and artificial propagation techniques for restoration.[111]

Consultations

The ESA proscribes activities that could kill or harm listed species or destroy those species' habitat.[112] Harm is very broadly defined. However, the ESA provides an exception to this prohibition against "takings" if such takings occur incidentally to otherwise lawful activities.[113] Section 7 provides a means for federal parties to obtain an incidental taking authorization. Section 10 provides a means for non-federal parties to obtain an incidental take permit.

Under section 7, federal action agencies are required to prepare biological assessments (BA's) for actions that they fund, authorize, or carry out that are likely to affect a listed species or its critical habitat. If the action is likely to *adversely* affect the species or its habitat, then NMFS initiates a consultation and prepares a biological opinion (BO) stating whether or not NMFS believes the action is likely to jeopardize the continued existence of the species or result in destruction or adverse modification of critical habitat of the species.[114] Under Section 10, non-federal parties may obtain an incidental take permit under a more complex process involving the preparation of a habitat conservation plan (HCP).[115]

In the Columbia Basin, section 7 consultations have taken place for harvest, hatchery activities, hydroelectric dam operation, and land management, among other activities. In each case, NMFS has preserved the status quo rather than heeding scientific information indicating jeopardy to the listed species and the need for operational changes to protect salmon.

Concerning harvest, consultation has generally taken place within the context of *US v. Oregon* processes including the Technical Advisory Committee, the Policy Committee and dispute resolution by the court. Repeatedly, the tribes have taken issue with NMFS draft BOs that set arbitrary harvest restrictions and fail to integrate the use of propagation and remedies for other sources of mortality. These issues were brought before the court and orders were approved by the court relating to some of these issues.[116]

With regard to hatchery activities, the NMFS BOs have generally permitted existing hatchery operations practices and releases for Mitchell Act facilities, a program administered by NMFS through contracts with the states and the USFWS. With regard to the LSRCP, NMFS has generally supported this USFWS program and its facilities, a program that was originally developed by NMFS as principle writer.

However, NMFS, based on its ESU policy, has vigorously opposed tribal propagation activities intended to rebuild of naturally-spawning runs. In response, the tribes brought certain production issues to CRFMP dispute resolution including the use of Rapid River spring chinook stock for rebuilding in the adjoining Grande Ronde basin; the use of Imnaha stock for rebuilding the listed Imnaha spring chinook population, and the use of Lyons Ferry Hatchery Snake River fall chinook stock for rebuilding naturally-spawning Snake River fall chinook populations. Though each issue was resolved in favor of tribal positions, the time and expense involved in dispute resolution as well as the potential for future disputes argue for policy modifications to support rebuilding and restoration.

With regard to hydroelectric projects, the NMFS hydrosystem BO was challenged by the Idaho Department of Fish and Game, the initial plaintiff, followed by the State of Oregon as a plaintiff-intervenor and the tribes as *amicus curiae.*[117] The defendants are NMFS, the Corps of Engineers and the Bureau of Reclamation. On March 28, 1994, Judge Malcolm Marsh held that the NMFS BO violated ESA and he ordered NMFS to remedy deficiencies in the 1994-1998 hydrosystem BO.[118] After a year of negotiations, NMFS issued its 1995 BO[119] and submitted a "Report of Compliance" with Judge Marsh's 1994 order.[120] The tribes objected to the BO and the "Report" based upon the failure of NMFS to articulate a clear jeopardy standard and its failure to give due weight to the recommendations or survival modelling of the states and tribes.

Also with regard to hydroelectric impacts on salmon, NMFS, in its BO, has chosen to devote substantial resources to research at its laboratories in Seattle, Washington. In FY 1996, NMFS estimates a need for $23 million for research that is not subject to consultation, peer-review, or co-management.

NMFS efforts to consult with the USDA Forest Service have been hampered by the absence of data and the existence of conflicting policies. The Forest Service has generally failed to assess the quality of existing habitat conditions in much of the Salmon River. Furthermore, it has developed plans for all Snake River Basin national forests that sanction additional degradation of fish habitat. Land resource management plans for national forests such as the Sawtooth, Salmon, and Challis made no mention of the rebuilding goals embodied in the Pacific Salmon Treaty or the Columbia Basin FWP. The Forest Service has made no attempt to identify chinook production goals in the land resource managment plans (LRMP) that are consistent with rebuilding programs nor did it discuss or disclose how its habitat management will affect harvest regimes. As addressed in its forest plans, it is impossible to determine the extent of consistency or inconsistency of these plans with rebuilding goals.[121]

In light of the consideration given to salmon in the LRMP's, the Forest Service did not consult with NMFS concerning the effect that the plans would have upon listed salmon populations. Environmental groups filed suit in the federal district court for Oregon against the Forest Service to require consultation on Oregon's Snake River national forests and won.[122] Both the Forest Service and the environmental organizations appealed to the Ninth Circuit Court of Appeals which affirmed the decision and, in August, 1994, the Forest Service initiated consultation with NMFS on the Snake River plans.

By December, 1994, NMFS had prepared a draft BO finding jeopardy but providing a "reasonable and prudent alternative" that included, among other things: 1) protection of roadless areas; 2) reallocation of riparian areas to salmon protection; 3) strict limitations on sediment increases in salmon habitat; 4) strict limitations on grazing and mining in salmon habitat; and, 5) direction to the Forest Service to reallocate resources in the forest plans consistent with plans for salmon watershed restoration. However, in March, 1995, NMFS backed away from the jeopardy opinion and issued, instead, a "conditional jeopardy" opinion that exempted LRMP's and rephrased the December "reasonable and prudent alternative" as a series of vague guidelines, although the final opinion was based upon the same biological information as the December draft opinion.[123]

Recovery

In the case of Snake River salmon, the ESA requires that the Secretary of Commerce "develop and implement" a recovery plan for the conservation and survival of the listed populations.[124] NMFS issued its *Proposed Recovery Plan for Snake River Salmon* (PRP) in March 1995.[125]

In general, the draft Recovery Plan overemphasizes minor sources of salmon mortality — treaty and non-treaty harvest — while failing to require significant reductions in major sources of mortality including the mainstem hydrosystem of dams and reservoirs and poor land and water manage-

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ment practices (logging, grazing, mining, and overappropriation) within essential tributary habitat.

The Plan gives priority to actions that *preserve* Snake River salmon populations and it focuses heavily on creation of new committees and processes linked together into a proposed institutional structure[126]In deference to the recommendations of the NMFS-appointed Snake River Scientific Recovery Team (SRSRT), NMFS will make final decisions where a consensus is not produced by its proposed institutional structure.[127] The institutional structure consists of a Salmon Recovery Implementation Team (SRIT) appointed, convened and chaired by NMFS[128]; a Scientific Advisory Panel (SAP) appointed, convened, and managed by NMFS[129]; and a series of committees established, appointed, and managed by NMFS[130]. In order to resolve disputes, NMFS proposes to adopt a formal dispute resolution process, parallel to that of *US v. Oregon*, "to resolve scientific and technical issues associated with Snake River salmon recovery"[131] NMFS also proposes "to map out a regional process for collecting, managing, and disseminating data."[132]

With regard to proposed committees and subcommittees, NMFS proposes to evaluate the memberships of existing committees to ensure "the necessary breadth of expertise," and may use them rather than creating a duplicate or competing process.[133] However NMFS intends to convene certain committees immediately "to facilitate the immediate implementation of critical conservation measures.[134] These include a Technical Management Team (TMT), a Passage Advisory Committee (PAC), a Habitat Committee (HC), and a Fish Production Committee (FPC) composed of a Natural Production Subcommittee and a Hatchery Management Subcommittee.[135]

The administration of the Endangered Species Act by the National Marine Fisheries Service has diverted resources from basin recovery envisioned by the CRFMP, the FWP, the Pacific Salmon Treaty and FERC orders. The draft ESA Recovery Plan institutional structure is inconsistent with the processes embodied by those plans and will divert future resources to another layer of committees and procedures.[136]

Other Authorities

Numerous other authorities affect anadromous fish habitat in the Columbia Basin. Federal statutes including the Clean Water Act, the National Forest Management Act and state statutes governing forest practices, water rights, growth management and statewide land use planning, and shorelines management should play significant roles in the restoration of Columbia Basin anadromous fish. However, currently they are not being used in an effective integrated manner for this purpose.

Implementation of the Clean Water Act, for instance, suffers from lack of enforcement. Temperature and turbidity regularly exceed standards in salmon habitat east of the Cascades due to the lack of non-point source enforcement provisions. The use of the total maximum daily load (TMDL) requirement for waters that exceed standards is the only tool available for enforcement yet the states have been reluctant to use TMDL's to address fish issues.

With regard to state statutes, decisions are often made at the local level at the request of resource users and developers without a view toward the cumulative impacts of decisions. With regard to water rights, in particular, instream flows are less than optimum, enforcement is inconsistent, and waste is rampant based upon a "use it or lose it" policy.

Achievement of basin-wide objectives for anadromous fish developed under CRFMP, FERC orders, the Pacific Salmon Treaty and the FWP is impossible without effective implementation of habitat protection laws at the watershed level. Yet federal and state enforcement has proven itself unable to achieve water quality goals. Watershed restoration is proposed by the tribes as a means of restoring anadromous fish by developing local buy-in and accountability for results consistent with federal and state laws and the treaties.

Conclusion

Restoration of Columbia Basin salmon, sturgeon and lamprey depends upon institutional structures that efficiently coordinate the actions and resources of relevant government agencies and enlist the support and energy of individuals and non-governmental agencies. A comprehensive restoration effort will require authoritative actions addressing the redirection of funding and personnel by federal, state, local and tribal entities in order to implement goals and objectives in a coordinated manner. Because of the limits of scientific knowledge about these species in specific ecosystems, an effective monitoring and evaluation program is indispensable for charting restoration progress and indicating the need for mid-course correction. Finally, when policy-makers, technical experts or implementors differ on the means for restoration, timely dispute resolution processes must be available at functional levels to address issues in a manner that does not stall the effort.

In combination, the CRFMP, the FWP, the PST, and FERC orders as well as an ESA process that incorporates the other structures provide a framework for restoration. However, by themselves, they are not sufficient to achieve tribal restoration goals. The recommendations that follow are designed to strengthen restoration efforts and provide a comprehensive approach that utilizes the authorities of the three sovereigns (federal, state, and tribal governments) that have an interest in anadromous fish.

1. *Seufert Brothers Co. v. United States*, 249 U.S. 194, 197 (1919).

2. *United States v. Wheeler*, 435 U.S. 313, 322-323 (1979)

3. *Worcester v. Georgia*, 31 U.S. (6 Pet.) 515 (1832)

4. *Washington v. Washington State Commercial Passenger Fishing Vessel Association*, 443 U.S. 658, 679 (1979)

5. *Tulee v. Washington*, 315 U.S. 681, 684-85 (1942)

6. *United States v. Winans*, 198 U.S. 371, 381 (1905)

7. *Antoine v. Washington*, 420 U.S. 194, 207 (1975); *see also, Puyallup Tribe v. Department of Game*, 414 U.S. 44, 49 (1973); *United States v. Fryberg*, 622 F.2d 1010, 1015 (9th Cir. 1980)

8. *See, Puyallup Tribe v. Department of Game, supra*; *Lac Courte Oreilles Band of Indians v. Wisconsin*, 668 F. Supp. 1233, 1237 (W.D. Wis. 1987)

9. *See e.g., United States v. Washington*, 520 F.2d 676, 686 (9th Cir. 1975), *cert. denied*, 423 U.S. 1086 (1976); *Lac Courte Oreilles Band of Indians v. Wisconsin, supra*, at 1235-36

10. *United States v. Oregon*, 718 F.2d 299, 305 (9th Cir. 1983). *See also, United States v. Washington*, 384 F. Supp. 312, 342 (W.D. Wash. 1974); *Sohappy v. Smith*, 302 F. Supp. 899, 908 (D. Or. 1969)

11. *United States v. Washington*, 520 F.2d 676, 685 (9th Cir. 1975) (finding that the treaty fishery resource is analogous to a cotenancy and thus neither treaty Indians or non-Indians may permit the subject matter of the treaties (the fish) to be destroyed).

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12. *Accord, Joint Board of Control of Flathead Irrigation District v. United States*, 832 F.2d 1127 (9th Cir. 1987) (by allocating water to non-Indian irrigators, district court ignored superior federal obligation to provide instream flows to protect fishery subject to treaty rights). *See also Colville Confederated Tribes v. Walton (Walton II)*, 647 F.2d 42 (9th Cir. 1981); *United States v. Adair*, 723 F.2d 1394 (9th Cir. 1983).

13. *Kittitas Reclamation District v. Sunnyside Valley Irrigation District*, 763 F.2d 1032 (9th Cir. 1985). See also *Winters v. United States*, 207 U.S. 564 (1908); *Colville Confederated Tribes v. Walton* (Walton II), 647 F.2d 42 (9th Cir. 1981); *United States v. Adair*, 723 F.2d 1394 (9th Cir. 1983). In *Winters*, the U.S. Supreme Court held that sufficient water was impliedly reserved at the time of the treaties to fulfill the purposes for which a reservation was created.

14. *Seminole Nation v. United States*, 316 U.S. 286, 296-97 (1942).

15. *US v. Oregon*, 699 F.Supp 1456 (D.Or. 1988)

16. Treaty Between the government of the United States of America and the Government of Canada Concerning Pacific Salmon, Treaty Doc. No. 99-2 (entered into force, March 18, 1985).

17. Pub. L. 95-501, 94 Stat. 2697 (1980), 16 U.S.C. §§ 839-839h (1982)

18. Pub. L. No. 95-91, §§301(b), 401-407, 91 Stat. 565, 578, 582-587 (1977)

19. Endangered Species Act of 1973, 16 U.S.C. §§ 1531-1544 (1988)

20. A Plan for Managing Fisheries on Stocks Originating from the Columbia River and its Tributaries above Bonneville Dam (1977)(entered into pursuant to *Sohappy v. Smith*, 302 F.Supp. 899, (D.Or. 1969)) [hereinafter 1977 Plan].

21. *Id.* at 3, para. 4

22. *Id.* at 4, para. 7

23. *United States v. Oregon*, Civ. 68-513 (August 24, 1983; September 6, 1983).

24. *US v. Oregon*, 699 F.Supp. 1456, 1459-1460 (D.Or. 1988)

25. In 1990, the Ninth Circuit Court of Appeals upheld the district court's ruling over the objections of Idaho, the Shoshone-Bannock and Makah tribes. Columbia River Fish Management Plan (October 1988)(entered into pursuant to *Sohappy v. Smith*, 302 F.Supp. 899 (D.Or. 1969), *aff'd* 913 F.2d 576 (9th Cir. 1990)[hereinafter CRFMP]

26. For spring chinook, the interim management goal at Bonneville Dam is 115,000 while at Lower Granite Dam, the goal is 35,000. The tribal ceremonial and subsistence entitlement is 10,000 fish. For run sizes less than these amounts, fisheries will occur at places other than zone 6 or the balance will be made up from abundant hatchery runs.

For upriver summer chinook, tribal fishery impacts will be limited to 5 percent of the run.

For sockeye, the management goal at Priest Rapids Dam is 65,000. Tribal sockeye harvest is managed according to run size and is shared 75/25 for Indian and non-Indian harvest.

For summer steelhead, the CRFMP allocates according to the number of wild/natural spawners. The interim management goal consists of 75,500 natural/wild steelhead (62,200 Group A and 13,300 Group B), which is expected to produce 30,000 natural/wild steelhead above Lower Granite Dam under present production and average upstream passage conditions.

For upriver fall chinook, the escapement goal is 40,000 natural spawners above McNary Dam. Treaty Indian fisheries in zone 6 and non-Indian fisheries below the Canadian border are to share catch equally. Ocean fishing regimes are to be set annually pursuant to a stated schedule.
For coho the CRFMP anticipated that enhancement actions would "provide expanded harvest opportunities for treaty Indian fisheries within tributary areas for early coho stock and within the mainstem area for late coho stock." (CRFMP at page 38). Coho are caught incidentally during the fall management period.

For sturgeon the CRFMP calls for a year-round setline fishery in Zone 6. Shortly after the completion of the CRFMP the Tribal/State Sturgeon Management Task Force (SMTF) was formed to address concerns on the population status of sturgeon. By agreement of the SMTF the commercial treaty harvest is limited to 1,650 fish annually.

For lamprey the CRFMP states:

> There shall be no commercial harvest of lamprey in Zone 6 and its tributaries. ... The Parties will seek to develop, in coordination with the U.S. Army Corps of Engineers, a method for harvesting from dam fishways that will not adversely impact fish passage. The Parties agree to work with the U.S. Army Corps of Engineers to provide the resulting harvest to Indian tribes for their ceremonial or subsistence use. (CRFMP at page 40).

Lamprey populations have declined significantly in recent years. Harvest is limited to a small number of fish collected at Willamette Falls.

27. CRFMP at 2

28. *Id.* at 2

29. *Id.* at 40-41

30. *Id.* at 44

31. Northwest Power Planning Council, 1987 Columbia River Basin Fish and Wildlife Program 44-45 (1987) [hereinafter 1987 Program]

32. CRFMP Appendix B at 66-72

33. *Id.* at 7

34. *Id.* at 48

35. *Id.* at 51

36. *Id.* at 50 and 53

37. *Id.* at 54

38. *Id.* at 54-56

39. *Id.* at 30-31

40. Treaty Between the Government of the United States of America and the Government of Canada Concerning Pacific Salmon, Treaty Doc. No. 99-2, (*entered into force*, March 18, 1985) [hereinafter cited as Pacific Salmon Treaty].

41. Letter from Rolland Schmitten, Director, Washington Dept. of Fisheries, to Malcolm Baldrige, Secretary of Commerce (Apr. 15, 1981). Director Schmitten wrote: "[s]erious conservation problems currently exist for nearly every chinook stock harvested in the southeast Alaska troll fishery, such that failure to meet natural spawning escapement goals for these lower U.S., Canadian and southeastern Alaska stocks in 1981 will be the rule rather than the exception."

42. Also integral to the signing of the treaty was an agreement within the United States, entered into before the federal district court of western Washington, by which the states of Alaska, Washington, and Oregon and the 24 treaty tribes agreed to put aside "North-South" allocation issues related to chinook until the completion of the chinook rebuilding program in 1998, so long as the Pacific Salmon Commission provided consensus recommendations to each country until 1998. *Confederated Tribes and Bands of the Yakima Indian Nation v. Baldrige,* 605 F.Supp. 833 at 835 (W.D. Wash. 1985)

43. Pacific Salmon Treaty at art. III, para 1. In addition, the principles are qualified by three guidelines:
   (a) the desirability in most cases of reducing interceptions;
   (b) the desirability in most cases of avoiding undue disruption of existing fisheries; and
   (c) annual variations in abundance of the stocks. *Id.* at art. III, para. 2.

44. United Nations Convention on the Law of the Sea (UNCLOS), Dec. 10, 1982, __ U.S.T. ____, 21 I.L.M. 1261 (entered into force Nov. 16, 1994)

45. *Id.* at art. II, para. 1.

46. *Id.* at art. II, para. 6.

47. Pacific Salmon Treaty Act of 1985, 16 U.S.C. §3631, 3632(g). The Treaty also provided panels of six representatives each for stocks originating in the Pacific Northwest and Southern British Columbia, stocks originating in the Fraser River and stocks originating in Alaskan and northern British Columbia rivers. *Id.* at Annex I. A commentator involved in negotiating the treaty on behalf of the Columbia River tribes summarized the treaty process as follows:

> [T]he panels will receive technical information from the two countries and from bi-lateral technical teams. The Commission will receive conservation and management information and recommendations from the panels. The Commission will recommend harvest regulations to each country, and each country will promulgate and enforce regulations to implement the Commission recommendations.Jensen, *The United States-Canada Pacific Salmon Treaty: An Historical and Legal Overview,* 16 Envtl. L. 363 at 403-404 (1986)

48. *Id.* at annex IV, chap. 3, para. 1(a)

49. As was noted shortly after the Treaty's signing:

> The ultimate success or failure of the Pacific Salmon Treaty is not only in the hands of the fishermen, but will be read in the decisions of the United States Forest Service, Environmental Protection Agency, Bureau of Land Management, Bonneville Power Administration, Federal Energy Regulatory Commission, Department of Energy, state and local government bodies, private land owners, industry and others. Will logging be managed to protect spawning habitat? Will adequate fish passage facilities be built and maintained at Columbia River and other Pacific Northwest dams? Will more dams be built? Will federal and state water quality laws be enforced? Will agricultural interests continue to be allowed to bleed spawning streams dry for crop irrigation? Jensen at 420.

50. To address habitat problems, the U.S. Section continues to discuss the formation of a Habitat Committee to provide a forum in which to develop recommendations for policy changes that will take into account the needs of the salmon resource and the people and communities that depend upon them. As for production, the Treaty already provides specific language regarding enhancement programs:

The Parties agree that enhancement efforts designed to increase production of chinook salmon would benefit the rebuilding program. They agree to consider utilizing and redirecting enhancement programs to assist, if needed, in the chinook rebuilding program. They agree that each region's catches will be allowed to increase above established ceilings based on demonstrations to the Commission and assessments by it of the specific contributions of each region's new enhancement activities, provided that the rebuilding schedule is not extended beyond 1998. *Id.* at annex IV, chap. 3, para. 2.

51. Leo Laythe, *The Fishery Development Program in the Lower Columbia River,* Trans. 78 Am. Fish. Soc. 42, 43-44, 49 (1948).

52. 16 U.S.C §792 et. seq. *But see supra.* note 119 and accompanying text regarding 1986 amendments to the Federal Power Act that explicitly reference "fish and wildlife (including related spawning grounds and habitat)" 16 U.S.C. §803(j) (1985 & Supp. 1995); Pub. L. No. 99-495 §3(c); 100 Stat. 1252 (1986).

53. 16 U.S.C. §§ 661 -666c (1988).

54. 16 U.S.C. §§ 755-757 (1988)

55. 16 U.S.C. § 832 (1985)

56. Laythe, *supra* note 80, at 53

57. Report to Congress on Mitchell Act Hatchery Fish Releases, National Marine Fisheries Service, February 1992, Appendix Table 1.

58. Laythe, supra at 49

59. *Public Works Appropriations, 1961: Hearings on H.R. 12326 Before the Subcommittee of the Senate Committee on Appropriations,* 86th Cong., 2nd Sess. 138 (February 18, 1960)

60. Water Resources Development Act of 1976

61. Idaho Department of Fish and Game, Idaho Anadromous Fisheries Management Plan at 16, 17 and 25 (March 1985)

62. Army Corps of Engineers, Annual Fish Passage Report — 1988, Table 93

63. Endangered and Threatened Species; Endangered Status for Snake River Sockeye Salmon, 56 Fed. Reg. 58,619 (1991)(codified at 50 C.F.R. §17.11)

64. Endangered and Threatened Status; Threatened Status for Snake River Fall Chinook Salmon, 57 Fed. Reg. 14,653 (1992)(codified at 50 C.F.R. §17.11). Updated to endangered ???

65. Though the Lower Snake Plan was presented to Congress as a means of improving salmon populations in their habitat, most salmon, other than steelhead, were released at the hatchery, except for releases in the Imnaha River in Northeastern Oregon and the Red River in the Clearwater system. These programs were designed to rebuild naturally-spawning spring chinook and demonstrated success during their few years of operation. *US v. Oregon* Production Advisory Committee, Imnaha River Spring Chinook Fact Sheet (August 24, 1993)

66. 42 U.S.C §§ 4331-4332 (1988)

67. 35 U.S.C. 1531-1539 (1988)

68. 16 U.S.C. 1600-1614 (1988)

69. Northwest Power Act, *supra.* note 4.

70. 16 USC §839b(h)(1)(A)(emphasis added)

71. 16 USC §839b(h)(10(A) (emphasis added)

72. Northwest Power Planning Council, Columbia River Basin Fish and Wildlife Program (November 1982) [hereinafter 1982 Program]. The 1982 Program called for a series of habitat and production measures (including major tribal production programs), as well as hydro operating objectives. It also called for research on supplementation as a means to rebuild diminished upriver runs and for reprogramming of the Mitchell Act hatcheries to rebuild upriver fish runs. The Program also prepared a base for a watershed strategy by including a number of tribal programs for the restoration of salmon in key ceded area and reservation watersheds through habitat protection and supplementation. *Id.* at Sec. 704 (d) and (e).

73. 1987 Program, *supra.* note 60

74. *Id.* at Sec. 704 (d) and (e)

75. *Id.* at Sec. 704 (d) and (e)

76. BPA expressed concern that it might overcompensate for the losses incurred by the hydro system. In 1984, the Council adopted measures designed to lead to establishment of program goals for anadromous fish. These included a requirement that BPA fund a study by the fish and wildlife agencies and tribes to identify salmon losses that occurred as a result of development and operation of the Columbia River hydro system. The tribes and fish and wildlife agencies submitted a report to the Council in 1985 outlining a proposed method for establishing losses and goals for salmon mitigation under the Northwest Power Act. Not satisfied with the report, the Council undertook its own assessment of Columbia Basin salmon losses in 1985.

77. Northwest Power Planning Council, Compilation of Information on Salmon and Steelhead Losses in the Columbia River Basin, 4 (1986)

78. 1987 Program, *supra.* note 101, Sec. 203-205

79. The Council established a model watershed program that would focus on three subbasins and included a subsection on subregional planning, a de-emphasis away from the three-year planning program costing $5 million completed by the agencies and tribes. Northwest Power Planning Council, 1993 Columbia Basin Fish and Wildlife Program (1993)

80. Northwest Power Planning Council, Columbia River Basin FWP (December 1994)[hereinafter 1994 Program) Chap. 7.

81. Bonneville Power Administration, Columbia River Basin Fish and Wildlife Program Annual Implementation Work Plan for Fiscal Year 1993 (September 1992) iii

82. House Comm. on Natural Resources, BPA at a Crossroads (May 1994) 38

83. BPA has signed trust agreements with Idaho and Montana. It is currently negotiating with Oregon and its affected tribes and has negotiated an interim agreement with the State of Washington for $43 million. Apart from the fact that BPA has responsibilities to protect, mitigate and enhance salmon at the mainstem hydro projects which should have no bearing on the issue of funding the FWP, there appears to be no substantive differences between the funding of the Council's salmon program and its wildlife program.

84. *Id.* at 38

85. *See NRIC v. NPPC,* slip. op. 10861 (9th Cir. 1994) for a detailed analysis of the deference that the NPPC must pay to tribes' and fish and wildlife agencies' proposals in the development of the NPPC FWP.

86. Federal Power Act, 16 U.S.C. §§ 791a-828c (1985 & Supp. 1995)

87. *Id.* at 797(e)

88. Pub. L. No. 99-495 §3(c); 100 Stat. 1252 (1986)

89. *Id.*

90. 16 U.S.C. §803(a) (1985 & Supp. 1995)

91. *Id.* at para. (2)(B)

92. *supra.* note 82

93. 16 U.S.C. §803(j) (1985 & Supp. 1995); Pub. L. No. 99-495 §3(c); 100 Stat. 1252 (1986) Though tribes are not entities named in the Fish and Wildlife Coordination Act, report language for the 1986 amendments, the Electric Consumers Protection Act of 1986 indicates that the section was not intended to change FERC's existing obligations to consider tribal fish and wildlife recommendations and accord them due weight. H.Rep. No. 99-934, 99th Cong., 2d Sess. 23-24.

94. (1) Wells Dam, Project No. 2149, operated by Douglas PUD and licensed by FERC in 1962; (2) Rocky Reach Dam, Project No. 2145, operated by Chelan PUD and licensed by FERC in 1957; (3) Rock Island Dam, Project No. 943, operated by Chelan PUD and licensed by FERC originally in 1930 but amended in 1974 and relicensed in 1987; (4)Wanapum and Priest Rapids dams, Project No. 2114, operated by Grant County PUD and licensed by FERC in 1955.

95. FERC Project No. 1971.

96. *Public Utility District No. 2 of Grant County, Washington,* 15 FPC 1005, at 1006 (1956)

97. Washington Department of Fisheries and Game, Complaint and Protest Re: Minimum Flows, Mid-Columbia Proceeding (FERC 1976). The original cause for concern for the fishery parties was a fish kill resulting from a test at Priest Rapids which held flows at a minimum level for approximately 30 hours killing approximately one million juvenile fall chinook that were leaving the spawning gravel.

98. *Id.* 6 FERC ¶ 61,210 at 61,537 (1979)

99. *Public Utility District No. 2 of Grant County, Washington,* Docket No. E-9569-003 (Grant County Phase) at 4-5. *See also* FERC's Mid-Columbia Proceeding: Ten Years and Still Counting, 16 Envtl. L. 555, 560-577 (1986) for an account of the Mid-Columbia proceedings.

100. Settlement Agreement, *Public Utility District No. 1 of Douglas County, Washington,* Docket No. E-9569 (FERC October 1, 1990). The measures of the Wells Agreement, when carried out according to its terms, are considered as fulfilling the PUD's obligation to protect, mitigate and compensate for anadromous fish resources "at least until March 1, 2004" and "are expected to contribute to the Northwest Power Planning Council's goals of rebuilding ... and providing harvest opportunities. *Id.* at 2. Though the agreement is intended to apply to the current license and annual licenses issued after the current license expires in 2012, the agreement includes a "reopener" effective after March 1, 2004, *Id.*, and a dispute resolution mechanism permitting review by a decision-maker (the presiding judge in the proceedings or certain other FERC officials) if the parties cannot reach a consensus agreement concerning compliance with the agreement *Id.* at 6.

101. *Id.* at 8-18

102. *Id.* at 18-19

103. *Id.* at 24

104. In addition to license modification, the standards for relicensing also were addressed during the mid-Columbia proceedings. When Chelan PUD sought relicensing of the Rock Island Dam in 1977, FERC found that the existing discussions in the consolidated proceedings satisfied Chelan's fishery obligations and issued a new license in 1981 without an EIS and with deferral of fishery conditions to the consolidated proceedings. FERC Order Issuing New License, Public Utility District No. 1 of Chelan County, Washington, Docket No. E-9569 (FERC May 13, 1981). The Yakama Indian Nation as well as the National Marine Fisheries Service, the Washington Departments of Fisheries and Wildlife and the National Wildlife Federation filed suit in the Ninth Circuit Court of Appeals. *Yakima,* 746 F.2d 466 (9th Cir. 1984), *cert. den.,* 105 S. Ct. 2858 (1985). The court's holding emphasized that the Federal Power Act requires that FERC inquire into fishery issues in a relicensing to the same extent as if it were assessing the initial licensing of a new project and before the issuance of a license. *Id.* at 470. Further, the court found that FERC had improperly failed to provide a NEPA statement given the similarity of relicensing to the issuance of a new license. *Id.* at 476-477.

105. ESA Section 2(3), 16 U.S.C. §1532(3) provides that *CONSERVE, CONSERVING AND CONSERVATION* mean to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures [of ESA] are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation [hatcheries], live trapping, and transplantation ..."

106. *Id.* at § 1532 (16)

107. 56 Fed. Reg. at 58,618 (1991)

108. 58 Fed. Reg. at 17574 (1993)

109. Robert Vrijenhoek, *Population Genetics and Conservation,* in Conservation for the Twenty-First Century 89-98 (D. Western & M. Pearl eds., 1989)

110. *See* Daniel J. Rohlf, *There's Something Going on Here: A Critique of the National Marine Fisheries Service's Definition of Species under the Endangered Species Act,* 24 Envtl. L. 618 (1994)

111. However, the courts have limited authority to review agency policies interpreting the statutes that an agency is authorized to enforce. When an agency is making policy "at the frontiers of science, a reviewing court must generally be at its most deferential."*Chevron U.S.A., Inc. v. NRDC,* 467 U.S. 837 (1984) Thus, the interim policy, though arguably inappropriate to accomplish the recovery purposes of ESA, is cloaked in science and utilized by NMFS as an authoritative interpretation of the Endangered Species Act.

112. 16 U.S.C. 1538

113. 16 U.S.C. 1536 & 1539

114. If, in its BO, NMFS finds "no jeopardy," then the BO will include an incidental take statement if an incidental taking is proposed and it may include alternatives to minimize impacts identified by NMFS. If NMFS finds "jeopardy," then it must identify reasonable and prudent alternatives or state that there are none. If the action agency wishes to proceed without modifying its proposal, then it must seek an exemption from the Endangered Species Committee (the "God Squad").

115. 16 U.S.C. 1539(a)(1)(B). The HCP must specify the impacts to the species or its critical habitat, detail steps to minimize and mitigate impacts and their funding sources, enumerate alternatives to the proposed action and the reason they were not chosen, and include measures deemed necessary by the Secretary. If, after public comment, the Secretary can make findings supporting the conclusions of the HCP, an incidental take permit will issue. NMFS has approved an HCP submitted by the Idaho Department of Fish and Game for the Idaho sports fishing program.Idaho Department of Fish and Game, Application for Individual Incidental Take Permit Pursuant to the ESA for the IDFG Sports Fishing Program, (March 1993).

116. *US v. Oregon,* Civ. 68-513 (Sept. 9, 1994 and Aug. 10, 1995)

117. *Idaho Department of Fish and Game v. National Marine Fisheries Service,* Civ. No. 93-1603-MA (D. Or.) [hereinafter *IDFG v. NMFS*]

118. *IDFG v. NMFS,* 850 F. Supp. 886 (D. Or. 1994)

119. NMFS, Endangered Species Act Section 7 Biological Opinion on the Reinitiation of Consultation on 1994-1998 Operation of the Federal Columbia River Power System and Juvenile Transportation Program, (March 2, 1995)

120. NMFS, Report of Compliance with Order of March 28, 1994 and Judgement, (March 22, 1995)

121. *See generally* CRITFC's Administrative Appeals of the Plans and Final EISs for the Salmon, Sawtooth, Challis, Boise, Payette, Clearwater, Nez Perce, Wallowa-Whitman, and Umatilla national forests.

122. *Pacific Rivers Council v. Thomas,* , (Oct. 6, 1993)

123. Joan Laatz, *Documents fault salmon decision,* The Oregonian, April 21, 1995, at 1. On February, 3, 1995, the United States petitioned the Supreme Court to review the ninth circuit decision arguing that consultation on the LRMP's was not necessary to protect the listed species because the plans themselves do not affect salmon; site specific activities affect salmon. The Supreme Court denied review. *Pacific Rivers Council v. Thomas,* 30 F. 3d. 1050 (9th Cir. 1994)(cert. den.) __ U.S. __ (1995)

124. 16 U.S.C. 1533(f)

125. NMFS, Proposed Recovery Plan for Snake River Salmon, (March 1995).

126. Id. at I-4

127. Id. at III-2

128. Id. at III-5

129. Id at III-7

130. Id. at III-8

131. Id. at III-13

132. Id. at III-16

133. Id. at III-8

134. Id. at III-10

135. The TMT is established to advise operating agencies on dam and reservoir operations, the distribution of flow augmentation, and transportation and spill. The Committee will consist of representatives from COE, BPA, BOR, FWS, and NMFS.

The PAC, consisting of experts appointed by NMFS, will provide technical recommendations and findings regarding passage improvements to the TMT.

The HC, consisting of experts appointed by NMFS, will be responsible for developing and coordinating assessment and inventory methods and for coordinating, implementing, and monitoring research activities.

The FPC, consisting of experts appointed by NMFS, "will provide an operational link between the Snake River recovery program, the *US v. Oregon* PAC and the NPPC FWP." The Natural Production Subcommittee will have particular concern for ensuring that broodstock and supplementation program contribute "positively" to the recovery of self-sustaining natural stocks.The Hatchery management Subcommittee is intended to recommend development of a "Columbia Basin-wide integrated hatchery plan, consistent with the overall management objectives of the Recovery Plan," and is to consist of experts appointed by NMFS with management experience from Federal, state, and tribal agencies and academia.

136. Given the proposed role of NMFS in recovery, it is appropriate to ask whether the agency and its predecessor, the Bureau of Commercial Fisheries, has played a constructive role, historically, in the recovery of naturally-spawning upriver stocks. In reviewing its role as regulator of ocean salmon fisheries, its authorship of the Lower Snake River Compensation Plan, and its administration of the Mitchell Act, NMFS has frequently exacerbated stock status. In addition, the work of the NMFS Seattle-based research program, with its focus on captive broodstock technology and its massive research contracts with the Corps of Engineers, has compromised itself as an honest broker on production and hydro operations issues.

SECTION 5

RECOMMENDATIONS

RECOMMENDATIONS

Institutional Changes

To implement treaty fishing rights through the restoration of anadromous fish in the Columbia Basin, the federal and state governments and the tribes must better utilize existing opportunities to develop and implement action plans based upon shared objectives. The following recommendations, for the most part, propose modest changes to the procedures adopted under the authority of *US v. Oregon* and the Northwest Power Act. Through these recommendations, the tribes seek to improve harvest and production management and to coordinate policies and resolve disputes particularly for hydro operations, public lands management and research. The recommendations attempt to join accountability with responsibility for fish restoration by shifting the funding prioritization process to the tribes and agencies and transferring certain federally-funded hatcheries to the tribes. The recommendations seek to limit policy barriers to the use of artificial propagation as a tool for restoration. The institutional changes also address private land management by recommending support for watershed initiatives and for enforcement of environmental laws.

Existing Mechanisms

Action: Modify the existing basin-wide mechanisms of the CRFMP, the Fish and Wildlife Program, and FERC Orders to more fully implement treaty fishing rights to take fish at all usual and accustomed fishing places. Use the Endangered Species Act in a manner that is consistent with implementation of treaty rights to natural resources.

The processes for basin-wide anadromous fish restoration are based on existing statutory authorities and treaties, and were developed by the federal, state and tribal entities of the region. They embody meaningful tribal participation but require additional authorities and measures as noted below in order to protect imperiled anadromous fish populations throughout the upper basin in order to implement treaty fishing promises. Though the ESA can be interpreted in a manner consistent with treaty rights, ESA implementation for Snake River chinook and sockeye has failed to address treaty requirements and has diverted critical resources from upper basin restoration.

CRFMP

Action: Fully implement CRFMP in terms of production provisions by calling upon the Policy Committee to initiate comprehensive production planning and an implementation process.

The CRFMP contains authoritative provisions for production planning from both a policy and technical standpoint and includes detailed measures for dispute resolution. Because fisheries on the abundant runs produced from hatcheries are constrained by protection of weak natural stocks, and hatchery practices and funding is under attack, incentives exist to shift hatchery emphasis toward saving stocks particularly in danger of extirpation and restoring a more balanced level of production above Bonneville Dam. The tribes' technical recommendations and subbasin plans address the locations and means to accomplish this shift and the parties to *US v. Oregon* are the sole parties with authority to develop comprehensive fish production plans.

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3 **Dispute Resolution**

Action: Implement a dispute resolution process similar to the CRFMP and FERC agreements, under the continuing jurisdiction of the federal district court, that addresses public lands and water project management as a means to support PST, CRFMP, FWP, and ESA rebuilding goals for the implementation of treaty fishing rights.

Federal hydro operations, and structural modifications as well as public lands management are not subject to an authoritative basin plan nor a dispute resolution process to resolve differences. The parties to *IDFG v. NMFS* are negotiating a resolution to the issues of the case and have an opportunity to develop a plan and dispute resolution mechanism under the auspices of the federal courts. The dispute resolution process utilized for mid-Columbia P.U.D. dams is a model in this regard. In the alternative, federal hydro projects could be subjected to the FERC process either by legislation or through the sale of the projects to public or private utilities.

With regard to public lands, the parties to *US v. Oregon* including the states and the United States, must act soon to replace the CRFMP which expires in 1998. These negotiations must address public lands management and dispute resolution under the habitat provisions of the CRFMP or develop a parallel mechanism.

4 **Fish and Wildlife Program Funding**

Action: Transfer BPA fish and wildlife funding in trust to the Fish and Wildlife Service for the time it takes to establish a new entity composed of the fishery agencies and tribes.

The state and federal fishery agencies and tribes are the primary entities with responsibility to protect fish and wildlife. In order to link authority with this responsibility, BPA should transfer an amount of funding to be negotiated, including resources provided under cooperative agreements with other agencies, for meeting specified goals and objectives for basin anadromous fish. The fishery agencies and tribes should report annually to the region on the achievement of goals and objectives, with funding contingent upon achievement of agreed-upon biological objectives.

5 **Watersheds**

Action: To secure fish resource protection on private lands in conjunction with public land management, actively support ongoing watershed approaches and start new ones to implement subbasin planning in accordance with the FWP and CRFMP through a Columbia Basin watershed trust program.

Currently, watershed approaches are being funded by BPA and used throughout the Columbia Basin to implement the Fish and Wildlife Program. Watersheds include the Grande Ronde, Lemhi, Pahsimeroi, East Fork of the Salmon, Asotin, Tucannon, Methow, Entiat, Wenatchee, and Yakima. In many cases, the Natural Resources Conservation Service (formerly the Soil Conservation Service) through its county offices is facilitating these efforts with participation from the states of Oregon, Washington, and Idaho and the tribes. But use of the watershed approach is not limited to the Columbia basin.

A survey of approaches in the United States found that watershed initiatives could provide a useful means of resolving environmental and natural resource conflicts:

> *Employ voluntary, multi-stakeholder collaborative approaches to protect, restore and monitor natural resources and to resolve natural resource conflicts. These approaches should be open and inclusive, based on existing laws, and conducted within a framework of natural systems — watershed, ecosystems, bio-regions or other defining land-forms — using the best available science. This recommendation is patterned after successful approaches used all across the country. It is intended to provide impetus for stakeholders*

and communities to work together in searching for common goals, resolving conflicts, becoming aware of and using best available science, meeting legal requirements for protecting the environment, monitoring natural resources and redeeming collective responsibility for conditions and trends of resources.[1]

These standards are applicable to the Columbia Basin and serve as an alternative to polarizing controversy and costly litigation that wastes time and money that could be spent on salmon restoration. The approach is also intended as an alternative approach to the implementation of state and federal habitat protection statutes that are not being effectively enforced. The tribal recommendations included in Volume II are proposed as fishery objectives for watershed planning in each subbasin and are based upon the best science available.

Funding is currently provided by a variety of sources including BPA, other federal agency support, state legislative appropriations, and private funding as well as significant in-kind contributions. Establish a Columbia Basin Watershed Trust to encourage additional resources and provide facilitation services and technical support without diminishing local initiative. In order to participate in watershed approaches, tribes will need at least 1 FTE per watershed for coordination purposes.

ESU

Action: Reconsider the ESU interim policy on the use of propagation.

The basis of the ESU is a genetics theory arguing that a salmon population's fitness is reduced by the inflow of genes from hatchery bred salmon populations, even when the broodstock for the population comes from the same or adjoining populations. A recent report by the National Research Council[2] supports tribal analysis of the ESU indicating that ESA policies should not stress reproductive isolation as an indicator of population distinctiveness or as a limitation on recovery. The NRC Report also confirms tribal analysis that estimates of distinctiveness should be based on a variety of indicators including behavioral, morphological, ecological, and molecular information as well as genetic information because "a single kind of information will often fail to provide compelling evidence of distinctiveness. Determination of distinctiveness and the associated features of an independent future usual requires the careful integration of several lines of evidence."[3]

While the ESU, developed in a more integrated format, may be an appropriate indicator of distinctiveness for listing purposes, it should not be used as a limitation on the recovery of a listed species in a particular habitat.

In light of the NRC Report, the NMFS should reconsider the ESU policy in a peer-reviewed process that addresses the use of propagation for species recovery as provided in the Endangered Species Act.[45]

Tribal Hatchery Management

Action: Transfer the Klickitat hatchery to the Yakama Indian Nation; the Kooskia, Clearwater, and Dworshak hatcheries to the Nez Perce Tribe; and the Lookingglass and Umatilla hatcheries to the Umatilla Tribes under authority of the Indian Self-Determination Act. Provide operation and maintenance funds for hatchery operation and for the transfer of other hatcheries as needed. Fund and implement Fish and Wildlife measures to construct tribal production facilities. Redirect Mitchell Act propagation facility capacity and implement mitigation for John Day Dam.

For over fifty years, basin hatchery policy has discriminated against tribal fisheries and has resulted in the loss of upriver naturally-spawning populations because of fishery effects and the taking of broodstock. Since 1982, tribes have proposed the use of hatcheries as a tool to recover naturally-spawning populations throughout the basin as a tool for salmon restoration and as a means to implement treaty

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rights to take fish "at all usual and accustomed fishing places." Though included in the Fish and Wildlife Program, construction of tribal production facilities has been delayed as the need for protection of declining stocks increased. Because tribes retain the exclusive right to take fish on their reservations and because the hatcheries listed are located within the boundaries of their reservations or ceded areas and serve the purpose of protecting treaty fish resources, tribes are entitled to a transfer of hatchery properties along with the operation and maintenance funding to maintain them. The federal government should also transfer other hatchery facilities that may assist in restoring upper river anadromous fish populations.

However, recovery activities proposed by the tribes in Volume II will require hatchery capacity beyond that proposed for transfer. Therefore, funding of new tribal facilities required under the Fish and Wildlife Program as well as the reprogramming of the Mitchell Act and implementation of John Day mitigation are also necessary measures for restoration.

8 9 **Research, Monitoring and Evaluation, and a Coordinated Information System**

Action: As an adjunct to the CRFMP and the Fish and Wildlife Program, representatives of the federal government, the states and tribes need to establish a research and monitoring program that sets long-term priorities and provides dispute resolution.

Federal government agencies control priorities, methodologies, implementation, and evaluation of research related to the impacts of federal hydropower projects on the Columbia Basin's anadromous fishery resources. Except in limited cases, federal research selection processes do not provide scientific peer review. Further, timely access to data obtained by federal researchers is problematic.

Other monitoring, evaluation and research on restoration is often uncoordinated and unconnected to related restoration measures.

Because a comprehensive restoration plan requires a coordinated research, monitoring and evaluation program that incorporates all life stages of anadromous fish, the tribes propose establishment of a basin-wide research and monitoring program that sets long-term priorities and provides dispute resolution among federal, state and tribal entities.

The FERC structure provides for research planning and dispute resolution as an element of its settlements. A similar policy-driven program is recommended for other research, particularly that concerned with the operation and structural modification of federal dams.

10 **Harvest Management**

Action: Fishing regimes that are consistent with treaty fishing rights, and with allocation and conservation issues, can be achieved through the current management process.

Both the Pacific Salmon Treaty and the Columbia River Fish Management Plan, keystones of the harvest management process, expire in 1998. Consistent with court-approved standards for management of treaty fisheries, the parties have an opportunity to update the provisions of the PST and CRFMP based on the latest information on survival rates and catch levels by modifying escapement objectives and harvest rate schedules as appropriate. The parties should also increase coordination with processes in other areas, such as hydro operations and habitat protection, to ensure adequate sharing of the conservation burden.

11 **Law Enforcement**

Action: Continue coordinated enforcement of harvest regulations and develop the capability of law enforcement personnel to enforce habitat protection laws.

Law enforcement personnel recently completed a survey of irrigation diversions and reported unscreened diversions to relevant agencies for enforcement action. Basin fisheries law enforce-

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ment agencies needs to continue addressing harvest infractions in a coordinated manner and expand their function by training personnel to recognize and document violations of habitat protection laws.

1. President's Council on Sustainable Development, Draft Recommendations of the Natural Resources Task Force (1995)

2. National Research Council, *Science and the Endangered Species Act (1995)*

3. *Id.* at pp. 45-46

4. ESA Section 2(3), 16 U.S.C. §1532(3) provides that CONSERVE, CONSERVING AND CONSERVATION mean to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures [of ESA] are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation [hatcheries], live trapping, and transplantation. . . ."

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Technical Recommendations

Introduction

Given the history of abundant salmon populations above Bonneville Dam, and the complexity of jurisdictions and interest groups whose activities have contributed to their demise, the Tribes conclude that significant actions must be undertaken immediately if we are to preserve our cultural heritage and treaty-guaranteed property rights. The preferred approach for managing these required activities is adaptive management. This approach combines the objective approach of scientific methodology with social and political decision making processes.

Adaptive management is a process consisting of identifying a problem, taking actions to address the problem, observing the results, and modifying the assessment of the problem and needed remedies. Adaptive management requires taking actions of a magnitude large enough to be likely to demonstrate measurable results in the face of inherent biological variability. It is a flexible process that does not require perfect knowledge to begin. It is self-correcting as new information is obtained.

An adaptive management approach to restoring salmon production in the Columbia River Basin above Bonneville Dam includes:

1. Initial assessment of the problem;
2. Formulation of goals, hypotheses about the nature of the problem(s), and needed solutions;
3. Identification of the expected results of the proposed actions;
4. Implementation of the proposed actions;
5. A monitoring program to observe the actual result of actions;
6. Communication of results among interested parties; and
7. Reevaluation of the problem definition and modification of management actions.

This plan addresses steps 1 through 3 of this process. We are now prepared to move forward with implementation of actions proposed in this plan.

Resources for restoring salmon (time, money, manpower) are limited and there is much we do not fully understand about the impacts of society's actions on salmon survival at each life stage. These uncertainties about actions and their consequences often lead to debate and inaction for fear the "wrong" action will be taken and limited resources will be wasted or that actions will have unintended negative results. The result is the worst possible for salmon populations - they continue to decline toward extirpation. We must identify and resolve the most important of these uncertainties so we may make most effective use of limited resources to rebuild declining populations.

The most effective way to resolve critical uncertainty is by application of sound scientific methods. We must first realize, however, that science itself is a process or methodology, a way of discovering things, not a number, or a collection of facts (Orians 1969). The best science, then, is a rigorous process conducted over time, not the best number or fact at a particular time. The scientific method consists of formulating a theory or hypothesis, developing and conducting a test which would disprove the hypothesis if it were false, drawing a conclusion from the results of the test, and formulating new hypotheses and theories.

These technical recommendations are designed to accomplish the tribal anadromous fish restoration goals and objectives:

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Goals

- Restore anadromous fishes to the rivers and streams that support the historical cultural and economic practices of the tribes. (These are generally areas above Bonneville Dam.)
- Emphasize strategies that rely on natural production and healthy river systems to achieve this goal.
- Protect tribal sovereignty and treaty rights.
- Reclaim the anadromous fish resource and the environment on which it depends for future generations.

Objectives

- Within 7 years, halt the declining trends in salmon, sturgeon, and lamprey populations upstream of Bonneville Dam.
- Within 25 years, increase the total adult salmon returns above Bonneville Dam to 4 million annually and in a manner that supports tribal commercial as well as ceremonial and subsistence harvests.
- Within 25 years, increase sturgeon and lamprey populations to naturally sustainable levels that also support tribal harvest opportunities.
- Restore anadromous fishes to historical abundance in perpetuity.

The objectives require gravel-to-gravel salmon survival levels for naturally reproducing populations approximately double the present level in seven years, and quadruple present rates in twenty-five years (see Anticipated Outcomes section). This will result in natural production levels greater than replacement while also providing for commercial, ceremonial, and subsistence harvest levels consistent with the treaties.

Measures that we believe are needed and appropriate to achieve these objectives are set forth in the following hypotheses. For instance the juvenile passage hypothesis calls for achieving a fish passage efficiency (FPE) at all mainstem dams of at least 80% immediately and at least 90% within eight years. The land use practices hypothesis is intended to protect and restore all existing tributary habitat, without any additional degradation over existing conditions.

There may be other actions which will achieve the objectives of this plan. The tribes are flexible on the details of specific actions as long as the end result, as measured by overall survival rates and fish abundance, is consistent with the above objectives.

The following hypotheses summarize the tribes' perception of the problem and their proposed initial responses. The hypotheses are organized within the life cycle stages of the salmon (Table 5B.1), beginning with the hypotheses affecting early life history stages (e.g. egg to juvenile survival). No prioritization of the importance of the hypotheses is implied by the sequence in which they presented. Several of the hypotheses have both short term and long term phases. The long term reflects actions intended to be carried out in year eight of this plan and in succeeding years.

HYPOTHESIS **1** | **Land-use Practices in Columbia River Sub-Basins**

HABITAT: Tributary

Problem Statement

Cumulative effects of land use practices have had severe impacts on tributary stream systems (NCASI 1984; Stull and Emery 1985; Li et al. 1994). Logging, irrigation, road construction, grazing, mining, and urbanization have increased rates of sedimentation, elevated water temperatures, decreased instream flows, reduced bank stability, decreased the amount of large woody debris in stream channels, and reduced channel

Table 5B.1. Summary of hypotheses.

	HYPOTHESIS	HABITAT	LIFE STAGE
1	Land Use Practices	Tributary	Adult, egg, parr
2	Water Quantity	Tributary	Adult, egg, parr
3	Habitat Restoration	Tributary	Adult, egg, parr
4	Supplementation	Tributary	Egg, parr
5	Reintroductions	Tributary	Egg, parr
6	Juvenile Salmon Passage	Mainstem	Smolt
7	Estuary	Estuary	Smolt, adult
8	Harvest Ceilings	Ocean	Adult
9	Adult Salmon Passage	Mainstem	Adult
10	Water Quality	Mainstem, tributary	Adult, smolt
11	Stock-specific Concerns	Mainstem, tributary	Adult
12	Lamprey Passage	Mainstem	Adult lamprey
13	White Sturgeon	Mainstem	All

complexity (Chamberlin et al. 1991; Furniss et al. 1991; Hicks et al. 1991; Platts 1991). This degradation has reduced the capacity of tributary habitat to support naturally spawning salmon populations. For instance, widespread studies in the Idaho batholith indicate that egg-to-smolt survival is 2% - 10% of predevelopment levels (Scully and Petrosky 1991). In some areas the impacts have been so severe that salmon survival is effectively zero (Scully and Petrosky 1991, NMFS 1993). Further, the overall productivity of remaining stream reaches providing suitable habitat is impaired when these habitat units are geographically fragmented. Cumulative habitat degradation in salmon-bearing stream systems, originating in headwaters, tends to progressively reduce the production capability and eliminate the potential for supporting the historical diversity of life history forms of the species (i.e., those that depended upon environmental conditions found in the downstream portions of the drainage).

Hypotheses: Improving or eliminating land use practices that degrade tributary habitat will allow watersheds to heal, and restore salmon productivity. Specifically, application of the Coarse Screening Process (Rhodes et al. 1994) to evaluate and guide land use practices will prevent further loss of habitat quality, will result in significant improvement in habitat quality and increase in habitat quantity, and will improve the egg-to-smolt survival of salmon in severely degraded habitat.

Recommended Actions/Tests

Short-term

- Enforce existing land use and water quality laws and regulations.
- U.S. Forest Service, Wallowa-Whitman National Forest: implement the Upper Grande Ronde Salmon Habitat Protection, Restoration and Monitoring Plan in the Upper Grande Ronde watershed.

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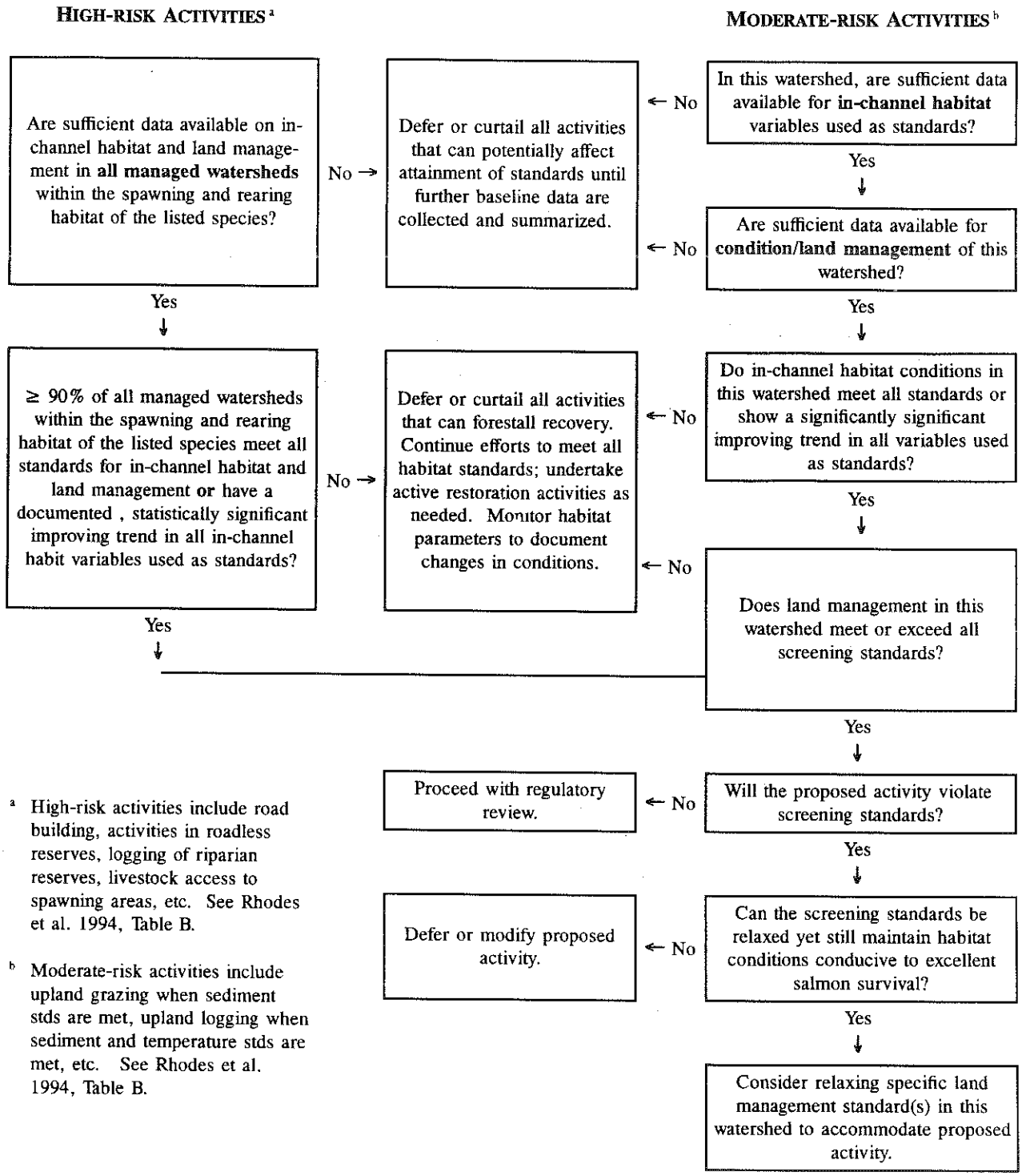

[a] High-risk activities include road building, activities in roadless reserves, logging of riparian reserves, livestock access to spawning areas, etc. See Rhodes et al. 1994, Table B.

[b] Moderate-risk activities include upland grazing when sediment stds are met, upland logging when sediment and temperature stds are met, etc. See Rhodes et al. 1994, Table B.

Figure 5B.1. The Coarse Screening Process for proposed activities in salmon-producing watersheds (adapted from Rhodes et al. 1994).

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Table 5B.2. Summary of Coarse Screening Process standards: **In-channel habitat conditions.**

ELEMENT AND STANDARD	CONDITION	RELATED LAND MANAGEMENT STANDARDS
CHANNEL SUBSTRATE		
Surface fine sediment (diam. < 0.25 in.): Average amount of area covered by surface fine sediment ≤20% in spawning habitat; no increase where already ≤20%.	Substrate standards met and estimated sediment delivery ≤20% over natural.	No increase in sediment delivery from single or combined activities. Offset all new activities with potential to produce sediment by at least equivalent sediment abatement via active restoration.
Cobble embeddedness (CE): Average CE ≤30% in rearing habitat; no increase where already ≤30%.	Substrate standards met but estimated sediment delivery >20% over natural.	Reduce sediment delivery via passive and active restoration[a] to ≤20% over natural. Combine all new activities that increase erosion with sediment abatement measures that result in a net reduction in sediment delivery.
	Substrate standard exceeded and estimated sediment delivery >20% over natural; surface fine sediment or CE increasing.	Reduce sediment delivery via ***complete*** passive restoration until sediment delivery ≤20% over natural and substrate conditions meet standards or exhibit a statistically significant ($p<0.05$) improving trend over ≥5-year period. Implement active restoration as needed to reduce sediment delivery and improve substrate conditions.
	Substrate standard exceeded and estimated sediment delivery ≤20% over natural.	Reduce sediment delivery via ***complete*** passive restoration until substrate conditions meet standards or exhibit a statistically significant ($p<0.05$) improving trend over ≥5-year period. Implement active restoration as needed to reduce sediment delivery and improve substrate conditions.
Fines (diam. < 0.25 in.) in spawning gravel to depth of egg deposition: Although not set as a numeric standard, monitoring substrate trends at depth is recommended as part of adaptive management.	Regardless of condition.	Monitor fines by depth in key areas to evaluate correlation with surface fine sediment by area.

[a] Passive restoration is defined as curtailing or deferring activities that contribute to degraded conditions or forestall natural recovery processes. ***Complete*** passive restoration is defined as curtailing and deferring all activities at the watershed scale that contribute to degradation or potentially forestall recovery. In the case of channel substrate, complete passive restoration entails curtailing and deferring all ground disturbing activities that increase erosion over natural levels.

Active restoration is defined as taking actions to reduce or eliminate the effects of existing impacts, such as obliterating or upgrading roads.

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Table 5B.2. *(continued)*

ELEMENT AND STANDARD	CONDITION	RELATED LAND MANAGEMENT STANDARDS
CHANNEL MORPHOLOGY		
Large woody debris (LWD): Land management standards set in lieu of numeric standard.	Regardless of condition.	Fully protect vegetation and soils within riparian reserves, meet bank stability standards, and monitor LWD. Implement active restoration as needed to reestablish natural LWD recruitment from riparian zones. Add LWD to streams only after causes of LWD loss have been adequately addressed and where ecologically appropriate.
Pool frequency and volume: Land management standards set in lieu of numeric standard.	Regardless of condition.	Fully protect vegetation and soils within riparian reserves, meet bank stability standards and limit/reduce sediment delivery to ≤20% over natural. Monitor pool frequency and volume. Add LWD only after causes of pool loss have been adequately addressed and where ecologically appropriate.
Residual pool volume: Not set as a numeric standard. Achieve an increasing trend in residual pool volume.	Regardless of condition.	Fully protect vegetation and soils in riparian reserves, meet bank stability standards, and limit/reduce sediment delivery to ≤20% over natural. Monitor residual pool volume.
	Declining trend from baseline.	Reduce sediment delivery via passive and/or active restoration.
Bank stability: Bank stability on all streams average ≥90%; no decrease in bank stability when >90%.	Average bank stability <90% or a decrease in bank stability.	Implement passive restoration (suspension of grazing within half one site potential old growth tree height of floodplains or streams) until bank stability meets standard or exhibits a statistically significant ($p<0.05$) improving trend over ≥5 years. Implement active restoration addressing causes of bank instability as needed to improve bank stability. Do not mechanically stabilize banks (e.g., rip-rap).
	Average bank stability ≥90%	Apply appropriate management controls to maintain bank stability.
WATER QUALITY AND QUANTITY		
Water temperature: Maximum daily water temperature ≤60°F in historically usable spawning and rearing habitat.	Maximum daily water temperature >60°F.	Fully protect vegetation in riparian reserves. Implement complete passive riparian restoration to reduce water temperature. Suspend grazing within riparian reserves until water temperature meets standard or exhibits a statistically significant improving trend over ≥5 years. Implement active restoration as needed to improve water temperature conditions.
	Maximum daily water temperature ≤60°F.	Fully protect vegetation within riparian reserves from any additional impacts. Control and monitor on-going activities within riparian reserves to ensure that they do not increase water temperatures.

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Table 5B.2. *(continued)*

ELEMENT AND STANDARD	CONDITION	RELATED LAND MANAGEMENT STANDARDS
Stream shading: Land management standards set in lieu of a numeric standard.	Regardless of condition.	Fully protect vegetation within riparian reserves. Prohibit activities that decrease shading or forestall recovery.
Miscellaneous pollutants: Review and revise current state and federal water quality standards as needed to adequately protect salmon. In the interim, meet current water quality standards.	Regardless of condition.	Monitor water quality parameters set as state and federal water quality standards where the potential for pollution exists. Eliminate or restrict transport of toxic materials along and upstream of spawning and rearing reaches. Eliminate storage of toxic materials within watersheds with spawning or rearing habitat.
Water quantity and timing: Not set as numeric standards.	Regardless of condition.	Suspend additional groundwater and surface water withdrawals in watersheds with spawning and rearing habitat until studies determine instream flows are more than adequate for salmon production and survival, and maintenance and restoration of favorable habitat conditions. Where flows are inadequate, acquire instream flows. Protect and restore wetlands and degraded meadow systems. Fully protect vegetation and soils within riparian and roadless reserves.

Table 5B.3. Coarse Screening Process summary of standards: **Land management standards.**

ELEMENT AND STANDARD	CONDITION	RELATED LAND MANAGEMENT STANDARDS
Sediment delivery: Sediment delivery ≤20% over natural.	(See Channel Substrate Standards in Rhodes et al. 1994, Table B)	
Riparian reserves: ≥300 ft slope distance from floodplains, or stream where floodplains do not exist, or to topographic divide, whichever is less.	Regardless of condition.	Fully protect vegetation and soils within riparian reserves from any additional anthropogenic disturbance. Do not implement approaches to riparian restoration involving vegetation removal until they have been shown to be effective under applicable ecological conditions. Reduce existing road mileage in reserves. Improve road drainage within reserves. Use active restoration to reduce impacts within riparian reserves where needed to improve habitat conditions.
	Water temperature standard exceeded.	Suspend grazing within riparian reserves until water temperatures meet standard or exhibit a statistically significant improving ($p<0.05$) trend over at least 5 years.
	Bank stability standard not met.	Suspend grazing within half one site potential, old growth tree height from the edge of floodplains, or streams when floodplains are absent, until bank stability meets standard or exhibits a statistically significant improving ($p<0.05$) trend over at least 5 years.
	All habitat standards met.	Carefully control and monitor all on-going activities within riparian reserves to assure degradation does not occur.
Equivalent clearcut area (ECA): Not recommended as a land use standard for limiting land disturbance.		Limit land disturbance via riparian and roadless reserves, application of in-channel habitat standards, and sediment delivery standard.
Roads: Decrease road mileage in managed watersheds. Improve drainage and decrease sediment delivery from roads that will not be obliterated or relocated.	Habitat conditions in <90% of managed watersheds either meet standards or have exhibited statistically significant ($p<0.05$) improvement.	Defer construction of new roads. Continue to upgrade, obliterate, or relocate existing roads.
	Habitat conditions in >90% either meet all habitat standards or have exhibited statistically significant improvement.	Consider reevaluation of prohibition on new road construction.
Grazing: Forage utilization standards not recommended as a numeric standard.	Regardless of condition	Eliminate livestock access to spawning reaches during spawning and incubation periods.
	Substrate standards exceeded.	Suspend grazing within watershed until sediment delivery is reduced via passive and active restoration to ≤20% over natural <u>and</u> substrate conditions meet standards or exhibit a statistically significant ($p<0.05$) improving trend over ≥5-year period.

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Table 5B.3. *(continued)*

ELEMENT AND STANDARD	CONDITION	RELATED LAND MANAGEMENT STANDARDS
	Substrate standards exceeded.	Suspend grazing within watershed until sediment delivery is reduced via passive and active restoration to ≤20% over natural and substrate conditions meet standards or exhibit a statistically significant ($p<0.05$) improving trend over ≥5-year period.
	Bank stability standard not met.	Suspend grazing within half one site potential, old growth tree height from the edge of floodplains, or streams when floodplains are absent, until bank stability meets standard or exhibits a statistically significant ($p<0.05$) improving trend over at least 5 years.
	Water temperature standard exceeded.	Suspend grazing within riparian reserves until water temperatures meet standard or exhibit a statistically significant ($p<0.05$) improving trend over at least 5 years.
	All habitat standards met.	Carefully control and monitor all grazing within riparian reserves to ensure that degradation does not occur.
Roadless reserves: Maintain all roadless tracts >1000 acres undisturbed; maintain smaller roadless tracts undisturbed until documented that disturbance will not forestall habitat recovery nor foreclose management options.	Habitat conditions in <90% of managed watersheds either meet all habitat standards or have exhibited statistically significant ($p<0.05$) improvement.	Maintain protection of roadless tracts.
	Habitat conditions in >90% of managed watersheds either meet all habitat standards or have exhibited statistically significant ($p<0.05$) improvement.	Consider re-evaluation of roadless reserves.
Spatial criteria for reevaluation of land management standards: Habitat conditions in >90% of managed watersheds either meet all habitat standards or have exhibited statistically significant improvement.	Habitat conditions in <90% of watersheds meet all habitat standards or have exhibited a statistically significant ($p<0.05$) improving trend in all habitat elements over ≥5-year period.	Maintain integrity of riparian and roadless reserves and continue to implement screening process. Monitor trends in habitat condition for the entire set of watersheds within the Columbia River Basin for trends. Implement active restoration as needed to improve habitat conditions.
	Habitat conditions in >90% of watersheds meet all habitat standards or have exhibited a statistically significant ($p<0.05$) improving trend in all habitat elements over ≥5-year period.	Consider reevaluation of land management standards (e.g., riparian and roadless reserves).

- Apply the Coarse Screening Process (Figure 5B.1) and in-channel and land use standards (Tables 5B.2 and 5B.3) on public lands throughout all watersheds upstream from Bonneville Dam that are accessible to anadromous fish to restore watershed, floodplain, and riparian conditions, and to improve existing salmon-production capability of in-stream habitat.
- Use the Coarse Screening Process land management standards, and other appropriate approaches (e.g., as developed for the Walla Walla subbasin), to identify and guide actions on private lands to achieve the in-channel conditions needed to support healthy naturally reproducing salmon populations.
- Conduct baseline surveys of watershed and in-channel conditions by ground-based survey and aerial photographic methodology in all watersheds upstream from Bonneville Dam. The minimum set of monitoring parameters should be those identified as standards in the Coarse Screening Process. Additional monitoring parameters will be required for baseline and trend monitoring, effectiveness, and validation monitoring in salmon-bearing streams. Trend monitoring will be used to document recovery. Effectiveness monitoring is needed to assess whether practices employed in land management have expected results. Validation monitoring is needed to test assumptions and key models used in land management. Among these will be validation of a sediment delivery model. A recommended guide to monitoring parameters and methodologies is given in McCullough et al. (in review).
- Monitor egg-to-smolt survival, total smolt production, and production per spawning pair in salmon-bearing watersheds.

Long-term

- Re-survey watershed and instream conditions at appropriate intervals to document watershed recovery.
- Consider re-instituting low-impact activities in the watershed, floodplain, or riparian area when land use and instream habitat standards have been met. Do not revise land use standards to allow activities that have higher risk or foreclose management options until at least 90% of the managed watersheds in the Columbia River Basin either meet all biologically based habitat standards, or have shown a statistically significant improving trend ($p < 0.05$) over at least a 5-year period, as documented by monitoring.

Expected Results

Short-term Present declining trends in watershed and riparian conditions will be slowed or halted.

Long-term Deterioration in in-stream conditions will cease. Measurable improvements will occur in most tributaries within a 10-year period of total rest. Full recovery will require a considerably longer period of time. The minimum set of monitoring parameters that need to be measured for all watersheds are those described in Rhodes et al. (1994). An extended set of monitoring parameters to be evaluated in selected, representative watersheds are described in McCullough et al. (in review).

Survival rates for salmon and lamprey will increase and, given stable and/or increasing escapements, freshwater rearing populations will be large enough to provide a buffer against natural environmental fluctuations.

Watershed carrying capacity for salmon and lamprey will increase, natural communities and ecological functions will be restored, and fragmented salmon habitats will be reconnected by improvement in condition of degraded stream reaches.

Institutional/Decision Structure

Federal and state land and water management agencies: enforce existing land use and water quality laws and regulations.

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Federal land and water management agencies and federal fishery managers: employ the Coarse Screening Process (Rhodes et al. 1994) in assessing consistency of land management actions with the goal of improving and protecting salmon habitat and populations.

Federal, state, and tribal land and fishery managers: develop various cooperative arrangements to accomplish the watershed and in-stream habitat restoration called for by the Coarse Screening Process (Rhodes et al. 1994).

Local Watershed Restoration Teams use the Coarse Screening Process as a tool to identify habitat problems and responses appropriate to local conditions.

HYPOTHESIS

2

Water Quantity

HABITAT: Tributary

Problem Statement

Inadequate instream flows and sometimes the complete absence of water due to irrigation withdrawals have severely affected Columbia basin salmon. For example, within Idaho, inadequate instream flows and localized de-watering are significant problems in the Lemhi and Pahsimeroi rivers, the Salmon River mainstem, and several Salmon River tributaries.

Other significant Snake River tributaries include the Grande Ronde River in Oregon and the Tucannon River in Washington. In the Grande Ronde, except during spring run-off, water appropriations exceed average flow in all major streams of the basin. Studies have shown that salmonid production is directly related to the level of summer and fall flows in juvenile rearing streams. Although minimum stream flows have been set at various locations in the Grande Ronde, the priority dates for these flows are too recent to provide any real protection for fish. Inadequate instream flows are also a significant constraint on fish habitat productivity in the Tucannon River basin. Other important Washington rivers in the Columbia basin where instream flows do not meet the needs of fish include the Methow and Okanogan, the Entiat, the Wenatchee, and the Yakima. Within Oregon, important rivers accessible to salmon where habitat productivity is significantly impaired by inadequate instream flows include the John Day and Umatilla.

Stream withdrawals for irrigation are not the only land use activities which adversely affects instream flows. Not surprisingly, groundwater pumping often reduces summer low flows (Rhodes et al. 1994). In addition, cattle grazing increases spring peak flows, while decreasing summer low flows. Cattle grazing decreases low flows by de-watering wet meadows by incised channels, increased overland flow due to compacted soils and reduced water storage in compacted soils (Rhodes et al. 1994). In general, mining, road construction, grazing, and tractor logging in wetlands disrupt wetland functions and reduce contributions to summer low flows (Rhodes et al. 1994).

Fish populations evolved, flourished, and provided large harvestable surpluses in watersheds with natural riparian areas and hydrologic regimes, including periodic flood events. Instream flows in the late summer were often fed by groundwater inputs, wetlands, and vegetated uncompacted riparian areas.

Hypothesis

Establishment of instream flows and protection of riparian vegetation, wetland preservation, and prevention of soil compaction would provide sufficient water to maintain fish habitat for adult and juvenile passage, spawning, rearing, and maintain channel structure and riparian areas necessary for fish habitat to persist over time.

Recommended Actions

Short-term

- Mandate utilization of most efficient irrigation methods.
- Halt any additional consumptive withdrawal of water from salmon subbasins until adequate instream flows and tribal instream flow reserved water rights are protected.
- Assure that no consumptive uses are occurring in excess of the amount permitted.
- Meter groundwater and surface water withdrawals.
- Halt any further impairments of wetlands.
- Prevent additional soil compaction.
- Prevent removal of riparian vegetation.
- Prohibit activities that would contribute to the creation or maintenance of peak flows earlier or greater than those that would occur naturally.

Long-term

- Establish instream flows designed to provide the full range of habitat conditions needed to provide healthy, naturally reproducing salmon populations.
- Identify, through negotiation or adjudication, instream flow water rights reserved by tribes' treaties.
- Implement actions to create wetlands, e.g., re-introduction of beavers.
- Implement actions needed to promote re-vegetation of riparian areas and de-compaction of soils where recovery is not occurring naturally.
- If necessary, initiate land management designed to return a watershed to a natural hydrologic regime, e.g., re-vegetation of areas adversely affected by past land- disturbing activities.

Expected Results

Short-term Halt the ongoing incremental losses of instream flows due to consumptive use or from land management activities that adversely affect natural watershed water storage and release processes.

Long-term Gradual improvements in the level of tributary instream flows. Increased spawning success and improve egg-to-smolt survival. As natural watershed processes are restored, more water will be available for instream and consumptive use year-round. Increased water use efficiency by existing consumptive users will, in some cases, result in greater water availability for additional consumptive uses.

Institution/Decision Structure

Federal and state water managers are called upon to enforce existing water rights, implement moratoria on all additional withdrawals of water, meter water withdrawals

Federal and state water managers must identify and assure implementation of best available water conservation methods.

Federal and state land managers must implement watershed protection measures to protect and improve natural watershed water storage processes. These efforts should be coordinated with federal and state water managers.

Federal and state water managers, along with federal, state and tribal fish managers must establish instream flows adequate to sustain healthy naturally reproducing salmon populations.

HYPOTHESIS **3** | **Watershed Restoration**

HABITAT: Tributary

Problem Statement

Some of the declining populations of naturally spawning salmon are at such low levels (e.g., spring chinook of the upper Grande Ronde River) that they may be extirpated before passive habitat restoration efforts yield significant

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benefits. Passive restoration involves curtailing or deferring activities that contribute to habitat degradation or forestall recovery. It is brought about by management that establishes riparian and roadless reserves and controls watershed-wide sediment delivery to streams to a level considered capable of allowing the stream channels to cleanse themselves of fine sediment, reestablish pools and channel morphology, and reduce embeddedness.

Active habitat restoration may be required in cases where watershed or stream restoration would not occur via natural processes for prolonged periods. However, past active restoration efforts (e.g., revegetating streambanks, providing instream structures, and obliterating roads) have frequently failed because of impacts (e.g., increased peak flows, sediment loads, and water temperatures) from cumulative actions elsewhere in the watershed (Beschta et al. 1991; Kauffman et al. 1993). Provided that land use standards are uniformly and consistently applied as described in Rhodes et al. (1994), including application of passive restoration techniques on a watershed basis, active watershed and riparian restoration (especially riparian planting of native vegetation, fencing, and road obliteration) will be an essential part of land management and restoration of in-channel habitat conditions.

Hypothesis

Active habitat restoration is needed to maintain and increase productivity of some of the naturally spawning salmon populations in areas where habitat is most damaged (e.g., many portions of the Yakima, Grande Ronde, Umatilla, and John Day Rivers). When it is part of a comprehensive watershed-based program that addresses cumulative impacts to in-channel habitat condition throughout salmon-bearing stream systems, active habitat restoration will increase egg-to-smolt survival, increase the productive capacity of watersheds for salmon and lamprey, and help halt present declines in these populations. Volume II describes many active restoration measures needed in subbasins above Bonneville Dam.

Recommended Actions/Tests

Short-term

- Implement active restoration measures identified in the Subbasin Plans in Volume II. Develop a tribal watershed restoration trust fund to fund restoration actions and provide active coordination and participation in watershed restoration activities through the provision of no less than 1 F.T.E. in each watershed. Ensure tribal participation and technical participation from the tribes in ongoing community based watershed councils to coordinate and implement watershed restoration actions. Organize community based watershed councils where appropriate.
- Develop, in cooperation with existing programs (e.g., Salmon Corps), active restoration projects in the Grande Ronde, John Day, and Yakima Rivers. Use, where appropriate, the Coarse Screening Process guidelines (Rhodes et al. 1994), other techniques, and problems identified in the Subbasin Plans to assist in the preservation and restoration of salmon populations identified as Badly Damaged and Declining by CRITFC (1992); to reconnect fragmented habitat for Badly Damaged and Declining populations, thereby restoring watershed-wide stream system integrity; and to improve chances for successful reintroduction to areas of extirpated salmon.
- Develop monitoring programs (baseline and trend, effectiveness, and validation at various geographic scales of resolution; see McCullough et al. (in press) for discussion of necessary forms of monitoring) in association with restoration projects to document recovery trends in habitat condition and to further define relationships among land use, instream habitat condition, and salmon production. Use community based watershed councils to develop volunteer monitoring programs to be used in conjunction with other scientific monitoring. These programs need to identify key land use-salmon production interactions, and effective ways to improve watershed conditions that degrade or impede habitat condition and

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decrease salmon production; be oriented toward application of measures known to be effective in promoting instream habitat recovery; and provide quantitative evaluation of the magnitude of improvement and rate of recovery of habitat quality and quantity, and associated benefits to salmon and lamprey survival and production.

Long-term

- Develop active habitat restoration and protection projects in additional watersheds as a part of ongoing and organizing community based watershed councils.
- Continue monitoring programs as needed for the purposes described in the short term.

Expected Results

Short-term Improvement in egg-to-smolt survival will be afforded some of the most threatened salmon populations (i.e., to those populations residing in watersheds selected as demonstration projects).

Long-term Assistance in rebuilding both the most seriously threatened salmon populations (e.g., Badly Damaged and Decreasing as defined by CRITFC 1992a) and also those populations that may be stable but confined to low production levels as a result of poor habitat quality/quantity or fragmented habitat. This is a result of improvement in habitat quality and quantity and stream system integrity. Survival rates and population densities for salmon and lamprey will increase, and thus restore a degree of buffering against natural environmental fluctuations.

The watershed productivity for salmon and lamprey will increase, and natural communities and ecological functions will be restored by increasing the quantity of usable habitat. In addition, connections will be reestablished among sections of fragmented salmon habitat, thereby improving stream system integrity.

By intensive monitoring of various representative stream reaches, entire stream systems, riparian areas, and watershed conditions in salmon-bearing watersheds, models used by land managers will be improved to better assist in controlling impacts or predicting improvements from restoration actions.

The ability to prescribe active restoration measures (e.g., plant species for revegetation) from identification of limitations to habitat recovery (e.g., riparian soil or hydrologic conditions) on a site-specific scale will improve.

Institutional/Decision Structure

Federal, state, tribal land and fishery managers as well as counties, local governments, and private landowners will be responsible for developing cooperative arrangements for land and water management activities which will increase salmon productivity using appropriate techniques. Monitoring must be used to ensure actions will provide increased productivity and to understand the connectivity of actions within the Columbia River Watershed.

HYPOTHESIS 4 | **Supplementation**

HABITAT: Tributary

Problem Statement

Many naturally spawning salmon populations in the Columbia River Basin are severely depressed, declining, and will be extirpated unless effective remedial actions are taken immediately (Nehlsen et al. 1991; CRITFC 1992; Fryer and Mundy 1993).

Supplementation has been and is being used successfully to rescue endangered species such as the greenback trout (U.S. Fish and Wildlife Service 1993), Lahontan cutthroat trout (U.S. Fish and Wildlife Service 1992), and peregrine falcon (U.S. Fish and Wildlife Service 1979,

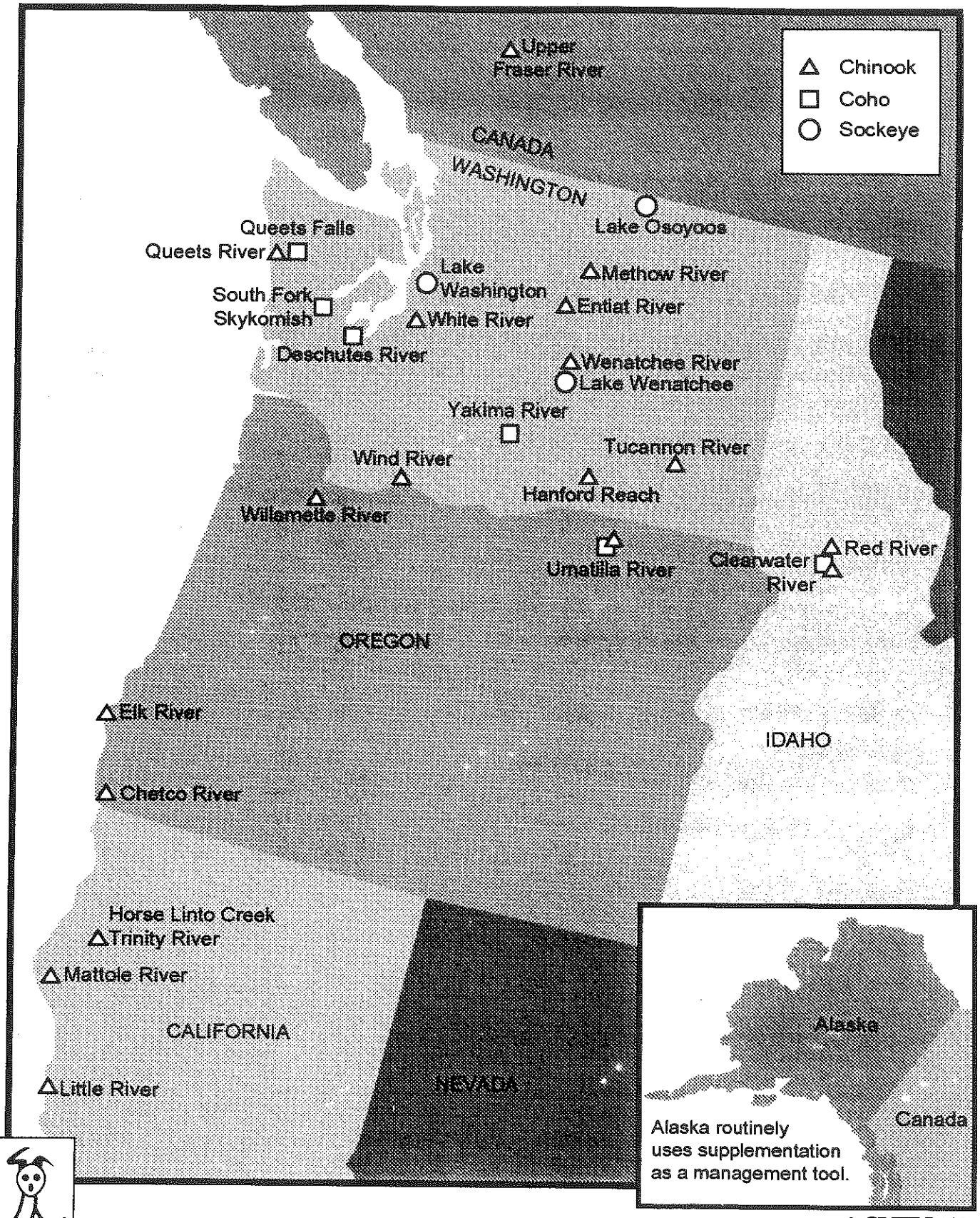

Figure 5B.2 Supplementation projects in the Pacific Northwest.

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1982) and for salmon in other locations (Figure 5B.2). Supplementation relies on the natural environment for the majority of the life cycle, and is less intrusive than expensive captive breeding programs. It is an appropriate tool for use with populations that are fragmented and declining, and where other remedial actions cannot be implemented quickly enough or on a scale that is large enough to halt further population losses. In these cases, survival of a portion of the natural population would be increased by rearing in a hatchery. Conditions in the hatchery should simulate natural conditions as much as necessary to ensure that the original and supplementation groups are managed as one gene pool (Cuenco *et al.* 1993).

Supplementation has been successful in rebuilding salmon populations in Horse Linto Creek (Buck 1990; Farro 1993), and Red River (White and Cochnauer 1989; Cochnauer and Elam 1990). Volume II of this plan sets forth numerous tribal supplementation proposals. Guidelines and procedures for applying supplementation strategies to Pacific salmon have been developed (RASP 1992; Cuenco et al. 1993) to ensure that the additional fish complement existing production and are able to survive and reproduce in the natural environment. Nevertheless, NMFS policies on artificial propagation under the Endangered Species Act have prevented implementation of tribal supplementation projects.

Hypothesis

Supplementation can be used to increase survival of naturally spawning salmon populations in the Columbia River Basin during the egg-to-smolt stage. This increased survival, in combination with other actions (e.g. passage protection and habitat restoration), is sufficiently large to halt and reverse present population declines.

Recommended Actions/Tests

<u>Short-term</u> Implement supplementation projects that have met the screening criteria of RASP (1992) and Cuenco et al. (1993). Volume II of this plan identifies supplementation actions for watersheds above Bonneville Dam. Table 5B.4 identifies facilities needed for broodstock and acclimation/final rearing for supplementation and reintroduction (hypothesis 5) actions called for in Volume II. High priority supplementation projects include:

- Entiat River spring chinook.
- Methow Subbasin spring chinook.
- Clearwater Subbasin (Meadow Creek, McGruder corridor) spring chinook.
- Grand Ronde Subbasin (Catherine Creek, Lookingglass Creek, Upper Grande Ronde) spring chinook.

Implement supplementation projects for other declining populations (identified in the Subbasin Plans and by CRITFC 1992) according to the RASP (1992) and Cuenco et al. (1993) protocols. Review and implement tribal proposals for supplementation according to the Cuenco *et al.* (1993) protocol.

Develop experimental and monitoring programs in association with these projects to study the relationships between natural and supplemented components of the populations.

<u>Long-term</u> Continue the successful short-term programs and modify less successful short-term programs consistent with supplementation protocols.

Expected Results

Supplementation will 1) provide a refuge from severe environmental disturbance for a portion of native populations, 2) minimize further loss in genetic variability by stabilizing and potentially increasing the gene pool, and 3) restoring the role of salmon in affected ecosystems (Meffe and Carroll 1994; Brown 1995).

Salmon stocks at risk will be stabilized from further loss, with subsequent increases in abundance in naturally reproducing populations.

Institutional/Decision Structure

Supplementation projects will be coordinated through the *U.S. v Oregon* Production Advisory Committee according to the guidelines provided

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Table 5B.4. Summary of supplementation and reintroduction recommendations for rebuilding runs of anadromous salmonids in Columbia River subbasins.[a] See Volume II for details.

SUBBASIN		FISH TO BE RELEASED (millions)						
		Chinook						
RELEASE SITE	HATCHERY	Fall	Spring	Summer	Coho	Sockeye	Steel-head	NEEDS
LOWER COLUMBIA RIVER MAINSTEM (Bonneville Dam → McNary Dam)								
hat.[b]	Spring Creek	14.4T[c]						Ø [d]
Rock Cr. Net Pen	Bonneville	0.5B						Ø
tbd	Oxbow	3.0T						tbd
Wind River								
hat.	Carson		1.6					Ø
NPA	Carson		1.0					A,T
NPA	Spring Creek	1.0T						Ø
NPA	Willard				≤ 0.5			A
NPA	Skamania						0.15	A,T
Little White Salmon River								
hat.	L Wh Salmon	2.0	0.5					Ø
NPA	L Wh Salmon		0.5					A
Big White Salmon River								
NPA	B Wh Salmon		0.45					A,T
NPA	Skamania						0.15	A,T
Hood River								
NPA	Pelton Ladder (Not listed)		0.125					A,T
NPA	Oak Springs						0.1	A,T
Klickitat River								
NPA	Klickitat		0.6					A,T
NPA	Y-K Project		tbd				tbd	A,T
hat.	Klickitat	4.0B						Ø
NPA	Washougal				2.5L[e]			A
NPA	Washougal							A
NPA	Skamania						0.2	A,T

[a] These recommendations, the result of initial assessments, will be prioritized and probably modified during implementation.

[b] hat. = hatchery; NPA = natural production area; tbd = to be determined

[c] T = tule fall chinook; B = bright fall chinook; tbd = to be determined.

[d] Ø = none; A = Acclimation facilities; T = adult Trap; tbd = to be determined.

[e] L = late run; E = early run

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Table 5B.4. *(continued)*

SUBBASIN / RELEASE SITE	HATCHERY	FISH TO BE RELEASED (millions) Chinook Fall	Chinook Spring	Chinook Summer	Coho	Sockeye	Steel-head	NEEDS
Deschutes River								
Adult Trap	Round Butte		0.3					A,T
NPA	Round Butte						0.16	T
NPA	tbd					tbd		tbd
hat.	Warm Springs		0.7					T
Umatilla River								
NPA	Bonneville	0.225B						∅
NPA	Bonneville		0.35					A
NPA	Umatilla		0.61					∅
NPA	Umatilla	5.94B					0.15	A
NPA	Cascade				1.0E			A
NPA	NE Oregon		0.589					∅
NPA	Herman Cr. Pond				0.5E			A
***MID-COLUMBIA RIVER MAINSTEM** (McNary Dam → Chief Joseph Dam)*								
Hanford NPA	Priest Rapids	6.7B						∅
Hanford NPA	Bonneville	4.0-5.0B						∅
Hanford NPA	Hanford K	≤ 5.0B						∅
Hanford NPA	Ringold SP	5.5B						∅
NPA	Ringold SP		1.0					A,T
NPA	Ringold TP						0.18	A,T
Walla Walla River								
NPA	NE Oregon		0.6				0.1	A,T
NPA	Willard			tbd				tbd
NPA	Lyons						0.38	A,T
Yakima River								
NPA	Y-K Project		1.125		2.0			A
Naches NPA	Y-K Project			0.2				A
NPA	Y-K Project	1.3B					0.4	A,T
Marion Drain	Y-K Project	1.3B						A,T
NPA	Cascade					0.7		A
Wenatchee River								
Nason Cr.	Leavenworth		0.4					A,T
White R.	Leavenworth		0.2					A,T
L. Wenatchee R.	Leavenworth		0.1					A,T

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Table 5B.4. *(continued)*

SUBBASIN		FISH TO BE RELEASED (millions)						
		Chinook						
RELEASE SITE	HATCHERY	Fall	Spring	Summer	Coho	Sockeye	Steel-head	NEEDS
hat.	Leavenworth		0.2					∅
Upr. Wenatchee R.	Leavenworth		0.1					A,T
Chiwawa R.	Eastbank		0.672					∅
NPA	Eastbank			0.84				∅
Lake Wenatchee	Eastbank					0.25		∅
NPA	Willard				≤ 0.5			A
NPA	Eastbank						0.2	A,T
NPA	Leavenworth						0.1	A,T
Entiat River								
NPA	Entiat		0.8					A,T
NPA	Eastbank			tbd				A,T
NPA	Turtle Rock				0.5			A,T
NPA	Willard				≤ 0.5			∅
NPA	Chelan						0.195	A,T
NPA	Eastbank						≤ 0.2	∅
Methow River								
NPA	Methow		0.246					A,T
Twisp R. NPA	Methow		0.246					∅
Chewuck NPA	Methow		0.246					∅
NPA	Winthrop		0.3					∅
Twisp R. NPA	Winthrop		0.25					∅
Chewuck NPA	Winthrop		0.25					∅
Lost R. NPA	Winthrop		0.2					A,T
NPA	Eastbank			0.4				∅
NPA	Wells			2.2				∅
NPA	Turtle Rock				0.5			A,T
NPA	Wells						0.3	A,T
Okanogan								
NPA	Wells			1.1			0.225	A,T
Similkameen NPA	Wells			1.1				T
Similkameen NPA	Eastbank			0.576				∅

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Table 5B.4. *(continued)*

SUBBASIN RELEASE SITE	HATCHERY	FISH TO BE RELEASED (millions) Chinook Fall	Spring	Summer	Coho	Sockeye	Steel-head	NEEDS
Lake Osoyoos	Net Pens[f]							∅
						0.375		
NPA	Turtle Rock				0.5			A
***LOWER SNAKE RIVER MAINSTEM** (Ice Harbor Dam → Hells Canyon Dam)*								
NPA	Lyons F.	tbd						A
hat.	Lyons F.						0.07	∅
Asotin NPA	Lyons F.						tbd	A,T
Tucannon River								
NPA	Lyons F.		0.132					A
NPA	Lyons F.						0.12	∅
NPA	Bonneville				tbd			A
NPA	Lyons F.	0.5B						A,T
Clearwater River								
hat.	Dworshak		0.4					∅
Eldorado Cr.	Dworshak		0.2					A,T
Squaw Cr.	Dworshak		0.2					A,T
Pete King Cr.	Dworshak		0.1					A,T
Papoose Cr.	Dworshak		0.1					A,T
White Sands	Dworshak		0.4					A,T
Crooked R.	Dworshak		0.2					∅
Selway R.	Kooskia		0.5					A,T
Selway R.	Clearwater		0.5					A,T
American R.	Clearwater		0.27					A,T
Crooked R.	Clearwater		0.2					A,T
Red R. Pond	Clearwater		0.35f[g]					∅
Crooked R. Pond	Clearwater		0.79f					∅
Powell R. Pond	Clearwater		0.35f					∅
Lolo Cr.	Nez Perce		0.5-0.75					A,T
Eldorado Cr.	Nez Perce		tbd					T
Meadow (Selway)	Nez Perce		0.5-1.0					A,T
Newsome Cr.	Nez Perce		0.3-0.4					A,T

[f] Wells Dam settlement.

[g] f = fingerlings (or presmolts), scheduled for release late summer or early fall.

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Table 5B.4. *(continued)*

SUBBASIN		FISH TO BE RELEASED (millions)						
		Chinook						
RELEASE SITE	HATCHERY	Fall	Spring	Summer	Coho	Sockeye	Steel-head	NEEDS
Mill Cr.	Nez Perce		tbd					A,T
Meadow (Selway)	Kooskia			0.3				A,T
NPA	Clearwater			0.4				∅
NPA	Lyons F.	≤ 4.5B						A
NPA	Nez Perce	0.5-0.8B						A
Orofino Cr.	Sandy				0.5			A
Fish Cr.	Sandy				0.5			A
NPA	Hagerman						0.5B[h]	A,T
NPA	Magic						1.0B	A,T
M. Fk & Lochsa tribs NPA	Clearwater						2.5B	A,T
S. Fork tribs NPA	Dworshak						1.3-2.5B	A,T
Grande Ronde River								
NPA	Lookingglass		0.90					A,T
Catherine Cr.	Lookingglass		0.25					A,T
NPA	Lyons F.	tbd						∅
NPA	Bonneville				2.0			A,T
Upper NPA	Irrigon						1.35	A
Lower NPA	Lyons F.						0.225	∅
Wallowa Lake	tbd					tbd		tbd
Salmon River								
Upr. Salmon	Sawtooth		0.9					A
Upr. E. Fork	Sawtooth		0.5					A
Herd Cr.	Sawtooth		0.1					A,T
Upr. Yankee Cr.	Sawtooth		0.2					T
Lemhi R.	Sawtooth		0.6					A,T
Upr. Yankee Cr.	Yankee Fk RP		0.2					∅
hat.	Rapid River		2.5					∅
Ltl. Salmon R.	Rapid River		0.5					A,T
Slate Cr.	Nez Perce		tbd					A,T
NPA	Pahsimeroi			0.6				A,T
Lwr. E. Fork	Pahsimeroi			0.2				A,T

[h] B = B-run; A = A-run

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Table 5B.4. *(continued)*

SUBBASIN RELEASE SITE	HATCHERY	FISH TO BE RELEASED (millions) Chinook Fall	Spring	Summer	Coho	Sockeye	Steel-head	NEEDS
Lwr. Valley Cr.	Pahsimeroi			0.2				A,T
S. Fork Salmon	McCall			0.7				A
Johnson Cr.	McCall			0.3				A,T
Upr. Salmon NPA	Hagerman						1.9A	A,T
Upr. Salmon NPA	Magic						1.0A	A,T
Lwr. Salmon NPA	Niagara						1.0A	A,T
Stanley Lk. NPAPP	PP Salmon					0.5		A
Lake NPA	PP Salmon					0.5		A
Pettit Lk. NPA	PP Salmon					0.5		A
Alturas Lk. NPAPP	PP Salmon					0.5		A
Salmon R. Lk. System NPA	Nez Perce					tbd		—
Imnaha River								
Imnaha R.	Lookingglass		0.492					A,T
Imnaha R.	Lyons F.	tbd						A
Imnaha R.	Irrigon						0.33	A,T

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by Cuenco *et al.* (1993). Tribes and states will implement supplementation projects using the resources of the Mitchell Act, Lower Snake River Compensation Program, Northeast Oregon Production Project, Yakima Production Project, Nez Perce Tribal Hatchery, and other resources which may become available.

HYPOTHESIS 5 | **Reintroductions**

HABITAT: Tributary

Problem Statement

Salmon populations have been extirpated from many areas of the Columbia River Basin where productive spawning and rearing habitat remains (NPPC 1986; Nehlsen et al. 1991; CRITFC 1992). This has occurred for a number of reasons, which include degraded tributary habitat, poor mainstem passage survival, and over harvest.

The present system of hatcheries was intended to replace salmon production lost when dams blocked formerly productive portions of the basin or flooded existing spawning areas. Although these areas were located in the upper basin, where tribal usual and accustomed fishing places exist, the majority of the mitigation hatcheries were located in the lower basin. Thus, the bulk of the fish produced by the mitigation hatcheries are not returned to the areas where the fish losses occurred and where tribal fisheries are located. Even where the hatcheries are located in the areas of loss, e.g. the Lower Snake River Compensation Program, mitigation was not always in-place, in-kind. Moreover, evaluation of these programs has been measured by the weight of smolts produced rather than the number of adults returned. As a result of these problems, tribal fishery needs are not being met, naturally reproducing stocks are in danger of being extirpated, resources have been optimized to produce smolt rather than adults, and the tribes' management authority over a significant portion of their historic fisheries has been diminished.

Hypothesis

Supplementation can be used to reintroduce salmon to many areas from which they have been extirpated, given that suitable spawning and rearing habitat is available in the native range, and a suitable donor stock is available.

Recommended Actions/Tests

Short-term

- Implement reintroduction projects that have met the screening criteria of Cuenco, *et al.* (1993) and RASP (1993). Table 5B.4 identifies facilities needed for broodstock and acclimation/final rearing for supplementation (hypothesis 4) and reintroduction actions called for in Volume II. High priority reintroductions include:

  Clearwater Subbasin (Meadow Creek) summer chinook

  Clearwater Subbasin (North Lapwai Valley, Fenn Pond) fall chinook

  Yakima Subbasin (Wapato Canal, Roza Wasteway, Upper Yakima, Naches) coho

  Walla Walla Subbasin spring chinook

  Grande Ronde Subbasin coho and sockeye

- Identify other high priority reintroduction indicated in CRITFC (1992), and the Subbasin Plans in Volume II. Using the Cuenco *et al.* (1993) process, develop and implement reintroduction plans. Coordinate reintroduction projects with habitat protection and restoration efforts.

Long-term Continue the successful short-term programs and modify less successful short-term programs consistent with supplementation protocols.

Expected Results

Total salmon production in the Columbia River Basin will increase through utilization of present-

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ly unused freshwater areas. The reintroduced populations may provide a buffer against extirpation and additional reservoirs of genetic resources.

Institutional/Decision Structure

Reintroduction projects will be coordinated through the *U.S. v Oregon* Production Advisory Committee according to the guidelines provided by Cuenco *et al.* (1993). Tribes and states will implement supplementation projects using the resources of the Mitchell Act, Lower Snake River Compensation Program, Northeast Oregon Production Project, Yakima Production Project, Nez Perce Tribal Hatchery, and other resources that may become available.

Problem Statement

The immediate and cumulative impacts of irrigation withdrawals, loss of mainstem littoral habitat through shoreline development, dredging, navigation, and point and nonpoint source pollution has highly impacted anadromous fish stocks as they spawn, rear and migrate through the mainstem Snake and Columbia rivers. However, while these activities have had profound impacts, they are largely unquantifiable. What has been quantified through many years and millions of research dollars are the impacts of construction and operation of mainstem and tributary hydroelectric projects. These have been particularly responsible for decimating anadromous fish through direct kills, selection against critical life history diversity and profound changes to the ecosystem and trophic structures in which salmonids evolved (NWPPC 1986; Mundie 1991; Diamond and Pribble 1979; Petts 1980).

HYPOTHESIS 6

Juvenile Salmon Passage

HABITAT: Mainstem

The Columbia River basin is probably the most dammed river system in the world. Since the construction of the first dams on the Willamette and Spokane rivers in the late 1800's, a total of 136 dams for hydropower and other purposes have been built in the basin (NWPPC 1986). The impounded portions of these rivers have undergone significant environmental change from their lotic, or free-flowing, ecology to biological and physical conditions associated with standing bodies of water. The migrations of juvenile salmon through the impounded mainstem sections of the Columbia and Snake are significantly affected as a result of the dams. For instance, juvenile salmon originating in the Lochsa River in Nez Perce Tribe's ceded area in central Idaho must traverse eight hydroelectric projects and approximately 300 miles of impounded river.

Estimates of cumulative mortality from the effects of hydropower development and operation range from 35% to 96% in the juvenile life stage (NMFS 1995). Reductions in smolt-to-adult survival have coincided with increased numbers of dams, turbines, increased storage capacity, decreased spill, and decreased flow (Raymond 1988; Petrosky 1991). Attempts to isolate and quantify the magnitude of mortality resulting from various aspects of the hydrosystem are difficult, because the sources of mortality do not operate independently from one another on affected salmon populations. Nonetheless, numerous studies have addressed major impacts -- e.g., water flow, turbines, water quality, spill, transportation, and structural barriers -- regarding juvenile passage through the hydroelectric system.

Selective mortality to particular life histories from hydrosystem impacts may be responsible for large reductions in overall population diversity and viability (Lichatowich and Mobrand 1995). Schluchter and Lichatowich (1977) showed that diversity in life history types influenced juvenile growth rates which in turn increased the variability at age of maturity, and that the existence of variable life history types lend stability to a stock. Different juvenile life histories have different migration times and

ing areas, thus there is a reduced probability of a single environmental disturbance impacting all life histories. They suggested that the annual abundance of adults in a stock containing multiple age classes would be stabilized because impacts to the variability of successes among broods would be distributed over several age classes in future adult populations.

Water Flow: Columbia and Snake river spring and summer flows have been substantially reduced as a result of hydropower, flood control, navigation, and irrigation development (Figure 5B.2). Reduced flows have changed the geometry of the river channel and water quality, and have increased the travel time of juvenile salmon to the ocean (CBFWA 1991; Cada et al. 1993). Increased travel time reduces juvenile salmon survival as a result of: residualism in reservoirs; reduced ability of juvenile migrants to tolerate saltwater; delayed entry into the estuary and ocean past the time period when conditions are most favorable for survival; increased exposure to predators; and exposure to increased water temperatures (Jaske and Goebel 1967; Diamond and Pribble 1978; Li et al. 1987; Vigg 1988; CBFWA 1991; Karr et al. 1992).

Turbines: Raymond (1979, 1988) and Anderson (1988) note that anadromous salmonid stocks in the Columbia River Basin are declining as a result of numerous factors, including installation and operation of turbines at mainstem Snake and Columbia river dams. Downstream migrating juveniles incur direct and indirect mortality when they pass through mainstem Kaplan turbines at hydroelectric dams (Wagner 1991; Bjornn and Peery 1992). Long et al. (1968) reported 30% combined turbine and predation mortality at Ice Harbor Dam. Reviews of turbine passage studies have concluded that turbine passage causes 10-30% direct mortality (NPPC 1986; Columbia Basin Tribes 1993). Further, the stress of turbine passage may affect resistance to disease (Maule et al. 1988; 1989) and ability to avoid predators (Olla and Davis 1989).

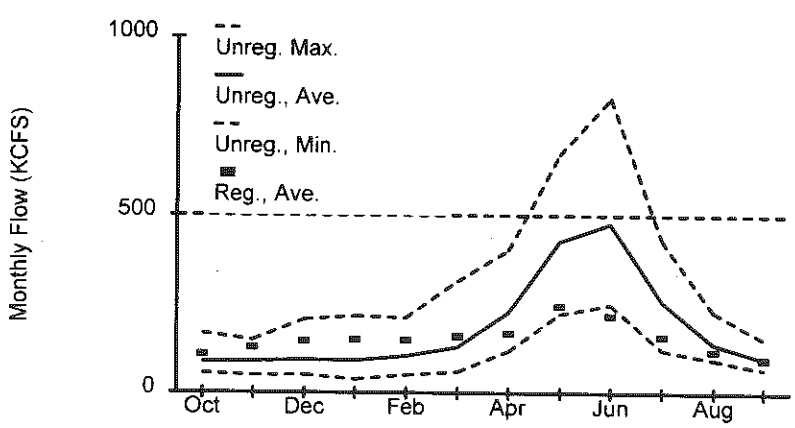

Figure 5B.3. Long-term unregulated (1928-89; BPA 1993) and regulated (1991-94) monthly Columbia R. flows at The Dalles.

River Ecology: The construction and operation of dams and cumulative impacts of mainstem habitat degradation have brought about many changes to physical and biological conditions to which salmon adapted, including changes in water quantity and quality (e.g. organic and inorganic sediment routing, turbidity and temperature) and the abundance of predator species (Junge and Oakley 1966; Li et al 1987; Petts 1980). Studies of predation in John Day Reservoir in the mid-1980's showed that predators may have consumed 2.7 million juvenile salmon annually, with most of the consumption by big mouth minnows. Ruggerone (1986) estimated that gulls consumed 2% of the entire spring migration as they passed through the tailrace of Wanapum Dam. Changes in temperature conditions are addressed in the section on mainstem passage of adult salmon. As seen in other riverbasins worldwide, the loss of floodplain habitat by the operation of dams, dredging and shoreline development may be a key factor limiting anadromous fish production and diversity (Dodge 1989).

Transportation: Mass collection and transportation of juvenile salmon by long haul barging and trucking has not offset the decline of Snake River salmon (Congleton et al. 1984;

NMFS 1995) (Figure 5B.4). While numerous experiments to measure the effect of transportation have been conducted since 1968, because of poor study design, there is still little or no definitive information to compare the cumulative and synergistic effects of transportation against historical passage conditions (e.g., spill, and increased flow) which supported sustained levels of stock productivity (Mundy et al. 1994). For example, the impact of juvenile transportation upon adults returning to the spawning grounds has never been fully investigated, although analysis by state, tribal and federal salmon biologists suggested that the overall effect has been negative (TRG 1993).

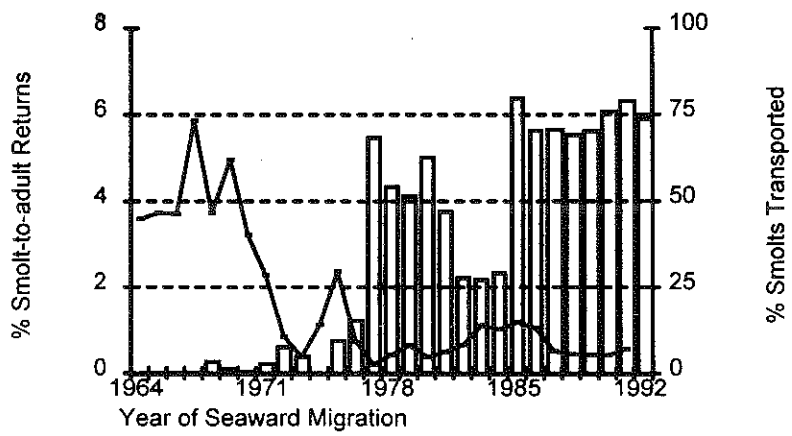

Figure 5B.4. Percent of smolts transported from the Snake R. and the percent of those returning as adults (from NMFS 1995).

It is likely that the transportation process (diverting juveniles into screened bypass systems, dewatering, sorting, handling, loading and unloading) is causing a selective mortality function to Columbia basin stocks as a whole, because when the transportation process is invoked, it precludes the use of spill and additional flow. Yearling juveniles, which are larger and have undergone greater physiological development, tend to be diverted by screened systems in much greater numbers than subyearlings and fry. For example, fish guidance efficiency (FGE) at Lower Granite Dam for yearlings is estimated at about 60%, while FGEs for subyearlings is estimated at 30% or less. Thus, 70% of the subyearling run is subjected to turbine passage, guidance screen impingement and density dependent mortality in reservoirs. As well, the transportation process further selects against the subyearling life history when guided fish are subjected to extremely high water temperatures within screen bypass systems. For example, in 1994, an estimated 100,000 subyearling chinook were lost in the McNary Dam screened system from thermal shock.

The transportation process further selects against the subyearling life history with respect to the timing of juvenile maturation. To achieve proper size at saltwater entry for ocean survival, juveniles must rear as they migrate downstream (Reimers 1973; Nicholas and Hankin 1988). Proper size at saltwater entry has been documented to be extremely important to survival to adult and age of maturation. For example, Reimers (1973) used scale analysis to find that returning adult fall chinook originated largely from juveniles which attained a size of 10-12 cm at saltwater entry. The transportation process interrupts rearing timing and places subyearlings in the lower Columbia in one or two days when under natural migration conditions, the juveniles would have utilized over a month to achieve the proper size for saltwater entry.

Historically, the subyearling life history dominated as the most abundant life history form basinwide. It is likely that this particular life history has been expressed to allow for stock resiliency in the face of changing environmental conditions (Lichatowich 1993; Schluchter and Lichatowich 1977). The continued selection against the subyearling life history by the use of the transportation process likely has and will

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continue to impact critical life stages such as freshwater and marine growth, age at maturation, fecundity, and spawner distribution. As these elements are profoundly impacted, peaks and troughs in stock abundance and the loss of diversity will become more extreme until extirpation eventually occurs.

Transportation has not resulted in improving smolt to adult survival rates to ranges necessary for restoration of basin salmon stocks. Unless these rates can be improved to historical ranges as documented by Raymond (1988), the issue of transportation is moot (Mundy et al. 1994).

Hypothesis

In an adaptive management context, changes in hydrosystem configurations and operations intended to improve juvenile salmon productivity and improvesurvival must be sufficient in magnitude to produce a detectable response in salmon populations. A prescribed set of actions, taken in concert with one another because effects are interactive and cumulative, can result in a three to five-fold increase in survival for salmon stocks originating above eight or more dams. These actions include:

Water Flow: Adequate flows are necessary to restore mainstem habitat and promote life history diversity. Specifically, these will reduce smolt exposure time to adverse conditions, and facilitate their urge to migrate once triggered by physiological cues. Adequate flows also improve the effectiveness of spill, allow for more efficient turbine operations, reduce water temperatures, and improve bypass system performance. In the long-term, water flow actions should be based on an approach to recreate the natural hydrograph and reduce hourly and daily fluctuations due to power peaking (Figure 5B.5). With respect to daily and hourly flows, assume no more than a 10% variance in flow volumes at any specific point in the river in a 24 hour period. Provide flow minimums which are biweekly averages with weekend and holiday flows at least 80% of the previous five days flow levels.

Turbines: Operation of turbines to maximize hydraulic efficiency improves the survival of juvenile and adult salmon that pass through turbines during their migration. Structural and nonstructural measures related to avoidance of turbine passage are discussed below.

Spill: Controlled spill improves passage survival of migrating salmon and steelhead and lamprey at mainstem hydroelectric projects. Spill allows juvenile migrations to pass hydroelectric projects without passing through turbines, reduces travel time through reservoirs, and reduces predation. In general, juveniles passed with controlled spill experience only 0-3% mortality (Holmes 1952; NPPC 1986; Raymond 1988; Ledgerwood *et al.* 1990). A program of controlled spills which maximize spill efficiency to allow 80-90% of juvenile migrants to pass each dam by nonturbine routes without creating unacceptable levels of dissolved gases should be implemented at all mainstem dams.

Transportation: Recognition that transportation is not part of a salmon recovery program. Halting barging and trucking salmon allows testing of alternative passage measures, otherwise foreclosed by transport measures. Alternative

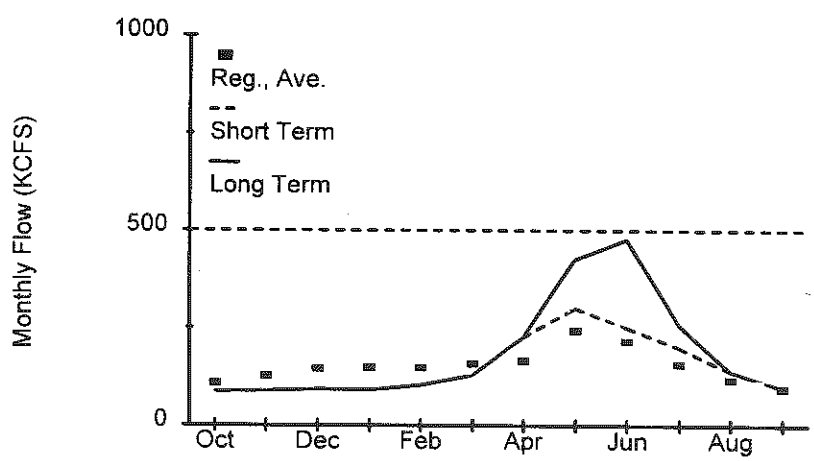

Figure 5B.5. Tribal short-term and long-term Columbia R. (The Dalles) flow plans relative to recent regulated averages.

otherwise foreclosed by transport measures. Alternative passage measures such as increased flows and spill have a proven historical basis (Raymond 1988) and are supported by studies of riverbasins worldwide (Dodge 1989) for increasing fish production.

Structural Considerations: Numerous studies have identified structural changes to improve juvenile salmon survival (U.S. Army Corps of Engineers 1992-5). Current structural features at the dams are inadequate for juvenile salmon passage. For instance, mortality to juveniles that travel through mechanical bypass systems ranges from 2 to 17% (NPPC 1986; WDFW 1994). Major structural modifications at mainstem dams are needed. Permanent drawdown of certain Snake and Columbia river reservoirs should substantially benefit the survival of migrating juvenile salmon. Further development of surface oriented bypass systems in conjunction with spill are warranted (HTI 1995). Other needed modifications include changes to existing juvenile mechanical bypass systems and installation of fliplips at dams and other gas abatement structures where excess total dissolved gas from uncontrolled spill can cause gas bubble trauma. Measures such as load shifting must be instituted to deal with over-generation spill during times of high flows to allow operation of turbine units to control high dissolved gas levels resulting from otherwise uncontrolled spill.

Recommended Actions/Tests

Implement a program of short-term and long-term juvenile passage and mainstem habitat restoration measures at federal and nonfederal dams on the mainstem Snake and Columbia rivers. Utilize the historical Columbia basin and information from river basins worldwide as templates to establish protocols and to measure comparative progress. Establish a monitoring program jointly designed by tribal, state, and federal fish management agencies to estimate smolt-to-adult survival and individual stock production and fitness. Use noninjurious measurement techniques, such as sonar and scale-sampling procedures, to rigorously enumerate stock responses through precise dam and spawning ground counts. Emphasize measurements of life history characteristics such as time and size at important life history stages instead of complete reliance of studies of survival and abundance because the former are more statistically sensitive to change (Cramer and Lichatowich 1979; Lichatowich a[illegible] Mobrand 1995). In-season manage[illegible] juvenile passage measures should [illegible] on cooperative efforts of federal, state, [illegible]tribal governments.

Table 5B.5. Sliding scale flow targets (kcfs) to be achieved at The Dalles. Flow targets are tied to critical-year firm energy load carrying capability (FELCC) declarations as defined by the Pacific Northwest Coordination Agreement.

	PERIOD						
			June				
YEAR	April 15-30	May	1-15	16-30	July	August	September
1	300	300	300	250	200	160	120
2	260	260	260	250	200	160	120
3	220	220	220	200	200	160	120

Short-term

Water flow: Implement instream flow measures (Table 5B.5) in the Snake and Columbia rivers.[1] Flow measures for the mainstem Snake River are defined in terms of volumes of water to be provided for flow augmentation. Columbia River are defined in terms of minimum instream flows as measured at The Dalles Dam. Canadian reservoirs, comprising approximately one-half of the Columbia River's storage, must be drafted as necessary to meet the flow targets at The Dalles. The targets change based upon

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reservoir conditions at the conclusion of each water year. These reservoir conditions generally reflect sequences of dry years, e.g. second critical year firm energy load carrying capability (FELCC) declarations generally reflect the second year of a two year drought. The sliding scale at the Dalles also includes a formula for increasing the flows based on storage capacities in above average water years, such that 40% of the runoff above average runoff volume at Hungry Horse and Libby dams would be provided in addition to the flow targets.

Provide the following Snake River flow augmentation volumes managed at the direction of the Columbia River treaty tribes and state and federal fishery agencies:

- Upper Snake -- (1-3 maf)
- Brownlee -- (450 kaf)
- Dworshak -- (1.5 maf spring, 1.0 maf summer. To minimize impacts on Dworshak resident fish, wildlife, and cultural resources and allow use of Dworshak for summer temperature control), priority for meeting flow needs shall be achieved from Upper Snake River storage. Springtime operation of Dworshak should attempt to mimic natural runoff.

Turbines: Avoid operating turbines outside of 1% of peak efficiency. Completely avoid excursions during peak migration periods, particularly at projects which are experiencing large juvenile and adult migrations. Complete index testing of all river turbine units. Implement powerhouse optimization programs to improve turbine operating efficiencies at all dams. Examine the theory of increasing fish survival through increasing wicket gate openings.

Spill: Implement a program of controlled spill to achieve an 80% fish passage efficiency (fish passing by nonturbine routes), while managing spill so that dissolved gas concentrations do not exceed 125-130% daily average total gas pressure. Spill efficiency should be maximized through the use of hydroacoustic monitoring across the entire dam, installation of full flow surface bypass systems and implementation of evaluated spill patterns. Dissolved gas monitoring measures should be implemented as a part of this program to identify physical aspects of the gas plumes in the water column and to determine effects on fish in the river.

Predator Control: Continue evaluation of site specific intensive removal of predaceous bigmouth minnow. Implement evaluation of control programs for other predators including seagulls, bass, and walleyes.

Table 5B.6. Prescribed minimum flows (kcfs) for the lower- and mid-Columbia and lower-Snake river mainstems.

MAINSTEM REACH and MONITORING POINT	PERIOD													
							Apr					Aug		
	Oct	Nov	Dec	Jan	Feb	Mar	1-15	16-30	May	Jun	Jul	1-15	15-31	Sep
LOWER-COLUMBIA The Dalles Dam	89	90	96	92	102	123	210	235	426	483	265	170	113	99
MID-COLUMBIA Priest Rapids Dam	55	55	55	55	55	55	100	140	295	358	214	130	92	69
LOWER SNAKE Lower Granite Dam	25	28	32	32	37	48	70	94	122	113	40	21	21	21

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Transportation: Halt mass transport barging and trucking of juvenile anadromous salmonids from Snake and Columbia river dams.

Structural Measures:

- Drawdown: Implement measures necessary to lower the surface elevations of mainstem reservoirs in an adaptive management framework that includes biological, economic, and cultural study and mitigation measures agreed to by the Columbia River treaty tribes. Drawdown should be implemented on permanent (i.e. not seasonal) basis for ecosystem considerations. Implement the following measures as soon as possible.
  - + John Day Dam should be drawn down to minimum operating pool, elevation 257 msl, by the 1996 juvenile salmon migration;
  - + Lower Granite should be drawn down to elevation 710 msl by the 1996 juvenile salmon migration;
  - + Little Goose, Lower Monumental, and Ice Harbor dams should be operated at minimum operating pool from April 15 to October 31; and
  - + Engineering and related planning should be undertaken in cooperation with tribes for long-term drawdown options identified below.

Surface bypass: Expedite prototype development of surface flow bypass systems, particularly to address passage needs at Bonneville, John Day, The Dalles, Ice Harbor, Rocky Reach, and Priest and Wanapum dams.

Other measures: Install fliplips at John Day, Ice Harbor, Wanapum, and Rocky Reach dams as soon as possible. Immediate investigate gas abatement solutions at Bonnville Dam and install structural measures to remedy problems as a top priority. Evaluate the benefits of modifying the juvenile bypass outfall location at Bonneville Dam.

Cultural resources protection: Before proceeding with any reservoir actions that may expose Indian burial sites, village sites, or other Indian cultural resources of the Columbia River treaty tribes, the Corps of Engineers shall implement a plan for protection of these sites and resources, including mitigation of any impacts, which has been developed in cooperation with the affected tribe. The Corps of Engineers and the U.S. Department of Justice will enter immediate consultations with the tribes to address tribal cultural resource protection needs.

Monitoring and evaluation: Monitor and evaluate salmon responses to restoration measures to the hydropower system by developing experimental and sampling designs for estimating total hydrosystem passage survival. Also evaluate restoration actions by measuring changes to statistically sensitive life history parameters such as time and size of juvenile entry into saltwater and timing and distribution of adult spawners (Lichatowich and Cramer 1979; Lichatowich and Mobrand 1995).

Long-term

Flow augmentation: Implement system operations to achieve mean historical flows during salmon migration periods (Table 5B.6). Historical flows in this context means those flows that would have existed prior to water resources development, including flows that would have occurred in the absence of irrigation depletions. To achieve these flows, dam operators should relax flood control rule curves to meet resident fish, wildlife, and salmon flow needs, and additional volumes should be obtained from Canadian storage reservoirs. Restore the natural hydrograph of the Clearwater River in the long-term.

Spill: Increase spill efficiency by installation of full flow surface bypass systems, gas abatement structures and modifications of spill patterns to achieve at least a 90% fish passage efficiency.

Drawdown: Implement one of the following alternatives with mitigation for biological, cultural and economic impacts agreed to by tribes and in conjunction with the other passage and

habitat measures set forth in this hypothesis. All drawdowns are year around in duration. Drawdown to natural river level is generally intended to restore flows to the water surface elevations that existed in the Snake River prior to impoundment. Alternative structural means of achieving these elevations are under consideration by the Corps of Engineers and HARZA. These alternative structural means include installation of low level water outlets at the dams, excavation of nonoverflow sections of the dams, and excavation of spillway sections of the dams.

1. John Day and Ice Harbor dams to natural river level;
2. John Day to spillway crest, Ice Harbor and Lower Monumental Dam to natural river; or
3. John Day and Snake River dams to natural river level;

In addition, implement drawdown at Wanapum and Rocky Reach dams. Besides reductions of passage and reservoir mortalities from these projects, substantial spawning areas for fall and summer chinook would be reestablished if these project were drawndown.

Hells Canyon complex: Take any actions necessary to restore salmon passage through the Hells Canyon complex.

Turbines: Retrofit existing turbines with more efficient turbine designs and automated operating procedures to decrease fish mortality. Reduce cavitation by eliminating fluctuations in forebay and tailrace elevations by restricting power peaking activities.

Expected Results

Modeling analysis conducted for purposes of this plan indicates that implementation of the long-term drawdown options in conjunction with the other measures set forth in the recommended actions/tests would increase survival of juvenile salmon originating from the Snake River above Lower Granite Dam by 3.0, 3.4 and 4.0 times recent survivals, respectively for options 1, 2, and 3. None of the long-term drawdown scenarios described above were modeled in *IDFG v. NMFS* settlement processes. Modeling analyses by the state and tribes involved in the *IDFG v. NMFS* processes indicate a high probability of survival and recovery of spring, summer, and fall chinook populations under a scenario that calls for natural river drawdown of the Snake River dams and spillway crest drawdown of the John Day Dam. This alternative is similar to option 3 and should result in survival increases that fall between options 2 and 3. If recent conditions are assumed into the future, modeling analyses show that Snake River spring, summer, and fall chinook are likely to be extirpated. Data collected will be used to improve and refine our understanding of smolt survival through the hydrosystem and to improve management tools.

Institutional/Decision Structure

Cooperative approaches among federal, state, and tribal governments are needed to ensure the success of these measures. Among other things, the Corps of Engineers will play a central role in development and application of technologies such as reservoir drawdown and the implementation of research programs intended to assess the effectiveness of fish passage measures. These technology development and research efforts should proceed with the full involvement of state and tribal governments and non-federal dam operators. Furthermore, implementation of fish passage measures, particularly including flows and spills, benefits from cooperation among federal, state, and tribal governments. In the case of measures at nonfederal dams on the Columbia River, the cooperative approaches now in place should serve as a model for the measures at the federal dams. These institutional recommendations are discussed more fully in the institutional and legal section of the plan.

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HYPOTHESIS 7

Estuary Protection and Restoration

HABITAT: Estuary

Problem Statement

The Columbia River Estuary provides juvenile and adult salmon critical habitat to allow sufficient time to gradually adjust body chemistry to the demands of a new environment. During this period, which can range from several weeks to several months, Salmon use aquatic vegetation and channel structure to hide from predators and take advantage of abundant food supplies created by the interface between river and ocean waters (Groot and Margolis 1991).

Estuaries also allow juveniles an opportunity to achieve the critical growth necessary to survive in the ocean (Wissmar and Simenstad 1988; Neilson and Geen 1986)). Juveniles spend days or weeks gradually acclimatizing themselves to increasing concentrations of salts. Adults use estuary areas to readjust body chemistry to a freshwater environment (Simenstad et al. 1982). Migration timing and size of juvenile salmon entering the estuary are key factors affecting stock life histories, maturation and ultimate survival (Reimers 1973; Schluchter and Lichatowich 1977; Groot and Margolis 1991).

Unfortunately, as is the case with tributaries and the mainstem, the Columbia River estuary habitat diversity has been significantly diminished and degraded. Human induced impacts in the last 150 years have substantially affected essential habitat. Reductions in sustained peak flows, and river sediment transport, as well as dredging, filling, diking and channelization of the estuary have had major regional and localized impacts on habitat (Sherwood et al. 1990). For example, target flows for the lower Columbia River and estuary recommended in the NMFS 1995 Biological Opinion for the FCRPS are only one third of average historical peak flow. Bottom and Jones (1990) hypothesized that fish production could be limited by the detrimental shifts in dynamic physical processes that control prey availability and create an advantage for predators. Dodge (1989) and Welcomme et al. (1989) demonstrated the close relationship between lower river and estuarine floodplains and fish production and diversity for river basins worldwide.

Changes to littoral ecology in the Columbia River basin have been significant. Sherwood et al. (1990) estimated that 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats had been lost from 1870 to 1970. Sherwood et al. (1990) also estimated that an 82% loss of emergent estuary plant production and a 15% loss of benthic macro algae production has contributed to a 52,000-metric-ton loss of local carbon input into the estuary. Concurrent impoundment of basin organic sediments behind mainstem dams has produced large blooms of phytoplankton in the reservoirs (Sherwood et al. 1990). As these populations are washed into the estuary, they increase microdetrital accumulations. The result is a shift in food webs to the benefit of exotic species, such as American shad, and benthic detrital feeders to the disadvantage of anadromous salmon (Bottom and Jones 1990).

Hypothesis

Implementation of available restoration measures such as moratoriums on floodplain development, and restriction of dredging will protect the remaining estuary for juvenile and adult anadromous fishes of the Columbia River Basin. Increasing flood events by controlled flooding will restore lost Columbia River lower river and estuarine areas resulting in increased fish diversity and production (Dodge 1989; Reiger et al. 1989; Lichatowich et al. 1995).

Recommended Actions/Tests

- Protect the remaining wetlands and intertidal areas in the estuary upon which anadromous fish are particularly dependent.

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- Undertake an immediate assessment of remaining and potential estuary habitat.
- Protect existing estuary habitat complexity.
- Evaluate and condition additional proposals for hydroelectric and water withdrawals developments, navigation projects, and shoreline developments on the basis of their impact on estuarine ecology.
- Identify and implement opportunities to reclaim former wetland areas by breaching existing dikes and levees.
- Reestablish sustained peaking flows which drive critical river and estuarine processes.

Expected Results

Physical, chemical, and biological attributes of the estuary complexity and diversity will be protected and restored, thus preserving necessary functions and values of critical anadromous fish habitat. This will result in increased fish production and diversity.

Institutional/Decision Structure

Because of its authority to regulate dams and dredge and fill activities, the Corps of Engineers and other federal and local agencies with water management and land development jurisdiction must be actively involved in implementing these measures along with the states of Oregon and Washington and the Columbia River treaty tribes. The designation of the Columbia Estuary into the National Estuary Program (NEP) provides a framework for working with a federal, state, tribal, local, public interest, and industry management structure and strategy for restoring the Columbia Estuary. Coordination with the Columbia NEP is crucial for estuary protection and restoration.

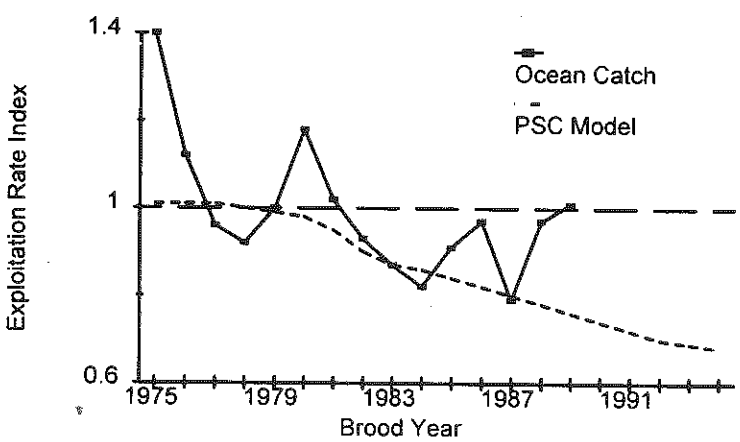

Figure 5B.6. Projected and actual ocean exploitation rates of chinook salmon, including Columbia Basin stocks.

HYPOTHESIS 8

Ocean Harvest Ceilings

HABITAT: Ocean

Problem Statement

Columbia River chinook conservation needs were a prominent concern in development of the Pacific Salmon Treaty by the United States and Canada. Unfortunately, chinook exploitation rates have been higher than originally anticipated at the time of treaty negotiations, because ceilings for northern ocean fisheries (Alaska and Canada) were premised on higher survival rates (Figure 5B.6). As a result of reduced rates of chinook survival, the goals of the coastwide chinook rebuilding program established by the Pacific Salmon Commission (PSC) are not being met (Chinook Technical Committee Report 1994).

Recent reductions in Oregon and Washington coastal fisheries, due to concerns about low numbers of naturally spawning salmon, has led to exploration of alternative fishing methods. One approach is selective fishing in which all hatchery fish are marked and fishing regulations are developed for the retention of marked fish only. The Ad-hoc Selective Fishery Evaluation Committee of the Pacific Salmon Commission has identified numerous issues which need to be resolved if the selective fishery

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strategy is to be employed consistent with data needs and management for weak stock conservation.

Hypothesis

Reductions in harvest ceilings for northern ocean fisheries, including incidental mortalities, will help meet the goals of the coastwide rebuilding program to progress toward achieving full production, escapement, and harvest goals. A management system relying on an abundance based approach will lead to establishment of appropriate ocean harvest levels.

Recommended Actions/Tests

- Immediately seek, through PSC processes, reductions in adult equivalent ocean exploitation total chinook mortalities in northern ocean fisheries which will lead to completion of the chinook rebuilding program. Encourage reductions in incidental mortalities by reducing the number of chinook nonretention days.
- Establish within 3 years a mutually agreeable approach to managing Alaskan and Canadian ocean fisheries based on changes in chinook abundance.
- Annually review all ocean fishing regimes, including alternative fishing methods, to determine effects on chinook rebuilding program.
- Take empirical observations of survival rates into account in all ocean fisheries management, and adjust fishing regimes accordingly.

Expected Results

Substantial reductions in total mortalities in northern ocean fisheries harvesting chinook will help achieve rebuilding goals for 1998, and returns of upriver bright fall chinook to the Columbia River will be increased by about 15%. Oregon and Washington ocean fisheries will be managed to conserve stocks, consistent with treaty obligations in U.S. v Oregon.

Institutional/Decision Structure

Use the existing Pacific Salmon Treaty, Pacific Fisheries Management Council, and *U.S. v Oregon* processes and committees to implement harvest recommendations.

HYPOTHESIS 9

Adult Salmon Passage

HABITAT: Mainstem

Problem Statement

The construction and operation of mainstem hydroelectric projects has impaired adult salmon migrations in the Columbia River Basin. Direct and indirect adult passage losses range from 5 to 10% per project (Gibson et al. 1979; Northwest Power Planning Council 1986, 1989; Kacyzinski and Palmisano 1992). Cumulative impacts of multiple hydroelectric projects on adult salmon result from changes in water temperature conditions altered by impoundment of the Columbia and Snake rivers and the physical barriers to upstream migration at each dam. A minimum estimate of the cumulative losses of fall chinook adult salmon due to passage through eight hydroelectric projects is 39% (NMFS 1995). State and tribal fishery managers estimate that the loss was approximately 50% on average from 1988 to 1993.

Water temperature: Columbia and Snake river mainstem temperatures are detrimental to adult migrants. Impoundments have altered the water temperature conditions of the mainstem Snake and Columbia rivers (Jaske and Goebel 1967). Water temperatures mainstem often exceed state water quality standards. Water temperatures in the Columbia River often exceed 21° C during August (Columbia River Water Management Group Reports 1975-1994). Water temperatures in the Snake River can exceed 24 degrees C (Karr et al. 1992). These levels equal or exceed lethal temperatures for Columbia River steelhead

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and chinook stocks (McCullough 1993). High water temperatures often lead to delay in migration.

Fishways and attraction flows: Adult fishways are not operated for maximum effectiveness for adult salmon passage much of the time (Beck *et al.* 1992; Basham 1993-4). Previous adult passage studies (Turner et al. 1983; Bjornn & Peery 1992) documented a need for additional fish ladders at Lower Granite and Little Goose dams, and for additional attraction water at fishways at all projects. This need is particularly evident during average to high runoff years, when water volumes passed through powerhouses and spillways are many times more than those from ladder and powerhouse entrances. Because fishway attraction flows are insufficient, adults are delayed in collection channels and dam tailraces. Adult salmon often "fall out" from ladder and powerhouse entrances, especially during high flows (Stuehrenberg et al. 1994). Attraction flows, which are generated by electric pumps dependent on turbine power production and conveyance systems, are at risk in the event of system failure. Large numbers of shad also impede salmon passage through adult fishways.

Fish Counts: The majority of adult salmon are counted at dams by real-time human observations, which are prone to errors. The current objective of the Corps of Engineers is to count only 80% of the adult run, with the majority of counts occurring during daytime hours. This does not account for stocks such as the listed Snake River sockeye which often pass in significant numbers at night (Hatch et al. 1993). Spawning counts have not been systematically evaluated and compared to passage counts at dams so that the impact of dams on escapement, spawning distribution and spawning success.

Hypotheses

Water temperature: Reducing water temperatures in the mainstem during adult salmon migrations will improve salmon survival to completion of spawning. Snake River water temperatures can be lowered substantially by releasing cool water from Dworshak Reservoir (Karr et al. 1992). Releases during September 1992 stimulated passage of adult fall chinook over Lower Granite Dam; conversely, upstream migration slowed substantially when augmentation flows ended (Heinith 1994). This finding corroborated the work of Stabler (1981) and Stabler et al. (1976).

Fishways and attraction flows: Fishway modification and attraction flow measures will contribute substantially to timely passage through dams, adequate escapement, minimum prespawning mortality, and adult spawning success.

Fish Counts: By accounting for adult passage losses through more accurate dam and spawning ground counts, the effectiveness of the measures in this plan may be evaluated through a comprehensive monitoring and evaluation program.

Recommended Actions/Tests

Water temperature: Provide at least 400 kaf of 1000 kaf of Dworshak storage for use during July, August, and September to provide cool water flow augmentation for adult Snake River fall chinook and steelhead. Continue monitoring the effects of cool water releases, development of the COLTEMP model (Karr et al. 1992), and analyzing the correlation between cool water flow augmentation and reductions in migration time, interdam losses, and increases in spawning success.

Fishways and attraction flows: Correct operations of all adult fishways so that they conform to 1994 Detailed Fishery Operating Plan criteria. Provide funding through the Corps and PUD's to the tribes and fishery agencies for frequent, independent inspection and monitoring of adult fishways.

The Corps and the Mid-Columbia PUDs, with fishery agency and tribal consultation and approval; complete ongoing structural analyses of all mainstem fishways and take corrective actions, including:

Improve extant fishway attraction flows, install additional pumps, gravity-flow systems,

automated systems, install additional ladders and modify ladder exits to reduce occurrence of adult fallback;

Identify and implement structural remedies to reduce the incidence of adult shad in fishways;

Evaluate and implement new ladder designs including modifications to weirs, baffles and pools. Emphasize designs which integrate fish swimming and leaping abilities with fluid mechanics, and designs based on fish responses rather than stimuli as recommended by Orsborn (1987); and

Implement hydraulic evaluations of all fishways, make operational and structural corrections, and combine these evaluations with limited radio-telemetry studies which can provide focus on specific problem areas.

Fish Counts: Employ more accurate and precise counting methods, such as video counting, as well as 24-hour counting at each dam and selected tributaries during the entire upstream migration of listed species.

Expected Results

These measures should increase the numbers of adult salmon successfully completing their upstream migration and reduce delay through the mainstem hydroelectric projects. The measures should also decrease pre-spawning mortality, contribute to increased spawning distribution with appropriate timing and increase spawner success.

Institutional/Decision Structure

The success of these measures depends on the cooperation of the Corps of Engineers, operators of non-federal dams, and tribal, state, and federal fishery managers. Implementation of institutional recommendations related to mainstem passage research and dispute resolution processes is essential for successful implementation of this proposal.

HYPOTHESIS

10

Water Quality

HABITAT: Mainstem and Tributaries

Problem Statement

The water quality of the mainstem Snake and Columbia rivers has been significantly altered in the last 150 years. The primary cause of pollution in the Columbia River Watershed is habitat alteration, flow alteration, sedimentation, elevated temperatures, and nutrients. The primary sources affecting beneficial uses of the Columbia River are hydrologic modifications, vegetation removal, steam bank modification, agriculture and forestry.

In the Columbia River Watershed, the major land uses are agriculture, grazing and forestry. These uses have had considerable impact on the riparian zone through increased stream temperature and stream bank erosion rates, which have serious negative impacts on anadromous fish habitat.

Agriculture, grazing and forestry accelerate erosion and sedimentation providing nonpoint source pollution into the stream system. Sands and coarse silts interfere with the flow of water through spawning gravel and the transport of oxygen to the incubating eggs. High sedimentation rates can also fill deeper pools in streams which are important for overwintering of fish and cold water refuges in the summer.

Sediments also tend to scavenge chemical contaminants from the water column and where they accumulate, may create toxic hot spots. Although sediments can act as a sink for toxics,

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binding up contaminants so that their availability to much of the aquatic biota is reduced, these sediments can also become a sources for these chemical to various organisms that live in close proximity to the bottom. Even when not a significant source, contaminated sediments can provide poorer habitat conditions and indirectly affect anadromous fish habitat.

Removal of stream vegetation causes stream temperature to increase in the summer and decrease in the winter. Elevated summer temperatures have a direct impact on salmon as well as having indirect effects through decreased dissolved oxygen and elevated biological oxygen demand.

The amount of dissolved oxygen in a stream depends on respiration and the biological oxygen demand of substances in the water. Intragravel dissolved oxygen is important to salmon spawning as it provides oxygen to incubating eggs. Agriculture, grazing and forestry have affected intragravel dissolved oxygen by increasing sand an silt to streams.

Nutrients stimulate algal growth which increases the biological oxygen demand and thereby decreases minimum dissolved oxygen. Many of the waters of the Columbia River Watershed have problems with excess nutrients. Nutrients come from a number of sources including animal wastes, fertilizers, sewage treatment plants and some industrial effluents.

In addition, toxic pollutants have been introduced to the rivers from numerous man-made sources. Federal, municipal, and industrial facilities are the major sources of hazardous chemicals and radionuclides. Industrial pollutants, such as fluoride, have been demonstrated to delay adult salmon migration (Damkaer and Dey 1986). Pesticides and other persistent highly toxic chemicals in fish tissue and sediment are present in samples collected from the Columbia River Basin. In the lower 150 miles of the mainstem Columbia River, where all migrating Columbia River salmon must pass, the states of Oregon and Washington have found that the following toxic pollutants are above guidance levels for fish tissue and sediments: Organochlorines (DDT, DDD, DDE, PCB, aldrin, dieldrin, endrin, trichlorobenzene, and PAHs), mercury, cyanide, arsenic, chromium, iron, nickel, pyrene, silver, zinc, cadmium, and copper (Tetra Tech 1993). These and other contaminants are known to adversely affect salmonid species.

Quantitative data characterizing the interaction of water quantity and water quality in the Columbia River Watershed is scarce, however, water quality and flow modification have the most likely impact on fisheries. Less quantity means less dilution and therefore higher concentrations of pollutants. Any stresses imposed on young fish by changes in river flows or water levels will be exacerbated by the presence of contaminants such as pesticides from agriculture, sedimentation from agriculture, grazing, logging, development, or mining; heavy metals from ore processing and other industries; and sewage effluent. Other stresses arise from deposition or removal of sediments from changes in river flow; the accumulation of hazardous substance in slackwater vs. free-flowing; the eutrophication processes of slackwater; and the influence of changes in the lower estuary where salmonid smolts physiologically adjust from freshwater to the marine environment.

The following water quality concerns have been identified by the U.S EPA for the Columbia Mainstem:

Columbia River estuary: Temperature, PCBs, dioxins, furans, pesticides, metals, and bacteria.

Mainstem below Bonneville Dam: Temperature, PCBs, dioxins, furans, pesticides, metals, bacteria, Dissolved Oxygen (DO), and Total Suspended Solids (TSS).

Mainstem, Bonneville Dam to Priest Rapids: Total dissolved gases, temperature, dioxins, furans, pesticides, PCBs, and metals.

Mainstem Snake, mouth to Hells Canyon: Temperature, sedimentation, total dissolved gases, algae, nutrients, DO, and organics.

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Snake Mainstem above Hells Canyon Dam: Temperature, sedimentation, pH, bacteria, ammonia, algae, nutrients, DO, and pesticides.

Mainstem, Priest Rapids to Chief Joseph: Total dissolved gases, dioxins, furans, pesticides, metals, and temperature.

Mainstem Chief Joseph to the Canadian Border: Metals, dioxin, furans (Lake Roosevelt), and bacteria.

Hypothesis

The implementation of comprehensive protection and restoration actions will greatly reduce nonpoint and point source inputs into the Columbia River Watershed. These actions must be taken at the federal, state, local and tribal level.

A comprehensive review and monitoring program for water quality parameters known to affect salmon, lamprey, sturgeon and the food sources upon which they depend in the mainstem Snake and Columbia rivers is needed to target pollution abatement programs to benefit salmon survival and protect human health.

Reducing and eliminating known sources of persistent, bioaccumulative toxic chemicals and heavy metals into the mainstem Columbia River will assist in reducing salmon exposure to these pollutants and the risk of salmon abnormalities and mortalities associated with such exposure. Abnormalities may include bodily and glandular tumors and lesions and endocrine imbalances affecting salmon reproductivity and cellular development. Mortalities may be from diseases, such as bacterial kidney disease, and from bioaccumulation of toxic pollutants.

Recommended Action/Test

- Immediately undertake adaptive management activities, through restoration and protection actions, to reduce or eliminate nonpoint source impacts. These actions are identified through the subbasin plans in Volume II.
- Implement a comprehensive review and monitoring program for water quality and substrate parameters affecting salmon, lamprey, and sturgeon and their food sources.
- Implement a biomonitoring program which: 1) identifies levels of organochlorine compounds, heavy metals and radionuclide isotopes at various points in the mainstem Columbia and in salmonid species and sediments; 2) documents physiological abnormalities, especially in fish reproductive organs; 3) identifies hormone protein levels in fish blood samples as an indicator of the presence of organochlorine compounds; and 4) identifies sources of contaminants.
- Prohibit all known permitted sources of persistent, bioaccumulative toxics affecting anadromous species or their habitat in the Columbia River Basin.
- Reduce discharges of other contaminants to meet water quality criteria fully protective of designated beneficial uses for anadromous fish.

Expected Results

A comprehensive review and monitoring program will identify pollutant sources and assist in compliance efforts. Eliminating known, permitted sources of heavy metals and persistent, bioaccumulative toxics will reduce physiological abnormalities and hormone and sex-specific protein imbalances in Columbia River salmon. Results from the proposed bio-monitoring program will indicate the scope and degree of salmonid exposure to toxic pollutants and heavy metals and may prompt new priorities in mainstem habitat protection and remediation.

Institutional/Decision Structure

State, federal, local, and tribal governments should implement actions to reduce the input of point source and nonpoint source pollutants in the Columbia River Watershed. Restoration actions implemented through Volume II will reduce nonpoint source pollution.

State, federal agencies and tribal governments, in coordination with CRITFC, will coordinate a water quality parameter review and biomonitor-

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ing program. Tribal staff and CRITFC will coordinate field collections of fish tissue and blood samples. An independent laboratory will be selected to perform tissue and blood analyses. These activities will be funded by the U.S. Environmental Protection Agency.

State water quality agencies and the Environmental Protection Agency will need to modify pollutant discharge permits to assure elimination and reduction of pollutants.

HYPOTHESIS **11**

Stock-specific Harvest Management Concerns

HABITAT: Mainstem and Tributary

Problem Statement

Harvest management of Columbia River salmon stocks involves five states, 24 Indian tribes, and two countries. These management efforts address allocation of harvestable fish among different fisheries and conservation of fish for rebuilding populations. By themselves, reductions in harvest of Columbia River Basin salmon stocks impacted by severely reduced freshwater survival have not been successful. Many stocks are projected to continue to decline in the absence of all harvest. Nevertheless, improved harvest management to account for differences in stock productivity is necessary to salmon rebuilding.

Salmon and steelhead fisheries operate on a mixture of stocks, some of which are inherently more productive than others. These stocks differ in their geographic distribution and may be either hatchery-produced or naturally spawning. Harvest management ideally should be scaled to the productivity of stocks comprising a fishery. When productivity is know, fisheries can be structured to allow catch while meeting target escapement levels. When fisheries operate on aggregates of stocks having different levels of productivity, some stock components and because of the lack of real-time, stock-specific information, harvest regulations may result in an exploitation of weak stocks at higher than expected rates (Larkin 1977; Whitcomb 1985).

Managers are faced with two objectives in mixed-stock fisheries; meeting escapement goals for each stock and documenting the effects of harvest management at the stock level. Both of these management objectives presume that managers can identify discrete stocks. Thus it is essential as a first step that stock identification methods be devised that can discriminate stock components at the level of resolution chosen for restoration.

Hypothesis

Fishery managers can incorporate analytical tools that provide stock-specific information to address stock-specific concerns to establish harvest rates that are consistent both with treaty rights to take fish at all usual and accustomed places and with escapement objectives. With appropriate levels of information, fisheries can be regulated to attempt to limit impact on less productive stocks.

Recommended Actions/Tests

- Develop assessment methodology for identifying individual stocks in order to track population dynamics. This requires stock-specific data on catch, escapement, age composition, and phenotypic and genetic traits. Population dynamics information will help relate fluctuations in productivity with environmental and induced effects on populations.
- Establish and monitor escapement checkpoints at mainstem dams and in index subbasins. Retrofitting of existing structures will be necessary. Monitor catches of salmon, lamprey, and sturgeon for stock composition. Methods to be used include video counting at hydropower dams and at key locations in tributaries, coded-wire-tags, scale pattern analysis, and genetic monitoring for heterozygosity. The least intrusive methods should be used to collect the necessary infor-

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mation. Make this information available through the Coordinated Information System.

- Establish additional monitoring programs for each of the subbasin tributary systems to monitor adult escapement and resulting smolt production, and to evaluate (by measuring the number of adults returning) the ability of managers to meet goals set by the Columbia River Fish Management Plan.
- Adapt current analytical models or develop new models to assess information on a more detailed stock-by-stock basis as the information is collected. Update the provisions of the PST and the CRFMP based on the latest information on survival rates and catch levels. Modify escapement objectives and harvest rate schedules as appropriate.

Expected Results

By establishing improved monitoring programs, stocks can be tracked throughout the life cycle, and problem areas can be identified. Better information will increase the accuracy of projections of future run status and enable managers to establish more responsive harvest regulations. Information can be used to project the harvest regulations needed to ensure escapement goals for weak stocks.

Institutional/Decision Structure

Expand existing efforts of tribal and state fishery agencies, and fund the increased effort under the NPPC Fish and Wildlife Program, Pacific Salmon Treaty, and other applicable programs.

HYPOTHESIS

12

Lamprey Passage

HABITAT: Mainstem

Problem Statement

Numbers of Pacific lamprey adults now returning past Bonneville and other federal projects are orders of magnitude lower than the numbers recorded during the last regular counting season (1969). The decrease in Columbia River Basin lamprey populations[2] above Bonneville Dam is due in part to the loss of juveniles killed or injured from contact with submerged screening devices, predation by exotic and native fishes, and from delays in reaching the estuary. Upstream migrating adults are delayed or killed at hydroelectric dams as a result of velocity barriers, picket spacing problems, fallback through turbines, and entrapment under diffuser grates.

Hypothesis

Appropriate research and follow-up actions to identify and implement passage conditions and related mitigation measures for adult and juvenile lamprey are necessary to ensure lamprey restoration.

Recommended Actions/Tests

- Document adult Pacific lamprey passage behavior and the conditions that impede optimal passage. Include and account for Pacific lamprey in ongoing and proposed passage research.
- Implement research specific to Pacific lamprey that prioritizes data collection on adult and juvenile passage behavior of this species.
- Resume daily counting of adult lamprey passing through fish ladders at mainstem dams.
- Conduct research to determine downstream passage survival of Pacific lamprey.
- Based upon research results, develop and implement recommendations to improve upstream and downstream passage survival.
- Develop and implement artificial propagation and/or transplantation programs where suitable habitat exists and fewer lamprey are present that rearing habitat can support.
- Increase the scale of successful artificial propagation and transplantation techniques to supplement natural lamprey production.

Expected Results

Research results will identify opportunities and guide recommendations for improving passage

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for adult and juvenile Pacific lamprey, without compromising passage for salmonid species. Improved conditions will increase passage survival, help to stabilize recent population declines, and aid efforts to re-establish populations in their historic habitat.

Institutional/Decision Structure

Tribes: Conduct juvenile and adults passage studies under contract with the U.S. Army Corps of Engineers.

Tribes: Conduct studies of natural production levels and limits and artificial production techniques as part of the NPPC Fish and Wildlife Program.

HYPOTHESIS

13

Enhancing Reservoir Populations of White Sturgeon

HABITAT: Mainstem

Problem Statement

Hydroelectric dams have eliminated historic unrestricted seasonal migrations of white sturgeon between freshwater and the ocean (North et al. 1993). As a result, white sturgeon upstream from Bonneville Dam are restricted to specific reservoirs and are considered to be resident fish. Nonetheless, some sturgeon are able to move upstream past the dams via navigation locks or fish ladders, or downstream through navigation locks (Warren and Beckman 1993). Even so, historic migration patterns have been eliminated above Bonneville Dam.

Because present populations are largely confined to their natal reservoir, only a finite amount of habitat is available for rearing. The amount of available rearing habitat probably contributes to limits on production and population size. However, marginal spawning habitat and poor spawning success, which are dictated by the amount and duration of spring flows, are believed to be the major factors that currently limit white sturgeon productivity in reservoirs (Parsley and Beckman 1994; Parsley et al. 1993). Turbulent flows are needed to help disperse eggs and reduce susceptibility to disease and predation. White sturgeon densities in reservoirs downstream from McNary Dam are considerably less than those in the unimpounded mainstem downstream from Bonneville Dam (Beamesderfer et al. in press). These differences in productivity are believed to be the result of access to the ocean and to seasonally abundant food resources (DeVore et al. 1993). The maximum extent of rearing habitat needs to be determined in reservoirs in order to enhance the productivity of these populations (Parsley and Beckman 1994; Beamesderfer et al. in press).

Hypothesis

Productivity of reservoir white sturgeon populations can be enhanced by modified flows and supplementation strategies.

Recommended Actions/Tests

- Complete initial stock assessment and life history studies to determine the status of sturgeon populations upstream from McNary reservoir.
- Complete research using transplanted juvenile white sturgeon from the healthy unimpounded population downstream of Bonneville Dam to enhance less productive reservoir populations.
- Conduct research to identify specific factors required for spawning success and recruitment of adults.
- Implement and refine methods for artificial propagation of white sturgeon using settling basins at the Hanford K reactor and other appropriate facilities
- Determine appropriate strategies to supplement less productive populations.
- Based upon the results of the previously mentioned studies, tribal, state, and federal fish managers shall develop and implement coordinated management plans for the targeted populations. The plans should estimate poten-

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tial levels of natural production under present conditions, the amount of additional natural production which could be achieved with modifications to flow and other environmental conditions, and additional increases which could be sustained with identified propagation and transplantation measures.

Expected Results

Production will be increased with modified flow regimes to enhance natural spawning success and by transplantation and propagation measures.

Implementation

The above activities will be funded by the U.S. Army Corps of Engineers and Bonneville Power Administration under the NPPC Fish and Wildlife Program and continue to be coordinated through the Sturgeon Management Task Force.

1. The result of initial assessments, these recommendations will be changed, modified, and prioritized through the implementation process.

1. The instream flow measures, including augmentation volumes and flow targets, presented in this plan (both short-term and long-term) are not intended in anyway to supersede or set a precedent with regard to claims filed by the United States or the Nez Perce Tribe in the Snake River adjudication or set a precedent for claims for reserved water rights intended to protect the tribes' treaty and aboriginal rights.

[2] Habitat for Pacific lamprey is not addressed directly in recommended actions. Although no specific research has been done on the spawning and early life history needs of Pacific lamprey, research done elsewhere that documents lamprey spawning and early life history habits suggests the general needs of this species. This information, combined with historical information strongly suggests that recovery measures to improve the quality, quantity, and stability of salmonid spawning and rearing habitat will also improve habitat for Pacific lamprey.

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Anticipated Outcomes

Columbia Basin salmon production has declined dramatically in recent years. Thirty-eight populations throughout the basin are less than half their former abundance and are showing statistically significant declining trends over a fifteen-year period (listed as BDD in Table 3.1). Of these, 66% are found in the Snake River, 18% in the mid-Columbia area, and 16% in the lower Columbia above Bonneville Dam. Eighty-seven percent of the declining populations are spring chinook and 13% are fall chinook. Many other populations also exhibit recent declining trends in abundance, but the information base was too brief to allow the same analysis.

Because the problem is greatest for chinook populations in the Snake River, and because the information base is most complete for those populations, we have focused our analysis of the impacts of this plan on Snake River spring and fall chinook. Other salmon populations in other portions of the basin should respond in a qualitatively similar manner, although the magnitude of the response would vary.

Methods

Management Scenarios

A total of nine scenarios were examined for Snake River spring and fall chinook:

1. prior to European development (Historical);
2. a recent base period (1990-1993) at about the time Snake River populations were listed (Recent);
3. Short term
    a. NMFS proposed recovery plan for 1995
    b. a tribal short term proposal (for the next 7 years)
4. Within 25 years three tribal proposals which differed only in the amount of river draw down as follows:
    a. John Day and Ice Harbor projects to natural river
    b. John Day project to spillway crest, Ice Harbor and Lower Monumental to natural river
    c. John Day and four lower Snake River projects to natural river levels.

Each scenario is briefly described in Table 5C.1. Rates for egg-smolt survival, upstream and downstream passage survival, and harvest rates in various fisheries were varied to estimate the effects of each scenario.

These scenarios were compared based upon 1) the probability of survival and recovery within 50 years, 2) the rate at which spawning populations would rebuild, and 3) the fisheries they might support. The effects of various hydropower system operation scenarios were estimated from technical analyses conducted as part of the *IDFG v NMFS* negotiations (Schaller *et al.* 1992; Schaller and Cooney 1992; BRWG 1994) and from output of the FLUSH salmon passage model. Salmon population characteristics were obtained from the Coordinated Information System Stock Summary Report for Idaho (Kiefer, *et al.* 1992). The effects of changes in harvest regulations were estimated by CRITFC staff using techniques developed by the Technical Advisory Committee and Pacific Salmon Commission (PSC) Chinook Technical Committee. The effects of habitat protection and restoration was estimated based upon the outcome of the Coarse Screening Process and the observations of its researchers.

Analytic approach

Most of the expected results of the preceding hypotheses and associated actions were estimated using a simplified spreadsheet model. Spring chinook survival rates were drawn from survival profiles of five modelled populations from the Snake River system (Schaller *et al.* 1992; Schaller and Cooney 1992; BRWG 1994) and represent a composite survival profile for Snake

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Table 5C.1. Conditions and/or actions called for under various Snake River salmon recovery plans.

SCENARIO			HABITAT	PASSAGE	HARVEST
Historical (1855)			Essentially pristine habitat (development impacts were negligible).	No mainstem dams.	Indian mainstem and tributary harvest only.
Recent (1990-93)			Extensive tributary degradation. Salmon rely on roadless areas.	8 mainstem dams. Passage takes at least 3 times as long as historically.	Fisheries have virtually been eliminated.
Short-term (0-7 yrs.)	NMFS		Allows increased logging, no reduction in grazing or agricultural uses. Reduces roadless areas.	Draw down 4 Lower Snake dams to MOP[a]; John Day reservoir to MOP.	Eliminates lower-river fishery, most tributary fisheries. Limits C&S catch to 5%.
	TRIBAL		Place a moratorium on uses that degrade riparian and channel conditions until habitat shows improving trend.	Draw down Lower Granite to 705' MSL, John Day to MOP; augment flow and increase spill.	Harvest rates consistent with CRFMP for runs of 50,000-128,000 spring and 400,000 fall chinook.
Medium-term (7-25 yrs.)	NMFS		Same as short-term.	Same as short-term.	Review run size and harvest rates.
	TRIBAL	Option 1	Adds active restoration to passive protection.	Draw down John Day and Ice Harbor to natural river level.	Harvest rates consistent with CRFMP for runs of 200,000 spring and 400,000 fall chinook.
		Option 2	Same as Option 1.	Draw down John Day to spillway crest, Ice Harbor and Lower Monumental to natural river level.	Same as Option 1.
		Option 3	Same as Option 1.	Draw down John Day and lower four Snake River dams to natural river level.	Same as Option 1.

[a] Minimum operating pool elevation.

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River spring chinook. Fall chinook survival rates were estimated from model results for Snake River fall chinook. The spreadsheet analysis calculated the results of various passage, harvest and habitat actions on total survival over the entire life history.

The analysis was organized by life stage and environment, similar to the hypotheses and our proposed monitoring program. We did not include a production function in the analysis, but rather looked at the fate of a unit of production over its lifetime under steady state conditions. This approach allowed rapid estimation of results while retaining consistency with assumptions and data of earlier analyses. The key assumptions used in these analyses were:

1. Egg→parr survival for Snake River spring chinook would decline 10% under NMFS plan because it is an action-by-action approach and would be unlikely to halt present declining trends in habitat quality, which result from cumulative non-point sources;
2. Egg→smolt survival would double for Snake River spring chinook by year 25 due primarily to survival increases associated with restoration of degraded habitat if the tribes' habitat protection and restoration measures were implemented immediately;
3. Average ocean natural survival rates are approximately constant over time, although we recognize there are decade-long cyclic patterns in ocean survival;
4. The average population structure of Snake River spring chinook is 50% female with an average fecundity of 4300 eggs per female. For fall chinook it is 40% females with an average fecundity of 5000 eggs per female.

While some level of detail was sacrificed by this approach (e.g., we could only compare steady-state outcomes, not trajectories over time to reach those outcomes), the results are appropriate for comparing the relative outcomes of various management scenarios.

Probability of Survival and Recovery During the *IDFG v. NMFS* negotiations, state and tribal fishery scientists estimated the probabilities that fish populations would a) survive over the next 50 years and b) rebuild to ESA delisting levels (STFA 1995a; 1995b). We have used that analysis as one measure of the management scenarios described in this plan. Readers are referred to the source documents for a full description of the analysis.

Rate of Rebuilding The time for populations to rebuild to delisting levels was estimated assuming steady-state conditions and using the rate of spawner increase (Spawner/spawner Ratio in Table 5C.2) per generation.

Fishery Impacts We examined each scenario for its ability to support various in-river fishery scenarios consistent with court adjudicated tribal treaty rights. We assumed total runs above Bonneville Dam would be 50,000-128,000 spring chinook and 400,000 fall chinook within seven years and 200,000 spring chinook and at least 400,000 fall chinook after 25 years. Harvest rates described in the CRFMP consistent with these run sizes were used.

Supplementation The recommendations in this plan are intended to support healthy naturally reproducing salmon populations throughout the Columbia Basin for populations of average productivity or higher. We realize, however, that salmon populations with low rates of production are also worthy of protection and long-term persistence, but may not be able to maintain themselves by natural reproduction alone. Also, it may not be possible to achieve all the objectives of this plan using only natural reproduction. We believe hatchery technology can play a significant role in the following cases:

1. To reduce the risk to those populations most in danger of short term extirpation;
2. To restore production to areas where the original population has been extirpated;

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Table 5C.2. Survival rates of Snake River spring and fall chinook under various management strategies.

MANAGEMENT STRATEGY	SURVIVAL RATE									
	Life History Stage or Source of Mortality								Lifetime Total (10^{-3})	SPAWNER/ SPAWNER RATIO[a]
	Egg→ smolt	Juvenile passage	Early ocean	Ocean natural	Ocean harvest	In-river harvest	Adult passage	Pre-spawning		
SPRING CHINOOK										
Historical	.25	.80	.16	.50	1.00	.70	.95	.95	10.11	25.25
Recent	.05	.18	.16	.50	1.00	.90	.70	.85	.39	.965
NMFS 1995	.045	.24	.16	.50	1.00	.90	.70	.85	.46	1.16
Tribal Strategies										
7-Yr	.05	.30	.16	.50	1.00	.88	.70	.85	.63	1.57
25-Yr Option 3	.10	.71	.16	.50	1.00	.61	.91	.85	2.69	6.74
FALL CHINOOK										
Historical	.50	.70	.20	.50	1.00	.80	.85	1.00	23.80	34.4
Recent	.50	.07	.20	.50	.78	.63	.42	1.00	.72	1.24
NMFS 1995	.50	.19	.20	.50	.79	.85	.55	1.00	3.51	6.04
Tribal Strategies										
7-Yr	.50	.19	.20	.50	.85	.564	.55	1.00	2.50	4.30
25-Yr Option 3	.50	.36	.20	.50	.85	.28	.83	1.00	3.56	6.13

[a] Assumes: Spring chinook: 50% ♀ and 4,300 mean fecundity.
Fall chinook: 40% ♀ and 5,000 mean fecundity.

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3. To provide partial mitigation for populations where society is unable or unwilling to take necessary preservation actions in other parts of the salmon's natural ecosystem;
4. To maintain individual populations with much lower-than-average productivity over the long term; and
5. To replace production lost because of permanent blockage or alteration of former habitat.

We estimated the potential effect of supplementation by examining the demographic impacts on a single hypothetical population of 1000 fish. We used CRFMP harvest rates as described in Table 5C.2, 70% egg-to-smolt survival in the hatchery, and equal survival of hatchery and naturally produced smolts. In addition, the model addresses only a single generation of salmon and does not account for effects over multiple generations. While the tribal plan proposes supplementation as a means of rescuing imperiled populations or reintroducing populations to barren habitat, the use of supplementation as compensation demonstrates its role in increasing egg-to-smolt survival as an element of basin-wide recovery.

Results

Survival rates for all life history stages under all the management scenarios are presented in Table 5C.2 for spring chinook and fall chinook. Only the effects of option 3 for the 25-year scenarios are presented in further analyses for the sake of simplicity. The impacts of the other two 25-year options are similar but of somewhat lesser magnitude.

Spring Chinook

Comparing historical and recent survival rates (Table 5C.2) shows that nearly all of the change has occurred in the tributary habitat (egg→smolt survival) and mainstem passage portions of the life cycle.

The proposed NMFS recovery plan fails all three of the comparison measures described above. First, it does not meet the potential interim standards for short-term survival and long-term recovery described by the State and Tribal Fishery Agencies Analytical Team (STFA 1995a; 1995b). Eighty percent of the modelled populations failed to meet the survival level and none of the populations achieved the recovery level over the next 48 years.

Second, the NMFS recovery plan produces a relatively small increase in the rate of rebuilding (27% greater than recently). It could be difficult to verify that a benefit of this magnitude actually resulted, given the amount of natural variation in the system. In most cases and over short periods, tests to measure changes in overall survival have low statistical power (DeLibero 1986; RASP 1992). It has been estimated (Lichatowich and Cramer 1979) that it could take 20-30 years of monitoring to have an 80% chance of detecting even a 50% change in overall salmon survival, given the level of natural variation. At best, rebuilding would be slowest under the NMFS plan.

Finally, Snake River spring chinook could not withstand a significant increase in harvest under the NMFS plan (a S/S ratio of 0.78 using the tribes' 25-year harvest rates, for instance). Snake River runs are one component of the spring chinook run above Bonneville Dam. Regardless of their actual abundance in a particular year, it is desirable that all population components of the run be able to sustain a fishery consistent with the cultural and treaty requirements of the tribes.

The proposed tribal restoration actions meet all three of the evaluation measures, except in the short term when options for increasing very small populations are limited. Eighty percent of the modelled populations meet both survival and recovery standards proposed by the state and tribal fishery managers (STFA 1995a). The spawning index is sixty percent greater than recently in the short term, and is over six times greater after 25 years. This projected level of change would be easier to identify with a modest monitoring program and to incorporate results into an adaptive management decision process.

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Finally, these populations could support increased harvests consistent with reserved treaty rights as Columbia Basin salmon runs are restored.

Current survival rates (egg-to-adult) for Snake River spring chinook are so low that the populations are not replacing themselves. Implementing the actions under the tribal plan would increase the survival rate for Snake River spring chinook 60% in seven years and almost 7-fold in 25 years. Figure 5C.1 compares the two survival rates and the necessary survival rate for replacement. The pie charts above the bars on Figure 5C.1 represent the relative mortalities from anthropogenic activities. Under current conditions mortalities due to passage through the hydropower system outweigh those from habitat and harvest.

The rate of growth of the population will determine the time necessary for recovery. Figure 5C.2 compares the estimated population rebuilding rates for Snake River spring chinook under existing conditions, the NMFS Proposed Recovery Plan, and the tribal plan. Under existing conditions the population will continue to decline. The estimated effects of the NMFS Plan are for a slow rate of increase, while the estimated growth rate under the tribal plan is about five times greater. It must be noted that for the purposes of this example that all proposed actions are assumed to be in place immediately and density dependence is handled through a simple logistic function based on a target escapement goal. In reality, actions would be phased in over time under all plans and population growth will depend on a number of factors including environmental variation.

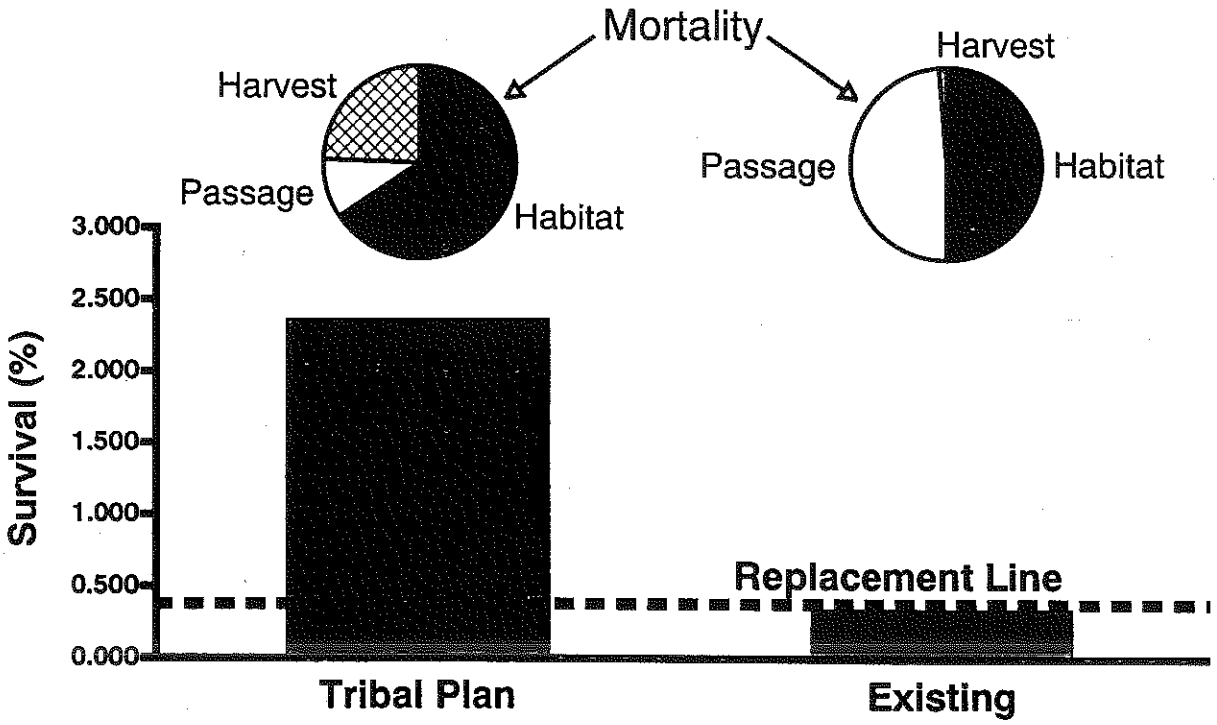

Figure 5C.1. Effects of Columbia Basin salmon restoration on mortality and survival of Snake River spring chinook.

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The analysis thus far has dealt with actions which affect all Snake River populations above Lower Granite Dam. The benefits are described in terms of an average population. Small populations in poor habitat are at greater risk of extirpation and may require additional help if they are to survive. This can be provided through use of active habitat restoration projects and short-term supplementation.

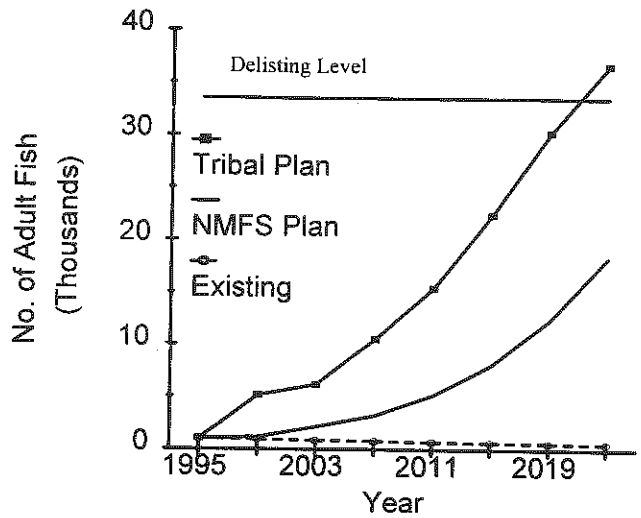

Figure 5C.2. Population projections for Snake River spring chinook salmon under three scenarios.

We estimated, for instance, that a combination of NMFS' proposed passage and habitat scenario plus supplementation at a rate of 35% (Scenario C) would produce approximately the same fishery and escapement benefits as the tribal 25-year option 1 scenario without supplementation (Figure 5C.3). A 25% supplementation effort plus the tribal short-term passage and habitat scenarios would also produce about the same level of benefits.

Supplementation should not be viewed as a panacea for maintaining salmon in the face of actions that create dysfunctional ecosystems — systems with a mortality schedule that prevents long-term maintenance of any natural production.

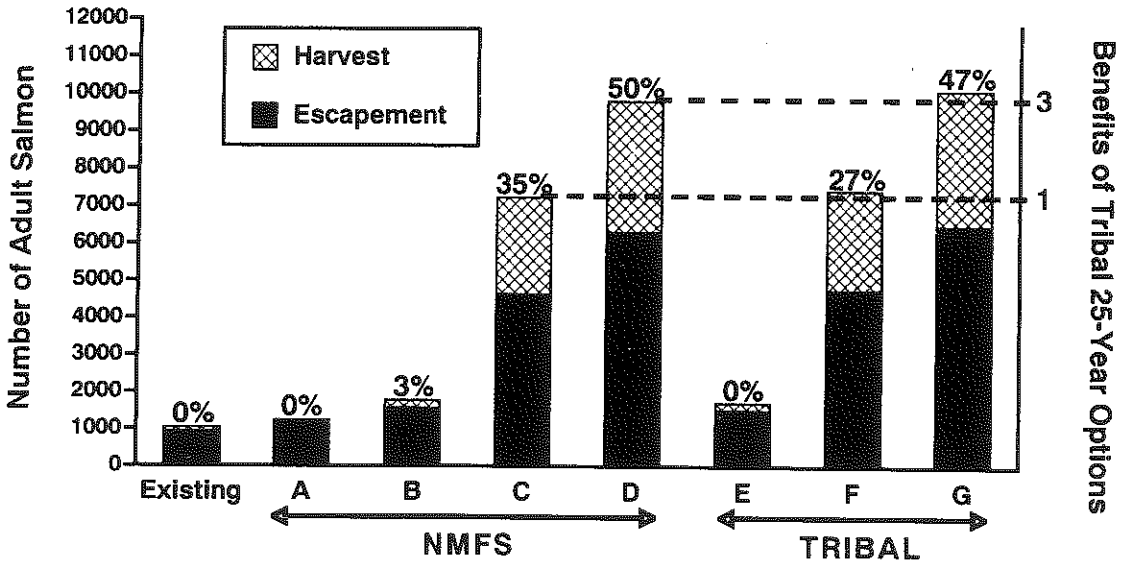

Figure 5C.3. Harvest and escapement of Columbia Basin salmon under existing and various short-term restoration scenarios. Level of supplementation (% of population) necessary for each scenario is shown atop bars; see Table 5C.1 for scenario descriptions.

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That approach would necessarily evolve into hatchery-only production without meaningful natural production.

Supplementation was analyzed as potential compensation for the lack of increased survival at certain life-cycle stages and its use yields significant results. Table 5C.3 and Figure 5C.2 describe alternative supplementation scenarios and the effects of these scenarios in a framework that compares the tribal options against existing conditions and the NMFS plan. For instance, assuming that recent conditions were to continue in the future, to achieve the restoration levels resulting from implementation of tribal options one or three, affected Snake River populations would need to be supplemented by 50% and 35% respectively. In other words, to achieve the restoration level that would be provided by option 3, 50% of the returning adult Snake River spring chinook would be captured, reared, and released in accordance with the supplementation guidelines of Cuenco *et al.* 1993.

Fall Chinook

Because fall chinook spawn primarily in the mainstem Columbia and Snake rivers and move into the ocean during their first year of life, it is more difficult to observe and measure their freshwater production and behavior. Consequently, we have assumed the primary change has been not in the rate of survival from egg-to-smolt, but in the amount of spawning area available, which has been drastically reduced by the construction of mainstem dams. Although it is likely that presmolt survival has decreased due to the cumulative effects of development, we have made no adjustments in these analyses.

Comparing historical and recent survival rates (Table 5C.2) shows that the major changes have occurred in the mainstem passage and harvest portions of the life cycle. Harvest rates shown have been reduced from previously higher levels.

As with spring chinook, NMFS' proposed scenario does not meet the survival and recovery standards (STFA 1995b). Unlike spring chinook, however, there are large increases in S/S ratios even with short-term harvest rates as described above. Tribal Option 3 meets the survival and recovery standards, incorporates restoration of viable fisheries, and provides significant increases in spawner indices

Table 5C.3. Escapement and harvest of Snake River spring chinook salmon under existing conditions and various restoration scenarios.

SCENARIO			TO OBTAIN BENEFITS EQUAL TO:	SUPPLE-MENTATION RATE (%)	TOTAL Escape-ment	TOTAL Catch
Existing Conditions			N/A	N/A	932	99
NMFS		A	Base Case	0	1175	64
		B	Tribal 7-Yr	3	1566	208
		D	Tribal 25-Yr Option 3	50	6292	3513
Tribal	**7-Yr**	E	Base Case	0	1514	201
		G	Tribal 25-Yr Option 3	40	6482	3619
	25-Yr Option 3	M	Base Case	0	6496	3627

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(Table 5C.2). Supplementation of Snake River fall chinook may be appropriate in the short term to provide additional buffering against environmental variation, but does not appear to be needed in the longer term under tribal scenarios.

Since so much of the fall chinook's mainstem habitat has been altered, permanent hatchery programs will be required to replace this lost production.

Other Salmon Populations

The above analyses are directly applicable to Snake River spring/summer chinook and fall chinook populations above Lower Granite Dam. We have not had the databases necessary to conduct similar analyses for other salmon populations. We can say qualitatively, however, that other salmon populations in other locations will also be affected to varying degrees. All populations migrate through the lower Columbia River above Bonneville Dam and will benefit from improved passage conditions in that area. Additionally, tribal habitat protection measures will apply basin-wide and will increase egg-smolt survival in many damaged areas. The need for active habitat restoration projects and/or supplementation should be judged on a case-by-case basis.

Lamprey and Sturgeon

We have not attempted to quantify the benefits of this plan for lamprey and sturgeon populations above Bonneville Dam. Qualitatively, both populations will probably benefit from restoration of conditions under which they evolved. Improved mainstem passage conditions should also improve lamprey migration. If natural river levels are reestablished in the Snake River, this may restore important sturgeon habitat. Improved tributary habitat, especially in the lower gradient portions of mainstem tributaries, will increase the amount and quality of habitat needed by juvenile lamprey.

Discussion

Salmon populations throughout the Columbia Basin are declining. All areas of the basin and all species are affected to some degree, although the problems are most critical in the Snake River portion of the basin.

This situation is the result of decades of fragmented use, development, and management of the natural resources in the Columbia Basin. Decisions have been made without proper thought for their impacts on anadromous fish, whose ecosystem encompasses tributary watersheds, mainstem portions of the Columbia and Snake rivers, and the North Pacific ocean. Consequently, the natural buffering and compensatory mechanisms, which allowed salmon to persist in times of environmental stress and thrive in times of average and good conditions, are now destroyed, and salmon populations are being extirpated at an alarming rate.

Future management of these culturally and economically valuable anadromous fish must take a more holistic view, integrating decisions across all stages of their life cycles. The bottom line in the tribal approach toward restoring anadromous fish populations is to increase their total survival rate to the point where we can maintain healthy naturally reproducing populations which can allow full exercise of fishing rights reserved by our tribes in treaties with the United States government.

Toward this end, we have identified survival standards for each life-history stage of spring and fall chinook (Tables 5C.2 and 5C.3, respectively) and actions which we feel will achieve these standards. We will work toward achieving these standards in an adaptive manner, realizing that present knowledge is imperfect and changes in this plan will be necessary over time, and that trade-offs can be made in the path we take, so long as the long-term objectives are met. We will hold ourselves and the people of the

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Columbia Basin accountable to the same rigorous standard:

We must increase total survivals to the point that anadromous fish can maintain healthy naturally reproducing populations which allow full exercise of treaty reserved fishing rights.

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Monitoring

Purpose

Often in the past, various programs designed to maintain or improve salmon abundance (e.g., hatchery mitigation programs, harvest management, mainstem passage programs) have claimed credit when abundance improved, but have blamed others when abundance declined. This has been easy to do and difficult to avoid, because people tend to draw conclusions from looking at only a portion of the salmon life cycle. A true picture of the response of salmon populations to environmental and anthropogenic perturbations will emerge only when we systematically track key parameters at each stage of the salmon's life.

A systematic monitoring program is necessary to assure that restoration actions at all levels are accountable for the funds expended and are effective in restoring anadromous fish populations. Coordination between monitoring programs throughout the Columbia Basin will also increase our rate of learning, reduce redundancy, and accelerate the rate of restoration.

The framework of a basic observation or monitoring program consistent with all human impacts on salmon is presented in Table 5D.1. This framework is initially general, allowing us to measure the total survival at each life stage and the impact of a few of our direct actions (e.g., fishing and operation of the hydropower system). The impacts of various activities at other life stages are initially aggregated (e.g., the effects of logging, grazing, road building, and agriculture on egg→smolt survival). Cause and effect relationships in these cases will be addressed in future modifications of the monitoring program or by targeted individual studies.

Types of Monitoring

Monitoring programs are needed for each of the major environments occupied by salmon during their life cycle: tributary watersheds where they spawn and rear; the mainstem Columbia and Snake rivers which are key migratory corridors; and the ocean where salmon grow and mature. Tracking annual changes in environmental conditions, salmon abundance, and the effects of management actions will allow us to separate environmental from anthropogenic effects on salmon abundance.

The State of Oregon has identified four kinds of monitoring relevant to watershed restoration efforts (OWHP 1995):

1. Trends in watershed health (ambient or environmental monitoring);
2. Effectiveness of watershed restoration actions in improving watershed conditions (program effectiveness monitoring);
3. Effectiveness of individual projects in treating watershed health conditions (project effectiveness monitoring); and
4. Implementation of individual projects (project implementation monitoring).

This four-fold monitoring approach is designed to describe the extent to which we can improve degraded habitat conditions within watersheds, but the approach can be generalized for the three major habitats comprising the anadromous fish ecosystem: tributary watersheds, mainstem rivers and estuary, and the ocean. For the purposes of this anadromous fish restoration plan, we need a fifth type of monitoring as well:

5. The response of anadromous fish populations as changes occur in ecosystem conditions (biological response monitoring).

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Table 5D.1. Summary of important observations necessary to an adaptive management approach for managing Columbia Basin salmon resources above Bonneville Dam. (*Italicized traits are not being monitored routinely.*)

ENVIRONMENT	SALMON LIFE STAGE	LOCATION	TRAIT (what we observe)	PARAMETER (what we learn)
Index Tributaries[a]	Adult	Tributary mouth	*Abundance*[b]	Escapement
			Length frequency[b]	Age composition
			Sex ratio[b]	Number females
	Adult, egg→smolt	Representative sites	*Temperature, silt, riparian condition, etc.*	Quality of habitat
	Parr	Within stream	*Abundance*[b]	Egg→parr survival
	Smolt	Tributary mouth	*Abundance*[b]	Parr→smolt survival
				Egg→smolt survival
Mainstem	Smolt	Uppermost dam	Abundance	No. entering hydropower system
		Bonneville Dam	*Abundance*	Survival through hydropower system
	Parr, smolt	Representative sites	*Pollutant levels, flow, riparian condition, temperature, etc.*	Quality of habitat
Ocean	Subadult, adult	Various	Catch by fishery	Harvest rates
		Various	*Temperature, upwelling, etc.*[c]	Index of natural survival
Mainstem	Adult	Lower river fishery	Catch	Harvest rate
		Bonneville Dam	Abundance	Return by species
		Zone 6 fishery	Catch	Harvest rate
		Intermediate dams	Abundance	Interdam losses by project
		Uppermost dam	Abundance	Total interdam loss
		Representative sites	*Pollutant levels, flow, temperature, etc.*	Quality of habitat

[a] Areas suitable for monitoring will be identified by the *U.S. v Oregon* Technical Advisory Committee.

[b] Information is available in a few areas but is not collected for most stocks.

[c] Information exists but has not been analyzed for application to salmon management.

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Watershed-level Monitoring

It is not the purpose of this document to describe these monitoring efforts in detail. Important parameters are summarized in Table 5D.1, and readers are referred to appropriate source documents (e.g., Rhodes, et al. 1995; McCullough *[in review]*) cited in this plan for further details. Conditions will vary somewhat between watersheds, and flexibility must be preserved for watershed teams to customize the monitoring program to meet the local situation.

In addition to routine monitoring activities that are needed in all watersheds with active restoration programs, we propose that the *U.S. v Oregon* Technical Advisory Committee establish eight watersheds for intensive monitoring activities. These would include projects to estimate the total numbers of anadromous fish at each freshwater life stage, to obtain detailed quantitative information on land use activities and habitat conditions, and to conduct special studies of critical uncertainties concerning anadromous fish restoration (e.g., natural stray rates between watersheds, the effects of supplementation on genetic diversity and fitness, full characterization of anadromous populations, etc.).

The implementation of watershed restoration actions in Volume II should include the involvement of citizens in monitoring and evaluation at the watershed level. This local involvement will increase education, awareness, and understanding about the watershed.

Mainstem and Estuary Monitoring

The major problems for anadromous fish in the mainstem Columbia and Snake rivers are environmental conditions (pollutants, temperature, and — especially for juvenile fall chinook — rearing habitat) and juvenile and adult passage conditions. Major estuary problems include the amount and quality of habitat available for fish during their transitions to and from salt water, changes in the food chain from a macrobenthos to a microbenthos base, and changes in hydrology caused by operation of the hydropower system. As changes are made to improve these situations, a monitoring program addressing the five elements described above must be implemented. Core parameters are listed in Table 5D.1. These will probably be expanded upon as specific actions and information needs are identified.

Ocean Monitoring

The main factors affecting salmon survival and abundance in the ocean are environmental conditions and fishery harvests.

Some believe that the ocean environment is limiting to salmon production, largely because of decreased ocean upwelling or the warming effects of *El Niño* (Pearcy 1992). These events have occurred in the past and salmon populations have endured. In fact, regular decades-long cycles occur in ocean environmental conditions. We must understand and follow changes in these conditions to be able to distinguish changes in abundance caused by the environment from those caused by actions under this restoration program. Changes in ocean environmental conditions and their effect on salmon abundance can be estimated from environmental monitoring data (e.g., the Aleution low pressure index) and salmon scale patterns.

The present harvest monitoring programs coastwide provide basic information on fishing effort and catches. We must maintain and enhance these programs to refine our ability to identify catches by area of origin. Presently this depends upon the recovery of coded-wire tags placed in juvenile salmon before they leave freshwater.

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Coordination

We must integrate the results of monitoring activities described above to evaluate the overall impacts of anadromous fish restoration actions. A coordinated assessment of monitoring results will provide the following benefits:

1. Ensure that impacts throughout the anadromous fishes life cycle are used to evaluate program success;
2. Provide information on rates of natural variation among watersheds;
3. Increase learning about the effects of human actions on anadromous fish populations, because information will be shared and each watershed group will not have to learn everything for itself;
4. Reduce redundancy of efforts through use of and coordination with existing monitoring programs;
5. Speed recovery by identifying the most effective actions and reducing the number of false starts;
6. Enable watershed teams to focus on the most productive and feasible projects within the unique context of each watershed;
7. Assist watershed teams in sharing scarce technical support such as economic evaluation, population vulnerability analysis, risk analysis, etc.;
8. Support adaptive management approaches at all scales of geographic resolution.

Over time, results of a regular monitoring program will provide the basis for evaluating the success of restoration efforts, identifying cost-effective methods, and refining the goals and objectives of this plan.

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SECTION 6

COSTS OF IMPLEMENTATION

COSTS OF IMPLEMENTATION

The Pacific Northwest Can Afford Salmon Restoration

Since time immemorial, the Columbia River's bountiful salmon sustained the culture and economies of the Indian people. With development of the Columbia River for hydropower, agriculture, and navigation, the economy of the Pacific Northwest has thrived, while the Columbia's salmon have declined. Annual tribal catches of salmon have dwindled from millions to thousands of fish. In 1995, the tribes will take fewer than 600 spring chinook from the Columbia River needed to support "first salmon" religious ceremonies for thousands of tribal members.

The Pacific Northwest can afford salmon restoration. Salmon are a significant part of the Northwest's quality of life, and the Northwest's quality of life and its economy go hand-in-hand. When asked whether maintaining a quality environment to attract people and business or relaxing environmental regulations was more important to economic growth, Oregonians responded overwhelmingly (75% versus 16%) in favor of maintaining a quality environment (OBC 1993).

The costs of Columbia River salmon restoration are significant, but they are also affordable. The Northwest's economy is robust and the cost of salmon restoration, in the context of the Northwest's economy, is small. The annual costs of the salmon restoration measures in this plan are estimated to be less than 0.2-0.5% of the region's annual personal income.

The Northwest's economy is experiencing relatively strong growth. Annual personal income in the region is approximately $200 billion and is forecast to grow 2.3% per year in real terms (adjusted for inflation) for the period 1993 to 2015 (NPPC 1994). At the same time, the Northwest's population is growing and is projected to continue growing. In recent years, for instance, approximately 150,000 persons have immigrated to Oregon annually (Niemi and Whitelaw 1995). Idaho's population growth and its growth in the number of jobs have exceeded the national average since 1988 (Niemi and Whitelaw 1995). Idaho's economy is projected to continue to outperform the national economy for the foreseeable future (Idaho Division of Financial Management 1995).

Employment in the Northwest, as a whole, is projected to continue to grow faster than the rest of the nation (NPPC 1995). The economic sectors experiencing the greatest employment growth in the Northwest are those associated with services. The retail trade, business, and health service sectors alone accounted for approximately half of the employment growth in Idaho from 1988-1993 (Niemi and Whitelaw 1995). All service sectors now account for 85% of the Northwest's employment (NPPC 1995).

While the Northwest's economy as a whole is relatively strong, the salmon fishing industry in the Northwest has suffered significant economic losses. The Northwest's sportfishing industry has suffered multi-million dollar losses in the last five years (American Sportfishing Association 1994). Nevertheless, salmon-related industries are a significant aspect of the Northwest's economy. In 1990, salmon fishing maintained over 60,000 jobs (PRC 1992). The net value of the Northwest's salmon fishing in 1990 was estimated to be $279 million (ASA 1994).

Severe declines have occurred in salmon fisheries. Landings in the Oregon and Washington coastal troll and commercial gillnet fisheries (not including tribal fisheries) have declined dramatically. Since 1988, the combined harvest in these fisheries has plummeted from approximately 18 million pounds landed in 1988 to 2 million pounds landed in 1993 (Huppert and Fluharty 1995). These declines have coincided with decreased salmon abundance.

The tribes' salmon fisheries have also declined dramatically since 1988. Catches in the tribes'

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commercial fisheries have declined from 261,600 in 1988 to 46,600 in 1994. While these fisheries primarily catch fall chinook, they tell only part of the story. The tribes have not held a commercial fishery on summer chinook since 1965. The tribes' last commercial fishery on spring chinook was in 1977. Since closing these commercial fisheries, the tribes have fished for spring and summer chinook only to meet their ceremonial and subsistence needs. Even these limited tribal fisheries on spring and summer chinook have declined since 1988 from 6800 to 1300 in 1994. In contrast, tribal people of the Columbia Basin annually consumed more than 40 million pounds of salmon prior to the arrival of non-Indians (NPPC 1986).

Who owns the Salmon?

In entering into treaties with the United States, the tribes reserved more than the right to dip their nets into empty waters. The treaties have been interpreted by the federal courts to guarantee the tribes the right to take 50% of the harvestable fish destined to pass their usual and accustomed fishing places. *U.S. v. Oregon*, 529 F.2d. 570 (9th Cir. 1976); *aff'd sub nom. Washington v. Washington State Commercial Passenger Fishing Vessel Ass'n*, 443 U.S. 658 (1979) *(Passenger Fishing Vessel)*.

In *Passenger Fishing Vessel*, the Court painstakingly examined the circumstances surrounding the negotiation of the treaties to understand the parties' long-term intentions. The Supreme Court emphasized that Governor Stevens invited the tribes to rely on the United States' good faith efforts to protect their right to a fisheries livelihood. Stevens specifically told the tribes: "This paper [the treaty] secures your fish." *Id.* at 667 n.11. During the treaty negotiations, "the Governor's promises that the treaties *would protect that source of food and commerce* were crucial in obtaining the Indians' assent." *Id.* at 676 (emphasis added). As the Supreme Court stressed:

It is absolutely clear, as Governor Stevens himself said, that neither he nor the Indians intended that the latter "should be excluded from their ancient fisheries," ... and it is accordingly inconceivable that either party deliberately agreed to authorize future settlers to crowd the Indians out of any meaningful use of their accustomed places to fish.

Id.

Inherent in many economic evaluations is the assumption of the status quo as the baseline for assessing costs of proposed actions. Such analyses assume that the existing distribution of property rights and responsibilities reflects existing legal mandates. Other analyses (e.g., Huppert and Fluharty 1995) recognize problems with this assumption, but nevertheless make this assumption because of the difficulty in establishing adjustments from the status quo.

Overlooking the tribes' rights to take salmon in an economic analysis would imply that the failure to restore salmon imposes no cost upon society. Yet the cumulative losses of millions of salmon that would have been harvestable by the tribes equates to losses of billions of dollars of commerce to the tribes. To date, most of these costs have been borne by the tribes. Yet, this distribution of costs is not what the tribes bargained for in their treaties. Compensating the billion-dollar losses incurred by the tribes is something that is often overlooked. For instance, the economics report to the NMFS on Snake River salmon recovery (Huppert and Fluharty 1995) does not account for the legal rights of the tribes. Such oversights have been a common problem in salmon mitigation analyses (Lothrop 1986).

Compounding the problems associated with assuming the status quo as a baseline for economic analyses is the role direct subsidies play in shaping the value of goods and services in the market place. Federal water, energy, timber, and grazing policies provide tremendous subsidies to the Northwest. These subsidies distort the real costs of goods and services. For example, the energy-related subsidies of the BPA annually total hundreds of millions of dollars (Table 6.1).

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Table 6.1. BPA energy-related subsidies.

BPA DISCOUNTS	ANNUAL SUBSIDY (1994)
Bureau of Reclamation irrigation pumping	$32.0 million
Private irrigation pumping	$13.5 million
Direct Service Industries (primarily aluminum smelting)	$179.0 million
Residential loads of investor-owned utilities	$210.0 million

Not included in these subsidies is the revenue BPA forgoes as a result of irrigation withdrawals. Annually, BPA loses $150-300 million in foregone revenues due to water withdrawn for irrigation purposes that does not generate power at federal dams (CNR 1994). In addition to these subsidies and foregone revenues, BPA is paying about $550 million in annual principle and interest payments on a $7.1 billion debt associated with Washington Public Power Supply System (WPPSS) nuclear projects. This debt was incurred on behalf of BPA's utility and industrial customers.

BPA is now struggling to remain competitive in the deregulated wholesale power market that resulted from the Energy Policy Act of 1992. Changes in federal regulations now allow wholesale power customers greater access to competitively priced power than ever before (FERC 1995). BPA can no longer afford to provide subsidies to its customers (many of whom are its chief competitors) and shoulder the region's nuclear power debts. The subsidies must be eliminated and BPA's stranded nuclear debt must be borne equitably by BPA and its customers on whose behalf the debt was incurred, whether or not those customers continue to purchase power from BPA.

The need for stranded debt recovery, brought about by changing energy regulations, is an industry-wide issue affecting utilities across the nation. The FERC recently proposed rules allowing for recovery of stranded debts for public utilities engaged in interstate commerce (FERC 1995). The principles in FERC's proposal square with BPA's need to recover the costs of WPPSS.

Benefits of Restoring Salmon

Benefits accrue not only to ocean and in-river fishers (commercial, tribal, and sport), but to a broader spectrum of related economic interests, such as fish processing, fishing gear manufacturing, retail outlets, and hotel/motel industries. Because many of these expenditures are made in coastal communities, fishing-related industries are the second largest source of income and employment in some of Oregon's coastal communities (Radtke 1993).

Most of the harvesting-related expenditures and much of the value-added processing activities resulting from salmon restoration will take place in Columbia River communities. These activities will benefit Indian people as well as other local residents of the area. For example, each additional spring chinook can generate about $100 of income to the local community (primary processing only).

Using a value-added approach to estimate economic activity associated with rebuilding tribal fisheries on the mainstem Columbia River, the economic benefits to tribal communities is substantial (CRITFC 1992). This value-added approach only considers economic activity directly associated with fishing, processing, and marketing. It is estimated that with healthy salmon runs, tribal marketing and processing of

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560,000 salmon caught by Indian fishers could generate $98 million in economic benefits, the equivalent of about 1400 annual jobs in these communities.

These benefits do not include estimated benefits to sport fisheries and non-Indian commercial fisheries, nor do the benefits consider multiplier effects for related industries. Because relatively weak Columbia River stocks are limiting fisheries from Oregon to Alaska, increased abundance of Columbia River salmon stocks could be expected to allow increased landings of other stronger stocks.

Costs of Restoration Measures (Estimated Annual)

The following cost estimates, aggregated into general categories, represent anticipated costs of implementing the tribes' recommended salmon restoration measures. The funding needs are in addition to ongoing (or currently programmed) expenditures, except where noted. Estimated costs for each of the 15 hypotheses in the Recommendations section (Table 6.2) and for tribal restoration plans in each salmon-producing watershed above Bonneville Dam (Table 6.3) are summarized below.

Artificial Propagation ($10 million)[1]

Over $20 million is currently expended annually on operating and maintaining federal salmon hatchery programs in the Columbia Basin (LSRMP 1994; R. Z. Smith, Biologist, NMFS Environmental and Technical Services Division, personal comment) Many of the measures in this plan call for redirecting ongoing operation and maintenance expenditures under the Mitchell Act and Lower Snake River Compensation Plan. In addition to redirecting these funds, additional funds needed for the construction, operation, and maintenance of broodstock collection and juvenile salmon acclimation and release facilities are required to implement the propagation measures called for in this plan. These funding needs are estimated to be approximately $10 million per year. These funding requirements also address emergency supplementation and other propagation measures recently adopted by the NPPC.

Habitat Protection and Restoration ($33 million)[2]

Protection (net savings)[3]

The federal government regularly invests more in timber and range programs than the receipts these programs generate. The timber programs on 10 out of the 15 national forests with salmon habitat above Bonneville Dam in the Columbia Basin reported a net loss to the federal government (Gorte 1994). The timber sales programs on the Umatilla and Wallowa-Whitman National Forests in fiscal year (FY) 1994 together lost more than $6 million (USDA Forest Service 1995). These costs do not include recreation and fishing-related losses associated with logging. Others have estimated that eliminating grazing on salmon-bearing federal lands in the Snake River Basin would result in net savings to the federal government when administration costs are compared to grazing receipts (Niemi and Whitelaw 1995). In this light, one must question the costs and the management sense of these land-disturbing activities.

Watershed Restoration ($33 million)[4]

The success of measures to restore degraded watershed habitat is often dependent on future and on-going land disturbing activities affecting the watershed where restoration activities take place (Beschta et al. 1991). Habitat restoration measures must take into account land management activities.

Implementation of new watershed restoration measures adopted by the NPPC in 1994 is estimated to require an increase in BPA habitat funding of approximately $9 million annually beginning in FY 1996 (BPA 1995). Many habitat restoration measures identified in the subbasin summaries in the tribal salmon restoration plan could be addressed if BPA committed to habitat restoration funding at this level. In addition, the costs of habitat restoration activities to be funded and carried out by federal land managers in each

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Table 6.2. Estimated costs of implementing hypotheses and institutional changes described in *Wy-Kan-Ush-Mi Wa-Kish-Wit*.

	DIRECT COST ($000) BY FISCAL YEAR						
	1996	1997	1998	1999	2000	2001	NOTES
Hypotheses							
1 Land use practices	469	774	2,995	6,008	6,004	6,184	Some sharing with #2, #3, & #13
2 Water quantity	5	200	600	800	100	100	Most FTE's supplied under #1
3 Habitat restoration	32,505	41,291	41,340	42,128	37,440	37,440	See Soscia memo for breakout of costs
4 Supplementation	0	0	0	0	0	0	Costs included under #3
5 Reintroduction	0	0	0	0	0	0	Costs included under #3
6 Juvenile salmon passage							
a. Capital facilities	17,892	38,922	61,094	97,653	137,643	149,959	From COE; 50 yr amortization @ 8%
b. Hydro. operations	270,000	270,000	270,000	270,000	270,000	270,000	From BPA rate case for BiOp
c. Existing O&M	40,000	40,000	40,000	40,000	40,000	40,000	From BPA rate case
d. Existing F&W debt serv.	73,000	80,000	88,000	95,000	102,000	106,000	From BPA rate case
7 Estuary							
8 Production index	83	65	40	47	44	45	
9 Selective fisheries	0	0	0	0	0	0	Costs included under #10
10 Harvest ceilings	365	370	382	398	405	416	Costs included under #6
11 Adult salmon passage							
12 Water quality	250	250	250	250	250	250	
13 Stock-specific concerns	398	859	1,830	2,357	1,103	1,116	
14 Lamprey passage	278	349	390	408	298	315	Assumes Umatilla tribe's BPA project is funded
15 White sturgeon	1,765	1,863	1,967	2,078	1,985	2,107	
Hypotheses Total	*437,010*	*474,943*	*508,888*	*557,127*	*597,272*	*613,932*	
Recommended Institutional Changes							
1 Enforcement	641	560	580	616	630	655	
2 Watershed teams	5,500	5,500	5,500	5,500	5,500	5,500	
GRAND TOTAL	***443,151***	***481,003***	***514,968***	***563,243***	***603,402***	***620,087***	

Table 6.3. Annual costs ($000) for tribal restoration plan projects, by watershed/subbasin. (Rounding causes discrepancies in some totals.)

SUBBASIN	1996	1997	1998	1999	2000	2001-5	SUBTOTAL
(Capital equipment)	866	866	0	0	0	180	1,912
LOWER COLUMBIA RIVER MAINSTEM *(Bonneville Dam → McNary Dam)*	860	1,112	712	712	387	1,385	5,168
Wind River	843	1,547	1,504	1,349	949	4,244	10,435
Little White Salmon River	987	1,558	1,396	1,446	1,446	4,728	11,559
Big White Salmon River	582	757	1,261	1,067	615	3,076	7,359
Hood River	875	1,138	1,225	975	728	3,638	8,578
Klickitat River	1,300	1,755	1,960	2,175	2,175	10,875	20,240
Fifteenmile Creek	487	633	682	730	730	3,652	6,915
Deschutes River	1,968	2,224	2,395	2,566	1,272	6,360	16,786
John Day River	1,760	2,288	2,474	2,690	2,690	13,450	25,352
Umatilla River	1,118	1,314	1,415	1,516	972	4,860	11,196
MID-COLUMBIA RIVER MAINSTEM *(McNary Dam → Chief Joseph Dam)*	900	1,160	1,280	1,400	1,400	7,000	13,140
Walla Walla River	1,598	1,799	2,198	2,056	1,306	6,529	15,485
Yakima River	2,498	2,959	3,478	3,456	2,706	13,529	28,625
Wenatchee River	1,574	2,179	1,982	1,816	1,272	6,360	15,184
Entiat River	1,025	1,227	1,302	1,101	1,101	5,505	11,261
Methow River	1,505	1,851	1,623	1,815	1,817	9,086	17,697
Okanogan River	2,060	2,578	2,400	2,648	2,648	13,238	25,570
LOWER SNAKE RIVER MAINSTEM *(Ice Harbor Dam → Hells Canyon Dam)*	750	728	811	546	546	2,730	6,111
Tucannon River	887	666	722	508	508	2,539	5,830
Clearwater River	2,405	3,535	3,807	4,079	4,079	20,394	38,299
Grande Ronde River	1,418	1,975	1,406	1,582	1,582	7,912	15,876
Salmon River	4,046	5,397	5,532	5,832	5,832	29,162	55,801
Imnaha River	1,030	847	930	1,028	896	4,479	9,209
GRAND TOTAL	32,505	41,291	41,340	42,128	37,440	183,830	378,534

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subbasin is likely to range up to $4 million annually depending on the basin (e.g., Wallowa-Whitman National Forest, et al. 1992). Such activities include road closures and road resurfacing in watersheds where existing road densities are high.

Cost estimates for restoration measures in the 23 subbasins are included at the end of this section. Volume II contains more detailed estimates of the costs of watershed restoration activities.

Mainstem Passage ($165-245 million)[5]

The estimated costs for capital facility construction and operation and maintenance for the mainstem passage measures in the tribal salmon restoration plan are estimated to be from $110 million to $190 million on an annualized basis. The range includes capital costs of $95 million to $167 million per year (from Huppert and Fluharty 1995) for Snake River natural river level drawdown. The high end of the range includes $55 million per year (from NPPC 1994) for John Day spillway crest drawdown. Also included are costs for adult ladder improvements, nitrogen abatement measures (e.g., flip lips at John Day Dam), surface bypass at Bonneville Dam, and relocation of bypass outfalls. Assuming embankment removal at only two Snake River dams (natural river drawdown), the annualized cost for the first six years' measures is approximately $150 million, based on a 50-year amortization at eight percent interest. The range does not include foregone energy costs[6] or the cost of measures at nonfederal hydroelectric projects.

Harvest Management (net benefits)[7]

The harvest-related measures call for changes in existing harvest management processes for more effective restoration of naturally spawning salmon populations. Although certain measures may result in near-term harvest restrictions (e.g., abundance-based management of Canadian and Alaskan fisheries intercepting Columbia River stocks), such restrictions would be eventually offset by improved salmon survival in other life stages due to other measures in this plan. Harvestable numbers of salmon would increase significantly as a result of implementing these measures. Such increases in the numbers of harvestable salmon would yield significant economic benefits to fisheries and related industries.

Research Coordination (net benefits)

In FY 1996, the BPA plans to allocate over $27 million to salmon research, monitoring, and development activities (BPA 1995). In FY 1996, the US Army Corps of Engineers plans to invest more than $45 million in research and development activities. Most of this funding will go to studies addressing the passage of juvenile salmon through the federal hydroelectric system. Unfortunately, many of the studies being carried out with these funds are proceeding over objections of state and tribal fish managers. Agreement on research priorities and study designs would reduce the amount of funding allocated to research to allow greater emphasis on measures physically improving salmon survival.

Monitoring and Evaluation ($5-$10 million)[8]

The costs accounted for in this category include those associated with improved stock and habitat monitoring. These measures call for establishing additional monitoring programs for each of the major tributary systems in the basin to monitor adult escapement and resulting smolt production.

Improving Federal Funding Mechanisms

Achieving salmon restoration goals requires significant improvement in ensuring that available funds yield results "on the ground." Mechanisms for funding projects must be made more efficient to achieve savings in costs and time. For instance, a review of the costs associated with irrigation screening by the Fish Screen Oversight Committee showed that screening projects funded by BPA cost nearly twice as much as screening projects funded by NMFS.

Needed improvements in federal funding mechanisms include: agreement on funding priorities by federal, state, and tribal governments;

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streamlining contracting procedures; and greater accountability by project implementors. To achieve these improvements, among others, various interests have called for transferring administration of measures funded under the NPPC's Fish and Wildlife Program from BPA to USFWS (Committee on Natural Resources 1994). Regardless of the specific mechanisms chosen, it is clear that improvements in the effectiveness of federal investments must be achieved.

1. This estimate addresses the costs associated with hypotheses 4, Supplementation; 5, Reintroductions; and 15, White Sturgeon.

2. Generally addresses the funding needs for implementing hypotheses 15, White Sturgeon; 4, Supplementation; and 5, Reintroductions.

3. Addresses hypothesis 1, Land Use Practices. The monitoring costs associated with this hypothesis are described infra.

4. Addresses the funding needs for hypothesis 3, Habitat Restoration.

5. Addresses funds needed to implement the recommended actions in hypotheses 11, Adult Salmon Passage; 14, Lamprey Passage; and 6, Juvenile Salmon Passage.

6. The following statement of Chief Joseph of the Nez Perce Tribe illustrates the chicanery that has befallen the tribes with regard to ownership of natural resources. "If we ever owned the land we own it still, for we never sold it. In the treaty councils the commissioners have claimed that our country had been sold to the Government. Suppose a white man should come to me and say, "Joseph, I like your horses, and I want to buy them." I say to him, "No, my horses suit me, I will not sell them." Then he goes to my neighbor, and says to him: "Joseph has some good horses. I want to buy them, but he refuses to sell." My neighbor answers, "Pay me the money, and I will sell you Joseph's horses." The white man returns to me, and says, "Joseph, I have bought your horses, and you must let me have them." If we sold our lands to the Government, this is the way they were bought." (Howard 1965). Just like the neighbor did not own the horses to sell, neither does BPA own the water of the Columbia River Basin to generate power.

7. The harvest-related measures are found in hypotheses 9, Selective Fisheries and 10, Harvest Ceilings.

8. This category addresses the costs associated with the monitoring activities recommended in the land-use practices, stock specific concerns, and water quantity and quality, hypotheses. Additional monitoring activities are incorporated in the habitat restoration, supplementation, and reintroduction hypotheses.

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SECTION 7

APPENDICES

APPENDICES

Appendix A

Appendix Table 7A.1. Descriptions of Columbia River subbasins (Figure 3.3) for which the Treaty Tribes have comanagement responsibility (per CTWS *et al.* 1988).

Lower Columbia River Mainstem (Bonneville Dam → McNary Dam)

The Lower Columbia River Mainstem is that section of the river from Bonneville Dam (RM[a] 146.1) to McNary Dam (RM 292). This section of the river flows eastward and forms the border between Oregon and Washington. The principal tributaries in this section include the Wind, Little White Salmon, Big White Salmon, and Klickitat rivers in Washington State and the Hood, Deschutes, John Day, and Umatilla rivers and Fifteenmile Creek in Oregon. Minor tributaries include Rock, Eagle, Herman, Mosier, Viento, and Willow creeks.

Management

Nez Perce
Umatilla
Warm Springs
Yakama

Wind River Subbasin

The Wind River originates in the Gifford Pinchot National Forest in southwestern Washington. The river flows southward through steep, narrow terrain and enters the Columbia River near Carson, Washington at RM 154.5. Because of the steep terrain, only about 1% of the land is urbanized. The major land uses in the subbasin are timber production and harvest. Principal tributaries include Panther, Trout, and Paradise creeks.

Management

Yakama

Little White Salmon River Subbasin

The Little White Salmon River originates in the Gifford Pinchot National Forest west of Monte Cristo Peak in southcentral Washington. The river flows south and enters the Columbia near Cooks, Washington at RM162. Most of the subbasin is contained within the boundaries of the Gifford Pinchot National Forest. The river runs through approximately 8 miles of private land, with urban development located primarily in the unincorporated town of Willard.

Management

Yakama

Big White Salmon River Subbasin

The Big White Salmon River originates in the Gifford Pinchot National Forest in southcentral Washington along the southwest slope of Mt. Adams. The river flows south and enters the Columbia River at Underwood, Washington at RM168.3. Major land uses in the subbasin include timber production, forest, range, and agriculture. Principal tributaries are Trout Lake and Buck and Rattlesnake creeks.

Management

Yakama

[a] RM = River Mile, the distance (in miles) upstream from the mouth of the Columbia River.

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Appendix Table 7A.1. *(continued)*

HOOD RIVER SUBBASIN	
Hood River, located in northcentral Oregon, flows in a northeasterly direction and enters the Columbia River at RM 169. The river is bounded on the west by the Cascade Range, the south by the Sandy and Wnite river drainages, and on the east by the Mosier, Mill, Threemile, and Fifteenmile creek drainages. Land in the subbasin is managed primarily for timber production and irrigated agriculture.	**Management** Warm Springs
KLICKITAT RIVER SUBBASIN	
The Klickitat River originates along the east slope of the Cascade Mountains in southcentral Washington. The watershed is bounded on the west by Mt. Adams, the north by Goat Rocks and by the Simcoe Mountains on the east. The river flows generally southward and enters the Columbia near Lyle, Washington at RM 180.4. Forestry and agriculture are the major economic industries in the subbasin. Major land ownership includes the Yakama Indian Nation, private individuals, and the state. The principal tributaries include the Little Klickitat River and Big Muddy, Summit, and Outlet creeks. Minor tributaries include White Brush and Trout creeks.	**Management** Yakama
FIFTEENMILE CREEK SUBBASIN	
The Fifteenmile Creek Drainage, located in northcentral Oregon, heads into the Mt. Hood National Forest just east of Mt. Hood. The creek flows northeast out of timbered higher elevations before it circles north through dryland wheat country southeast of The Dalles. It enters the Columbia River at RM 192. The Fifteenmile Creek drainage is bounded on the west by the Mosier, Mill, Threemile, and Hood River drainages, on the south by the White River dainage, and on the east by the Deschutes River drainage. The principal tributaries are Eightmile, Ramsey, and Fivemile creeks. The U.S.D.A. Forest Service manages 19% of the subbasin for timber production.	**Management** Yakama
DESCHUTES RIVER SUBBASIN	
The Deschutes River subbasin in northcentral Oregon flows north through central Oregon and enters the Columbia River at RM 205. Major tributaries include White and Warm Springs rivers, and Shitike, Buck Hollow, Bakeover, and Trout creeks. Land ownership in the lower Deschutes River subbasin is primarily private (62%) and tribal (21%). The major land use in the subbasin is agriculture, grazing is widespread.	**Management** Warm Springs
JOHN DAY RIVER SUBBASIN	
John Day River in eastcentral Oregon is the longest free-flowing river with wild anadromous salmon in the Columbia River Basin. The John Day includes 11 counties, and is bounded by the Columbia River to the north, the Blue Mountains to the east, the Aldrich Mountains and strawberry Range to the south, and the Ochoco Mountains to the west. The mainstem John Day river flows from the Strawberry Mountains to its mouth at RM 218 on the Columbia River. Mojor tributaries include the North Fork, and South Fork. Over 60% of the subbasin is privately owned. Federal ownership amounts to approximately 37%, including lands managed by the U.S.D.A. Forest Service (30%), and U.S.D. Bureau of Land managment (7%).	**Management** Umatilla Warm Springs

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Appendix Table 7A.1. *(continued)*

UMATILLA RIVER SUBBASIN

The Umatilla River originates on the west slope of the Blue Mountains in the Umatilla National Forest. It flows northwest and enters the Columbia River at RM 289 near Irrigon, Oregon. Principal tributaries include the North Fork and South Fork, as well as Meacham, Birch, McKay, and Butter creeks. The major land ownership is private (51%), Federal (37%), and tribal (11%). Forest lands in the subbasin are managed for timber harvest, grazing, and recreation. Much of the lower subbasin has been developed for irrigated agriculture.

Management

Umatilla

MID-COLUMBIA RIVER MAINSTEM (McNary Dam → Chief Joseph Dam)

The mid-Columbia River mainstem is that section of the Columbia River from McNary Dam (RM 292) to Chief Joseph Dam (RM 545). This section of the river generally flows southward through eastern Washington until it turns westward in the vicinity of Pasco, Washington. Its principal tributaries include the Walla Walla, Yakima, Wenatchee, Entiat, Methow, Okanogan, and Snake rivers.

Management

Yakama
Umatilla

WALLA WALLA RIVER SUBBASIN

The Walla Walla River originates in the Blue Mountains of northeast Oregon. It flows generally west and north and enters the Columbia River at RM 315 near Wallula, Washington. The main tributaries are the North Fork, South Fork, and Touchet rivers, and Couse, Birch, Mill, Pine, Dry, Yellowhawk, and Cottonwood creeks. The higher elevation forested lands are managed for timber harvest, livestock grazing, and recreation, whereas mid-elevation lands are managed for dryland farming and grazing. Most of the valley lands are managed for irrigated agriculture. Private land ownership dominates in the subbasin, and is approximately 96% in Washington state.

Management

Umatilla

YAKIMA RIVER SUBBASIN

The Yakima River originates in the Cascade Mountains at Lake Keechlus. The river flows southeast and enters the Columbia River at RM 335 near Richland, Washington. Major tributaries include the Naches, American, Bumping, Tieton, Little Naches, Cle Elum, and Teanaway rivers, in addition to Status, Toppenish, Rattlesnake, and Mile creeks. The major land use in the subbasin includes irrigated agriculture, timber harvest, grazing, and urbanization. Land ownership is approximately 32% private, 30% tribal, 28% federal, and 10% state.

Management

Yakama

WENATCHEE RIVER SUBBASIN

The Wenatchee river Watershed drains a portion of the east Cascade Mountains in northcentral Washington into Chelan County, and enters the Columbia River at RM 486.4. The drainage originates in high mountainous regions of the Cascade Crest, with numerous tributaries draining subalpine regions within the Alpine Lakes and Glacier Peak Wilderness areas. The Little Wenatchee and White rivers flow into Lake Wenatchee, the source of the Wenatchee River. From the lake outlet, the river descends rapidly through Tumwater Canyon, and drops into a lower gradient section in the region of Leavenworth, where Icicle Creek joins the mainstem. Other tributaries include Peshastin Creek, Chiwawa River, and Nason Creek. Much of the basin is managed for timber production. Land ownership is primarily federal (77%) and private (22%).

Management

Yakama

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Appendix Table 7A.1. *(continued)*

ENTIAT RIVER SUBBASIN	
The Entiat River Subbasin is located in northcentral Washington in Chelan County. The Entiat River flows southeast and enters the Columbia River at RM 483.7. The system has two major tributaries, the North Fork Entiat and Mad River. The subbasin is managed mainly for timber production. Land ownership is primarily federal (84%) and private (12%).	**Management** Yakama
METHOW RIVER SUBBASIN	
The Methow River is located in northcentral Washington with its source on the eastern slopes of the Cascade Mountains. The river flows southeast and enters the Columbia River at RM 524, near the town of Pateros, Washington. The principal landuse in the subbasin is forest, seconded by livestock grazing. The U.S.D.A. Forest Service owns most (94%) of the land in the subbasin.	**Management** Yakama
OKANOGAN RIVER SUBBASIN	
The Okanogan River enters the Columbia between Wells and Chief Joseph dams. This subbasin straddles British Columbia and Washington. It begins near Armstrong, British Columbia, and flows south through a chain of lakes. The first and largest of these is Lake Okanogan, followed by Lakes Skaha, Vaseaux, and Osoyoos. The United States-Canada border divides Lake Osoyoos into tw nearly equal parts. From there the river flows about 80 miles south and enters the Columbia River near Brewster at TM 533. The Similkameen River is the main tributary. Forest and rangeland dominate the subbasin. The major landowners include the Colville Indian Tribe and the U.S.D.A. Forest Service.	**Management** Yakama
***LOWER SNAKE RIVER MAINSTEM** (Columbia River → Hells Canyon Dam)*	
This section of the river generally flows northwest, and forms the border of Idaho, Oregon, and Wasington until it turns westward at Lewiston, Idaho and enters the Columbia at RM[b] 324.2. The Lower Snake River Mainstem is that portion of the river from its junction at the Columbia to Hells Canyon Dam at RM 247. The Snake River Subhasin is the largest drainage system entering the Columbia River. Major land use for this subbasin includes wilderness and agriculture. The principal tributaries in this section of the river are the Tucannon, Clearwater, Grande Ronde, Salmon, and Imnaha rivers.	**Management** Nez Perce Umatilla Yakama
TUCANNON RIVER SUBBASIN	
The Tucannon River originates in the Blue Mountains of the Umatilla National Forest and flows north through Washington State; it enters the Snake near Starbuck at FM 62. The river's principal tributary is Pataha Creek. Land use is dominated by cropland (36.9%), primarily for dryland winter wheat, rangeland (35.1%), and forestry (27%).	**Management** Umatilla Nez Perce

[b] For the Snake River Basin, RM = river miles upstream from the mouth of the Snake River.

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Appendix Table 7A.1. *(continued)*

CLEARWATER RIVER SUBBASIN	
The Clearwater River Basin is located in northcentral Idaho. The subbasin extends from the Wahsington and Idaho border in the west to the eastern headwaters along the west slope of the Bitterroot Mountains. The river generally flows westward from the headwaters and enters the Snake at Lewiston, Idaho, RM 139. The main tributaries include the Lochsa, Selway, South Fork, and Lapwai creeks. Land ownership is mainly federal (61.2%) and private sector (32.3%). Major land use in the subbasin includes forestry-related activities. agriculture, grazing, and mining.	**Management** Nez Perce
GRANDE RONDE RIVER SUBBASIN	
The Grande Ronde River originates in the Blue Mountains of northeastern Oregon. The watershed is bounded by the Blue Mountains to the west and northwest, and the Wallowa Mountains to the southeast. Its principal tributaries are the Wenaha, Wallowa, and Minsam rivers, and Catherine and Lookingglass creeks. Smaller trbutaries include the Bear, Hurricane, Sheep, and Indian Creeks. The U.S.D.A. forest service is the major landowner (45%) in the subbasin, and forestry, range, and cropland are the major land uses.	**Management** Umatilla Nez Perce
SALMON RIVER SUBBASIN	
The Salmon River originates in the Sawtooth Mountains of central Idaho, and, after flowing west through the River of No Return Wilderness, enters the Snake River in the Hells Canyon reach at RM 188. The Salmon River subbasin is the largest in the Colubmia River system, excluding the Snake. Major tribuatries include the East Fork, Pahsemeroi, Lemhi, North Fork, and Little Salmon rivers. Additional tributaries include Balley, Yankee Fork, Panther, Chamberlin, Slate, and Allison creeks. The namor land owner in the subbasin is the U.S.D.A. Forest service (90.3%). Namor land use includes forestry, recreation, wilderness, agriculture, and grazing.	**Management** Nez Perce Shoshone/ Bannock
IMNAHA RIVER SUBBASIN	
The Imnaha River originates in the Wallowa/Whitman National Forest in northeast Oregon. From the junction of the North and South forks. the river flows north and enters the Snake River in the Hells Canyon reach at RM 191.7. Big Creek si the principal tributary. Land ownership is mainly federal (71.5%) and private (28.5%). Forestry-related uses, including recreation and wilderness, doninate in the subbasin, and the namor land use on private land is grazing.	**Management** Nez Perce Umatilla

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Appendix B

Appendix Table 7B.2. Columbia River Basin hatcheries and rearing capacities.

SUBBASIN	REARING CAPACITY (millions of fish)					
	Chinook					
HATCHERY (Abbreviation)	Fall	Spring	Summer	Coho	Sockeye	Steelhead
Clackamas River						
Eagle Creek NFH[a] (Eagle)[b]				2.0		
Sandy River						
Sandy River Hatchery (Sandy)				1.0		
Washougal River						
Washougal (Washougal)				3.0		
Skamania (Skamania)						0.65
LOWER COLUMBIA RIVER MAINSTEM (Bonneville Dam → McNary Dam)						
Spring Creek (Spring Creek)	$15.0T_S$[c]					
Bonneville Fish Hatchery (Bonneville)	$8.5B_S$	0.35		2.0		
Cascade Fish Hatchery (Cascade)				1.7		
Oxbow Fish Hatchery (Oxbow)	$3.0T_S$					
Umatilla Hatchery (Umatilla)	2.0B	$0.21,1.08_S$				0.15
Irrigon Hatchery (Irrigon)						1.677
Wind River						
Carson NFH (Carson)		2.6				
Little White Salmon River						
Willard NFH (Willard)				2.5		
Little White Salmon NFH (L Wh Salmon)	$5.4B_S$	1.0				
Big White Salmon River						
Big White Salmon Rearing Ponds (B Wh Salmon)		1.45				
Klickitat River						
Klickitat Hatchery (Klickitat)	$4.0B_S$	0.6				

[a] National Fish Hatchery.

[b] Abbreviations correspond to those used in Table 5B.4.

[c] T = tule fall chinook; B = bright fall chinook; $_S$ = subyearlings.

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Appendix Table 7B.2. *(continued)*

SUBBASIN	REARING CAPACITY (millions of fish)					
	Chinook					
HATCHERY (Abbreviation)	Fall	Spring	Summer	Coho	Sockeye	Steelhead
Deschutes River						
Oak Springs Hatchery (Oak Springs)						0.14
Round Butte Hatchery (Round Butte)		0.3				0.16
Warm Springs NFH (Warm Springs)		0.7				
***MID-COLUMBIA RIVER MAINSTEM** (McNary Dam → Chief Joseph Dam)*						
Ringold Salmon Pond (Ringold SP)	4.0_S	1.0				
Ringold Trout Pond (Ringold TP)						0.18
Hanford K-Ponds (Hanford K)	$4.0\text{-}5.0_S$					
Priest Rapids Hatchery (Priest Rapids)	$6.7\text{-}7.7B_S$					
Eastbank Hatchery (Eastbank)			1.816		0.25	0.2
Turtle Rock[d] (Turtle Rock)				1.0		
Chelan Hatchery (Chelan)			4.4_S			1.05
Wells Hatchery (Wells)						
Walla Walla River						
Northeast Oregon Hatchery[e] (NE Oregon)		0.6				0.1
Yakima River						
Yakima-Klickitat Fisheries Project[6] (Y-K Project)	3.6_S	1.125	0.2	2.0		0.6
Wenatchee River						
Leavenworth NFH (Leavenworth)		3.0				0.1
Entiat River						
Entiat NFH (Entiat)		0.8				
Methow River						
Methow River Spring Chinook Hatchery (Methow)		0.738				
Winthrop NFH (Winthrop)		1.0				
Okanogan						
Casamere Springs (Casamere)					0.2	

[d] Proposed change in facility operation to rear coho.

[e] New hatchery facility proposed since 1982 in Northwest Power Planning council Fish and Wildlife Program.

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Appendix Table 7B.2. *(continued)*

SUBBASIN	REARING CAPACITY (millions of fish)					
	Chinook					
HATCHERY (Abbreviation)	Fall	Spring	Summer	Coho	Sockeye	Steelhead
LOWER SNAKE RIVER MAINSTEM *(Columbia River → Hells Canyon Dam)*						
Lyons Ferry Hatchery (Lyons)		9.1_S	0.132			1.169
Hagerman NFH (Hagerman)						2.4
Magic Valley Hatchery (Magic)						2.0
Niagara Springs Hatchery (Niagara)						1.6
Clearwater River						
Nez Perce[f] (Nez Perce)	$0.5\text{-}0.8_S$	TBD				
Dworshak Hatchery (Dworshak)		1.6				1.3-2.5
Clearwater Anad. Hatchery (Clearwater)		$1.37\text{-}1.45_S$				2.5
Kooskia NFH (Kooskia)		0.8				
Grande Ronde						
Lookingglass (Lookingglass)		1.39				
Salmon River						
Sawtooth (Sawtooth)		2.3				
Public/Private Hatcheries (PP Hatcheries)						2.0
Nez Perce (NP)					TBD	
Yankee Fork Rearing Ponds (Yankee Fork)		0.2_S				
Pahsimeroi Hatchery (Pahsimeroi)			1.0			
McCall Hatchery (McCall)			1.0			
Rapid River Hatchery (Rapid River)		3.0				

[f] New hatchery facility proposed since 1982 in Northwest Power Planning Council Fish and Wildlife Program.

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Appendix C

Glossary

anadromous fish Fish, such as salmon and lamprey, that hatch in freshwater, migrate to the ocean, where they grow, and then return to freshwater as mature fish to spawn.

anthropogenic Produced or caused by humans.

artificial propagation Using a human-controlled system to spawn, incubate, hatch and/or raise fish.

basin See **watershed**.

batholith See **Idaho batholith**.

BA Biological assessment ***

BCF Bureau of Commercial Fisheries

Best Management Practices (BMPs) An action or combination of actions that are the most effective and practical (including technological, economic, and institutional considerations) means of preventing or reducing non-specific sources of water pollution.

BIA Bureau of Indian Affairs

BLM Bureau of Land Management

BO Biological opinion ***

Bonneville Power Administration (BPA) Created in 1937, the agency markets and distributes power generated by the Federal Columbia River Hydroelectric System and provides funding for salmon recovery projects under the Northwest Power Act.

BPA See **Bonneville Power Administration**.

broodstock Adult fish that produce the next generation of fish.

CBFWA Columbia Basin Fish and Wildlife Authority

CCT Confederated Colville Tribes

ceded area Territory transferred from one government to another.

CFF Commission of Fish and Fisheries

Clean Water Act A federal statute with the primary goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. The act delegates the authority to develop and implement water quality standards to the U.S. Environmental Protection Agency (EPA). The EPA also acts to ensure that each state's water quality standards and pollution control programs are consistent with the act's purposes.

COE U.S. Army Corps of Engineers

Columbia River Fish Management Plan (CRFMP) A consent decree approved by and entered as an order of the district court in *United States v. Oregon*, in which the parties to *United States v. Oregon* may exercise their sovereign power in a coordinated and systematic manner to protect and rebuild upper Columbia River fish runs and allocate their harvest between Indian and non-Indian fisheries.

Columbia River Inter-Tribal Fish Commission (CRITFC) A coordinating fisheries agency, founded in 1977 by the Nez Perce, Umatilla, Warm Springs, and Yakama tribes – the four Columbia River tribes that reserved fishing rights in 1855 treaties with the United States government. CRITFC, through its staff of biologists, policy analysts, law enforcement officers, and other specialists, strives to protect the tribes' fishing rights and works to restore the fish resources upon which tribal religion, culture and livelihood depend.

COLTEMP (Columbia Temperature Model) A simulation model describing salmon passage through the Columbia and Snake River hydropower system.

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cotenancy An interest and possession in real property by several distinct titles but by unity of possession, or any joint ownership or common interest with its grantor.

CRFMP See **Columbia River Fish Management Plan.**

CRiSP Columbia River Salmon Passage Model

CRITFC See **Columbia River Inter-Tribal Fish Commission.**

CTUIR Confederated Tribes of the Umatilla Indian Reservation

CTWSIR Confederated Tribes of the Warm Springs Indian Reservation

DFOP Detailed Fisheries Operating Plan

DOE Department of Energy

downstream migration The journey of young salmon or lamprey from streams and rivers to the ocean.

DPS Discrete population segment ***

Endangered Species Act (ESA) A federal statute with a primary goal of protecting threatened and endangered species and the ecosystems on which they depend. Under the act, the U.S. Fish and Wildlife Service (USFWS) has the authority to designate species for protection and the responsibility to develop recovery plans. The National Marine Fisheries Service, under an agreement with the USFWS, administers the ESA for Pacific salmon.

EPA Environmental Protection Agency

ESA (see **Endangered Species Act**)

escapement The number of salmon surviving to return to a specified point of measurement. Spawning escapement consists of those fish that survive to spawn.

ESU Evolutionarily Significant Unit ***

FCRPS Federal Columbia River Power System

FELCC Firm Energy Load Carrying Capacity

FERC Federal Energy Regulatory Commission

fiduciary A person or institution who manages money or property for another and who must exercise a standard of care in such management activity imposed by law or contract.

fish ladder (also known as **fishway**) A series of ascending pools of water, constructed to enable salmon or other fish to swim upstream around or over a dam. Resembles a stairway.

fish screen A meshlike structure placed across a water intake, pipe or passageway to divert fish from the intake.

flow The rate at which water passes a given point on a stream or river; often expressed as cubic feet per second (cfs).

FLUSH (Fish Leaving Under Several Hypotheses) A simulation model describing salmon passage through the Columbia and Snake River hydropower system.

FPC Fish Passage Center

FPE Fish Passage Efficiency

FTE Full-Time equivalent employees

FWP Northwest Power Planning Council Fish and Wildlife Program

genetics The study of heredity and variation in organisms of the same or related kinds.

genotypic Pertaining to the genetic make-up of an organism.

habitat The place where a plant or animal lives and grows.

HC ***

HCP Habitat conservation plan ***

hydrograph A representation of water levels over time.

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hypothesis An unproved logically consistent theory tentatively accepted to explain certain facts or to provide a basis for further investigation, argument, etc.

ICFRU Idaho Cooperative Fish and Wildlife Research Unit

Idaho batholith The mountainous area in north central Idaho composed primarily of granitic parent rock. Soils weathered from this parent rock are generally non-cohesive and prone to erosion.

IDFG Idaho Department of Fish and Game

inbreeding depression A reduction in fitness resulting from mating between close relatives.

infectious hematapoietic necrosis (IHN) A virus that can kill salmonids including chinook, sockeye and steelhead; the most severe outbreaks occur when fish are young (i.e. fry or fingerlings).

ISP Integrated System Plan ***

juvenile Young fish, usually two years of age or less.

LRMP Land Resource Management Plan ***

mainstem The main channel of a river as opposed to tributary streams and smaller rivers that feed into it.

MCPUD Mid-Columbia Public Utilities Districts

Mitchell Act A federal statute passed in 1938 to mitigate for fishery damage caused by Bonneville Dam and subsequent federal water projects; and implemented by state and federal agencies primarily through hatchery programs which resulted in the taking of upper Columbia and Snake river salmon as broodstock for downriver hatcheries.

mitigation Actions taken to help compensate for damage, such as human-caused damage to fish and wildlife resources. Mitigation for fish losses often takes the form of hatchery production.

mortality The death of fish from natural or human causes.

natural production Fish that are raised and return to spawn in streams, either by natural spawning or by outplanting hatchery fish.

NCASI National Council of the Paper Industry for Air and Stream Improvement, Inc.

NMFS National Marine Fisheries Service, National Oceanic and Atmospheric ***

Northwest Power Act The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (also known as the Regional Power Act), which authorized the Northwest Power Planning Council and called for the development of a Columbia Basin fish and wildlife mitigation program to be funded by the Bonneville Power Administration. See Northwest Power Planning Council.

Northwest Power Planning Council (NPPC) The NPPC, authorized by the Northwest Power Act, consists of eight members appointed by the governors of Idaho, Montana, Oregon and Washington. Under the federal act, NPPC is charged with the development of a fish and wildlife program to protect, mitigate, and restore Columbia Basin fish and wildlife (including related spawning grounds and habitat) harmed by hydroelectric dams.

NPPC (see Northwest Power Planning Council)

NPT Nez Perce Tribe

NPTEC Nez Perce Tribal Executive Committee ***

NRC ***

ODEQ Oregon Department of Environmental Quality

ODFW Oregon Department of Fish and Wildlife

outbreeding depression A reduction in fitness resulting from mating distant relatives potentially causing problems in adaptation.

outplanting See **supplementation**.

PAC Production Advisory Committee

passage The movement of migratory fish through a

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river system.

phenotypic Pertaining to the visible or otherwise measurable physical characteristics of an organism.

PNL Pacific Northwest Laboratories

population A group of organisms of a species living in a certain area.

PRP ***

PSC Pacific Salmon Commission

PSMFC Pacific States Marine Fisheries Commission ***

PST Pacific Salmon Treaty

PUD Public Utilities District

RASP Regional Assessment of Supplementation Projects

rearing The juvenile life stage of anadromous fish that is spent in freshwater rivers, streams, and lakes before migrating to the ocean.

recruit A fish of sufficient size to be subject to harvest and/or a mature fish arriving at a spawning area.

redd A spawning nest dug into gravel in a stream bed by an adult salmon.

riparian areas The region adjacent to bodies of water, such as streams, springs, rivers, ponds, and lakes.

run A population of fish of the same species consisting of one or more stocks migrating at a discrete time.

salmonid A fish of the Salmonidae family, which includes salmon and trout.

SAP ***

SBT Shoshone Bannock Tribes of Fort Hall

sedimentation The settling of silt or any matter in bodies of water.

smolt A juvenile salmon migrating to the ocean and undergoing physiological changes (smoltification) to adapt its body from a freshwater to a saltwater environment.

spawner A mature fish that produces eggs or sperm.

species Basic category of biological classification. In sexually reproducing organisms, a group of interbreeding individuals not normally able to interbreed with other groups. Under the ESA, a species can be either a biological species, biological sub-species, or distinct population segment of a biological species.

SRIT ***

SRSRT Snake River Salmon Recovery Team ?***

STFA State and Tribal Fish Agency Analytical Team

stock A group of fish that spawn together in a particular stream during a particular season that generally do not interbreed with any other group of their species that spawns at a different time.

straying The tendency of some anadromous fish to return and spawn in streams other than those in which they were born.

subbasin A designated watershed with a single entry river into either the Snake or Columbia River basin.

supplementation The act of releasing young, artificially propogated fish into natural spawning and rearing habitat. As adults, these fish will return to spawn naturally in the stream where they were released rather than returning to the propagation facility. (Also called outplanting.)

TAC Technical Advisory Committee

tailrace The canal or channel immediately downstream of a dam's powershouse and spillway that carries water away from the dam

total maximum daily load (TMDL) Under the Clean

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Water Act, the total amounts of different pollutants allowable for a particular watershed.

tributary A stream of lower order than the stream or river it joins. For example, the Clearwater River is a tributary of the Snake River which is a tributary of the Columbia River.

United States v. Oregon The federal court case that upheld the treaty fishing rights of the Columbia River treaty tribes in a 1969 decision. The case remains under the court's jurisdiction. In 1983 the court ordered tribes, states, and the federal government to develop a management plan which the court then approved in 1988. See **Columbia River Fish Management Plan**.

United States-Canada Salmon Treaty (also called the **Pacific Salmon Treaty**) Signed in 1985, the United States-Canada Pacific Salmon Interception Treaty limits each country's interception of the other's salmon to promote the ability of stocks to rebuild in both nations.

upstream migration The return of adult salmon from the ocean to inriver areas where they were born and where they will spawn the next generation.

USDA U.S. Department of Agriculture ***

USFS U.S. Forest Service

USFWS U.S. Fish and Wildlife Service

watershed The drainage area contributing water, organic matter, dissolved nutrients and sediments to a river or lake. Used interchangeably with basin or subbasin.

waterspreading The illegal or unauthorized use of federally subsized water for irrigation.

WDOE Washington Department of Ecology

WDF Washington Department of Fisheries

WDFW Washington Department of Fish and Wildlife

WDW Washington Department of Wildlife

WPPSS Washington Public Power Supply System ***

YIN Yakama Indian Nation

Definitions are provided for additional clarification; they have no legal significance.

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SECTION 8

REFERENCES

REFERENCES CITED

Anadromous Salmonid Environmental Task Force. 1979. Freshwater habitat, salmon produced, and escapements for natural spawning along the Pacific Coast of the U.S. Pacific Fishery Management Council. 68 p.

Anders, P.J. and L.G. Beckman. 1993a. Location and timing of white sturgeon spawning in three Columbia River impoundments, p. 47-59. *In* R.C. Beamesderfer and A.A. Nigro [ed.] Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam. Volume I. Final report (contract DE-A179-86BP63584) to Bonneville Power Administration, Portland, Oregon.

Anders, P.J. and L.G. Beckman. 1993b. Comparisons of white sturgeon egg mortality and juvenile deformity among four areas of the Columbia River, p. 355-363. *In* R.C. Beamesderfer and A.A. Nigro [ed.] Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam. Volume II. Final Report (Contract DE-A179-86BP63584) to Bonneville Power Administration, Portland, Oregon.

Anderson, J.J. 1988. Diverting migrating fish past turbines. The Northwest Environmental Journal 4:109-128. University of Washington, Seattle, Washington.

ASA (American Sportfishing Association). 1994. Economic value of recreational and commercial use of Pacific anadromous fish in Washington, Oregon, California, and Idaho. Report prepared under cooperative agreement for USDA Forest Service. Available from ASA, Alexandria, VA.

Bajkov, A.D. 1949. A preliminary report on the Columbia River sturgeon. Fish Commission of Oregon, Department of Research 2(2):3-10.

Bardack, D. and R. Zangerl. 1968. First fossil lamprey: a record from the Pennsylvanian of Illinois. Science 155 (3767):1276-1278.

Basham, L. 1993-94. Adult fishway inspection reports. Memoranda to the Fish Passage Advisory Committee. Fish Passage Center, Portland, Oregon.

Beamesderfer, R.C., T.A. Rien, and A.A. Nigro. In press. Differences in the dynamics and potential production of impounded and unimpounded white sturgeon populations in the lower Columbia River. Trans. Am. Fish. Soc.

Beamish, R.J. 1980. Adult biology of the river lamprey (*Lampetra ayresi*) and the Pacific lamprey (*Lampetra tridentata*) from the Pacific coast of Canada. Can. J. Fish. Aquat. Sci. 37:1906-1923.

Beck, L.M., G.M. Starke, and R.J. Stansell. 1992. Evaluation of the fish passage facilities at Bonneville, The Dalles and John Day dams in 1991. CENPP-OP-PF. U.S. Army Corps of Engineers. Bonneville Lock and Dam. Cascade Locks, Oregon. 122 p.

Beschta, R.L., W.S. Platts, and B. Kauffman. 1991. Field review of fish habitat improvement projects in the Grande Ronde and John Day river basins of eastern Oregon. Project 91-069. Bonneville Power Administration. Portland, Oregon.

Beverton, R.G.H. and S.J. Holt. 1957. On the dynamics of exploited fish populations. Her Majesty's Stationery Office. London.

Bisson, P.A., J.L. Nielsen, and J.W. Ward. 1988. Summer production of coho salmon stocked in Mount St. Helens streams 3-6 years after the 1980 eruption. Trans. Am. Fish. Soc. 117:322-335.

Bjornn, T.C. and C.A. Peery. 1992. A review of literature related to movements of adult salmon and steelhead past dams and through reservoirs in the Lower Snake River. Draft Technical Report 92-1. U.S. Army Corps of Engineers, Walla Walla District. Idaho Cooperative Fish and Wildlife Research Unit. Moscow, Idaho. 107 p.

Bottom, D.L. and K.K. Jones. 1990. Species composition, distribution, and invertebrate prey assemblages in the Columbia River Estuary, p. 243-270. *In* Columbia River: estuarine system. Angel and Smith (eds). Progress in Oceanography 25. Numbers 1-4.

BPA (Bonneville Power Administration). 1995. Letter from D. Robert Lohn, Director, Fish and Wildlife Division, Bonneville Power Administration to Interested Parties, dated January 5, 1995.

Brannon 1985

Brege. 1992.

Brown. 1982.

Brown, B. 1995. Deep time and shallow history: wild salmon in the ecology and history of the Pacific Rim. Thirty-first Annual Meeting, American Fisheries Society, Oregon Chapter.

BRWG (Biological Requirements Work Group). 1994. Analytical methods for determining requirements of listed Snake River salmon relative to survival and recovery. A report submitted to the Federal District Court for Oregon as part of the *IDFG et al. v NMFS et al.* litigation.

Buck, M.K. 1990. Horse Linto bioenhancement facility: 1981-1990 progress report. U.S.D.A. Forest Service, Six Rivers National Forest. Eureka, California. 23 p.

Cada, G.F., M.D. Deacon, S.V. Mitz, and M.S. Bevelhimer. 1993. Review of information pertaining to the effect of water velocity on the survival of juvenile salmon and steelhead in the Columbia River Basin. Prepared for the Northwest Power Planning Council by the Oak Ridge National Laboratory under contract DE-AC05-840R21400. 70 p.

CBFWA (Columbia Basin Fish and Wildlife Authority). 1991. Integrated system plan for salmon and steelhead production in the Columbia River Basin. CBFWA, Portland, Oregon.

CBFWA (Columbia Basin Fish and Wildlife Authority). 1991. The biological and technical justification for the flow proposal of the Columbia Basin Fish and Wildlife Authority. CBFWA, Portland, Oregon. 72 p.

CBFWA (Columbia Basin Fish and Wildlife Authority). 1994. Status of basin tributary screening and recommendations for improvements. January 13, 1994 letter and enclosures from J. Donaldson to T. Bottiger, Northwest Power Planning Council.

Chamberlin, T.W., R.D. Harr, and F.H. Everest. 1991. Timber harvesting, silviculture, and watershed practices, p. 181-205. *In* W.R. Meehan [ed.] Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, Maryland. 751 p.

Chinook Technical Committee. 1994.

Cochnauer, T. and S. Elam. 1990. Fish hatchery evaluations — Idaho. Idaho Department of Fish and Game. Boise, Idaho.

Collins, G.B. 1963. Fish passage research in the Columbia River Basin, p. 356-360. Transactions of the 28th North American Wildlife Natural Resources Conference Wildlife Management Institute. Washington, D.C.

[Columbia Basin Tribes] (Columbia Basin Indian Tribes and the State and Federal fish and wildlife agencies). 1993. Detailed fishery operating plan with 1994 criteria. Fish Passage Center, Portland, Oregon. 44 p. + appendices.

Columbia River Water Management Group. 1975-1994. Columbia River Water Management Group Reports, water years 1975-1994. Portland, Oregon.

Columbia Basin Tribes. 1993.

Committee on Natural Resources. 1994. BPA at a Crossroads, a Majority Staff Report. U.S. House of Representatives. Washington, D.C.

Congleton et al. 1994.

EX5022-000179-TRB

Congleton, J.L., T.C. Bjornn, B.H. Burton, B.D. Watson, J.I. Irving, and R.R. Ringe. 1985a. Effects of handling and crowding on the stress response and viability of chinook salmon parr and smolts. Idaho Cooperative Fisheries Research Unit, College of Forestry, Wildlife and Range Sciences. University of Idaho, Moscow, Idaho. Completion Report 1984 to Bonneville Power Administration. Project 82-5. Contract DE-A179-83BP11196. 151 p.

Congleton, J.L., T.C. Bjornn, C.A. Roberston, J.L. Irving, and R.R. Ringe. 1985b. Evaluating the effects of stress on the viability of chinook salmon smolts transported from the Snake River to the Columbia River estuary. Final Report to the U.S. Army Corps of Engineers, Walla Walla District. Contract DACW68-83-C-0029. Submitted by University of Idaho Cooperative Fishery Unit, Moscow, Idaho.

Coon, J.C., R.R. Ringe, and T.C. Bjornn. 1977. Abundance, growth, distribution, and movements of white sturgeon in the mid-Snake River. Research Technical Completion Report, Project B-126-IDA. Idaho Water Resources Research Institute, University of Idaho, Moscow, Idaho.

Corps of Engineers. 1992-5. Columbia River Salmon Mitigation Analysis, System Configuration Study, Phase I - Interim Status Report. Phase II priority report. Spill abatement and surface flow bypass system reports. U.S. Army Corps of Engineers, Walla Walla and Portland Districts, Walla Walla, Washington and Portland, Oregon.

Coutant, C.C. 1970. Thermal resistance of adult coho *(Oncorhynchus kisutch)* and jack chinook *(O. tshawytscha)* salmon, and adult steelhead trout *(Salmo gairdneri)* from the Columbia River. Report to the United States Bureau of Commercial Fisheries. Submitted by Battelle Memorial Institute, Pacific Northwest Laboratory, Richland, Washington. 25 p.

Craig and Hacker. 1940.

CRITFC (Columbia River Inter-Tribal Fish Commission). 1992a. Salmon recovery proposal for the Columbia River Basin. An advisory report prepared for the U.S. Congress and other parties interested in salmon restoration efforts. Columbia River Inter-Tribal Fish Commission. Portland, Oregon. 48 p. + appendices.

CRITFC (Columbia River Inter-Tribal Fish Commission). 1992b. Business plan for tribal affiliated company to market salmon. Portland, Oregon.

Cuenco, M.L., T.W.H. Backman, and P.R. Mundy. 1993. The use of supplementation to aid in natural stock restoration, p. 269-293. *In* J.G. Cloud and G.H. Thorgaard [ed.] Genetic conservation of salmonid fishes. Plenum Press, New York.

Damkaer and Dey. 1986.

DeLibero, F.E. 1986. A statistical assessment of the use of the coded wire tag for chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) studies. Ph.D. dissertation, University of Washington, Seattle, Washington. 227 p.

DeVore, J.D., B.W. James, C.A. Tracy, and D.A. Hale. In press. Dynamics and potential production of white sturgeon in the unimpounded lower Columbia River. Trans. Am. Fish. Soc.

DeVore, J.D. and J.T. Grimes. 1993. Migration and distribution of white sturgeon in the Columbia River downstream from Bonneville Dam and in adjacent marine areas, p. 83-100. *In* R.C. Beamesderfer and A.A. Nigro [ed.] Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam. Volume 1. Final report (contract DE-AI79-86BP63584) to Bonneville Power Administration. Portland, Oregon.

DeVore et al. 1993.

Diamond, J. and H.J. Pribble. 1978. A review of factors affecting seaward migration and survival of juvenile salmon in the Columbia River and ocean. Oregon Department of Fish and Wildlife. Information Report Series, Fisheries. Number 78-7. Portland, Oregon.

Dodge, D.P. [ed.] 1989. Proceedings of the International Large River Symposium (LARS). Honey Harbour, Ontario, Canada, September 14-21, 1986. Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Duston, J., R.L. Saunders, and D.E. Knox. 1991. Effects of increases in freshwater temperature on loss of smolt characteristics in Atlantic salmon (*Salmo salar*). Can. J. Fish. Aquat. Sci. 48:164-169.

Ebel, W.J. 1979. Effects of atmospheric gas supersaturation on survival of fish and evaluation of proposed solutions. *In* U.S. Army Corps of Engineers fifth progress report on fisheries engineering research program 1973-1978. Portland District, Fish and Wildlife Section, Portland, Oregon.

Ebel and Raymond. 1976.

Ebel, W.J., H.L. Raymond, G.E. Monan, W.E. Farr, and G.K. Tanonaka. 1975. Effect of atmospheric gas supersaturation caused by dams on salmon and steelhead trout of the Snake and Columbia rivers. National Marine Fisheries Service, Northwest Fisheries Center, Seattle, Washington.

Farro, M. 1993. Salmon restoration projects: progress report. Pacific Coast Federation of Fishermen Association, Arcata, California.

FERC (Federal Energy Regulatory Commission). 1995. Promoting wholesale competition through open access non-discriminatory transmission services by public utilities, recovery of stranded costs by public utilities and transmitting utilities; Proposed rulemaking and supplemental notice of proposed rulemaking. 67 Federal Register 17662 (April 7, 1995).

Filardo, M. 1990. Wild/natural steelhead conversion rates and hydrologic conditions. Memorandum 308.mf to Technical Advisory Committee, Fish Passage Center. Portland, Oregon. 10 p.

Foerster, R.E. 1968. The sockeye salmon *Oncorhynchus nerka*. Fisheries Research Board of Canada, Bulletin 162. Ottawa. 422 p.

Fryer, J.K. and P.R. Mundy. 1993. Determining the relative importance of survival rates at different life history stages on time required to double adult salmon populations. *In* R.J. Gibson and R.E. Cutting [ed.] Production of juvenile Atlantic salmon, *Salmo salar*, in natural waters. Canadian Special Publication of Fisheries and Aquatic Sciences 118:219-223.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance, p. 297-323. *In* W.R. Meehan [ed.] Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, Maryland. 751 p.

Galbreath. 1985.

Gessel, M.H., B.H. Monk, D.A. Berge, and J.G. Williams. 1989. Fish guidance efficiency studies at Bonneville Dam first and second powerhouses —- 1988. Report to U.S. Army Corps of Engineers. Contract no. DACW57-87-F-0322. Coastal Zone and Estuarine Studies, National Marine Fisheries Service, Montlake, Washington.

Gessel, M.H., D.A. Brege, B.H. Monk, and J.G. Williams. 1990. Continued studies to evaluate the juvenile bypass systems at Bonneville Dam-1989. Report to the U.S. Army Corps of Engineers. Delivery order E8689095. Submitted by Coastal Zone and Estuarine Services Division, National Marine Fisheries Service, Seattle, Washington. 20 p.

Gibson G., R. Michimoto, F. Young, and C. Junge. 1979. Passage problems of adult Columbia River chinook salmon and steelhead, 1973-1978. Oregon Department of Fish and Wildlife, Portland, Oregon.

Glubokov, A.I. 1990. Growth of three species of fish during early ontogeny under normal and toxic conditions. Voprosy ikhtiologii 30(1):137-143. Translated from Russian by Scripta Technica, Inc. ISSN 0032-9452/90/0002-0051.

Gorte, R.W. 1994. Below-cost timber sales: overview. CRS Report for Congress. Congressional Research Service, Washington D.C.

EX5022-000181-TRB

Groot, C. and L. Margolis [ed.]. 1991. Pacific salmon life histories. University of British Columbia Press, Vancouver, British Columbia. 564 p.

Hale, D.A. and B.W. James. 1993. Recreational and commercial fisheries in the Columbia River between Bonneville and McNary dams, 1987-1991. *In* R.C. Beamesderfer and A.A. Nigro [ed.] Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam. Volume II. Final Report (Contract DE-A179-86BP63584) to Bonneville Power Administration. Portland, Oregon.

Hammond, R.J. 1979. Larval biology of the Pacific lamprey, *Entosphenus tridentatus* (Gairdner), of the Potlatch River, Idaho. M.S. thesis. University of Idaho, Moscow, Idaho. 44 p.

Hansen-Murray, C.S., N.A. Bolon, and R.W. Haynes. 1993. The estimated impacts on the timber, range, and recreation programs on national forest and BLM public lands from adopting the proposed PACFISH strategy. USFS, Pacific Northwest Research Station, Portland, Oregon.

Hartt, A.C. 1980. Juvenile salmonids in the oceanic ecosystem —- the critical first summer, p. 25-57. *In* McNeil, W.J. and D.C. Himsworth [ed.] Salmonid ecosystems of the North Pacific. Oregon State University Press and Oregon State University Sea Grant College Program, Corvallis, Oregon.

Hatch, D.R., A. Wand, D.R. Peterson, and M. Schwartzberg. 1993. The feasibility of documenting and estimating adult fish passage at large hydroelectric facilities in the Snake River using video technology. Annual report 1992, project number 92-055, contract number DE-B179-92BP61404, Bonneville Power Administration, Portland, Oregon. Submitted by Columbia River Inter-Tribal Fish Commission, Portland, Oregon.

Healy. 1982.

Heinith, R. 1994. Affidavit in support of mainstem measures to benefit fall chinook. Civil No. 68-513 MA. United States District Court for the District of Oregon. Portland, Oregon.

Hicks, B.J., J.C. Hall, P.A. Bisson, and J.R. Sedell. 1991. Responses of salmonids to habitat changes, p. 483-518. *In* W.R. Meehan [ed.] Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, Maryland. 751 p.

Hilborn, R. 1987. Living with uncertainty in resource management. North American Journal of Fisheries Management 7:1-5.

Holmes, H.B. 1952. Loss of salmon fingerlings in passing Bonneville Dam as determined by marking experiments. Unpublished manuscript. U.S. Fish and Wildlife Service. 62 p.

Huppert, D.D. and D.L. Fluharty. 1995. Economics of Snake River salmon recovery. A report to the National Marine Fisheries Service. Research supported by Washington Sea Grant College Program, grant number R/MS-40. Seattle, Washington.

Hymer, J., R. Pettit, M. Wastel, P. Hahn, and K. Hatch. 1992a. Stock summary reports for Columbia River anadromous salmonids. Volume III. Washington subbasins below McNary Dam. Bonneville Power Administration, Portland, Oregon.

Hymer, J., R. Pettit, M. Wastel, P. Hahn, and K. Hatch. 1992b. Stock summary reports for Columbia River anadromous salmonids. Volume IV. Washington subbasins above McNary Dam. Bonneville Power Administration, Portland, Oregon.

Idaho Division of Financial Management. 1995. Idaho economic forecast. Vol. XVII, No. 1. ISSN 8756-1840.

Jaske, R.T. and J.B. Goebel. 1967. Effects of dam construction on temperatures of the Columbia River. Journal of the American Waterworks Association 59:935-942.

EX5022-000182-TRB

Johnson, G.A., J.R. Kuskie, Jr., W.T. Nagy, K.L. Liscom, and L. Stuehrenburg. 1982. The John Day Dam powerhouse adult fish collection system evaluation, 1979-80. U.S. Army Corps of Engineers, Portland District, Portland, Oregon.

Junge, C.O. and A.L. Oakley. 1966. Trends in production rates for upper Columbia runs of salmon and steelhead and possible effects of changes in turbidity. Fish Commission of Oregon Research Briefs 12(1):22-43.

Kacyzinski, V.W. and J.F. Palmisano. 1992. A review of management and environmental factors responsible for the decline and lack of recovery of Oregon's wild anadromous salmonids. Oregon Forest Industries Council, Salem, Oregon.

Kan, T.T. 1975. Systematics, variation, distribution, and biology of lampreys of the genus *Lampetra* in Oregon. Ph.D. dissertation, Oregon State University, Corvallis, Oregon. 193 p.

Karr, M. 1992. Snake River water temperature control project. 1991 operations and results. Summary report. Columbia River Inter-Tribal Fish Commission, Portland, Oregon. 13 p.

Karr, M., B. Tanovan, R.Turner, and D.Bennett. 1992. Snake River water temperature control project. Interim report: model studies and 1991 operations. Columbia River Inter-Tribal Fish Commission, U.S. Army Corps of Engineers, University of Idaho Fish and Wildlife Resources Department. 58 p.

Kauffman, J.B., R.L. Beschta, and W.S. Platts. 1993. Fish habitat improvement projects in the Fifteenmile Creek and Trout Creek basins of central Oregon: field review and management recommendations. Projects 86-079 and 84-062. Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon.

Kiefer, S., M. Rowe, and K. Hatch. 1992. Stock summary reports for Columbia River anadromous salmonids. Volume V. Idaho subbasins. Bonneville Power Administration, Portland, Oregon.

Larkin, P.A. 1977. Pacific salmon. Chapter 8. *In* J.A. Gulland [ed.] Fish population dynamics. John Wiley & Sons, Inc., New York.

Ledgerwood, R.D., E.M. Dawley, L.G. Gilbreath, P.J. Bentley, B.P. Sandford, and M.H. Schiewe. 1990. Relative survival of subyearling chinook salmon which have passed Bonneville dam via the spillway or the second powerhouse turbines of bypass system in 1989, with comparisons to 1987 and 1988. Report to the U.S. Army Corps of Engineers, contract E85890024/E86890097. Submitted by the Coastal Zone and Estuarine Services Division, National Marine Fisheries Service, Seattle, Washington.

Li, H.W., C.B. Schreck, C.E. Bond, and E. Rexstad. 1987. Factors influencing changes in fish assemblages of Pacific Northwest streams, p. 193-202. *In* W.J. Matthews and D.C. Heins [ed.] Community and evolutionary ecology of North American stream fishes. University of Oklahoma Press, Norman, OK.

Li, H.W., G.A. Lamberti, T.N. Parsons, C.K. Tait, J.L. Li, and J.C. Buckhouse. 1994. Cumulative effects of riparian disturbances along high desert trout streams of the John Day Basin, Oregon. Trans. Am. Fish. Soc. 123:627-640.

Lichatowich, J. and S. Cramer. 1979. Parameter selection and sample sizes in studies of anadromous salmonids. Information Report Series, Fisheries. Number 80-1. Contract DACW-57-77-C-0027 to the U.S. Army Corps of Engineers. Submitted by the Oregon Department of Fish and Wildlife, Portland, Oregon.

Lichatowich, J.A. and L.E. Mobrand. 1995. Analysis of chinook salmon in the Columbia River from an ecosystem perspective. Contract no. DE-AM79-92BP25105 to the Bonneville Power Adminstration. Submitted by Mobrand Biometrics, Inc., Vashon Island, Washington.

Lichatowich, J.A., L. Mobrand, L. Lestelle, and T. Vogel. 1995. An approach to the diagnosis and treatment of depleted salmon populations in Pacific Northwest watersheds. Fisheries 20(1):10-18.

EX5022-000183-TRB

Karr, M., B. Tanovan, R. Turner and D. Bennett. 1992. Water temperature control project, Snake River, interim report: model studies and 1991 operations. Columbia River Inter-Tribal Fish Commission, U.S. Army Corps of Engineers, University of Idaho Fish and Wildlife Resource Department. 58 p.

Liscom, K., L. Stuehrenberg, and F. Ossiander. 1985. Radio-tracking studies of adult chinook salmon and steelhead to determine the effect of "zero" river flow during water storage at Little Goose Dam on the lower Snake River. Contract DE-A179-81BP27780 to the Bonneville Power Administration. Final Report submitted by the National Marine Fisheries Service, Coastal Zone and Estuarine Services Division, Seattle, Washington. 64 p.

Long, C.W., R.F. Krcma, and F.J. Ossiander. 1968. Research on fingerling mortality in Kaplan turbines, 1968. Progress Report. Bureau of Commercial Fisheries, Seattle, Washington. 7 p.

Lothrop, R.C. 1986. The misplaced role of cost-benefit analysis in Columbia River Basin fishery mitigation. Environmental Law 16(3).

LSRCP (Lower Snake River Compensation Plan Office). 1994. Annual report fiscal year 1994. Boise, Idaho.

Lukens, J.R. 1985. Hells Canyon white sturgeon investigations. Idaho Department of Fish and Game, River and Stream Investigations, Job Performance Report, Federal Aid Project No. F-73-R-7. Idaho Department of Fish and Game, Boise, Idaho.

Major, R.L. and J.L. Mighell. 1966. Influence of Rocky Reach and the temperature of the Okanogan River on the upstream migration of sockeye salmon. U.S. Fish and Wildlife Service Fishery Bulletin 66:131-147.

Martin et al. 1986

Martin, D.J., L.J. Wasserman, R.P. Jones, and E.O. Salo. 1984. Effects of Mount St. Helens eruption on salmon populations and habitat in the Toutle River. Technical Completion Report for the U.S.D.I. Bureau of Reclamation, FRI-UW-8412. 130 p.

Mattson, C.R. 1949. The lamprey fishery at Willamette Falls, Oregon. Fish Commission of Oregon. Fish Commission Research Briefs 2(2):23-27.

Maule, A. G., C. B. Schreck, C. S. Bradford, and B. A. Barton. 1988. Physiological effects of collecting and transporting emigrating juvenile chinook salmon past dams on the Columbia River. Trans. Am. Fish. Soc. 117:245-261.

Maule, A.G., R.A. Tripp, S.L. Kaattari, and C.B. Schreck. 1989. Stress alters immune function and disease resistance in chinook salmon (*Oncorhynchus tshawytscha*). Journal of Endocrinology 120:135-142.

McAllister, M.K. and R.M. Peterman. 1992. Experimental design in the management of fisheries: a review. North American Journal of Fisheries Management 12:1-18.

McCabe, G.T., Jr. and C.A. Tracy. 1993. Spawning characteristics and early life history of white sturgeon *Acipenser transmontanus* in the lower Columbia River, p. 19-46. *In* R.C. Beamesderfer and A.A. Nigro [ed.] Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam. Volume 1. Final report (contract DE-AI79-86BP63584) to Bonneville Power Administration, Portland, Oregon.

McCain, B.B., D.C. Malins, M.M. Krahn, D.W. Brown, W.D. Gronlund, L.K. Moore, and S-L. Chan. 1990. Uptake of aromatic and chlorinated hydrocarbons by juvenile chinook salmon (*Oncorhynchus tshawytscha*) in an urban estuary. Archives of Environmental Contamination and Toxicology 19:10-16.

McCullough, D. 1993. Stream temperature criteria for salmon. Literature review for the Oregon Department of Environmental Quality. Columbia River Inter-Tribal Fish Commission, Portland, Oregon.

EX5022-000184-TRB

McCullough, D.A., F. A. Espinosa, Jr., and J.J. Rhodes. In review. A monitoring strategy for the ESA screening process for application to salmon watersheds. Submitted to the National Marine Fisheries Service. Columbia River Inter-Tribal Fish Commission, Portland, Oregon.

McDonald et al. 1987

McGie, A. 1992. Rogue Basin fisheries evaluation, effects of Lost Creek Dam on fall chinook salmon in the Rogue River. Phase II completion report. Contract DACW57-77-C-0033 to the U.S. Army Corps of Engineers, Portland District. Submitted by Oregon Department of Fish and Wildlife, Rogue River Fisheries Evaluation Project Research and Evaluation Section, Portland, Oregon.

Meffe, G.K. and C.R. Carroll. 1994. Principles of conservation biology. Sinaur Associates, Inc. Sunderland, Massachusetts.

Meyer, E.B. 1989. Evaluation of data collected on the thermal stress problem for juvenile chinook salmon at McNary Dam, Washington. Memorandum for record. CEWES-HS-R (1105-2-10b). Reservoir and water quality branch. Waterways Experiment Station. U.S. Army Corps of Engineers. Vicksburg, Mississippi.

Muir, J.F. 1957. Passage of adult and young fish over proposed low and high head dams across the Fraser River. Prepared for the Technical Committee of the Fraser River Hydro and Fisheries Research Project. University of British Columbia, Vancouver, British Columbia.

Mundie, J.H. 1991. Overview of effects of Pacific coast regulation on salmonids and opportunities for mitigation. American Fisheries Society Symposium 10:1-11.

Mundy, P.R., D. Neeley, C.R. Steward, T.P. Quinn, B.A. Barton, R.N. Williams, D. Goodman, R.R. Whitney, M.W. Erho, Jr., and L.W. Botsford. 1994. Transportation of juvenile salmonids from hydroelectric in the Columbia River Basin: an independent review. Final report submitted to the U.S. Fish and Wildlife Service. Portland, Oregon.

NCASI (National Council of the paper industry for Air and Stream Improvement, Inc.). 1984. Forestry management practices and cumulative effects on water quality and utility. Technical Bulletin 435. New York.

Nehlsen, W., J.E. Williams, and J.A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16:4-21.

Neilson, J.D., and G.H. Geen. 1986. First year growth rate of Sixes River chinook salmon as inferred from otoliths: effects on mortality and age a maturity. Trans. Am. Fish. Soc. 115:28-33.

Nevo. 1978.

Nickelson. 1986.

Niemi, E. and E. Whitelaw. 1995. The economic consequences of protecting salmon habitat in Idaho (preliminary report). ECONorthwest, Eugene, Oregon.

NMFS. 1993.

NMFS (National Marine Fisheries Service). 1995. Draft Proposed Recovery Plan. United States Department of Commerce. National Oceanic and Atmospheric Administration. Washington, D.C.

North, J.A., R.C. Beamesderfer, and T.A. Rien. 1993. Distribution and movements of white sturgeon in three lower Columbia River reservoirs. Northwest Science 67:105-111.

North, J.A., A.L. Ashenfelter, and R.C. Beamesderfer. 1993. Distribution and movements of white sturgeon in the three lower Columbia River reservoirs. *In* Beamesderfer, R.C. and A.A. Nigro [ed.] Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam. Volume I. Final report (contract DE-A179-86BP63584) to Bonneville Power Administration. Portland, Oregon.

EX5022-000185-TRB

Northcote, T.C. 1973. Some impacts of man on Kootenay Lake and its salmonids. Great Lakes Fishery Commission, Technical Report Number 2. Ann Arbor, Michigan.

NPPC (Northwest Power Planning Council). 1986. Council staff compilation of information on salmon and steelhead losses in the Columbia River Basin. Northwest Power Planning Council. Portland, Oregon. 252 p.

NPPC (Northwest Power Planning Council). 1989. Salmon and steelhead system planning documentation. Prepared by the Monitoring and Evaluation Group. August 1, 1989.

NPPC (Northwest Power Planning Council). 1994. Columbia River Basin Fish and Wildlife Program. Appendix C. Assuring an adequate, efficient, economical and reliable power supply and the ability to carry out other purposes of the Power Act. Portland, Oregon.

NPPC (Northwest Power Planning Council). 1995. Preliminary draft economic and demographic forecasts. Portland, Oregon.

ODEQ (Oregon Department of Environmental Quality). 1994. Oregon's 1994 water quality status assessment report, 305(b) report. Portland, Oregon.

ODFW and WDFW. 1990-1994. Fish Runs and Fisheries...

ODFW (Oregon Department of Fish and Wildlife). 1977. Passage problems of adult chinook salmon and steelhead trout in the Columbia River between Bonneville and McNary Dams during 1975. Annual Progress Report to the U.S. Army Corps of Engineers. Contract DACW57-76-C-0068. 49 p.

ODSP (Oregon Department of State Police). 1993. Columbia River pump station inventory. Bonneville Dam to the Oregon/Washington Border. July 19, 1993 letter and report from L.A. Kraft, Fish and Wildlife Division. Oregon Department of State Police. Salem, Oregon.

Olla, B.L., and M.W. Davis. 1989. The role of learning and stress in predator avoidance of hatchery-reared coho salmon (*Oncorhynchus kisutch*) juveniles. Aquaculture 79:209-214.

Olsen, E. P. Pierce, M. McLean, and K. Hatch. 1992a. Stock summary reports for Columbia River anadromous salmonids. Volume I. Oregon subbasins below Bonneville Dam. Bonneville Power Administration, Portland, Oregon.

Olsen, E. P. Pierce, M. McLean, and K. Hatch. 1992b. Stock summary reports for Columbia River anadromous salmonids. Volume II. Oregon subbasins above Bonneville Dam. Bonneville Power Administration, Portland, Oregon.

Oregon Business Council. 1993. Oregon values and beliefs study: summary. Portland, Oregon.

Orians, G.H. 1969. The study of life: an introduction to biology. Allyn and Bacon, Boston, Massachussetts. 841 p.

Orsborn, J.F. 1987. Fishways—historical assessment of design practices. American Fisheries Society Symposium 1:122-130.

OWHP. 1995.

Parsley, M.G., L.G. Beckman, and G.T. McCabe, Jr. 1993. Spawning and rearing habitat use by white sturgeons in the Columbia River downstream from McNary Dam. Trans. Am. Fish. Soc. 122:217-227.

Parsley and Beckman. 1993.

Parsley, M.J. and L.G. Beckman. 1994. White sturgeon spawning and rearing habitat in the lower Columbia River. North American Journal of Fisheries Management 14:812-827.

Pearcy, W. G. 1992. Ocean ecology of North Pacific salmonids. University of Washington Press, Seattle, Washington. 179 p.

Peterman, R.M. 1977. A simple mechanism that causes collapsing stability regions in exploited salmonid populations. J. Fish. Res. Board Can. (34)8:1130-1142.

EX5022-000186-TRB

Petrosky, C.E. 1991. Influence of smolt migration flows on recruitment and return rates of Idaho spring chinook. Idaho Department of Fish and Game, Boise, Idaho.

Petrosky and Schaller. 1992.

Petts, G.E. 1980. Long-term consequences of upstream impoundment. Environmental Conservation 7:325-332.

PFMC. 1985. 1984 ocean salmon fisheries review. Pacific Fisheries Management Council, Portland, Oregon.

Platts, W.S. 1991. Livestock grazing, p. 389-423. *In* W.R. Meehan [ed.] Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, Maryland. 751 p.

PNW (Pacific Northwest Region, USDA Forest Service). 1995. Timber sale program annual report, fiscal year 1994. Portland, Oregon.

PRC (Pacific Rivers Council). 1992. The economic imperative of protecting riverine habitat in the Pacific Northwest. Eugene, Oregon.

PSMFC (Pacific States Marine Fisheries Commission). 1992. White sturgeon management framework plan. Portland, Oregon. 201 p.

Quinn et al. 1991.

Radtke, H. 1993. Economic contribution of salmon to Oregon's coastal communities. Prepared for the Governor's Coastal Salmonid Initiative Conference, with assistance from The Research Group, Corvallis, Oregon.

RASP (Regional Assessment of Supplementation Project). 1992. RASP summary report series. Part I. Background, description, performance measures, uncertainty, and theory. Project 85-62. Bonneville Power Administration, Portland, Oregon.

RASP (Regional Assessment of Supplementation Project). 1992. RASP summary report series. Part III. Planning guidelines. Bonneville Power Administration, Portland, Oregon. 45 p. + appendices A-D.

RASP 1993.

Raymond, H.L. 1979. Effects of dams and impoundments on migration of juvenile chinook salmon and steelhead from the Snake River, 1966-1975. Trans. Am. Fish. Soc. 109:505-529

Raymond, H.L. 1988. Effects of hydroelectric development and fisheries enhancement on spring and summer chinook salmon and steelhead in the Columbia River basin. North American Journal of Fisheries Management 8:1-24.

Regier, H.A., R.L. Welcomme, R.J. Steedman and H. F. Henderson. 1989. Rehabilitation of degraded river ecosystems, p. 86-97. *In* D.P. Dodge [ed.] Proceedings of the international large river symposium. Canadian Special Publication in Fisheries and Aquatic Sciences 106.

Reimers, P.E. 1973. The length of residence of juvenile chinook salmon in the Sixes River, Oregon. Fish Commission of Oregon Research Reports 4 (2):1-43.

Reiman and Beamsderfer. 1990.

Reiman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. General Technical Report INT-302. U.S.D.A. Forest Service, Intermountain Research Station, Ogden, UT. 38 p.

Rhodes, J.J., D.A. McCullough, and F.A. Espinosa, Jr. 1994. A coarse screening process for evaluation of the effects of land management activities on salmon spawning and rearing habitat in ESA consultations. Technical Report 94-4. Columbia River Inter-Tribal Fish Commission, Portland, Oregon. 127 p.

Rhodes et al. 1995.

Rothschild 1986.

EX5022-000187-TRB

Schluchter, M.D. and J.A. Lichatowich. 1977. Juvenile life histories of Rogue River spring chinook salmon *Oncorhynchus tshawytscha* (Walbaum), as determined by scale analysis. Information Report Series, Fisheries Number 77-5. Oregon Department of Fish and Wildlife, Research Section, Corvallis, Oregon.

Ricker, W.E. 1954. Stock and recruitment. J. Fish. Res. Board Can. 11:559-623.

Ruggerone, G.T. 1986. Consumption of migrating juvenile salmonids by gulls foraging below a Columbia River dam. Trans. Am. Fish. Soc. 115:736-742.

Schaller, H. and T. Cooney. 1992. Snake River fall chinook life-cycle simulation model for recovery and rebuilding plan evaluation. Oregon Department of Fish and Wildlife, Portland, Oregon.

Schaller, H., C. Petrosky, E. Weber, and T. Cooney. 1992. Chinook analytical framework Snake River spring/summer chinook empirical life-cycle simulation model for recovery and rebuilding plan evaluation. Oregon Department of Fish and Wildlife, Portland, Oregon.

Schluchter, M.D. and J.A. Lichatowich. 1977. Juvenile life histories of Rogue River spring chinook salmon *Oncorhynchus tshawytscha* (Walbaum), as determined by scale analysis. Information Report Series, Fisheries Number 77-5. Oregon Department of Fish and Wildlife, Research Section. Corvallis, Oregon.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada, Bulletin 184. The Bryant Press Limited, Ottawa, Canada. 966 p.

Scully, R.J. and C.E. Petrosky. 1991. Idaho habitat and natural production monitoring. Part I. General monitoring subproject annual report 1989. Project No. 83-7. Division of Fish and Wildlife, Bonneville Power Administration, Portland, Oregon.

Sherwood, C.R., D.A. Jay, R.B. Harvey, P. Hamilton, and C.A. Simenstad. 1990. Historical changes in the Columbia River estuary, p. 299-352. *In* Angel and Smith [ed.] Columbia River:estuarine system. Progress in Oceanography. Volume 25(1-4).

Shew, D.M., R.D. Peters, R.J. Stansell, D.R. Bryson, W.R. Case, and A.R. Turner, Jr. 1985. Evaluation of adult fish passage at Bonneville and John Day dams in 1984. U.S. Army Corps of Engineers, Portland District, Portland, Oregon. 84 p.

Simenstad, C.A., K.L. Fresh, and E.O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of Pacific salmon: an unappreciated function, p. 343-364. *In* V.S. Kennedy [ed.] Estuarine comparisons. Academic Press, New York.

Simenstad et al. 1990.

Smith, T.I.J. 1990. Culture of North American sturgeons for fishery enhancement. NOAA Technical Report, National Marine Fisheries Service 85:19-27.

Spiden, H.J. 1908. The Nez Perce Indians. Volume II, Part 3. Memoirs of the American Anthropological Association. The New Era Printing Company, Lancaster, Pennsylvania.

Stabler, D.F., R.G. White, R.R. Ringe, and T.C. Bjornn. 1976. Effects of altered flow regimes, temperatures, and river impoundment on adult steelhead trout and chinook salmon. Progress report on contract number DACW68-75-C-0046. Idaho Cooperative Fishery Unit, University of Idaho, Moscow, Idaho. 14 p.

Stabler, D.F. 1981. Effects of altered flow regimes, temperature and river impoundment on adult steelhead trout and chinook salmon. Masters thesis. Department of Forestry and Natural Resources, University of Idaho, Moscow, Idaho. 80 p.

Starke, G.M and J.T. Dalen. 1995. Pacific lamprey (Lampetra tridentata) passage patterns past Bonneville Dam and incidental observations of lamprey at the Portland District Columbia River dams in 1993. CENPP-OP-PF. U.S. Army Corps of Engineers. Cascade Locks, Oregon.

EX5022-000188-TRB

Stearly, R.F. 1992. Historical ecology of Salmoninae, with special reference to *Oncorhynchus*. *In* R.L. Mayden [ed.] Systematics, historical ecology and North American freshwater fishes. Stanford University Press, Stanford, California.

Stearns, S.C. 1976. Life history tactics: a review of the ideas. Quarterly Review of Biology 51:3-47.

Steward, C. 1993. Biodiversity and the recovery of threatened and endangered salmon species in the Columbia River Basin. Technical report 8.

STFA (State and Tribal Fishery Agencies Analytical Team). 1995a. Preliminary summary of spring/summer chinook model results for 1995 biological opinion.

STFA (State and Tribal Fishery Agencies Analytical Team). 1995b. Preliminary summary of fall chinook model results for 1995 biological opinion.

Stuehrenberg, L.C., G.A. Swan, L.K. Timme, P.A. Ocker, M.B. Eppard, R.W. Iwamoto, B.L. Iverson and B.P Sandford. 1994. Migrational characteristics of adult spring chinook salmon through the mid-Columbia reservoirs and dams. Draft final report to the Mid-Columbia Public Utility Districts. Submitted by Coastal Zone and Estuarine Studies Division, National Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington.

Stull, E. and R. Emery. 1985. Pathways and interactions among development activities that result in cumulative effects on fish and wildlife in the Columbia River Basin. DE-AI179-84BP19461. Prepared for Bonneville Power Administration, Portland, Oregon. Argonne National Laboratory, Environmental Research Division, Argonne, Illinois.

Tetra Tech. 1993. Reconnaissance survey of the lower Columbia River. Task 6, Reconnaissance report, Volume 1.

Tetra Tech. 1992. Reconnaissance survey of the lower Columbia River. Task 6, Draft reconnaissance report. Prepared for the Lower Columbia River Bi-State Water Quality Program, Bellevue, Washington.

Thompson. 1959.

Thompson, K. 1974. Chapter 7: Salmonids, p. 85-103. *In* K. Bayha and C. Koski [ed.] Anatomy of a river. Pacific Northwest River Basins Commission, Vancouver, Washington.

Thorpe, J.E. 1994. Salmonid flexibility: responses to environmental extremes, p. 606-612. *In* C.A. Dolloff and P.A. Flebbe [ed.] Strategies for survival: salmonids in marginal habitats. Special Section. Trans. Am. Fish. Soc. 123.

Trefethen, P.S. and D.F. Sutherland. 1968. Passage of adult chinook salmon through Brownlee Reservoir, 1960-62. U.S. Fish and Wildlife Service Fisheries Bulletin 67:35-45.

Turner, A.R., J.R. Kuskie, and K.E. Kostow. 1983. Evaluation of adult fish passage at Little Goose and Lower Granite Dams, 1981. U.S. Army Corps of Engineers, Portland District, Project Operations Division, Fisheries Field Unit, Bonneville Lock and Dam, Cascade Locks, Oregon.

USACE (U.S. Army Corps of Engineers). 1993. Seventh progress report. Fish Passage Development and Evaluation Program 1984-1990. North Pacific Division. Portland, Oregon.

USACE (U.S. Army Corps of Engineers). 1940-1969. Annual fish passage reports.

USACE (U.S. Army Corps of Engineers). 19xx.

USACE. Unpublished data

USDA Forest Service. 1995.

USFWS (U.S. Fish and Wildlife Service. 1979. Eastern peregrine falcon recovery plan. U.S. Fish and Wildlife Service, Washington, D.C.

USFWS (U.S. Fish and Wildlife Service. 1982. Pacific coast recovery plan for the American peregrine falcon. U.S. Fish and Wildlife Service, Washington, D.C.

USFWS (U.S. Fish and Wildlife Service. 1992. Lahontan cutthroat trout, *Oncorhynchus clarki*

EX5022-000189-TRB

henshawi (Salmonidae) recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service. 1993. Greenback cutthroat trout recovery plan. U.S. Fish and Wildlife Service, Denver, CO.

Vigg, S. 1988. Functional response of northern squawfish predation to salmon prey density in McNary tailrace, Columbia River. *In* T.P. Poe and B.E. Rieman [ed.] Predation by resident fish on juvenile salmonids in John Day Reservoir, 1988. Volume 1. Final Report of Research. Bonneville Power Administration, Portland, Oregon.

Vigg and Watkins. 1988.

Vigg, S. and D.L. Watkins. 1991. Temperature control and flow augmentation to enhance spawning migration of salmonids in the Snake River, especially fall chinook salmon. Bonneville Power Administration manuscript. Portland, Oregon.

Wagner, P.G. 1991. 1990 evaluation of the use of the McNary bypass system to divert adult fallbacks away from turbine intakes. Interim Report to U.S. Army Corps of Engineers, Walla Walla District. Contract number DACW68-82-C-0077. Task order number 9. 18 p.

Wallowa-Whitman National Forest, Pacific Northwest Forest and Range Experiment Station, Oregon Department of Fish and Wildlife, Columbia River Inter-Tribal Fish Commission, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Oregon State University. 1992. Upper Grande Ronde River anadromous fish habitat protection, restoration and monitoring plan. Available from CRITFC, Portland, Oregon.

Ware and Thompson. 1991.

Warren, J.J. and L.G. Beckman. 1993. Fishway use by white sturgeon to bypass mainstem Columbia River dams, p. 119-136. *In* R.C. Beamesderfer and A.A. Nigro [ed.] Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam. Volume 1. Final report (contract DE-A179-86BP63584) to Bonneville Power Administration, Portland, Oregon.

WDFW (Washington Department of Fish and Wildlife). 1994. McNary Dam weekly summary reports. Olympia, Washington.

WDOE (Washington State Department of Ecology). 1992. 1992 statewide water quality assessment, 305(b) report. Publication #92-04.

Weitkamp, D.E. and M. Katz. 1980. A review of dissolved gas supersaturation literature. Trans. Am. Fish. Soc. 109:659-702.

Whitcomb, C.C. 1985. Bioeconomic modelling and fisheries management. John Wiley & Sons, Inc., New York.

White, M. and T. Cochnauer. 1989. Salmon spawning ground surveys. Idaho Department of Fish and Game, Boise, Idaho.

Wissmar, R.C. and C.A. Simenstad. 1988. Energetic constraints of juvenile chum salmon (*Oncorhynchus keta*) migrating in estuaries. Can. J. Fish. Aquat. Sci. 45:1555-1560.

Wootton. 1990.

Wydoski, R.S. and R.R. Whitney. 1979. Inland fishes of Washington. University of Washington Press, Seattle, Washington. 220 p.

EX5022-000190-TRB

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