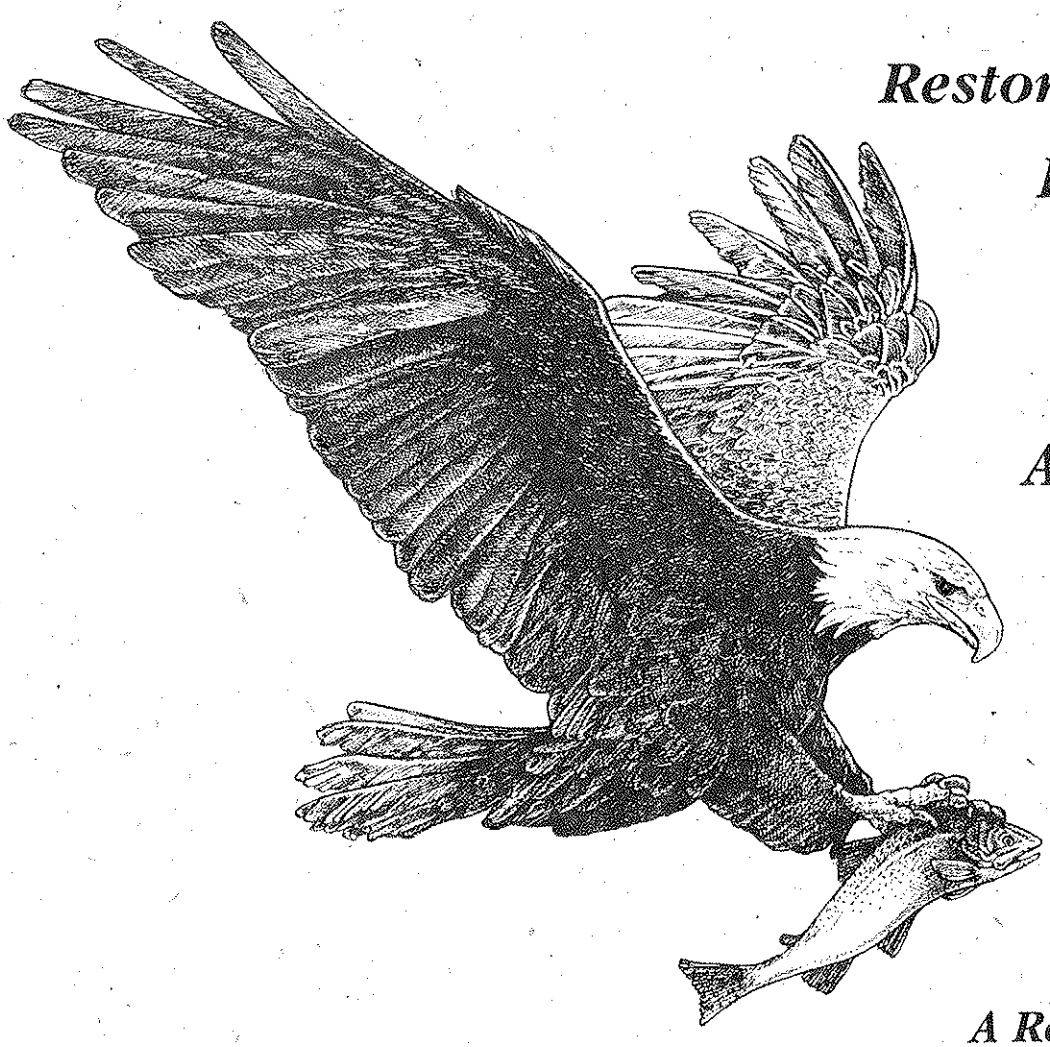
The Elwha Report



Restoration of the Elwha River Ecosystem & Native Anadromous Fisheries

A Report Submitted Pursuant to Public Law 102-495

January 1994

Department of the Interior
National Park Service
U.S. Fish and Wildlife Service
Bureau of Reclamation
Bureau of Indian Affairs

Department of Commerce
National Marine Fisheries Service

Lower Elwha S'Klallam Tribe

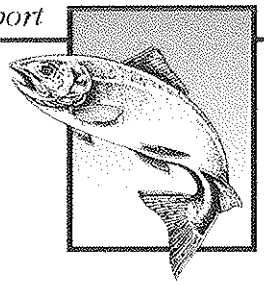


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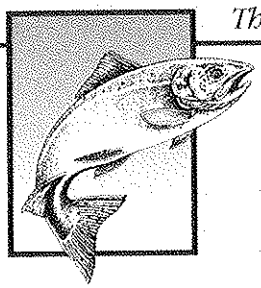
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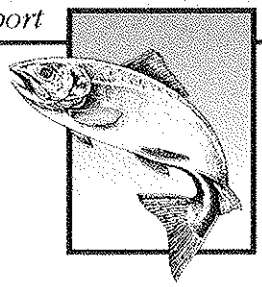


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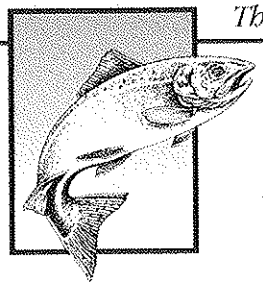


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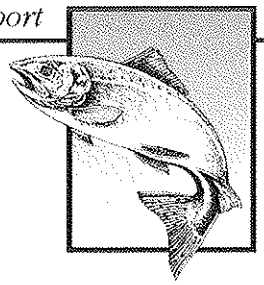
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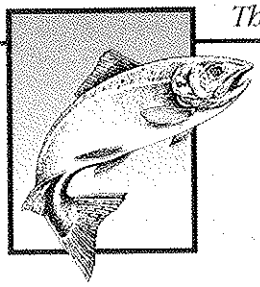
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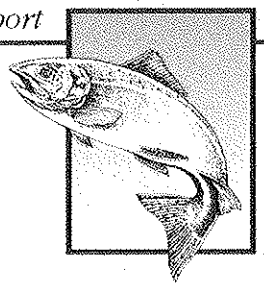
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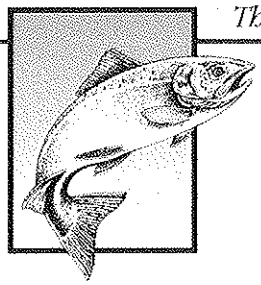
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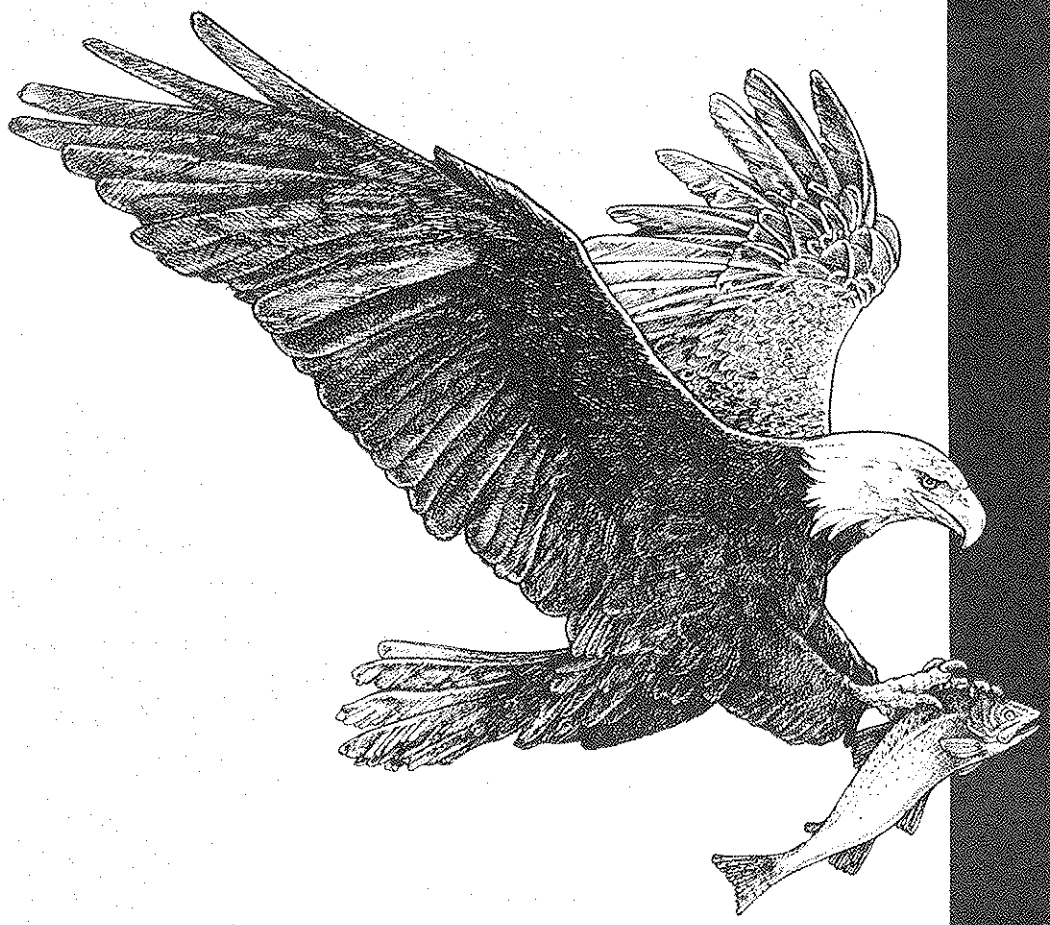
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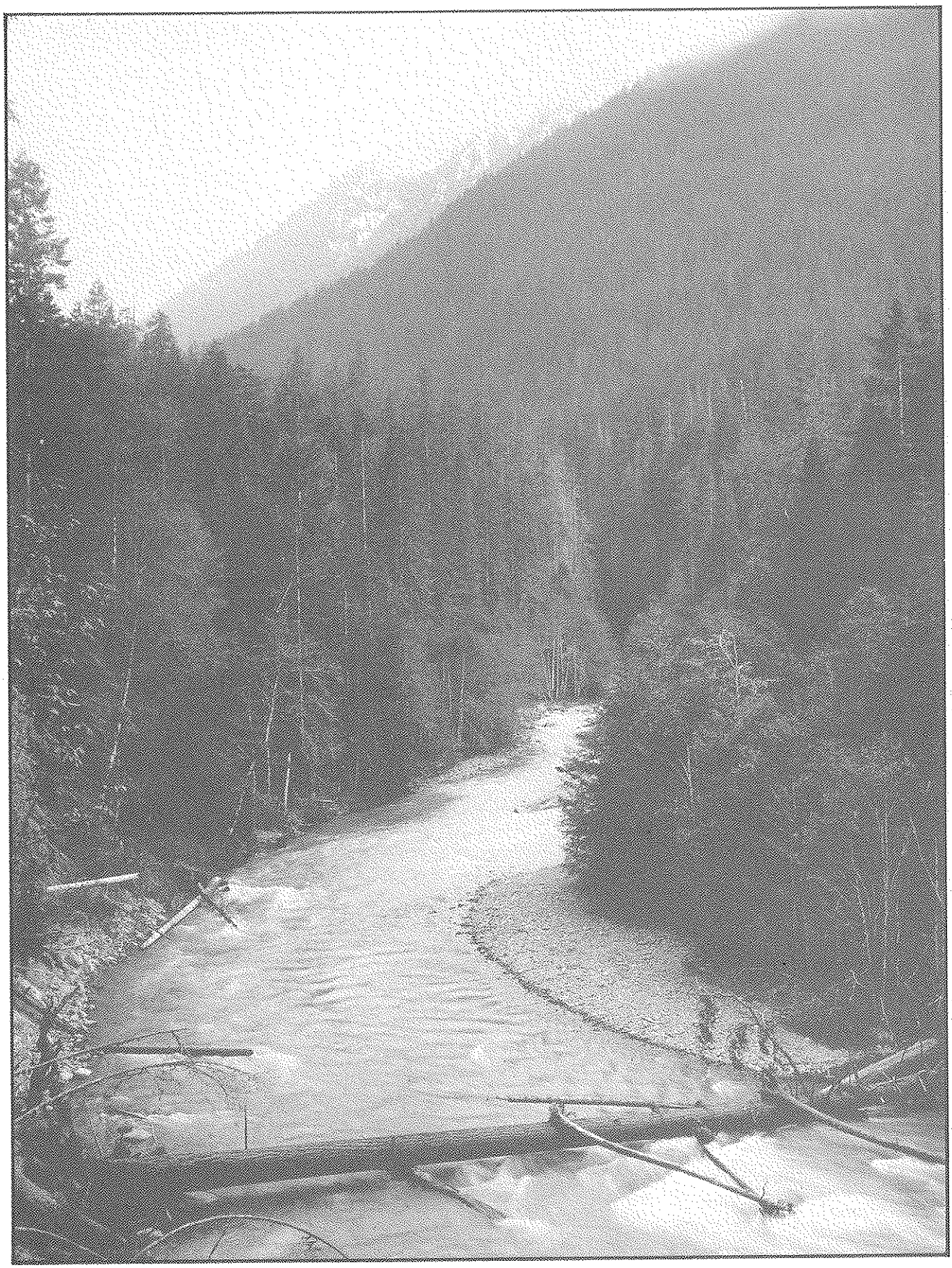
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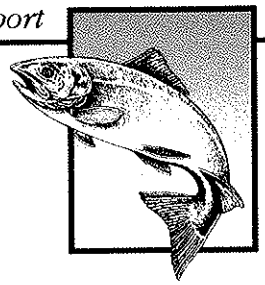
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Executive Summary





Elwha River at Island Camp, May 27, 1907. (Asahel Curtis photo, Washington State Historical Society)



Executive Summary

Background

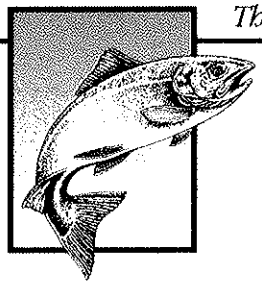
The Elwha and Glines Canyon dams were constructed on the Elwha River. Elwha Dam was constructed from 1910 to 1913 without fish passage facilities and does not have a Federal license to operate. The Glines Canyon Project was constructed from 1925 to 1927, was licensed by the Federal Power Commission for a period of 50 years in 1926, and has received annual licenses since 1976. The privately-owned projects' combined average annual generation of 18.7 megawatts of energy serves Daishowa America's Pulp and Paper Mill in Port Angeles, Washington supplying about 38% of the mill's power needs. The contemporary Federal licensing process began when the Crown Zellerbach Corporation (previous owner) submitted license applications to the Federal Power Commission (precursor to the Federal Energy Regulatory Commission (FERC)) for the Elwha Project in 1968 and the Glines Canyon Project in 1973 (Projects).

Since 1911, the Elwha and Glines Canyon dams have blocked anadromous fish passage to more than 70 miles of the Elwha River and its tributaries . . .

Since 1911, the Elwha and Glines Canyon dams have blocked anadromous fish passage to more than 70 miles of the Elwha River and its tributaries, limiting anadromous salmon and trout production to the lower 4.9 miles of the river below Elwha Dam. As a result, all 10 native Elwha River anadromous fish runs (i.e., spring and summer/fall chinook, coho, pink, chum, and sockeye salmon, winter and summer runs of steelhead, sea-run cutthroat trout, and native char) have been severely diminished and the ecosystem disrupted, especially within a large portion (19%) of Olympic National Park. Numerous wildlife populations within the basin are suspected to have declined.

During the 1980's, the FERC licensing process became extremely contentious and drawn out, due primarily to national policy implications of licensing a project within a National Park, the inability to design fish and wildlife mitigation measures capable of meeting Federal, State, and Indian Tribe resource goals, and legal challenges by conservation groups (i.e., Seattle Audubon Society, Sierra Club, Friends of the Earth, and Olympic Park Associates). Continued attempts to resolve FERC licensing issues were certain to result in protracted litigation, and considerable delay and expense for all parties, including the Federal Government. Failure to reach consensus would lead to the courts deciding vital issues without the opportunity for rational compromise. Verdicts would be narrowly defined by the issues taken before the courts, resulting in a piecemeal approach to the problem when a comprehensive solution is needed.

To resolve these conflicts, Congress enacted a legislative settlement of the issue. The Elwha River Ecosystem and Fisheries Restoration Act was signed into law as Public Law 102-495 by President Bush on October 24, 1992. P.L. 102-495 represents a negotiated solution that provides an avenue to negate lengthy and costly litigation, protect 300 jobs at the Daishowa America Mill, contribute to numerous jobs throughout the region through restoration activities and increased commercial and recreational fishing and tourism, support economic development for the Lower Elwha S'Klallam Tribe, restore a national park ecosystem, contribute to the understanding and improvement of restoration techniques, and assure the protection of



municipal and industrial water supplies. Removal of the dams and restoration of the ecosystem and native anadromous fisheries would also promote tribal fisheries and the Federal trust responsibility to affected Indian Tribes.

Public Law 102-495

The goal of the Elwha River Ecosystem and Fisheries Restoration Act is the "full restoration of the Elwha River ecosystem and native anadromous fisheries" (Section 3(c)). The Act authorized the Secretary of the Interior to acquire the Projects and remove the dams if he determined that their removal was necessary to meet this goal. The Secretary was to develop a report documenting his conclusion and provide it to the Congress no later than January 31, 1994. Additionally, the Secretary was directed to include in the report information on dam retention alternatives that would provide less than full restoration.

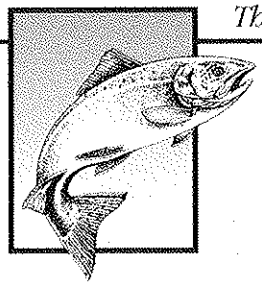
The goal of the Elwha River Ecosystem and Fisheries Restoration Act is the "full restoration of the Elwha River ecosystem and native anadromous fisheries."

The Secretary's Determination

Objectives of Elwha River restoration will be to emulate a natural functioning, self-regulating ecosystem. To evaluate ways to meet these objectives, Department of the Interior bureaus (including the National Park Service, Fish and Wildlife Service, Bureau of Reclamation, and Bureau of Indian Affairs) and cooperating entities, including the Lower Elwha S'Klallam Tribe and the Department of Commerce's National Marine Fisheries Service, developed additional information on dam removal, water quality protection, and fisheries and habitat restoration. As a result of these investigations, the Secretary has determined that removal of both the Elwha and Glines Canyon dams is the only alternative that would achieve the goal of full restoration of the Elwha River ecosystem and native anadromous fisheries. Although some anadromous fish stocks are extinct (sockeye salmon) or are only present in very small numbers (spring chinook and pink salmon), other stocks of fish that are physically and/or genetically close to Elwha River fish could be substituted.

The Secretary has also determined that removal of the Elwha and Glines Canyon dams, while providing for ecosystem and fisheries restoration and the protection of water users, is feasible. Therefore, this report also contains details regarding acquisition of the Projects including an analysis of responsibilities and liabilities, alternatives for dam removal and sediment management, plans for fish and habitat restoration and the protection of existing municipal and industrial water supplies, analyses of impacts to historic properties and the regional power supply, and a discussion of alternatives for disposition of project property.

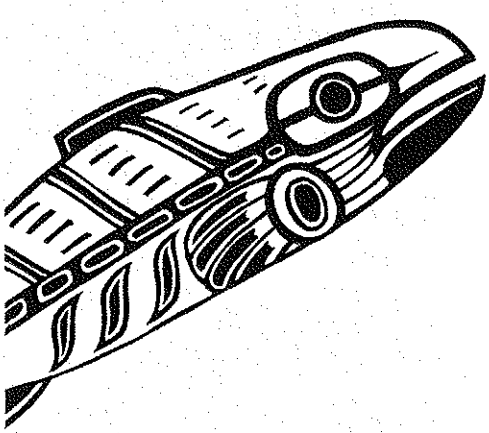
Public Law 102-495 directed the Secretary to include in his report a "definite plan" for removal of the Elwha and Glines Canyon dams. Removal of the dams would constitute a major Federal action, thereby requiring compliance with the National Environmental Policy Act (NEPA). The Secretary's report demonstrates that dam removal is feasible and is necessary for full restoration of the ecosystem and native anadromous fisheries. The report describes plans consisting of four options for removal of the dams, nine scenarios for managing the accumulated sediments, and



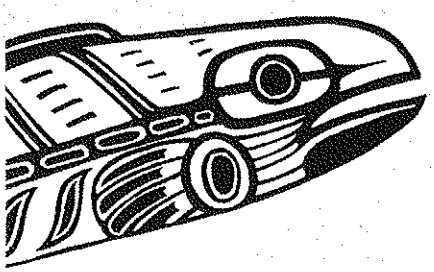
methods of fish and habitat restoration. The preliminary cost estimate for removal of the projects is $66.7 to $80.0 million (in 1992 dollars). However, additional costs for water user protection, fish and habitat restoration, flood control measures, and the acquisition of the projects ($29.5 million) increase the total cost to $147.59 to $203.28 million, to be incurred over the 20 year restoration period. If all accumulated sediments were completely removed, the total cost would be $307.36 million. Although this option is not recommended at this time, it would be included with an analysis of all sediment management options in the EIS/advanced planning report.

A restoration schedule is depicted in Figure 7. Illustrations of project costs associated with the retention or removal of the accumulated sediments within the reservoirs are contained in Figures 8 and 9. Project cost summaries for four sediment management options can be found in Tables 13 to 16.

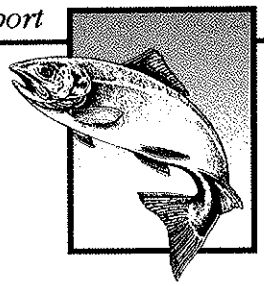
Conclusions



The removal of the Elwha and Glines Canyon dams is the only alternative that would result in the "full restoration of the Elwha River ecosystem and native anadromous fisheries" as prescribed by the Elwha River Ecosystem and Fisheries Restoration Act (Section 3(c)). A synopsis of the consequences of each restoration alternative is provided in Table 3. Retention of either or both dams, even with the provision of fish passage facilities and other measures, would not allow for the full restoration of native anadromous fisheries, in particular chinook, pink, and chum salmon. Additionally, retention of either or both dams would prevent the restoration of natural sediment transport processes, resulting in continued degradation of the river below the dams, the estuary, and near coastal areas. Retention of either or both reservoirs would prevent the restoration of important bottom land and riverine habitat for wildlife and anadromous fish, as well as prevent full nutrient transport, thus impacting freshwater organisms.



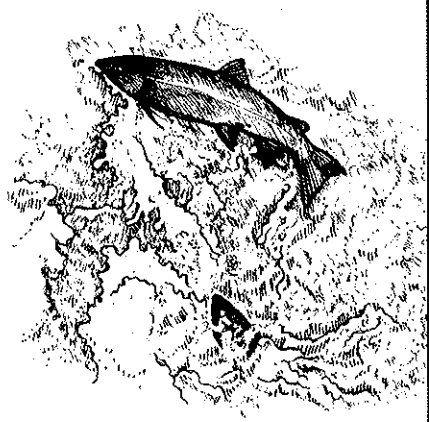
Removal of the Elwha and Glines Canyon dams, while protecting water users and accomplishing fish and habitat restoration, is feasible. The costs to fully restore the Elwha River ecosystem and native anadromous fisheries are generally on a par with restoration activities elsewhere in the region. However, it is important to note that restoration of the Elwha River would be essentially complete following removal of the Elwha and Glines Canyon dams and the completion of associated activities, whereas habitat impacts in other Pacific Northwest basins are likely to continue. Also, implementation of P.L. 102-495 would negate lengthy and costly litigation and provide significant benefits to an economically depressed region. Full restoration of the ecosystem and native anadromous fisheries would promote tribal fisheries and the Federal trust responsibility to affected Indian Tribes. Because it is a negotiated solution rather than a litigated decision, P.L. 102-495 provides a rare "win-win" opportunity for all affected parties.



survey and an ethnographic survey would be needed to document resources in the Project area. Following this work, the recommended course of action to protect archeological sites during and after dam removal would be to monitor the reservoir as sediments are moved. Recommended mitigation for removal of the dams is documentation of the structures according to standards set for the Historic American Engineering Record.

Impacts on Regional Power Supply

Recent economic growth, early shutdown of the Trojan nuclear plant, and reductions in the generating capability of the Columbia River hydropower system to support fisheries mitigation have produced a need to secure new electric power resources in the Northwest. Because of cost-effectiveness and environmental attributes, acquisition of conservation has been accorded the highest priority by the Northwest Power Planning Council (Council). The Council's goal for regionwide acquisition of at least 1,500 average megawatts of conservation over a 10 year period has been adopted by the Bonneville Power Administration, the state utility commissions, and the principal regional utilities. Current evidence indicates that actual rates of conservation are consistent with this goal. However, the acquisition of a mix of projects would probably be advanced to cover the small size of the Elwha and Glines Canyon projects (18.7 average megawatts).



Cost-Sharing

Restoration of the Elwha River ecosystem and native anadromous fisheries would result in benefits to a broad spectrum of public and private interests. However, certain parties (i.e., tribes) would be excluded from cost-sharing.

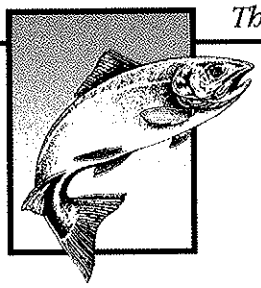
There are a number of Federal statutes -- both generic and project-specific -- that address the issue of cost-sharing for fish and wildlife mitigation, enhancement, or restoration at Federal water resources development projects of the Army Corps of Engineers, Interior's Bureau of Reclamation, and the Department of Agriculture's Soil Conservation Service.

While these statutes do not apply directly to the removal of the Elwha and Glines Canyon dams, there is certainly precedent to require as much as 25 percent non-Federal cost-sharing for certain fish and wildlife resource activities.

Appropriate cost-sharing terms will be explored during development of the advanced planning report and NEPA compliance process. Based on the results of this review, a formal cost-sharing agreement would be negotiated prior to initiation of the selected alternative.

Restoration Costs

Additional investigations are necessary to identify the preferred dam removal and sediment management option. This would in turn allow the further identification of the measures that are necessary to protect existing water users and the best



restoration. Plantings of native vegetation in the area would be undertaken to mimic the pre-dam landscape while measures to control the invasion of exotic plants would be implemented. Over time, the drained reservoir areas would attain characteristics of the surrounding lands.

Disposition of Project Lands

Pursuant to the Act, the lands associated with the Glines Canyon Project would be managed in accordance with National Park Service authorities upon acquisition. The lands associated with the Elwha Project could be included in the Olympic National Park or National Wildlife Refuge System (NWRS), held in trust for the Lower Elwha S'Klallam Tribe (Tribe), or provided for use by the State, as long as such use supports the Federal investment in restoration.

The National Park Service has determined that Elwha Project lands qualify for inclusion into Olympic National Park. The U.S. Fish and Wildlife Service (FWS) has preliminarily recommended against establishing a National Fish and Wildlife Refuge administered solely by the FWS but is interested in cooperative management of the area. The Tribe has developed a land use proposal that would protect restoration while supporting needed housing and economic opportunities for the Tribe. The State of Washington has not expressed an interest in the lands. The potential for cooperative management of the Elwha Projects lands, for example the NPS, FWS, Tribe, and/or State, needs further analysis.

Interpretation of Dam Removal

Removal of the Elwha and Glines Canyon dams would be of national interest resulting in wide publicity. For many years, interest would increase visitation to Olympic National Park and Clallam County by people desiring a firsthand view and the inside story of this historic event. A range of options are available to provide an interagency/intergovernment presentation of dam removal efforts and ecosystem restoration. Such efforts would provide an important boost to the local economy and enhance regional partnerships.

Devi Sharp, Department of Natural Resources, studies radio-tagged carcasses in Olympic National Park. (Janis Burger)

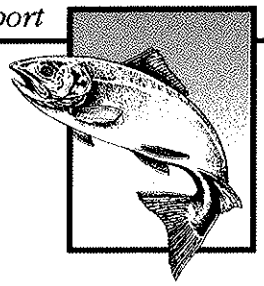


Living Laboratory

There is great interest in making use of the Elwha River basin as a "Living Laboratory." To fully explore this concept, a panel consisting of fish and wildlife biologists, ecologists, silviculturists, hydrologists, soil scientists, tribal representatives and other specialists would be convened to develop a study plan to monitor changes to the ecosystem resulting from dam removal. Federal funds may be secured to act as seed money to initiate and/or cost-share identified research investigations.

Impacts to Cultural Resources

If the dams are removed, the cultural resource that is the Elwha River can be restored, with benefits to both Indians and non-Indians. An initial archeological



anadromous fisheries. The definite plan includes a number of dam removal and sediment management options that would result in full restoration. However, additional studies in support of an EIS/advanced planning report will be required to select a preferred alternative.

Water Quality Protection

Several options (e.g., new wells, new inlet and settling basin, modification of existing systems) have been identified to protect the major Elwha River water users from the impacts of dam removal. Additional work would be required during the EIS/advanced planning stage to confirm the viability of each option, to identify any additional options, and to work with the affected entities to develop consensus regarding a preferred option for each diversion.

Fish Restoration

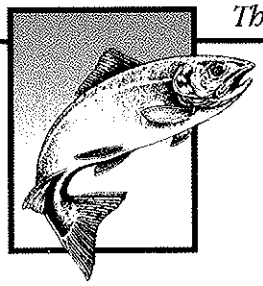
For most of the Elwha River stocks, the fish restoration plan recommends accelerating the recovery process through the outplanting of juvenile fish into the upper river. Although indigenous stocks would receive first priority in brood development and restoration, some salmon stocks are extinct or are only present in very small numbers. Other salmon stocks that are physically or genetically close to Elwha River salmon could be substituted. Sea-run cutthroat trout and native char would be allowed to recover naturally. To ensure that fish are available for outplanting when access to the upper river is restored, stock assessment and brood development has already begun. Stock status assessments will continue and will be expanded to identify the most promising sources of broodstock for restoration.



Hatchery support would be required to develop and maintain broodstock for outplanting. The two existing fish production facilities in the lower river (those of the Washington Department of Fisheries and the Lower Elwha S'Klallam Tribe) would be modified to produce juvenile fish for outplanting. Use of these facilities would reduce logistical costs and limit the possibility of future transfer restrictions due to fish disease concerns. Modifications to support this effort would include improvements to water supplies and the expansion of incubation and support capabilities. Juvenile outplanting would take place when safe downstream passage at the dam sites is assured and would occur for up to two fish generations (8 to 10 years) at levels consistent with the carrying capacity of the habitat and the ability to effectively reintroduce each stock to the upper river at its target time and size of release.

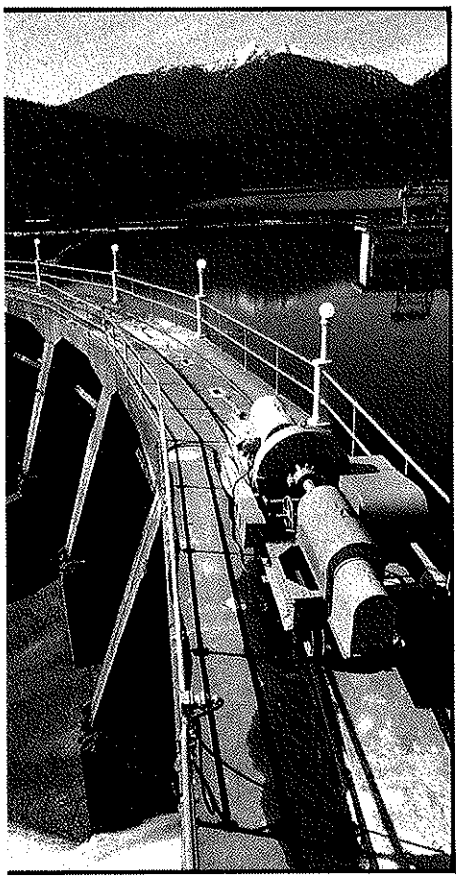
Habitat Restoration

The primary objective of habitat restoration in the areas inundated by Lake Mills and Lake Aldwell is the restoration of the ecosystem and native anadromous fisheries. The plan includes measures to restore the biological, hydrological, and physical processes that occurred prior to construction of the Projects. Although a precise replication of past conditions is impossible, historic photographs of the reservoir areas prior to inundation and other information provide a guide for



impounds 2.8 mile long Lake Mills. Fish passage facilities also were not provided at Glines Canyon Dam.

Measures to restore anadromous fish with the retention of either or both dams would include upstream and downstream fish passage facilities and operational changes. To pass fish at Elwha Dam, the necessary facilities would include an adult fish ladder, juvenile fish screen system, and spillway improvements. To pass fish past Glines Canyon Dam, a trap-and-haul operation would be necessary for adult fish and continuous spill and a facility for screening fish away from the turbine intake would be necessary for juvenile fish.



Spillway bridge, Glines Canyon Dam. (Pat O'Hara)

Dam Removal

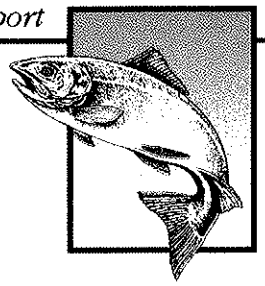
The removal of both dams would involve decommissioning the Elwha and Glines Canyon projects, removing most if not all of the existing auxiliary structures, returning the river to a free-flowing condition, and implementing habitat and fish restoration plans. The electrical energy produced by the Projects and consumed by the mill would be replaced by power provided by the Bonneville Power Administration. Measures to protect water users would be implemented.

The primary steps involved in removing the projects would include diverting the river around the dam structures, removing the structures, and managing the sediments that have accumulated in each reservoir. Four plans for diverting the river and demolishing the dam structures have been investigated, including diverting the river (1) in tunnels, (2) around the dams in a surface channel, (3) through the dam structures, and (4) over the dams by creating a notch through the structures.

For nearly 80 years the reservoirs have acted as large settling basins, slowing the river flow and trapping material behind the dams. Most of this material has been trapped in the upstream reservoir, Lake Mills. The trapped material can be roughly divided into two categories. Coarse material ranging in size from small sand to large gravel has been deposited at the heads of the reservoirs to form deltas. Fine material consisting of smaller clay and silt sized particles is fairly evenly deposited throughout the beds of the reservoirs.

Three major options for managing the sediments have been identified: (1) the material could be removed from the inundated regions and relocated to a terrestrial or saltwater site; (2) the river could be allowed to erode a new channel through the trapped material with subsequent deposition in saltwater; and (3) only the material in the path of the river would be relocated and stabilized adjacent to the new channel leaving the remaining material in place for revegetation. Nine different scenarios involving combinations of each of the sediment management options described above have been recommended for further review during the EIS/ advanced planning stage.

The information developed for this report demonstrates that it is feasible to remove the dams, protect existing water users, and fully restore the ecosystem and native

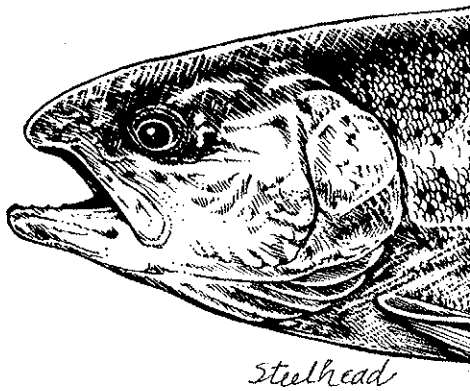


a process for analysis of these alternatives consistent with full restoration of the ecosystem and native anadromous fisheries. A preferred alternative would be selected during the Environmental Impact Statement (EIS)/advanced planning stage. The EIS/advanced planning report would be initiated following submittal of The Elwha Report to the Congress.

Affected Environment

The Elwha River, 45 miles long, is located on the Olympic Peninsula in northwest Washington. With a drainage area of 321 square miles, of which 83% is located within Olympic National Park, the Elwha River is the fourth largest river by drainage area on the peninsula. The maritime climate of the area is characterized by mild, wet winters and relatively cool, dry summers. Rainfall averages 60 to 80 inches per year. The average instantaneous discharge of the Elwha River is 1,507 cfs. Water is withdrawn from the river for private, municipal, industrial, and fish propagation purposes.

Although historical quantitative records of pre-dam run sizes of Elwha River anadromous fish are limited, the Elwha River was historically noted as one of the largest producers of salmon and steelhead on the Olympic Peninsula. Anadromous fish included stocks of spring and summer/fall run chinook, coho, pink, chum, and sockeye salmon, summer and winter runs of steelhead, sea-run cutthroat trout, and native char (Dolly Varden and bull trout). Current runs are only a small portion of their former size. At least one Elwha River salmon stock (sockeye salmon) may be extinct while two stocks (spring chinook and pink salmon) may only be present in extremely small numbers.



Steelhead

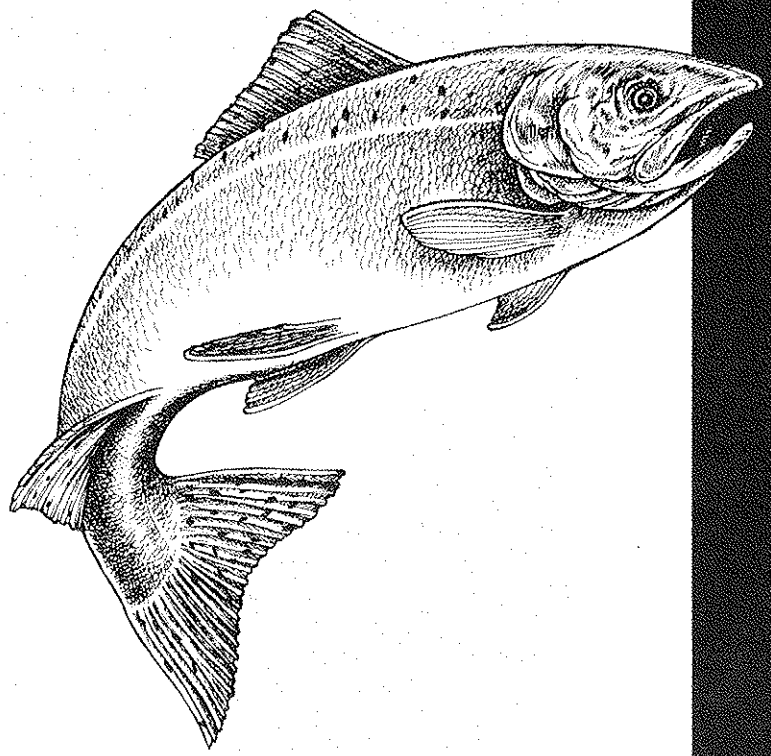
Because most of the valley lies within Olympic National Park, the Elwha River basin is primarily pristine. The Projects have, however, dramatically altered the landscape by inundating about 5.3 miles of river and 684 acres of lowland habitat. About 11.3 million cubic yards of sediment are trapped in Lake Mills and from 2.6 to 4 million cubic yards are trapped in Lake Aldwell. With the interception of bedload (cobbles, gravel, and sand) by Lake Mills and Lake Aldwell, the spawning habitat downstream from both dams has been badly eroded such that much of the former spawning area now consists of substrate that is too large to be used by spawning fish. The trapping of bedload in the reservoirs has also contributed to the erosion of estuarine and near-shore marine habitat, including Ediz Hook at Port Angeles Harbor.

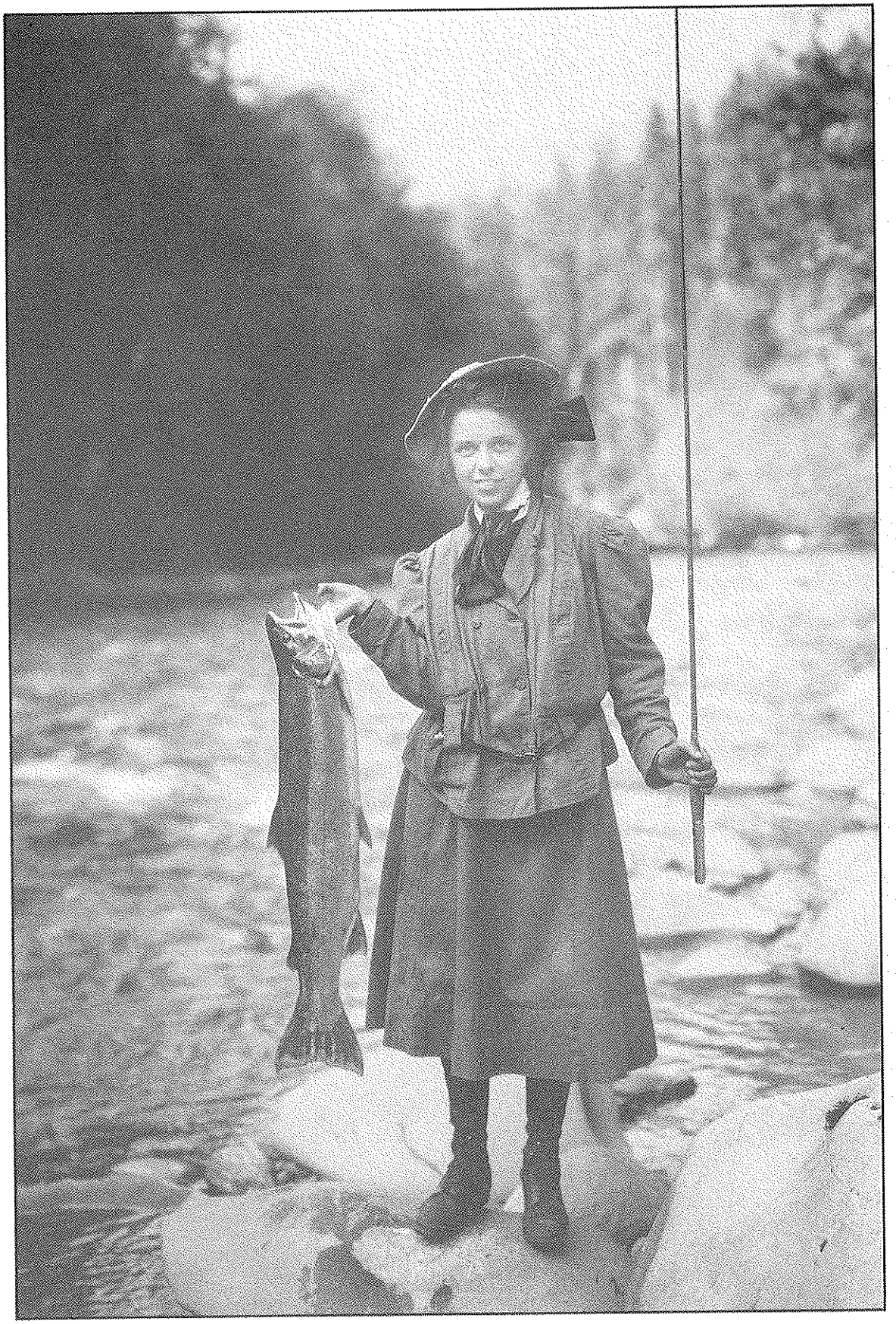
Dam Retention Alternatives

Elwha Dam is a concrete and earth-fill structure that is about 450 feet long at its crest and 105 feet high. The impoundment created by the dam, Lake Aldwell, is 2.5 miles in length. Elwha Dam was constructed without fish passage facilities.

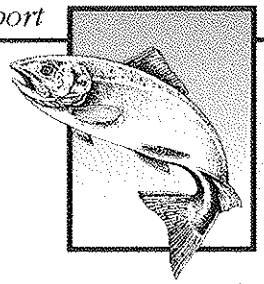
Glines Canyon Dam is a varied radius, single arch concrete dam that is 210 feet high and varies in width from 55 feet at its base to 270 feet at its crest. The dam

I. Introduction





Elinor Chittenden displays a steelhead caught in 1907, before the Elwha Dam was constructed. (Asahel Curtis photo, Washington State Historical Society)



I. Introduction

The Elwha and Glines Canyon dams were constructed on the Elwha River to provide hydroelectric power for local consumption. Elwha Dam was constructed from 1910 to 1913 without fish passage facilities and does not have a Federal license to operate. The Glines Canyon Project was constructed from 1925 to 1927, was licensed by the Federal Power Commission for a period of 50 years in 1926, and has received annual licenses since 1976. The privately-owned projects' combined average annual generation of 18.7 megawatts (MW) of energy serves Daishowa America's Pulp and Paper Mill in Port Angeles, Washington, supplying about 38% of the Mill's power needs.

The contemporary Federal licensing process began when the Crown Zellerbach Corporation (previous owner) submitted license applications to the Federal Power Commission (precursor to the Federal Energy Regulatory Commission (FERC)) for the Elwha Project in 1968 and the Glines Canyon Project in 1973 (Projects).

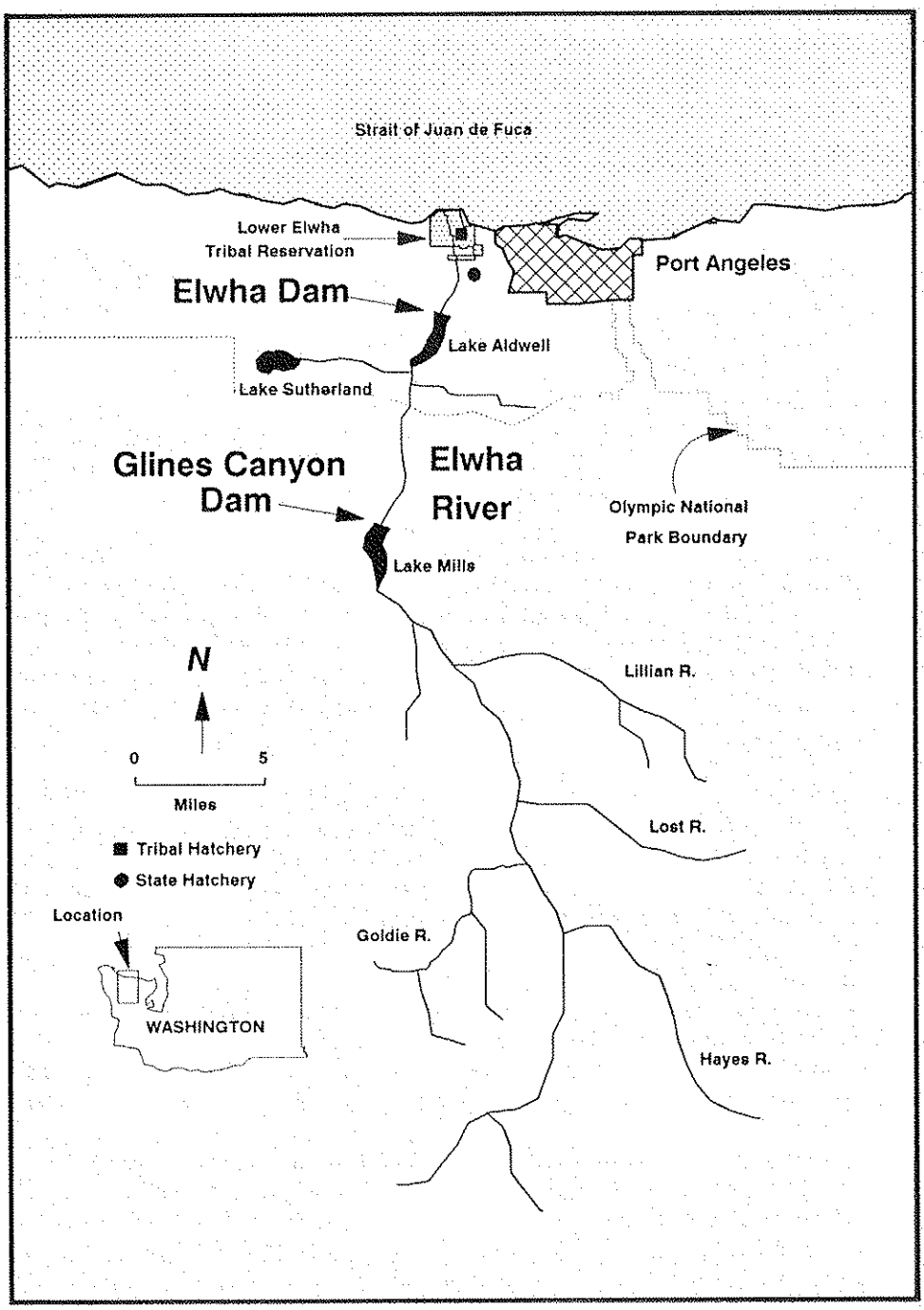
Since 1911, the Elwha and Glines Canyon dams have blocked anadromous fish passage to more than 70 miles of the Elwha River and its tributaries, limiting salmon production to the lower 4.9 miles of the river below Elwha Dam (Figure 1). As a result, all native Elwha River anadromous fish runs have been severely diminished and the ecosystem disrupted, especially within a large portion (about 19%) of Olympic National Park. At least one Elwha River salmon stock[1] (sockeye salmon) may be extinct while two stocks (spring chinook and pink salmon) may only be present in extremely small numbers. Numerous wildlife populations within the basin are suspected to have declined. In addition to ecological damage, the Projects have dramatically reduced the treaty fisheries of at least four federally recognized Indian Tribes (including the Lower Elwha S'Klallam, the Port Gamble Klallam, the Jamestown Klallam, and the Makah) and blocked access to many traditional fishing sites and other traditional cultural properties.

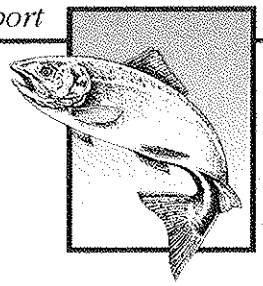
During the 1980's, the FERC licensing process became extremely contentious and drawn out, due primarily to national policy implications of licensing a project within a National Park, the inability to design fish and wildlife mitigation measures capable of meeting Federal, State, and Indian Tribe resource goals, and legal challenges by conservation groups (i.e., Seattle Audubon Society, Sierra Club, Friends of the Earth, and Olympic Park Associates). Continued attempts to resolve FERC licensing issues were certain to result in protracted litigation, and considerable delay and expense for all parties, including the Federal Government. Failure to reach consensus would lead to the courts deciding vital issues without the opportunity for rational compromise. Verdicts would be narrowly defined by the issues taken before the courts, resulting in a piecemeal approach to the problem when a comprehensive solution is needed.

To resolve these conflicts, Congress enacted a legislative settlement of the issue. The Elwha River Ecosystem and Fisheries Restoration Act was signed into law as Public Law 102-495 by President Bush on October 24, 1992 (Appendix A). P.L. 102-495 represents a negotiated solution that provides an avenue to negate lengthy and costly litigation, protect 300 jobs at the Daishowa America Mill, contribute to numerous jobs throughout the region through restoration activities and increased commercial and recreational fishing and tourism, support economic development for an impoverished

[1] *A fish stock refers to "the fish spawning in a particular lake or stream (or portion of it) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season" (Ricker 1972).*

Figure 1. *Location map for the Elwha and Glines Canyon dams.*





Indian Tribe, restore a national park ecosystem and native anadromous fisheries, contribute to the understanding and improvement of restoration techniques, and assure the protection of municipal and industrial water supplies. In addition, removal of the dams and restoration of the ecosystem and native anadromous fisheries would promote tribal fisheries and the Federal trust responsibility to affected Indian Tribes.

The goal of the Elwha River Ecosystem and Fisheries Restoration Act is the "full restoration of the Elwha River ecosystem and native anadromous fisheries" (Section 3(c)). The Act authorized the Secretary of the Interior to acquire the Projects and remove the dams if he determined that their removal was necessary to meet this goal. The Secretary was to develop a report documenting his conclusion and provide it to the Congress no later than January 31, 1994. Additionally, the Secretary was directed to include in the report information on dam retention alternatives that would provide less than full restoration. FERC had analyzed the dam retention alternatives in detail in a March 1993 "Draft Staff Report for the Glines Canyon (FERC No. 588) and Elwha (FERC No. 2683) Hydroelectric Projects, Washington." FERC's findings have been summarized herein[2].

Objectives of this restoration will be to emulate a natural functioning, self-regulating ecosystem. To evaluate ways to meet these objectives, Department of the Interior bureaus (including the National Park Service, Fish and Wildlife Service, Bureau of Reclamation, and Bureau of Indian Affairs) and cooperating entities, including the Lower Elwha S'Klallam Tribe and the Department of Commerce's National Marine Fisheries Service, developed additional information on dam removal, water quality protection, and fisheries and habitat restoration. As a result of these investigations, the Secretary has determined that removal of both the Elwha and Glines Canyon dams is the only alternative that would achieve the goal of full restoration of the Elwha River ecosystem and native anadromous fisheries. Although some anadromous fish stocks are extinct (sockeye salmon) or are only present in very small numbers (spring chinook and pink salmon), other stocks of fish that are physically and/or genetically close to Elwha River fish could be substituted.

The Secretary has also determined that removal of the Elwha and Glines Canyon dams, while providing for ecosystem and fisheries restoration and the protection of water users, is feasible. Therefore, this report also contains details regarding acquisition of the Projects including an analysis of responsibilities and liabilities, alternatives for dam removal and sediment management, plans for fish and habitat restoration and the protection of existing municipal and industrial water supplies, analyses of impacts to historic properties and the regional power supply, and a discussion of alternatives for disposition of project property.

Public Law 102-495 directed the Secretary of the Interior to include in his report a "definite plan" for removal of the Elwha and Glines Canyon dams. Removal of the dams would constitute a major Federal action, thereby requiring compliance with the National Environmental Policy Act (NEPA). The Secretary's report demonstrates that dam removal is feasible and is necessary for the full restoration of the ecosystem and native anadromous fisheries. The report describes plans consisting of four options

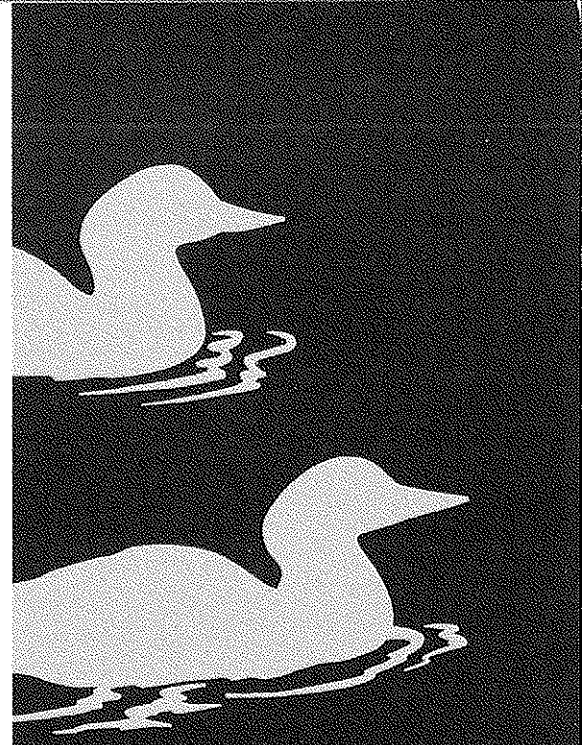
[2]*Reference to the Draft Staff Report does not denote Department of the Interior concurrence with specific FERC findings. Rather, FERC text and analyses incorporated in this report have been adjusted based on the standard of "full restoration" as specified in P.L. 102-495 and errors have been corrected.*

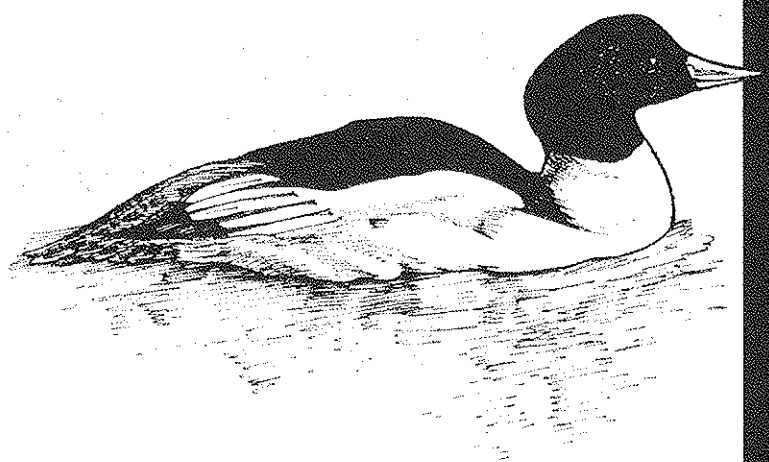
for removal of the dams, nine scenarios for managing the accumulated sediments, and a process for analysis of these alternatives consistent with full restoration of the ecosystem and native anadromous fisheries. A preferred alternative would be selected during the Environmental Impact Statement (EIS)/advanced planning stage, to be initiated in fiscal year 1994. Acquisition of the projects could occur either prior to or following the EIS/advanced planning report.

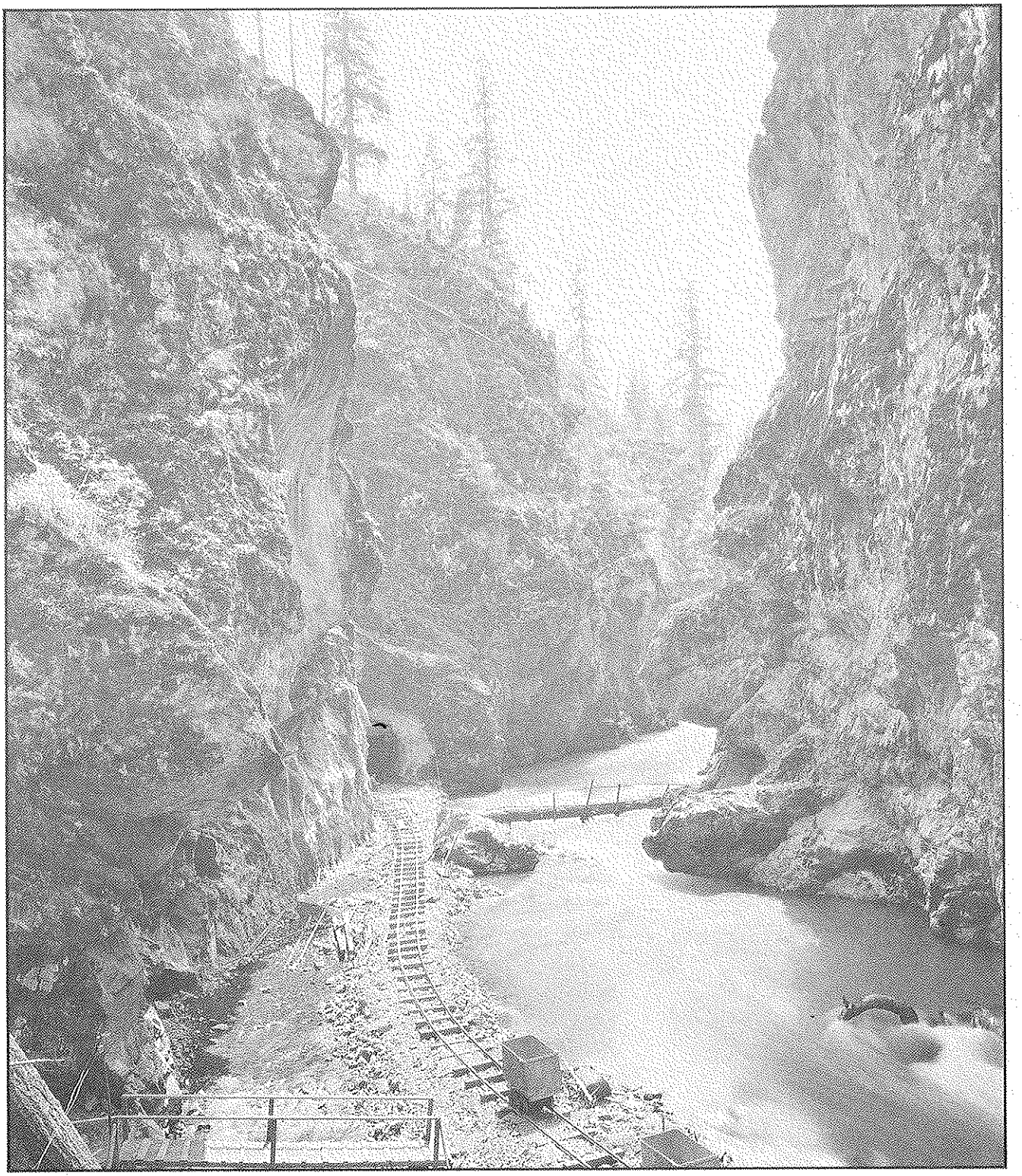


Elwha River, May 27, 1907. (Asahel Curtis photo, Washington State Historical Society)

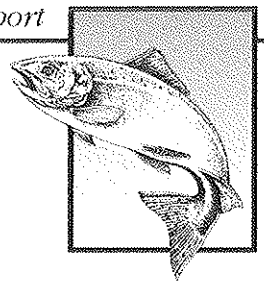
II. Background of the Problem







Excavating for diversion tunnel, Glines Canyon Dam site, June 15, 1926. (Northwestern Power & Light Company photo)



II. Background of the Problem

A. History of the Projects

The Elwha Valley, with its river and tributaries rich in salmon, was used by Native Americans for thousands of years before the first European explorers reached the Northwest coast. The Lower Elwha S'Klallam Tribe based much of its culture and economy on the multiple runs of salmon in the Elwha River. Ethnographic accounts identify as many as 12 residential and camping sites on the lower river, including major villages on the west bank at the confluence of the river with both Indian Creek and Little River (Wesson and Welch 1987).

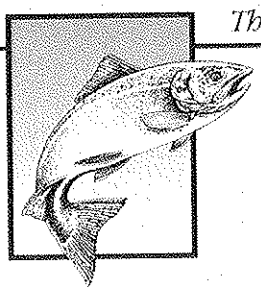
The Elwha Valley, with its river and tributaries rich in salmon, was used by Native Americans for thousands of years before the first European explorers reached the Northwest coast.

In 1889, a young Canadian named Thomas Aldwell arrived on the peninsula and began purchasing land on both sides up and downstream of the narrowest gorge on the Elwha river. By 1908 Aldwell had succeeded in buying all the land he needed for a dam and its reservoir. Aldwell convinced George A. Glines, a wealthy Canadian, to help finance power development on the Elwha. With Glines' financial backing, Aldwell was able to purchase a half interest in the site where the Glines Canyon Dam would be built and form the T. T. Aldwell Company (Adamire and Fish 1991). In 1910, Aldwell formed the Olympic Power and Development Company and obtained the financial backing of Chicago capitalists to begin construction of the Elwha Dam. Despite repeated contacts from the Washington State Fish Commissioner, reminding Aldwell of the legal requirement to provide passage for migrating fish and the complaints from local salmon cannery officials, no accommodation for fish passage was made. The State Game Warden, even before the dam closed its gates, complained that the fish were blocked from migrating. On the last day of October 1912, the dam foundation blew out, taking with it the downstream bridge. The blow out was the result of a failure to provide a secure foundation down to bedrock under the gravity dam.

Aldwell obtained the financing to repair the dam. State and local fish commissioners thought they saw a new chance to provide for the fish, but their efforts were ignored. When the project became operational in 1913, supplying power to Bremerton Navy Yard, Port Angeles and Sequim, the fish question remained unsettled. Ultimately, a compromise was reached allowing Aldwell to construct a fish hatchery at the dam in lieu of a fishway. The hatchery was unsuccessful and finally abandoned in 1922 due to the scarcity of salmon making their way upriver.

Although all of the power generated by the Projects since 1920 has been used by the Mill (except for emergencies), the power provided by the Elwha Project helped fuel the growth of Port Angeles. In 1949, power provided by the Bonneville Power Administration reached the Olympic Peninsula.

When Glines Canyon Dam, located upriver from Elwha Dam, was licensed in 1926 by the Federal Power Commission, impacts to the fisheries were not considered; the



traditional fishing grounds at the confluence of Indian Creek and the Elwha had been flooded by Lake Aldwell and fish migration had already been blocked. Over the next decade, ownership of both the dams and the land surrounding the Glines Canyon Project changed. Crown Zellerbach Corporation, which had purchased the Elwha Project in 1919, received permission from the Federal Power Commission to purchase the Glines Canyon Project in 1937. The following year, with the establishment of Olympic National Park, most of the lands inundated by Lake Mills became part of the park, although ownership of the facilities and the land upon which they were constructed remained with Crown Zellerbach.

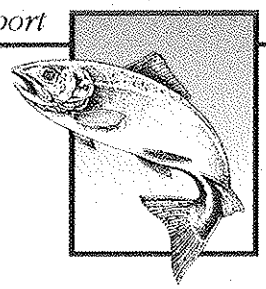
Applications for licensing the Elwha Project and relicensing the Glines Canyon Project were filed by Crown Zellerbach in 1968 and 1973, respectively, initiating more than two decades of debate ranging from jurisdictional disputes to fisheries issues to the weakening of Ediz Hook, the breakwater creating the Port Angeles harbor which was partially fed by the littoral drift pushed downstream by the Elwha River before the dams' construction. James River II, Inc. (currently James River Paper Company), which purchased both dams and power plants in 1987, became Crown Zellerbach's successor in the center of the controversy.

As a result of the obvious adverse impacts of the Elwha and Glines Canyon projects on the salmon populations of the Elwha River (primarily blockage of adult salmon migration and frequent, rapid, and dramatic stream flow fluctuations for power generation purposes), the Washington Department of Fisheries (WDF) entered into a settlement agreement with the Crown Zellerbach Corporation (CZC) on April 25, 1975. In return for WDF's commitment not to oppose licenses for the Projects, CZC agreed to operate the Elwha Project in a run-of-the-river mode and to provide 23.6% of the construction and operating costs for a rearing facility to produce a maximum of 360,000 pounds of juvenile chinook salmon. Disease problems (e.g., *Dermocystidium salmonis*) have limited chinook salmon production at the facility. No other species have been produced at this facility.

In an attempt to replace a small portion of its economic base, the Lower Elwha S'Klallam Tribe obtained Federal funds to construct a hatchery on Reservation lands near the mouth of the river. The hatchery began operation in 1976 and produces coho and chinook salmon and steelhead but is not considered mitigation for the Projects.

B. Description of the Projects

After initiating construction in 1910, the Olympic Power and Development Company (Olympic Power) began operation of Elwha Dam in 1913. The dam is a concrete structure consisting of a central gravity-type section with an adjacent buttress-type intake section and flanked by spillways at each abutment. It is approximately 450 feet long at its crest and is about 105 feet high. Lake Aldwell, the 2.5 mile impoundment created by the dam, has a total storage capacity of about 8,100 acre-feet with a maximum drawdown of 7 feet, as limited by the surface intakes. However, the 1975 settlement agreement with the Washington Department of Fisheries requires that the Elwha Project be operated in a run-of-the-river mode, necessitating a stable



water surface elevation (see Section II.A). The total installed power generation capacity is 14.8 MW.

The Northwestern Power & Light Company began operation of the Glines Canyon Project in 1927. The structure is a varied radius, single arch concrete dam that is 210 feet high and varies in width from 55 feet at its base to 270 at its crest. The Lake Mills reservoir provides about 30,000 acre-feet of active storage, although operations since the 1975 agreement with WDF have involved drawdowns of 10 feet or less, corresponding to about 4,000 acre-feet of storage. The total installed capacity is 16.0 MW.

The two projects provide about 18.7 average MW to the Daishowa America Mill in Port Angeles, which equals about 38% of the power needs of the mill. The rest of the mill's power is supplied by the Bonneville Power Administration (BPA) through the City of Port Angeles (City). A power line connects the Glines Canyon and Elwha projects. A power line 6 miles in length transmits energy directly to the mill. Additional Project descriptions can be found in Appendix F.

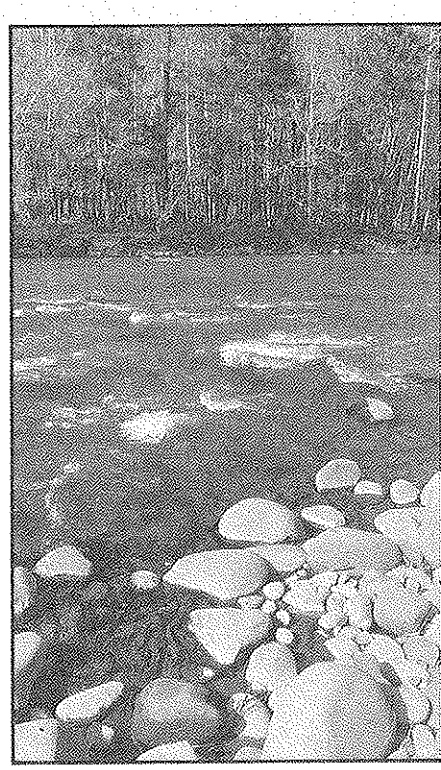
C. Affected Environment

The Elwha and Glines Canyon hydroelectric projects are located on the Elwha River on the Olympic Peninsula in northwest Washington (Figure 1). The Elwha River has a north-south orientation and is 45 miles long with over 100 miles of tributary streams. With a drainage area of 321 square miles, of which 267 square miles (83%) are located within Olympic National Park, the Elwha River is the fourth largest river by drainage area on the peninsula and comprises 19% of total Park lands.

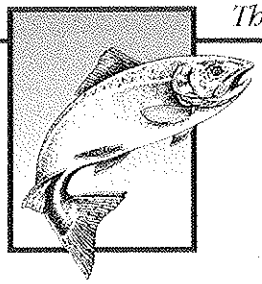
1. Fluvial Processes and Conditions. Because the Elwha River basin above Lake Mills lies within Olympic National Park, it is pristine. The Glines Canyon and Elwha projects have, however, dramatically altered the landscape. The Projects have inundated over 5 miles of riverine and 684 acres of lowland habitat beneath Lake Mills and Lake Aldwell.

About 11.3 million cubic yards of sediment are trapped in Lake Mills (known as Smoky Bottom before inundation). At an estimated rate of 180,000 cubic yards per year, Lake Mills would be expected to fill with sediment in 260-300 years. Estimates of the amount of sediment trapped in Lake Aldwell vary between 2.6 and 4 million cubic yards. Most of these sediments accumulated prior to construction of Glines Canyon Dam. At an estimated rate of 31,000 cubic yards per year with the retention of Glines Canyon Dam, it would take about 400 years to fill Lake Aldwell with sediments.

With the trapping of bedload (cobbles, gravel, and sand) in Lake Mills and Lake Aldwell, the greatly reduced supply in the middle (between Glines Canyon Dam and Lake Aldwell) and lower (below Elwha Dam) Elwha River reaches has resulted in a coarser surface pavement when compared to the upper (above Lake Mills) reach and other rivers in the region. With limited bedload transport from the Elwha River basin, the lower river channel is primarily reworking older river deposits and locally eroding



Large cobbles on Elwha River below Glines Canyon Dam. (Janis Burger)



the high banks of the glacial outwash. For additional information on Elwha River sediments, please see Section VI.C.

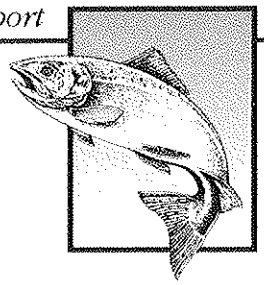
Except for the blockage of anadromous fish with the associated impacts (e.g., lack of salmon carcasses, reduced wildlife populations) and the local deposition of sediments at the mouths of Indian Creek and the Little River, the over 100 miles of tributary streams (Williams et al. 1975), including stream reaches above areas of historic salmon use, have been largely unaffected by the Projects. Most of these streams lie within Olympic National Park, so are, in other respects, pristine and offer significant fish and wildlife restoration opportunities.

The Glines Canyon and Elwha projects have altered the nearshore marine environment by reducing the sediment supply by about 280,000 cubic yards annually (James River II, Inc. 1989). Because of this loss of sediment replenishment, the shoreline has both receded and steepened, and the intertidal and shallow subtidal zone now has a bottom dominated by large cobbles instead of sand. In addition, the formation of Ediz Hook is closely linked with the Elwha River (Galster 1989). The cause of erosion of Ediz Hook is the decrease in sediment supply brought on by construction of water supply pipeline protective works along the base of the sea cliffs and the dams on the Elwha River (USACE 1971, Galster 1989). As a result of the reduction in the sediment supply, the offshore area of sand and gravel deposits has been reduced in volume leading to over-steepened beach slopes, landslides, and exposure of Ediz Hook to greater erosion (Galster 1989).

2. Water Quantity, Quality, and Use. The average instantaneous discharge of the Elwha River at the McDonald gauge, representing the upper 269 square miles (84%) of the drainage basin, is 1,507 cubic feet per second (cfs). With the majority of the watershed in pristine condition and the trapping of sediments in the two reservoirs, the waters of the Elwha River are classified by the State of Washington Department of Ecology as having Class AA waters. Water quality degradation is minimal and is primarily limited to effects of logging and agriculture that occur in the lower portion of the watershed outside Olympic National Park. However, increased water temperatures occur in the middle and lower reaches of the river in late summer and early fall from storage of heat in Lake Mills and Lake Aldwell. Water is withdrawn from the river for municipal, industrial, domestic, irrigation, and fish propagation purposes. Water quantity, quality and use is discussed in detail in Section VI.E.

Lake Mills and Lake Aldwell prevent nutrients and organic matter transported by the upper river from reaching the middle and lower river reaches, as reservoirs are known to block the downstream transport of these materials (Webster et al. 1979, Newbold 1987). The lack of this organic material in the middle and lower river has likely limited benthic invertebrate production in the middle and lower river, which in turn limits the growth and survival of fish.

3. Fisheries Resources. Written documentation concerning pre-dam run sizes of Elwha River native anadromous fish is largely unavailable. However, recollections of local residents, fragmentary written records, and the testimony of



Indian elders are supported by post-dam data. Indian residents who fished the river in the years before Elwha Dam was built have testified that salmon and steelhead stocks were abundant and that fishing occurred year-round, all along the river. In fact, the Elwha River was historically noted as one of the largest producers of salmon and steelhead on the Olympic Peninsula (WDF 1971).

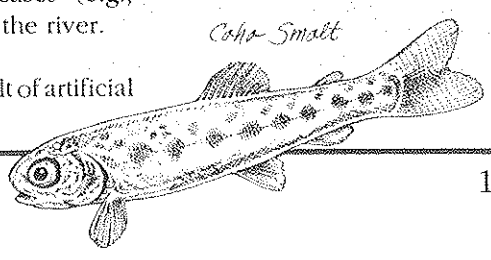
Current runs are only a small portion of their former size, largely because of the Elwha and Glines Canyon dams. In addition to blocking anadromous fish passage to over 70 miles of mainstem and tributary habitat, the Projects were historically operated (primarily in the 1930's and 1940's) in a way that resulted in frequent and extreme stream flow fluctuations downstream, stranding juvenile and adult fish (Maib undated, WDF undated). Other adverse impacts have resulted from the inundation of 5.3 miles of riverine habitat, trapping of bedload with the consequent loss of spawning substrate below the dams, the retention of a portion of the nutrients and woody debris in Lake Mills and Lake Aldwell that would normally pass downstream, and the elevation of water temperatures.

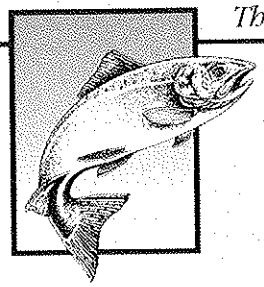
Anadromous fish historically included stocks of spring and summer/fall run chinook salmon, coho, pink, chum, and sockeye salmon, summer and winter runs of steelhead, sea-run cutthroat trout, and native char (Dolly Varden and bull trout). Perhaps the best-known salmon was the run of chinook that produced fish of very large size, some exceeding 100 pounds. These fish were "easily the largest on the Olympic Peninsula" and apparently persisted in the lower river until at least 1930 (Brown 1982). Unfortunately, fish of this size are no longer observed. The last exceptionally large fish was gaffed by a Washington Department of Fisheries (WDF) biologist in 1946 and weighed 70 pounds. Although fish up to 50 pounds still occasionally return to the river, the size of the fish now appears to be typical of most other Puget Sound and Washington coastal rivers.

a. Spring Chinook Salmon. Unfortunately, few, if any, spring chinook salmon still return to the Elwha River. Spring chinook are upriver spawners, and lack of access to habitat in the upper Elwha as a result of the dams has undoubtedly had a major adverse impact on their abundance. Any spring chinook that may remain in the river are probably dependent upon natural spawning, although WDF may collect eggs for the Channel from "early returning" fish.

b. Summer/Fall Chinook Salmon. Summer/fall chinook salmon populations in the Elwha River are currently supported by both natural and artificial propagation. Chinook salmon spawn naturally in the river below Elwha Dam, but returns are largely the result of production at the WDF Rearing Channel, and to a lesser extent the Lower Elwha S'Klallam Tribe's hatchery. The WDF facility annually releases up to 4 million fingerling and yearling chinook salmon, while the tribal hatchery releases up to 400,000 fingerling chinook each year. The resulting combined annual returns to the river have averaged about 4,000 fish since 1982. However, diseases (e.g., *Dermocystidium salmonis*) have limited chinook salmon production in the river.

c. Coho Salmon. Coho salmon returns to the river are primarily the result of artificial





propagation, with approximately 800,000 yearling coho produced at the tribal hatchery. Since 1977, coho returns have ranged from about 5,000 to 16,000 fish annually, and they represent about 16% of runs returning to four major North Coast rivers. However, during the past few years, coho salmon run sizes have declined throughout the Strait of Juan de Fuca region with returns to the Elwha River as low as 1,100 fish in 1991.

d. Chum Salmon. Although chum salmon were produced at the tribal hatchery from 1978 to 1987, that program has been terminated. Now, all chum salmon returning to the Elwha River are the result of natural production. The total annual chum salmon returns to the river are measured in the hundreds.

e. Pink Salmon. Pink salmon have never been artificially produced in the Elwha River. It is estimated that less than 50 pink salmon return each odd year[1]. The current substrate composition (primarily boulders and large cobbles) is not conducive to pink and chum salmon spawning.

f. Sockeye Salmon. Sockeye salmon have never been artificially produced in the Elwha River. A few sockeye are observed each year in the river, but these fish are believed to be strays from other systems. The Elwha sockeye stock is thought to be extinct because the fish cannot reach Lake Sutherland[2].

g. Winter Steelhead. Winter-run steelhead are produced in the tribal hatchery, and represent the largest steelhead run in the Strait of Juan de Fuca. Since 1981-82, the hatchery winter run has averaged about 3,800 fish annually. A stock of naturally produced winter-run steelhead enters the river generally following the return of the hatchery fish.

h. Summer Steelhead. Approximately 20,000 summer run steelhead used to be planted annually in the Elwha River by the Washington Department of Wildlife, with average annual returns of 439 fish. Currently, there is a small but unknown number of naturally produced fish each year.

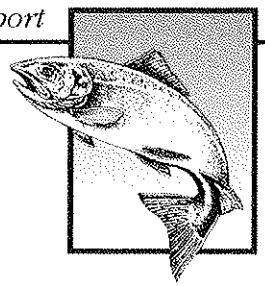
i. Sea-run Cutthroat Trout and Native Char. Sea-run cutthroat trout and native char (Dolly Varden and bull trout) are present in the river below Elwha Dam in low numbers. These fish are the progeny of natural spawners. Bull trout are Category 2 species under the Endangered Species Act.

j. Resident Fish. Resident sport fish in the Elwha River system above Elwha Dam are dominated by rainbow trout and, to a lesser extent, native char. A small number of cutthroat trout and brook trout are also present. Additionally, based on surveys conducted in similar rivers in Washington, the Elwha River probably harbored, and continues to harbor, fish species such as dace, peamouth, squawfish, largescale sucker, threespine stickleback, sculpins, whitefish, and marine species such as flounders. White sturgeon and smelt are also occasionally observed in the river.

k. Shellfish. The most commonly pursued shellfish in intertidal areas are hardshell

[1] *Puget Sound pink salmon only return in odd years.*

[2] *A lake or lake-like environment is necessary for sockeye salmon to complete their freshwater rearing phase.*



clams, specifically littleneck clams, butter clams, and horseclams. The Elwha River intertidal area should support populations of hardshell clams although the beaches are depleted of gravel and finer sediments and have steep slopes that reduce the intertidal area. The composition and abundance of shellfish prior to dam construction are not known. However, hardshell clams may have been more abundant than at present because of the change in sediment composition from sand-gravel-cobble to a more coarse gravel-cobble mix, and possibly because the intertidal area is smaller than it once was.

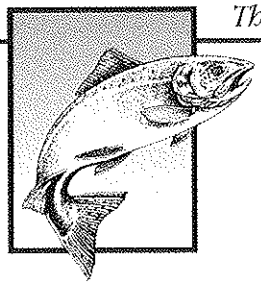
I. Harvest Management. The Washington Departments of Fisheries and Wildlife (WDF and WDW) along with the Port Gamble S'Klallam, Jamestown S'Klallam, Lower Elwha S'Klallam and Makah Tribe (SJF Tribes) cooperatively manage the fisheries in the Strait of Juan de Fuca (SJF) region. The four tribes share the responsibility for managing tribal marine fisheries in the SJF, while the Point No Point Treaty Council (PNPTC), a consortium of tribes comprised of the three S'Klallam Tribes and the Skokomish Tribe, administers the marine fisheries for the S'Klallam Tribes. The Makah Tribe, WDF, and WDW communicate regularly with the PNPTC to facilitate cooperative management in the SJF. Primary management responsibilities of tribal freshwater fisheries within the SJF are further broken down geographically, with the Elwha Tribe administering the area from the Hoko River to Morse Creek, including the Elwha River.

In addition to the State and tribal management agencies, the Fraser Panel of the Pacific Salmon Commission (PSC), by order of the Pacific Salmon Treaty first ratified in 1985, is responsible for the management of both Canadian and U.S. fisheries occurring in the SJF targeting Fraser origin sockeye and pink salmon stocks. The Fraser Panel consists of four voting representatives each from the U.S. and Canada. Fisheries under the jurisdiction of the Fraser Panel are managed in accordance with policies set forth in short-term species specific annexes to the Treaty which are mutually adopted and agreed to by the two countries.

Finally, the Pacific Fisheries Management Council (PFMC) is responsible for the management of all intercepting U.S. salmon fisheries occurring in the Conservation Management Zone along the coastal marine waters of Washington, Oregon, and California that potentially impact SJF origin stocks. Each year, management guidelines are adopted by the PFMC based on projected run-sizes and fishery objectives.

The Elwha River is one of the production components of the SJF region. Chinook salmon and coho salmon populations in the river are presently managed to achieve the objectives of the two Elwha hatchery facilities, as the Elwha and Glines Canyon dams severely limit natural production. These objectives include the full harvest of all surplus hatchery production and the maintenance of brood sources for future fisheries restoration efforts. Pink and chum salmon populations in the river are specifically managed for natural production. Steelhead are managed to protect the remnant wild run while providing recreational and commercial harvest through hatchery releases.

With the exception of the Dungeness River Hatchery coho salmon stock and the



artificially augmented Hoko River chinook salmon stock, the remainder of the U.S. portion of the SJF region is managed for the natural production of all salmon species. Long-term regional harvest and habitat management planning in U.S. waters is being jointly developed by WDF, WDW, and the SJF tribes and will be incorporated in the "Salmon and Steelhead Management Plan for Strait of Juan de Fuca Terminal Areas" (Strait Plan). The draft Strait Plan recognizes the present management priority of hatchery stocks in the Elwha River but further identifies a phase-in to a natural production priority once the dams are removed. In addition, the draft Strait Plan reemphasizes the priority status of all naturally reared stocks throughout the rest of the SJF region.

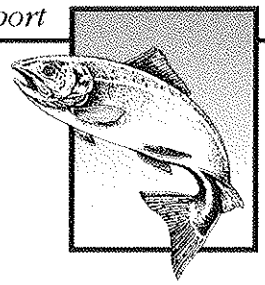
Natural stocks in the SJF region have been generally experiencing a decline in production. In the past 10 years, wild coho salmon returning to SJF streams have not met management's aggregate escapement goals for this species. A few individual stocks have declined to critically low levels. Beginning in 1994, in accordance with the management objectives for the region, the PFMC will be requested to begin taking specific management actions during ocean fisheries to ensure that the SJF wild coho salmon are protected in order to facilitate their restoration.

m. Marine Harvests. Marine harvests of Elwha River and other SJF salmon stocks can generally be broken down into four categories: (1) Alaskan interceptions; (2) Canadian interceptions; (3) U.S. coastal interceptions; and (4) SJF and Puget Sound catches. All data presently available indicate that all SJF salmon stocks west of the Elwha River are subject to similar interception and harvest rates as the Elwha River salmon stocks.

The best available data indicate that approximately 58% of the total Elwha River chinook run is harvested prior to entering the SJF (U.S. coastal - Canadian combined). An additional 3% are taken in the SJF, primarily in nontreaty sport fisheries, although limited treaty commercial setnet and subsistence hook-and-line fisheries also take a few fish in Freshwater Bay, immediately adjacent to the mouth of the Elwha River.

The total harvest rate of Elwha River origin coho salmon from the years 1984 through 1991 was 77%. Just over 38% of the combined return was taken in Canadian fisheries while a similar amount was taken in U.S. fisheries (marine and freshwater combined). Of the U.S. harvests, 70% occur in marine waters with just over 20% of the catch coming in U.S. coastal areas. The remainder of the marine harvest was taken in the SJF or Puget Sound. It should be noted that the percentage of the harvest that is taken in different fisheries varies from year to year, depending on run size and harvest strategies.

As chum salmon stocks in the Elwha River and SJF are relatively small, very little is known about their catch distribution. Although there are fisheries in the SJF targeting chum salmon ("directed" fisheries), their present impact is likely very limited. It is estimated that less than 5% of the total run is harvested in U.S. coastal and Canadian waters combined, while an additional 10% might be taken in SJF and Puget Sound fisheries.



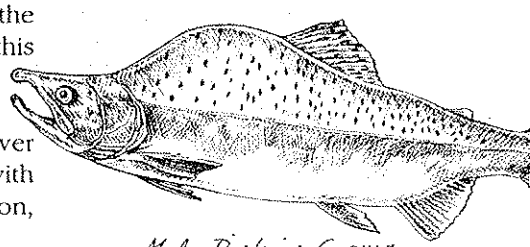
It is estimated that between 15% and 49% of the SJF and Elwha River pink salmon run may be taken in Canadian and U.S. coastal fisheries prior to entering the SJF. An additional 10% to 15% may be taken in directed pink salmon net fisheries and recreational fisheries in the SJF and Puget Sound.

The marine harvest of steelhead is extremely limited and inconsequential. It is estimated that no more than a few Elwha River steelhead are taken in marine waters.

n. Freshwater Harvests. In-river harvests of chinook salmon have been restricted in the Elwha River, sometimes in response to significant prespawning mortalities associated with fish diseases (e.g., *Dermocystidium salmonis*). Catches by the Lower Elwha S'Klallam Tribe (Tribe) have generally been limited to less than 100 fish per year taken incidental to coho fisheries. However, the Tribe did conduct directed chinook salmon test fisheries from 1988 to 1991 resulting in a harvest of 200 to 400 fish per year. A limited entry commercial chinook fishery was implemented by the Tribe in 1992 which took about 150 fish. It is anticipated that the Tribe will continue to conduct a limited commercial fishery for chinook in the Elwha River, as run size dictates. There are no nontreaty fisheries for chinook salmon in the Elwha River.

The Tribe has annually conducted a directed in-river commercial fishery targeting hatchery coho salmon since 1977. Catches of these fish have been as high as 15,000 but were usually 6,000 to 10,000 fish; catches have not exceeded 2,000 fish since 1989. In addition to the tribal commercial fishery, there is also a small but significant nontreaty sport fishery for coho in the river.

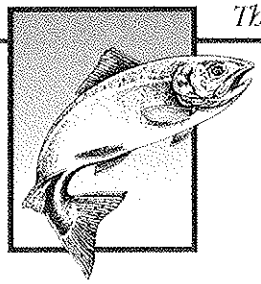
During the years the Tribal hatchery produced chum salmon, the Tribe conducted a limited commercial chum fishery in the river. Since abandonment of the chum program, chum harvests in the river have been limited to incidental catches taken during late season coho salmon fisheries and early steelhead fisheries. These incidental catches have averaged just over 100 fish per year since 1988. Although the sport harvest of chum salmon is permitted in the Elwha River, participation in this fishery is very limited and is likely insignificant.



Male Pink in Spawn

There have never been directed commercial pink salmon fisheries in the Elwha River and there have been no reported incidental harvests of pinks since at least 1980, with the exception of a few pink salmon taken during the chinook test fisheries. In addition, there are no sport fisheries for pink salmon in the river.

Winter and summer steelhead in the Elwha River are managed as a single unit for harvest allocation purposes, although separate run sizes and harvestable numbers are estimated for each stock. The Tribe concentrates its commercial fisheries on the hatchery portion of the winter run from mid-December through early March. The sport fishery targets only hatchery steelhead from June 1 through November 30 while the river is open for the harvest of both hatchery and wild fish from December 1 through April 15. Tribal harvests of steelhead have averaged about 1,600 fish per year (mostly winter-run fish) while a similar number are taken each year by sport fishers (winter-



and summer-run combined). The harvest of summer-run fish has averaged about 460 fish per year.

4. Vegetation. The maritime climate of the area is characterized by mild, wet winters and relatively cool, dry summers. Rainfall averages 60-80 inches per year. The relatively cool climate of the Elwha Valley represents a gradient between drier conditions to the east and wetter climate to the west. Consequently, the valley supports a unique mix of vegetation with over 167 vascular plant species transitional between vegetation communities occurring to the east and west.

Douglas-fir dominated communities with Pacific madrone, manzanita, and grand fir occur on dry, well-drained sites and represent eastern peninsula vegetation types. Forests dominated by western hemlock occur on moist sites throughout the valley and are more characteristic of western peninsula vegetation.

The Elwha River basin supports a wide variety of wildlife, although populations have been adversely impacted by the lack of salmon carcasses in the middle and upper river . . .

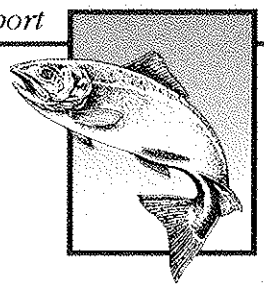
Most of the area surrounding Lake Mills consists of a lowland/montane forest type dominated by Douglas-fir, with an understory of swordfern and Oregon grape. Mixed communities of conifer/hardwood occur in riparian areas, including Douglas-fir, grand fir, western redcedar, red alder, black cottonwood, and bigleaf maple. Streamside vegetation consists of alder, cottonwood, and willow species mixed with grass/sedge communities. Upland areas are characterized by moderate to heavy accumulations of downed woody material, with lighter buildups in riparian zones.

There are no Federally-listed plant species within the Glines Canyon Project area. However, six State-listed species have been documented in the area or are suspected to occur there. Additionally, 15 locally rare species (plants with very limited distributions or very small population size) have been designated by the National Park Service.

Some 64 exotic/adventive (non-native) plant species are established in the Elwha Valley within the park. Sixty-five percent of these species are perennials and are known to be difficult to control or eradicate. Several species are considered noxious and a serious threat to native plant communities, including Scot's broom, reed canarygrass, and tansy ragwort. Many species of introduced grasses are found in old fields and near former habitation sites. Canada thistle, curly dock, sheep sorrel, and other nonnative species are established on the delta.

5. Wildlife. The Elwha River basin supports a wide variety of wildlife, although populations have been adversely impacted by the lack of salmon carcasses in the middle and upper river and the inundation of lowland valley habitat by Lake Mills and Lake Aldwell. The bottomland floodplain and riparian areas inundated by the reservoirs once provided important habitat for grazing, shelter, and reproduction for a variety of species (see Section V.D.6 Wildlife).

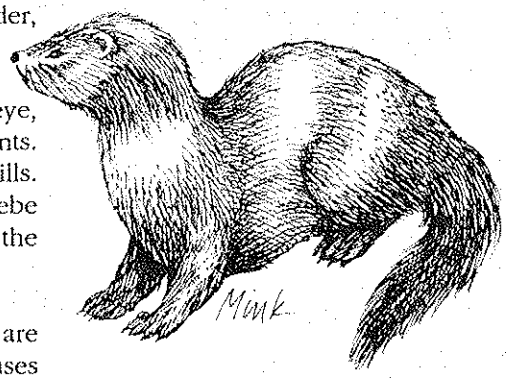
Roosevelt elk and black-tailed deer are found throughout the drainage and are year-round residents. Primary elk travel routes cross the Lake Mills delta between the mouth of Cat Creek and the Whiskey Bend road to the east. Another important route



traverses the slopes between Glines Canyon Dam and Altaire Campground along the lower spur ridges of Happy Lake Ridge. Important elk calving areas are located near the mouth of Cat Creek and in hardwood flats near the river in the vicinity of Altaire Campground.

Other mammals include black bear, cougar, bobcat, coyote, raccoon, muskrat, mink, long-tailed weasel, river otter, pine marten, beaver, snowshoe hare, mountain beaver, spotted skunk, and striped skunk. Fisher is a species which historically occurred in the Elwha but is now rarely observed and its status is uncertain. Smaller mammals include Douglas squirrel, northern flying squirrel, Townsend's chipmunk, bushy-tailed woodrat, deer mouse, shrews, shrew-mole, and several species of bats. Most of these species are dependent on forested habitat; some are dependent on old-growth forest.

Reptiles and amphibians include the western garter snake, Pacific chorus frog, red-legged frog, tailed frog, ensatina, rough-skinned newt, Olympic torrent salamander, Van Dyke's salamander, northwestern salamander, and others.

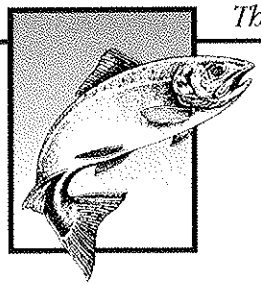


The reservoirs provide habitat for a variety of waterfowl. The common goldeneye, bufflehead, common merganser, and mallards are common year-round residents. Trumpeter swans routinely winter on Lake Aldwell and often visit Lake Mills. Harlequin ducks breed in this area. Common loon, western grebe, and horned grebe are occasionally observed. Spotted sandpipers have been observed nesting at the delta.

Marine bird species such as double-crested cormorants and various gulls are occasionally seen on the river or reservoir. The Federally-listed marbled murrelet uses the Elwha Valley as a flight corridor, and it may nest in forests along Stukey, Boulder, and Cat Creeks, and in the vicinity of Altaire Campground.

Other representative bird species in the area include the blue grouse, ruffed grouse, and band-tailed pigeon, which are common breeding residents in forest habitats. The American dipper breeds along the river and tributary streams. Violet-green swallows are common in areas near Glines Canyon Dam, bridges, and buildings. The robin, Townsend's warbler, dark-eyed junco, winter wren, and brown creeper are common breeding residents of conifer and hardwood forests of the area. The hairy woodpecker, warbling vireo, evening grosbeak, and olive-sided flycatcher are found in deciduous forests of riparian areas. Old-growth in the area provides habitat for pileated woodpecker, red-breasted nuthatch, golden-crowned kinglet, varied thrush, and chestnut-backed chickadee. Open habitats support the MacGillivray's warbler, white-crowned sparrow, and rufous hummingbird. Other species include belted kingfisher along the river and streams, Stellar's jay, gray jay, American crow, and raven.

6. Threatened and Endangered Species. The U.S. Fish and Wildlife Service has documented the occurrence of three Federally protected species in the Elwha/Glines Canyon study area, the bald eagle, northern spotted owl, and marbled murrelet. A petition to list the bull trout has been received by the U.S. Fish and Wildlife



Service, initiating a status review of that species. Other species of concern, several of which are proposed for state-listing, include the northern goshawk, Vaux's swift, osprey, great blue heron, barred owl, and turkey vulture, as well as the pileated woodpecker. A number of other plants and wildlife potentially occurring in the study area are state-listed by the WDW or Washington Natural Heritage Program (WNHP) as endangered, threatened, sensitive, or monitor species. In addition, the National Park Service maintains a list of plants, including several WNHP-listed species, that are considered unique within Olympic National Park.

7. Cultural Resources. The Elwha S'Klallam lived in and utilized the Elwha River basin for thousands of years. Villages and fish camps, archaeological treasures, traditional cultural properties, tribal history and tribal culture are all integrally connected to the watershed and river system. Because it was the heart of the culture and the economy, the whole river is a cultural resource.

The Elwha and Glines Canyon projects are both listed on the National Register of Historic Places. Additional cultural sites include Indian homesteads, seasonal camps, and the remains of a cable ferry. These sites have not been evaluated for the National Register.

8. Other Resources. Olympic National Park is designated a mandatory Class I area under the Clean Air Act. Although air quality is generally excellent, there is potential for occasional temporary impairment of visibility during temperature inversions as a result of industrial emissions in Port Angeles and from local point source pollution such as wood smoke from prescribed fires.

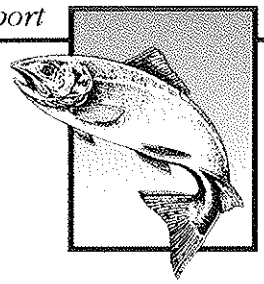
Some of the area bordering Lake Mills is within designated wilderness. The park has also received special international designation as a United Nations International Biosphere Reserve and World Heritage Site.

Recreational facilities include secondary roads to several popular trailheads, several foot trails leading to the Lake Mills shoreline and upper watersheds, and boat launch facilities. Two automobile campgrounds are maintained nearby. Developed recreational opportunities are limited in the Elwha Valley, and dispersed, primitive types of recreation are emphasized. Hiking, fishing, river rafting, and camping are the most popular visitor activities.

The river itself, along with numerous sites, objects, and practices in the river corridor, are traditional cultural properties at the heart of the Elwha S'Klallam culture. These cultural resources are central to the identity and well being of the Elwha S'Klallam people. An assessment of cultural and historical resources of the Elwha Valley is contained in Section VI.L and Appendix L.

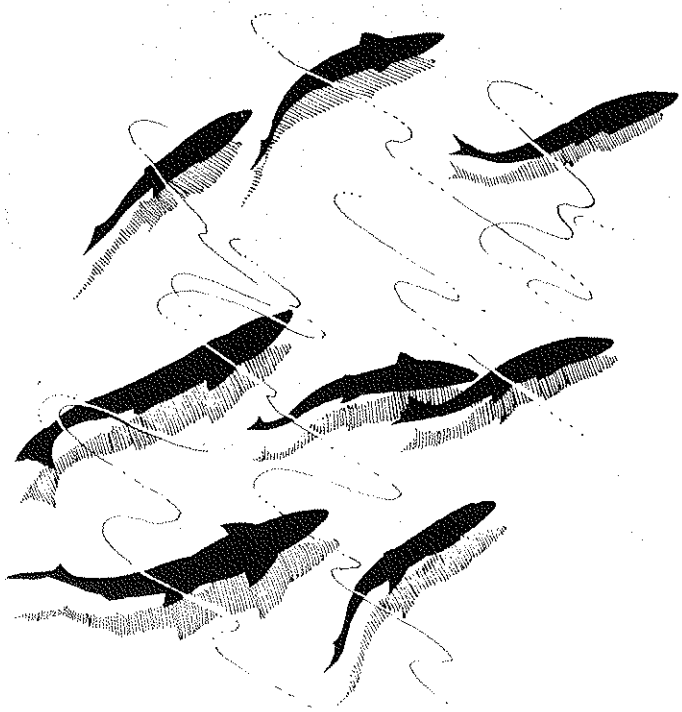
D. Fisheries Restoration Efforts in the Pacific Northwest

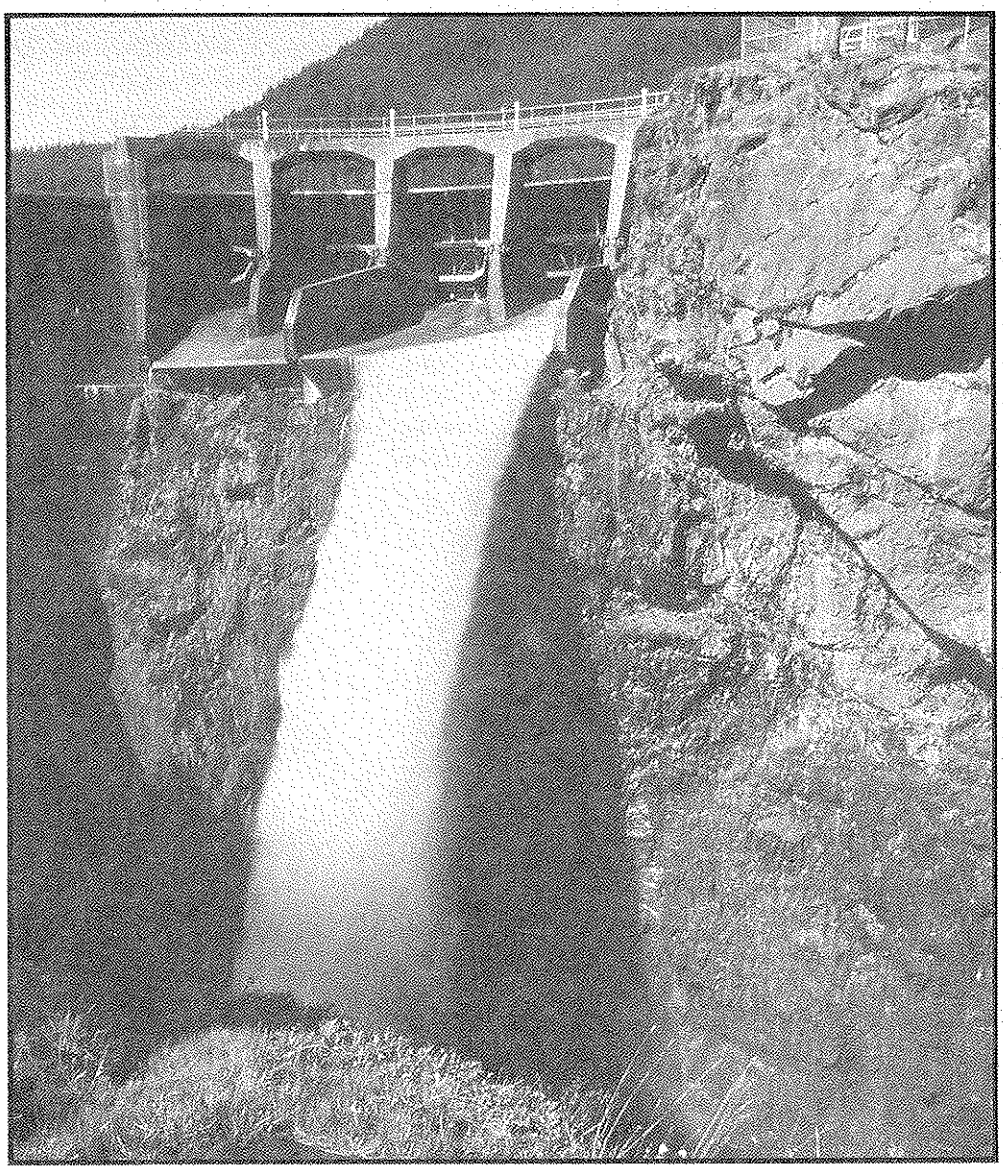
Salmon and steelhead are important biological, commercial, recreational, and cultural resources in the Pacific Northwest. Unfortunately, many of these fish runs are in



decline (Nehlsen et al. 1991, WDF et al. 1993). Hydropower projects, as in the Elwha River, are often significant contributors to declines (Tyus and Winter 1992). With important Federal support, regional efforts are attempting to reverse the trend. For example, a conservative estimate of the cost of actions taken since 1981 to maintain and improve salmon runs in the Columbia River Basin alone exceeds $1.3 billion (GAO 1992), and over the next decade and a half may exceed $7 billion (Buck et al. 1993). Federal salmon and steelhead restoration projects in the Umatilla River basin will total $80 million over 15 years while similar efforts in the Yakima River basin will total about $70 million for at least 20 years. In northern California, Congress has authorized salmon and steelhead restoration efforts in the Klamath ($21 million over 20 years), Trinity ($57 million over 10 years), and Sacramento (provisionally $30 million over 10 years) rivers. In southwest Washington, salmon habitat restoration proposed for the Chehalis River basin would amount to $20 million over 20 years. These efforts are important economically since salmon and steelhead support $1.2 billion annually in personal income and sustain more than 60,000 jobs in the Pacific Northwest (Buck et al. 1993).

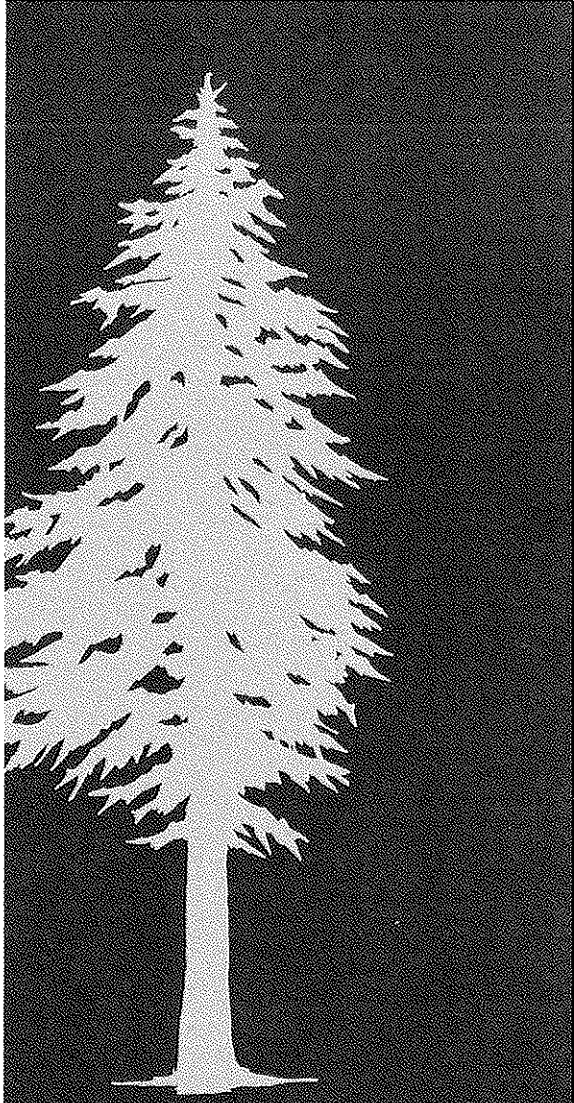
In the context of these restoration efforts, the Elwha River is unique because 83% (267 square miles) of the basin is in pristine condition, lying within Olympic National Park and designated as wilderness. As a result, restoration of the Elwha River ecosystem and native anadromous fish should not be significantly threatened by future land use practices, in contrast to the other streams noted above.



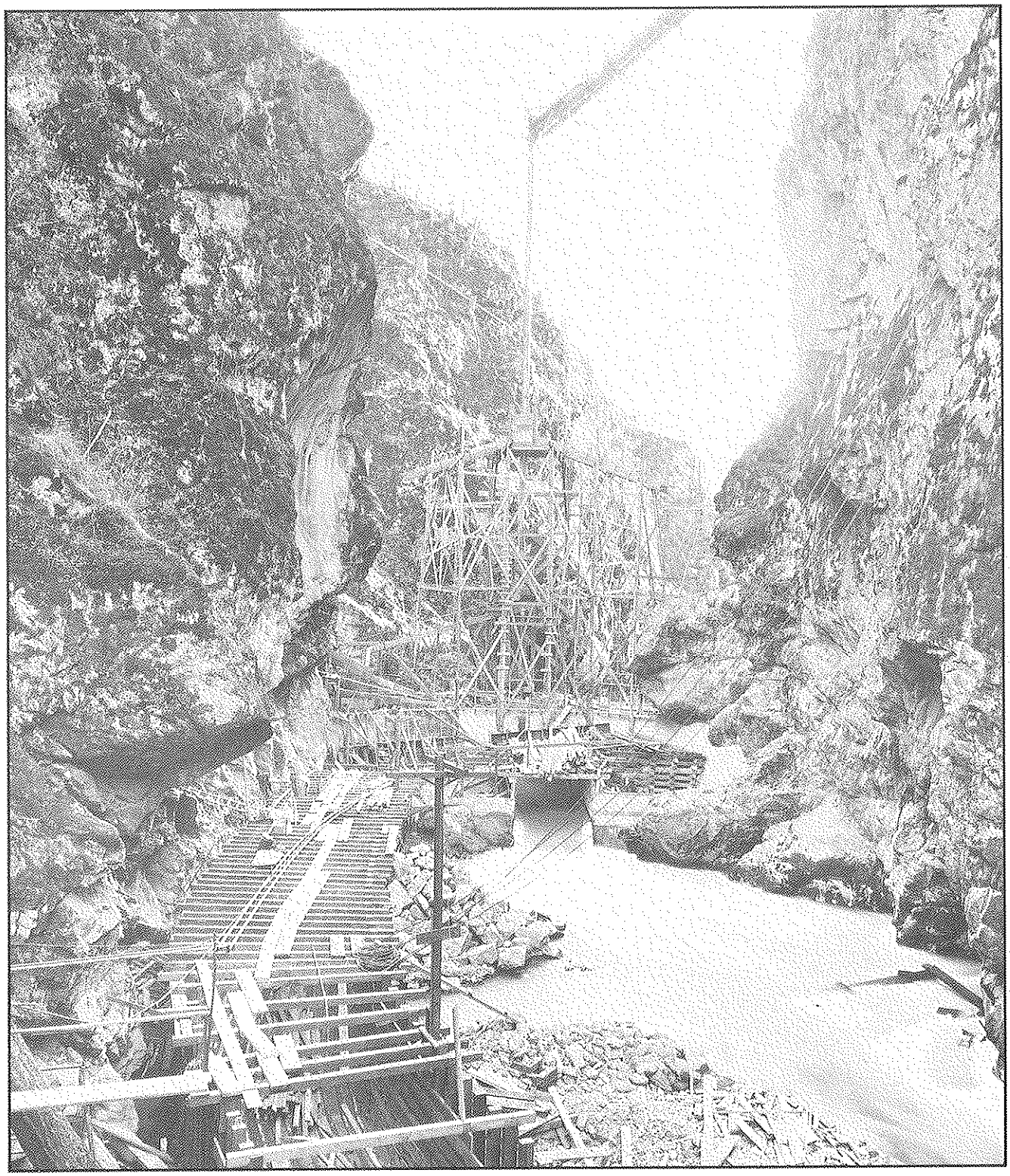


Glines Canyon Dam.
(Pat O'Hara)

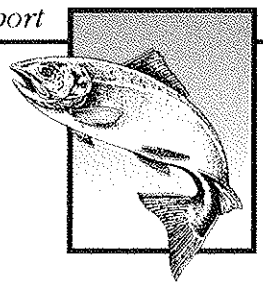
III. History of FERC







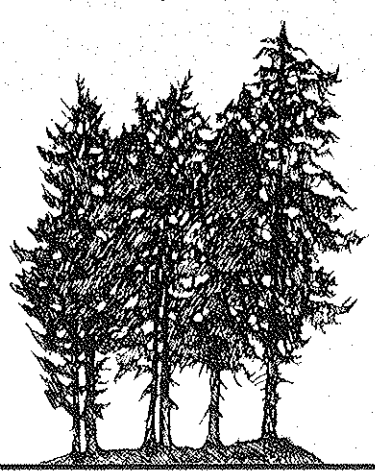
Constructing dam foundations,
Glines Canyon Dam site,
September 7, 1926.
(Northwestern Power & Light
Company photo)

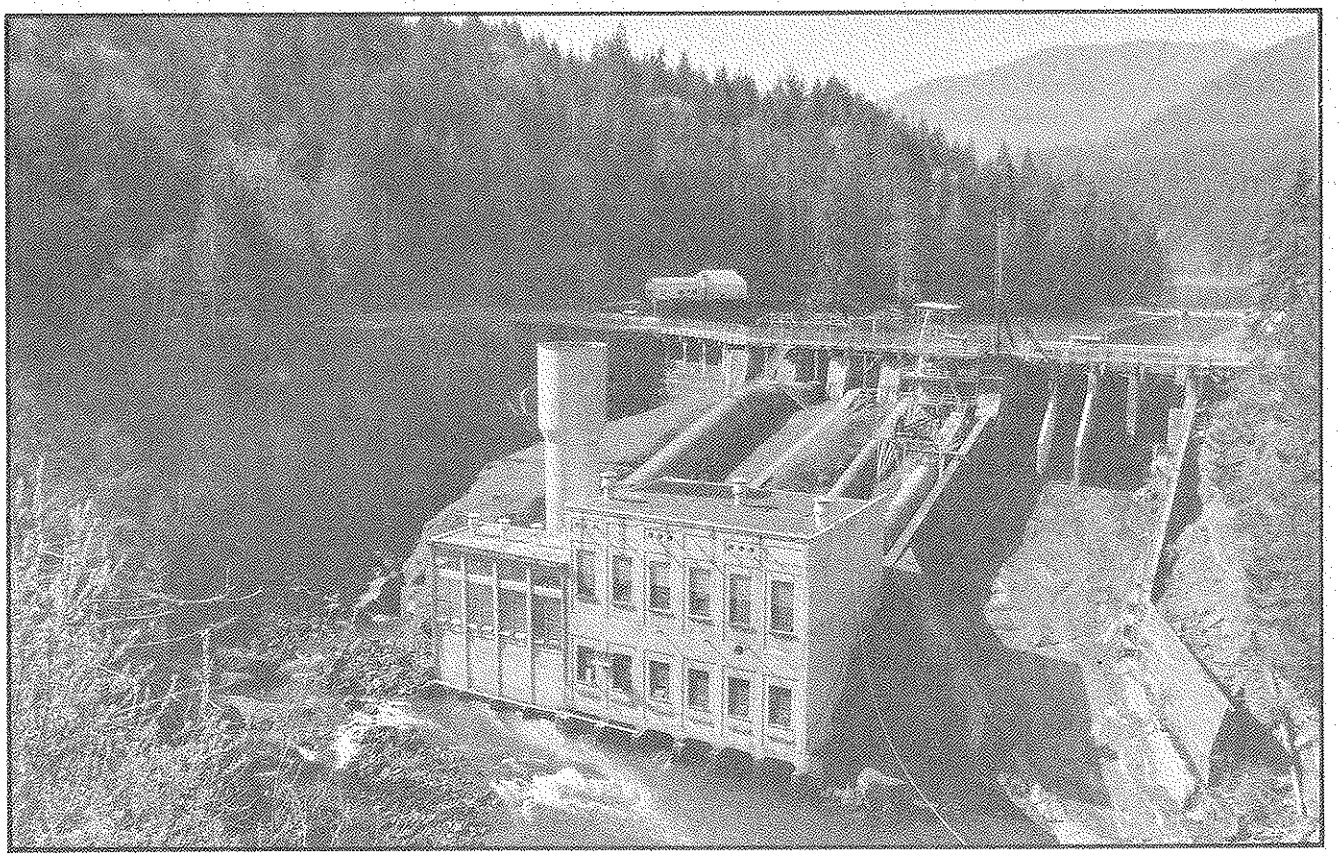


III. History of the FERC Process

Federal licensing of the Elwha Project was initiated in 1968 when the owner of the project at that time, the Crown Zellerbach Corporation, filed an application for license with the Federal Power Commission (FPC). The Northwestern Power & Light Company filed a license application with the FPC for the Glines Canyon Project on March 23, 1926 (Appendix B). The FPC issued a 50-year license for the Project on June 6, 1926, with no provisions for fish passage measures or other mitigation. On November 20, 1970, the FPC issued a notice of expiration of the original Glines Canyon license. With the passage of P.L. 102-495, the Federal Energy Regulatory Commission (FERC) halted its licensing/relicensing activities, other than the issuance of annual licenses for the Glines Canyon Project.

FERC's authority to license the Glines Canyon Project has been in question for some time. In a February 13, 1986, filing, the Department of the Interior asserted that FERC lacks authority to relicense the Glines Canyon Project since it is located within the boundaries of Olympic National Park. This position was supported by the General Accounting Office in February 1990. Various conservation groups (i.e., Olympic Park Associates, Seattle Audubon Society, Friends of the Earth, and the Sierra Club) filed a motion with FERC to intervene in the proceeding and called for the removal of both dams. In response to various petitions by Federal agencies, the Tribe, and the conservation groups, FERC determined by final order that it had jurisdiction over the Glines Canyon Project. That determination was then challenged in court. The Justice Department (for the Departments of Interior and Commerce), Tribe, and conservation groups filed Petitions for Review in May and June 1991 with the Ninth Circuit Court for review of the FERC decisions. James River, Daishowa America, the National Hydropower Association, the Edison Electric Institute, and local government and industry groups participated in the litigation in support of FERC's determination. With the enactment of P.L. 102-495, all parties to the case requested that the Ninth Circuit issue a stay of the lawsuit. A stay was granted on February 1, 1993, and will expire April 30, 1994, at which point the court has directed the parties to "file a status report and a request for either the calendaring or voluntary dismissal of the petition for review or other appropriate relief."





Elwha Dam. (Janis Burger)

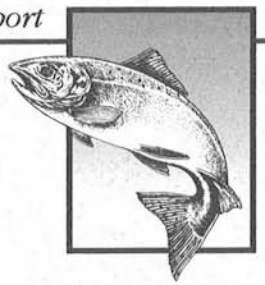


IV. Alternatives





Glines Canyon project with power house in right foreground and dam in left background, October 19, 1926. (Northwestern Power & Light Company photo)



IV. Alternatives for Restoration

FERC extensively evaluated the alternatives of removal or retention of both dams, the removal of Elwha Dam, and the removal of Glines Canyon Dam in the context of balancing fish and wildlife protection with hydropower production. In contrast, P.L. 102-495 prescribes the standard of full ecosystem and native anadromous fisheries restoration. Consequently, the following two sections (IV and V) provide excerpts from FERC (1993) but include modifications consistent with the standard of full restoration.

A. Removal of Both Dams

This alternative would meet the standard of full ecosystem and native anadromous fisheries restoration. It involves decommissioning the Elwha and Glines Canyon projects, removing most if not all of the existing auxiliary structures, returning the river to a free-flowing condition, and implementing habitat (Section VI.H) and fish restoration (Section VI.F) plans. The electrical energy presently produced by the Projects and consumed by the Daishowa America Mill would be discontinued and replaced by power provided by the Bonneville Power Administration through Port Angeles City Light. An evaluation of the impacts on regional power as a result of this alternative can be found in Section VI.M. A description of potential dam removal techniques can be found in Section VI.C.

B. Removal of Glines Canyon Dam

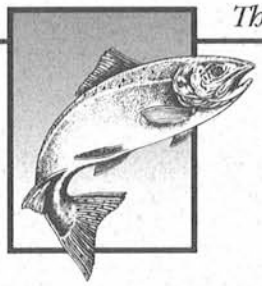
This alternative would not meet the standard of full ecosystem and native anadromous fisheries restoration. It involves the incorporation of upstream and downstream fish passage measures at the Elwha Project and the removal of the Glines Canyon Project. The fish passage measures for the Elwha Project would be those described in Section IV.D. Glines Canyon Project removal would be accomplished in a manner described in Section VI.C.

C. Removal of Elwha Dam

This alternative would not meet the standard of full ecosystem and native anadromous fisheries restoration. It involves the incorporation of upstream and downstream fish passage measures at the Glines Canyon Project and the removal of the Elwha Project. The fish passage measures for the Glines Canyon Project would be those described in Section IV.D. Elwha Project removal would be accomplished in a manner described in Section VI.C.

D. Retention of Both Dams

This alternative would not meet the standard of full ecosystem and native anadromous fisheries restoration. It involves the retention of both the Elwha and Glines Canyon projects with the addition of fish passage facilities and operational changes to restore



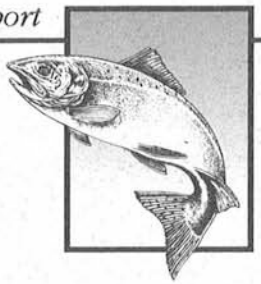
anadromous fish runs in the middle and upper reaches of the Elwha River to the extent practicable. Project automation improvements and measures related to terrestrial, recreational, and cultural resources would also be accomplished.

To pass naturally migrating adult anadromous fish upstream of Elwha Dam, the following facilities would be necessary: (1) an inclined bar rack at the powerhouse tailrace exit portals to prevent fish attraction and entry into the draft tubes where the fish could be delayed or injured; (2) a ladder entrance, barrier weir at the base of the right bank spillway, and fishway; (3) a fish ladder on the south shore of the existing right bank spillway; and (4) holding and sorting pools for sorting and counting migrating fish.

For passing outmigrating anadromous juveniles downstream, all water used for power production would be screened to divert fish and all other water would be passed through spillways modified for fish protection. The fish screen system would include (1) four Eicher screens installed in the 9-foot-diameter project penstocks, (2) a bypass pipe and vertical traveling screen facility, (3) an open channel flume, and (4) a concrete pool-and-weir structure to convey fish to the powerhouse tailrace. However, because the Department of the Interior, National Marine Fisheries Service, and Washington Departments of Fisheries and Wildlife consider the Eicher screen technology to be experimental at this time, a contingency plan involving conventional forebay screens would also have to be developed to address the possibility of unacceptable Eicher screen performance.

For protecting outmigrating juveniles that pass over the spillway, gate bays Nos. 2 and 3 of the Elwha Dam left bank spillway would be modified to include (1) an ogee transition section in gate bay No. 2, (2) concrete-lined chutes and training walls the full length of the spillway chute below bays No. 2 and No. 3, (3) reconstruction of the spillway gate bottom seals to minimize turbulence, and (4) installation of an additional spillway gate hoist to facilitate spillway operation. To ensure stable control of the reservoir water level, prevent flow over the top of the spillway gates, and to control ramping rates, the spillway gate operation for bays No. 2 and No. 3 would be automated.

To pass migrating anadromous fish upstream at Glines Canyon Dam, a trap-and-haul operation would be necessary to convey adult fish past the 190-feet vertical lift of the dam. The collection and sorting facility would be located near the Glines Canyon powerhouse, and fish would be trucked to the existing boat ramp on Lake Mills for release. The trap-and-haul facilities would include (1) a velocity barrier and electric weir structure to prevent fish from moving up the river past the powerhouse and to direct fish to the fishway entrance, (2) a tailrace bar rack downstream of the powerhouse to prevent fish from entering the draft tubes where they could be delayed or injured, (3) a fishway entrance structure, (4) a fish ladder along the face of the powerhouse, (5) holding, sorting, and transport pools, (6) a hoist system for loading adult fish onto a transport truck, (7) 3,000 feet of roadway stabilization and resurfacing, and (8) boat launch site improvements for the transport vehicle. To improve control of the reservoir water level, prevent spills over the top of the spillway

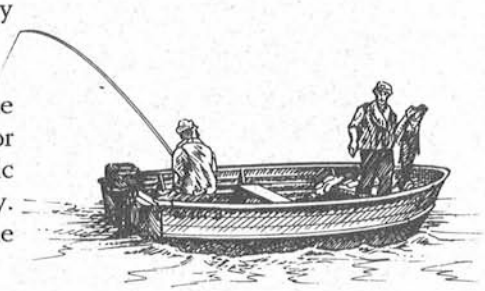


gates and the fixed spillway section, and to control ramping rates, operation of the turbine and generators and one spillway gate would be automated.

For downstream passage of outmigrating anadromous juveniles, 450 cfs would have to be released continuously over the Glines Canyon Dam spillway during the outmigration period, until such time as agency approved passage tests have identified a lesser flow that would provide adequate passage. A screen facility would have to be constructed and operated to protect the juvenile anadromous fish (primarily chinook salmon) that exit Lake Mills via the turbine intake. This facility would include either an Eicher screen in the penstock and a fish bypass system or construction of a new power intake with forebay screening and a fish bypass system. To minimize the potential for adverse impacts to reservoir fisheries, wildlife, and recreation as well as outmigrating anadromous juveniles, the Glines Canyon Project would be operated in a run-of-the-river mode.

FERC estimated the capital costs (in 1990 dollars) of the fish passage measures, as proposed by James River and modified by FERC staff, to be $10,297,000 for Elwha Dam and $3,359,000 for Glines Canyon Dam (total of $13,656,000). If the Eicher screen and bypass system proved unacceptable at Elwha Dam, a conventional screen facility would cost an additional $9,333,000. The measures proposed by James River and FERC do not include fish screens at Glines Canyon Dam, which would vary from about $4 million for an Eicher screen to $10,861,000 for a new intake and screen system. They also do not include the cost for the placement and maintenance of spawning gravel and large organic debris.

In addition to fish measures, 898 acres of James River property outside of Olympic National Park, including Elwha Project lands, property adjacent to Lake Aldwell, and the McDonald gauge tract, would be retained and enhanced for wildlife benefits. Management activities would include (1) gating access roads, (2) creating snags, (3) thinning, (4) creating and enhancing wetlands, (5) recontouring shorelines, (6) fencing to prevent disturbance, and (7) protecting the area from encroaching development. Shoreline areas would be enhanced by thinning the dense overstory and allowing hydrophytic shrubs and trees to regenerate.



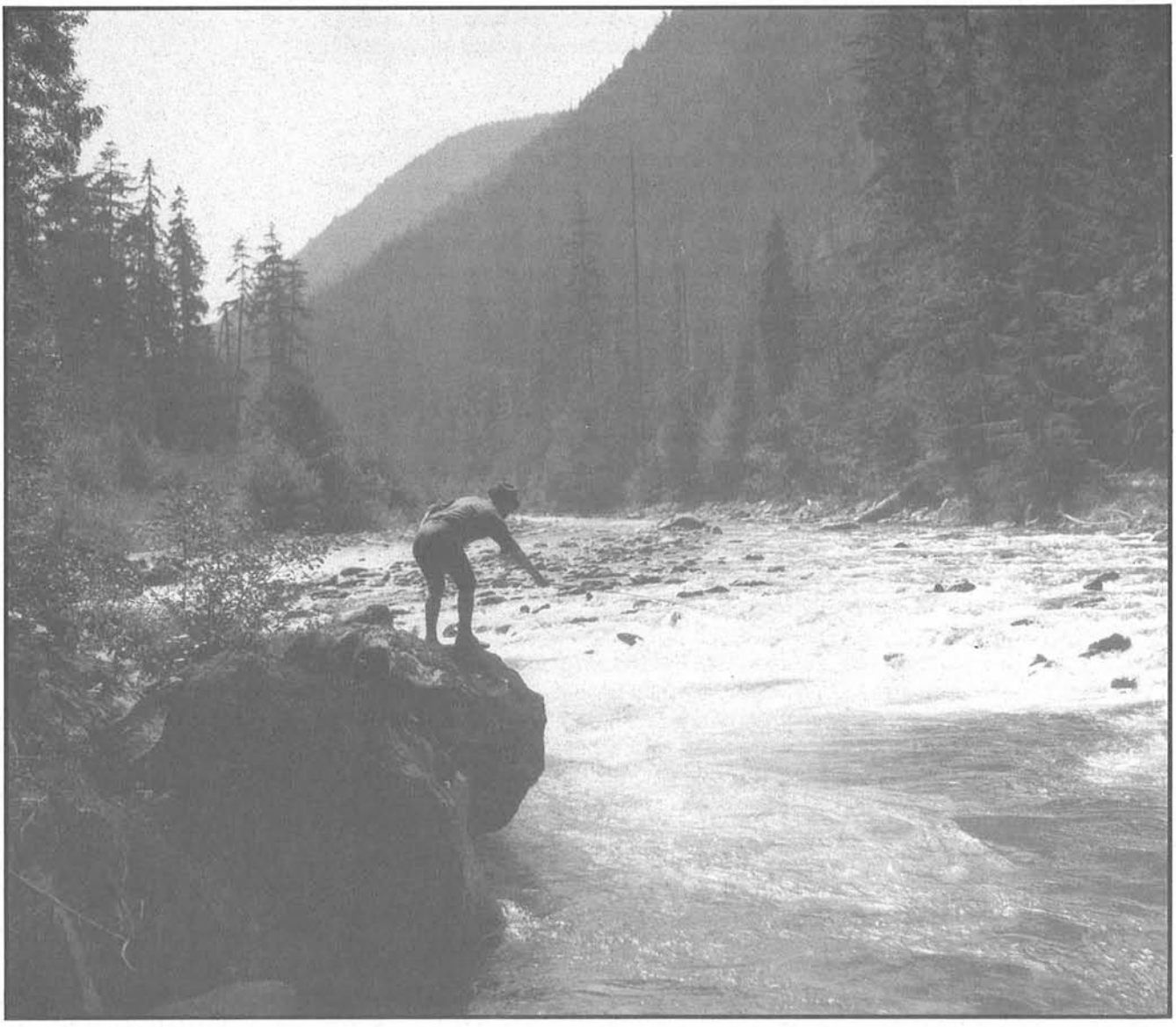
Attempts to restore the ecosystem and anadromous fisheries of the river would come under intense public scrutiny. Consequently, it would be important to fully monitor and document the success of the restoration effort. Monitoring programs and specific studies (e.g., elk radio-tagging, fish passage and production) would be necessary. Modifications to the restoration program would depend on the results of the monitoring.

Developed recreational opportunities would be augmented by the installation of the following: (1) three remote boat-in campsites on the east side of Lake Aldwell; (2) a project overlook with parking, sanitary facilities and interpretive signs; (3) a trail to the pool below Elwha Dam for recreationists; and (4) additional interpretive signs.

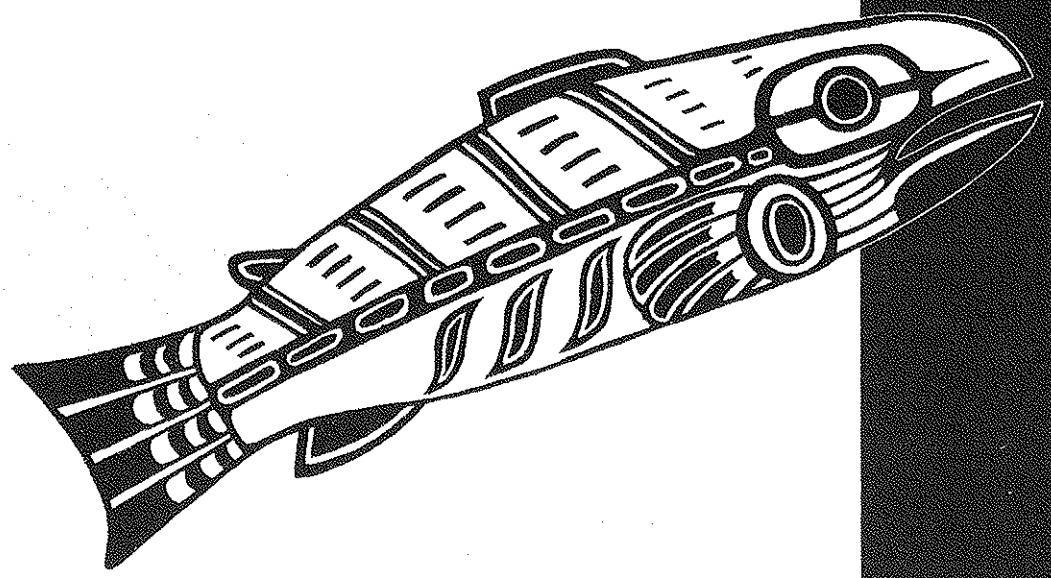
Fish restoration would be consistent with that discussed in Section VI.F. However,

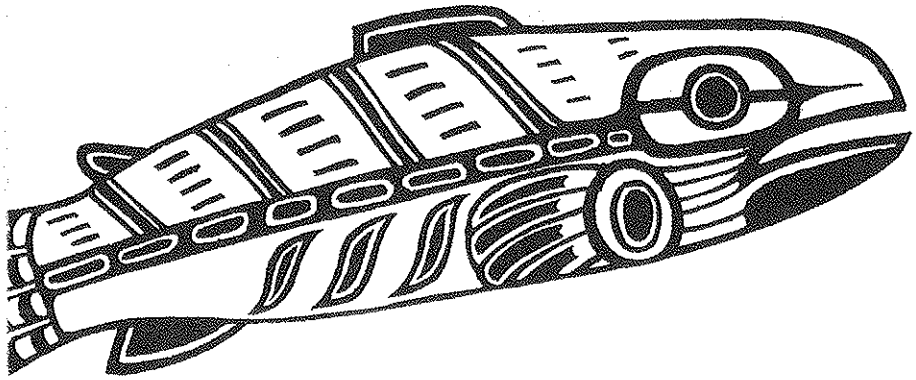
because of the difficulties associated with the retention of both dams (see Section V.D), some of the stocks could not be restored and others are expected to require continual supplementation for the life of the Projects. Therefore, the costs of fish restoration under the dam retention alternative would likely greatly exceed the FERC estimated cost of $3,754,000 which only assumed fish plants for a 10 year period.

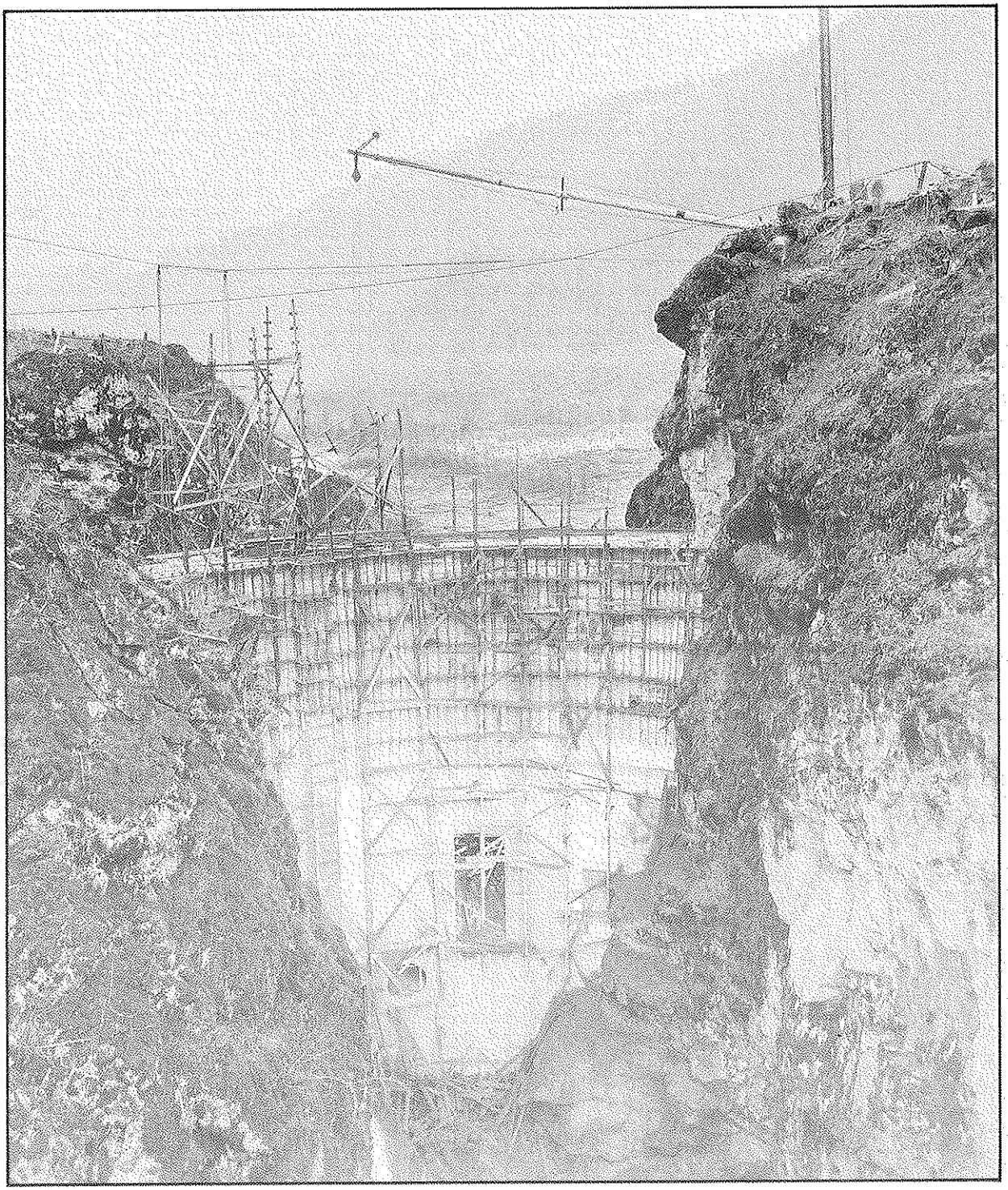
Fishing the Elwha in the 1920s. (Asahel Curtis photo, Washington State Historical Society)



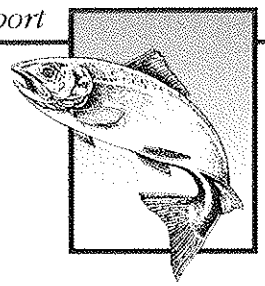
V. Consequences of Alternatives







Glines Canyon Dam with reservoir clearing in background, December 28, 1926. (Northwestern Power & Light Company photo)



V. Consequences of Alternatives

The following sections describe the potential for each alternative to meet the statutory standard of full ecosystem and native anadromous fisheries restoration.

A. Removal of Both Dams

This section provides a brief discussion of the potential consequences of removing both the Elwha and Glines Canyon projects. Additional details are provided in Section VI.

1. Restoration of the Ecosystem and Native Anadromous Fisheries. Removal of both dams would allow for the full restoration of the ecosystem and native anadromous fisheries, except perhaps sockeye salmon (Table 1). Removal of the dams and the revegetation of the areas currently inundated by Lake Mills and Lake Aldwell would ultimately return the natural vegetation and habitats on project lands. These areas were probably prime wildlife habitat by providing valuable cover, forage, and winter range for a variety of animals. Recovery of natural sediment transport processes would provide needed beach replenishment material to nearshore areas allowing increased shellfish production. Dam removal and restoration of anadromous fish would result in returns of fish to the river throughout the entire year, optimize utilization of all accessible portions of the watershed, produce much greater numbers of fish, and result in the restoration of ecosystem processes. Wildlife prey and nutrients would be provided by fish carcasses, eggs deposited in the gravel, and the numbers of juveniles and adults occupying the river. Removal of the two reservoirs would allow nutrients to naturally pass downstream.

Table 1. *Restoration prospects for stocks of anadromous salmonids native to the Elwha River.*

	Removal of both dams	Glines Dam removal	Elwha Dam removal	Retention of both dams
Fall chinook salmon	Excellent	Fair/good [a]	Fair/poor [g]	Poor [a]
Spring chinook salmon	Good	Fair/good [a]	Fair/poor [g]	Poor
Coho salmon	Good/exc. [e]	Fair/good [a]	Fair [g]	Fair
Winter steelhead	Excellent	Good [a]	Fair [g]	Fair [a]
Summer steelhead	Good	Good	Fair [g]	Fair
Pink salmon	Good	Poor/None [b]	Poor [h]	Poor/None [b]
Chum salmon	Good	Poor/None [b]	Poor [h]	Poor/None [b]
Sockeye salmon	Fair/Poor [f]	Poor/None [c]	Fair/Poor [f]	Poor/None [c]
Cutthroat trout	Good	Unknown [d]	Unknown [d]	Unknown [d]
Native char	Good	Unknown [d]	Unknown [d]	Unknown [d]

[a] Significant uncertainties associated with reservoir, spillway, and Eicher screen passage mortality as well as degraded habitat and water quality.

[b] Inability of juveniles to survive reservoir passage and continued degraded habitat indicates there is little chance of successful restoration of these stocks.

[c] Lack of a broodstock and expected low probability of successful passage through Eicher screens makes restoration of sockeye unlikely.

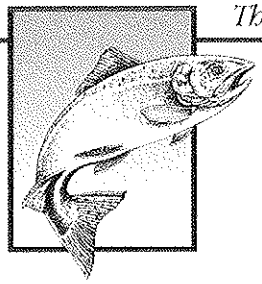
[d] The ability of cutthroat and native char to successfully navigate the proposed passage facilities is unknown.

[e] Existing coho stock should be adequate to restore run.

[f] Habitat within Lake Sutherland rated as marginal.

[g] Significant uncertainties associated with reservoir and spillway passage, degraded habitat and water quality, and unscreened intake.

[h] Continuation of habitat inundation and degradation.



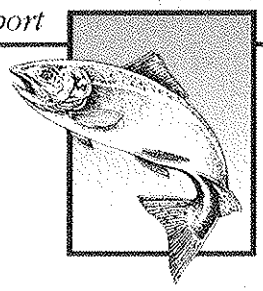
Total carcass biomass deposited in the system would be substantially greater than other alternatives (Table 2). This biomass would be distributed throughout the watershed resulting in the distribution of prey and nutrients over the maximum area possible. For example, spring chinook migrate to the river's headwaters, enter the river in April through June, and spawn from August through October. Chum salmon use the lower river and arrive in late fall and early winter making them available to bald eagles and other predators just prior to the winter months when other food supplies are scarce. Coho salmon penetrate tributary streams where they spawn, leaving carcasses for wildlife species that do not migrate over long distances.

The nutrient inputs from carcasses distributed over the watershed would be substantial. Sugai and Burrell (1984) found significant increases in phosphorus and nitrogen, the two nutrients generally limiting productivity in Northwest streams, following spawning by salmon. If their assumptions are applied to the Elwha River ecosystem (full decomposition of all carcasses and nitrogen and phosphorus fractions of 1.3% and 0.38% of carcass weight, respectively), removal of both dams would potentially provide over 13,000 pounds of these essential nutrients while the other alternatives would result in 1,800 to 5,200 pounds. However, some carcasses would be consumed by wildlife making those nutrients available to terrestrial systems but unavailable to aquatic organisms.

Table 2. *Potential carcass biomass (pounds) contributed to the Elwha River ecosystem from salmon stocks with at least fair prospects for restoration. Spawning escapement based on agency estimates; mean carcass weight from FERC (1993).*

	Both dams removed	Glines removal	Elwha removal	Dam retention
Spring chinook salmon	35,000	35,000	35,000	0
Summer/fall chinook salmon	140,400	135,700	135,700	0
Coho salmon	117,600	113,700	113,700	109,700
Chum salmon	236,000	0	0	0
Pink salmon	261,200	0	0	0
Sockeye salmon	27,600	0	27,600	0
Total	817,800	284,400	312,000	109,700

2. Fluvial Processes and Conditions. This alternative would result in the reintroduction of the natural bedload to the middle and lower reaches of the Elwha River. If uncontrolled, the erosion of reservoir sediments could result in the significant temporary buildup of sands in these areas, decreasing channel stability, increasing flood risks, and reducing fish spawning habitat. The precise magnitude, duration and areal distribution of sediment deposition would depend primarily on



how fast and how much of the stored sediment is released. For a discussion of this issue, see Section VI.C.

With the restoration of natural sediment transport below Glines Canyon Dam, the riverbed would aggrade from 2 to 5 feet. The substrate would contain more sand and gravels thus returning the channel to near pre-dam conditions and eliminating much of the currently armored nature of the middle and lower reaches. Channel flood levels for the 200-year recurrence interval flood would be 1 to 2 feet higher along the lower Elwha levee. The levee would need to be raised about 4 feet and be armored with larger riprap to maintain present flood protection and levee freeboard.

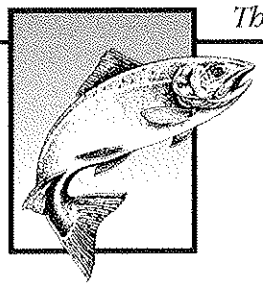
Depending on the sediment management option selected (Section VI.C), the channel substrate composition, channel meander, and riffle/pool sequence would rapidly approach pre-project conditions following dam removal and development of natural vegetation. River systems generally recover from extreme sediment events within 2 to 7 years from the time of reduced sediment supply (Platts and Megahan 1975, Pfeifer and Fletcher 1976, Knutzen et al. 1978, Lucas 1985, Thompson 1988, Platts et al. 1989). Further study of potential sediment management options (Section VI.C) is necessary to estimate the likely physical recovery period for the Elwha River following dam removal.

Sediment to the coastal zone would be increased by an average of 281,000 cubic yards per year. Shoaling of sand- to cobble-sized material would develop coastal bars at the river mouth similar to, or more extended than, conditions observed in 1926 (James River II 1989). Sediment supply would increase to the Angeles Point area soon after dam removal and to Ediz Hook within 10 to 20 years.

3. Water Quantity and Quality. Impacts to water quality from removal of both dams must be considered in the context of Section 101(a) of the Clean Water Act, which contains a goal to "*restore* and maintain the chemical, physical, and biological integrity of the nation's water" (emphasis added). Application of this goal should also apply to the dam retention alternatives.

With removal of both dams, discharge of the Elwha River would achieve a true run-of-the-river pattern of flow. Flow augmentation would not be possible during critical low flow periods in the absence of Lake Mills, although flow augmentation has not demonstrated tangible benefits. High frequency floods would no longer be attenuated by the reservoirs resulting in higher water surface elevations during high frequency flood events.

Average and maximum daily water temperatures in the river below Glines Canyon Dam would be from 2° to 4° C cooler than existing conditions during the late summer and early fall (James River II 1988). Cooling in September and October would have particularly positive benefits for salmon egg survival and avoidance of diseases such as *Dermocystidium salmonis*. Cooler water temperatures would result from the absence of reservoir heating.

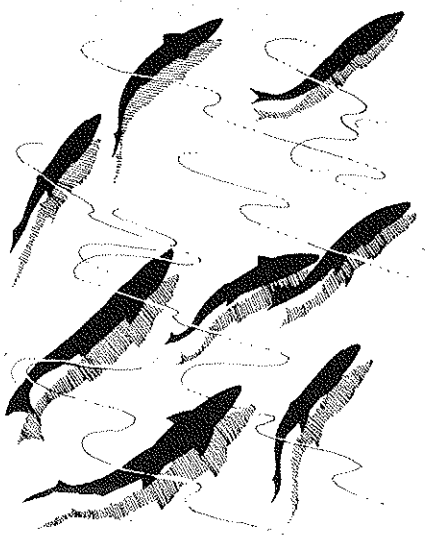


Temporary impacts on existing water quality during construction would depend on the dam removal alternative selected, necessitating varying levels of mitigative measures (Section VI.E). For the long-term, suspended sediment concentrations in the middle and lower reaches of the river would be generally the same as those currently existing in the upper river. Additional data would be collected during the EIS/advanced planning stage to accurately characterize turbidity in the upper river.

4. Fisheries and Other Freshwater Aquatic Communities. The removal of both dams alternative provides the only opportunity for the full restoration of all of the native anadromous fish of the Elwha River, with the possible exception of sockeye salmon.

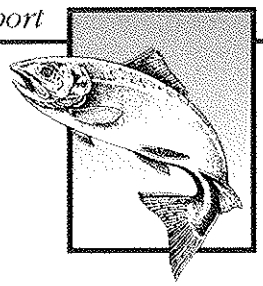
Depending on the dam removal option chosen, temporary sedimentation and turbidity effects during dam removal could negatively affect salmon and trout and aquatic invertebrate production and survival. High concentrations of suspended sediments could cause the deaths of fish exposed for several weeks or several months. Generally, aquatic insects and younger salmonids are more sensitive to suspended sediment than adult trout or salmon (Newcombe and MacDonald 1991). In addition, high concentrations of fine sediments could smother incubating eggs and emerging fry in the middle and lower river. Limiting total sediment releases or limiting releases during time periods that are not critical to fish would minimize impacts to existing fish stocks in the middle and lower river. Broodstock from each fish stock of concern might be held in "clean" water for propagation and later transplanting in the upper river or in the middle and lower river once turbidity levels recede. However, additional risks are incurred with increased reliance on hatchery propagation for this purpose. Further engineering analysis is necessary to identify opportunities for limiting sediment releases to minimize impacts on lower river fish stocks.

For the long-term, the restoration of the natural sediment regime would have positive benefits to aquatic communities. The armored middle and lower reaches would once again provide substrate suitable for greater populations of aquatic invertebrates. The recovery of spawning gravels and woody debris would benefit resident and anadromous fish.



Overall, aquatic communities would benefit from dam removal Removal of the dams would restore the amount of nutrients and organic matter reaching the middle and lower river from the upper river, as reservoirs are known to block the downstream transport of these materials (Webster et al. 1979, Newbold 1987). These additional organic materials would increase benthic invertebrate production in the middle and lower rivers, which would in turn improve growth and survival of fish (see Table 1).

a. Chinook Salmon. Removal of the Glines Canyon and Elwha projects would eliminate passage losses associated with residualism, predation, and movement past passage facilities associated with the retention of both dams alternative. Dam removal would probably reduce the incidence and virulence of diseases such as *Dermocystidium salmonis*, which chinook salmon are particularly vulnerable to. Dam removal would



have two potentially beneficial effects that could reduce the incidence of the disease. First, middle and lower river water temperatures would be reduced from 2° to 4° C during the summer and early fall. Second, dam removal would allow fish to disperse, thus reducing crowding and the potential for spreading the disease. The reestablishment of unimpeded fish passage to the middle and upper Elwha River could result in the recovery of chinook salmon of extremely large size. Although restoration of spring chinook would take time, removal of the dams would ultimately result in the full restoration of all stocks of chinook salmon.

b. Coho Salmon. With removal of the dams, upstream and downstream passage problems at both projects would be eliminated, thereby allowing access to tributary spawning and rearing locations. In addition, recovery of the riverine areas inundated by the two reservoirs would restore important spawning and rearing areas. The poor quality spawning habitat of the middle reach, with its large-sized and armored substrate, would be restored with natural gravel transport from upriver. Coho salmon could be fully restored under this alternative.

c. Steelhead. Winter and summer runs of steelhead could be fully restored following removal of the Elwha and Glines Canyon dams. Upstream and downstream passage would no longer be obstructed, allowing access to important tributary spawning and rearing locations, and reclamation of the riverine areas inundated by Lake Mills and Lake Aldwell would restore important spawning and rearing areas.

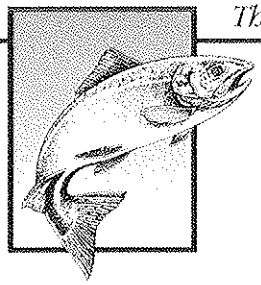
d. Pink Salmon. With the removal of the dams, passage conditions would be favorable for pink salmon. Removal of the dams would also allow the natural bedload regime to occur, resulting in the recovery of pink salmon spawning habitat in the presently inundated areas of Lake Mills and Lake Aldwell as well as the armored reaches of the middle and lower river. Pink salmon could be fully restored under this alternative.

e. Chum Salmon. Chum salmon could be fully restored for the same reasons as pink salmon.

f. Sockeye Salmon. Although adult sockeye salmon are observed in the Elwha River each year, a native stock of Elwha River sockeye probably does not exist. Historical accounts identify kokanee as being present in Lake Sutherland prior to the construction of Elwha Dam, but numerous plants of nonnative kokanee and other anadromous fish would have impacted any native stock. The lack of an identified donor stock of sockeye from another system limits restoration potential.

Current habitat conditions also limit the restoration potential for sockeye salmon in the Elwha River basin. Limited tributary spawning habitat is available while the construction of homes around Lake Sutherland may have impacted shoreline spawning habitat.

g. Sea-run Cutthroat Trout and Native Char. With the removal of both dams, favorable passage conditions would be reestablished and habitat in the middle and

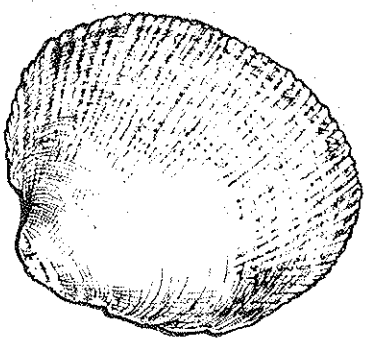


lower river would recover. Sea-run cutthroat trout and native char populations could be fully restored with dam removal.

h. Resident Fish. Removal of both dams would bring about an overall positive change in the fish community of the Elwha River. Salmon carcasses would provide increased nutrients in the upper and middle river. Improvements in spawning and rearing habitat would occur. The increased nutrients and organic matter from dam removal would increase production in the lower and middle reaches. However, rearing habitat for old age classes of trout could be reduced from the loss of the reservoirs. Also, as with all of the alternatives, resident trout populations would decline because of competition with anadromous fish, conditions that existed prior to the dams.

i. Stream Ecology. Overall, the ecology of the Elwha River would change significantly, from present conditions, following removal of the dams. The dams and reservoirs would no longer control habitat conditions in the middle and lower river. Changes in water quality would improve stream productivity of the middle and lower river. Average water temperatures in the middle and lower river during the summer and early fall would be 2° to 4° C lower than present (FERC 1993), which would benefit salmon by causing water temperatures to be more within the optimal range for these fish, thereby by lowering the threat of diseases. The productivity of the upper and middle river would also improve with the addition of salmon carcasses to those reaches. The ecosystem could be restored.

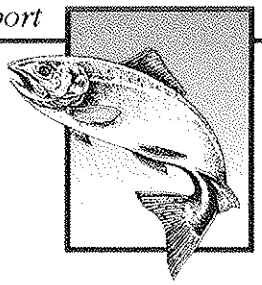
The ability to provide flow augmentation during critical low flow periods would not be possible with the removal of Glines Canyon Dam. Since the potential benefits of flow augmentation are questionable, no adverse effects from the loss of this alternative are anticipated unless problems associated with low summer/fall flows in the river are aggravated by increased diversion of water in the future.



Butter Clam

j. Shellfish. With the removal of both dams, the amount of sand and coarse gravel along the coast between the Elwha River and Point Angeles/Ediz Hook would increase. Increased gravel substrate would benefit butter clams and little neck clams while increased sand would benefit horse clams. Clam populations would also increase because the restoration of sediment transport would increase the size of the Elwha River delta.

5. Living Marine Resources. Short-term impacts would be dependent on the sediment management scenario ultimately selected (see Section VI(C)). Retention of the accumulated sediments within the confines of the existing reservoirs would limit short-term impacts to the marine environment by limiting sediment releases, as would physical removal of the sediments to a terrestrial site. Impacts from physical removal of the sediments with deposition at a saltwater location would depend on the site selected. Erosion of the accumulated sediments to saltwater would potentially have significant short-term impacts to the near-shore area east of Freshwater Bay. Further study is necessary to determine those impacts, and potential measures to



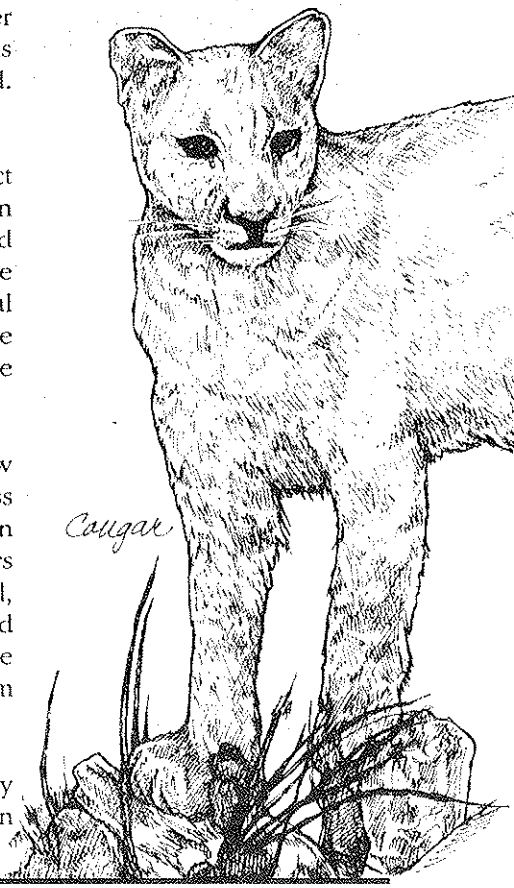
mitigate those impacts, from the erosion of sediments to saltwater or from the deposition at a particular saltwater site.

For the long-term, restoration of natural sediment transport processes in the Elwha River would likely build out the estuary approximately 0.5 mile resulting in a shape similar to, or more extended than, that which existed in 1926. The existing near-shore marine and estuarine community would be affected as a result of the change in the environment from that of a rocky substrate to one dominated by sand. The plants and animals (e.g., kelp, rock crab, barnacles, and mussels) that require a hard and stable surface for attachment or are adapted to living in a rocky environment would be impacted by this change. Plants and animals (e.g., eelgrass, Dungeness crab, and flatfish) that are adapted to an environment dominated by sand would likely benefit from the significant increase in sediment input and the expansion of the estuary.

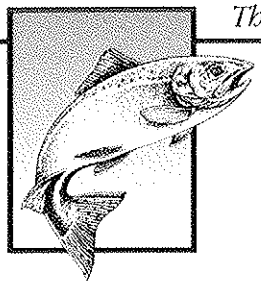
6. Vegetation. Removal of both dams would have minor long-term impacts on existing vegetation and significant long-term impacts associated with revegetation of the reservoir areas. Rubble disposal, staging areas, and new access roads, if needed, would cause the temporary loss of vegetation. Removal of the reservoirs may eliminate or degrade several associated wetlands, although some wetlands would be naturally created along the river. Once the river in the middle and lower reaches stabilizes following dam removal, new plant communities would establish on exposed gravel beds and abandoned channel sections and wetlands would develop in backwater areas, sloughs, and oxbows. Reclamation of the reservoirs and project facility locations would revegetate approximately 715 acres that are currently inundated or developed. For a further discussion of revegetation, see Section VI.H.

7. Wildlife. Restoration of the areas occupied by the reservoirs and project facilities would result in the reclamation of 715 acres of important wildlife habitat in the Elwha Valley, including wetland and riparian areas along the river. Bottomland floodplain and riparian areas are not abundant in the region, but they provide important habitat for a variety of species (see below). Since the dam removal alternative would result in the restoration of important low land habitat and all native anadromous fish runs except perhaps sockeye salmon, a major food source would be restored for many species of wildlife.

The dam removal alternative would have minor adverse impacts on wildlife. Any new access roads, staging areas, and rubble disposal sites would cause the temporary loss of wildlife habitat. Dam removal and restoration activities would disturb wildlife in the vicinity of each reservoir during the construction period. Removal of the reservoirs may temporarily eliminate or degrade habitat in wetlands adjacent to Lake Aldwell, and along the river downstream of each dam location. Loss of the reservoirs would have temporary adverse impacts on some species. However, any temporary adverse impacts would be offset many times by the benefits to all native wildlife species from restoration of the habitat currently inundated by the reservoirs.



a. Mammals. The reclamation of 715 acres of lowland habitat in the Elwha Valley would benefit species such as deer and elk. Since forage habitat for deer and elk in



the project vicinity is of low quality, the additional overwintering habitat provided by the reclaimed lands could result in an increase in populations of deer and elk in the Elwha Valley. Restoration of previously inundated lands would provide additional habitat for small- and medium-sized mammals.

Restoration of riverine habitat would benefit many smaller animals, although these species would experience a temporary loss of suitable habitat during the dam removal process. However, the stands of alder and willow that would dominate the reclaimed habitat shortly after dam removal would provide excellent forage for beaver as well as cover for otter and mink. As conifers invade and tree size increases, the quality of beaver habitat along the river would decline, but over the long-term, reclamation would provide a significant increase in habitat for beaver. Over the long-term, restoration of the reservoir areas would also benefit terrestrial species that require large stands of mature forest such as the marten and bobcat.

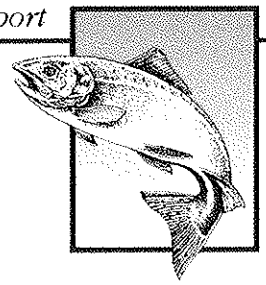
Small mammals such as mice and voles would gradually invade the alder and willow stands on the reclaimed lands. As conifers invade and mature, squirrels, chipmunks, and other small- and medium-sized mammals that depend on forests would benefit, including the long-eared myotis, a State monitor species.

b. Birds. Restoration of the areas currently occupied by the reservoirs and project facilities would, in the long-term, benefit raptors that use forest habitats, including the northern goshawk, a State candidate monitor species. The Cooper's hawk, sharp-shinned hawk, and screech owl would also benefit from an increase in mature forest habitat. Removal of the reservoirs would eliminate 663 acres of forage habitat for the osprey, a State monitor species. However, since prey of suitable size and density would be available in the river, no adverse long-term effects on osprey are expected from the loss of the reservoirs.

Dam removal would benefit waterfowl that use riverine environments but would have a negative effect on species that are dependent on the slower, shallower water found in lacustrine environments. Waterfowl that would gain habitat include the common merganser, harlequin duck, wood duck, hooded merganser, and other species with similar habitat preference. Loss of lacustrine habitat would have a negative impact on species that are commonly observed wintering on the reservoirs, primarily in the shallow water of the Lake Aldwell delta. These species include the trumpeter swan, lesser scaup, mallard, and bufflehead. However, the back channels and wetlands that would develop along the restored river would mitigate this loss to some extent. Also, restoration plans should consider the creation of wetland/pond areas to replace habitat suitable for species such as the trumpeter swan. In addition, since wintering habitat for waterfowl is currently not limited in western Washington, it is unlikely that the removal of the reservoirs would have a negative effect on the overall populations of these species.

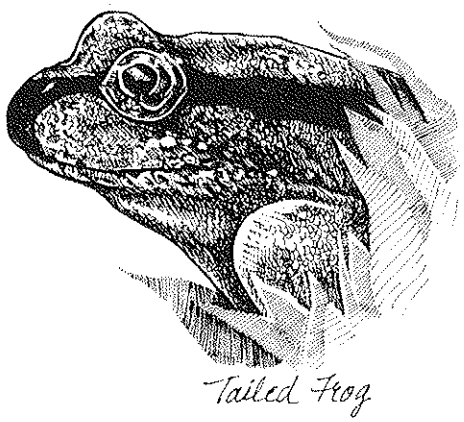


The long-term development of conifer, mixed conifer/deciduous, and hardwood stands in the reclaimed lowlands would provide habitat for upland birds, primarily ruffed grouse and blue grouse.



Initially, alders and willows in the restored reservoir areas would provide high quality habitat for the yellow warbler and other birds that are dependent on dense stands of shrubs near water. As conifers become established, the amount of habitat for the yellow warbler would decrease, restricted primarily to stands of palustrine or bottomland hardwoods with well developed shrub layers. As the conifers mature and large snags develop, the restored reservoir areas would provide habitat for the pileated woodpecker and Vaux's swift, both State candidate species, as well as other birds that require large trees and/or snags for nesting or foraging.

Loss of the reservoirs could also affect other bird species that forage in or above the reservoirs, including the belted kingfisher and violet green swallow. Effects could be significant while the river in the restoration area is stabilizing due to decreased water clarity and reduction of fish and insect biomass. Populations of these species along the Elwha River may be temporarily depressed but should recover once the river stabilizes and anadromous fish are restored.



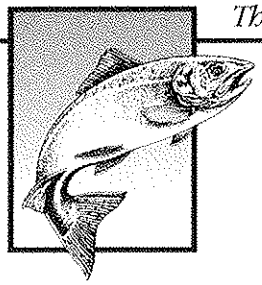
Tailed Frog

c. Reptiles and Amphibians. Restoration of the reservoir lands would increase the amount of habitat available to reptiles and amphibians. Populations of some species would be expected to increase, depending on the successional stage of the vegetation.

d. Restoration of Anadromous Fish. When compared to the other alternatives, wildlife would benefit most from the removal of both dams. The coho salmon runs would provide biomass primarily to the tributaries and upper reaches of the Elwha river. The chinook, pink, and chum salmon runs would significantly increase the biomass currently available in the middle and lower river. Most of the biomass from the restored runs would be available to wildlife in the fall and winter, when food is limited. Carcasses from steelhead would provide some supplemental food during the spring and summer. In concert with habitat restoration, the full restoration of native anadromous fish to all reaches of the Elwha River would be an integral part of the restoration of all wildlife populations in the Elwha Valley.

8. Threatened and Endangered Species. Removal of both dams would have no adverse impacts on federally listed or proposed species. The restoration of the reservoir areas and project facilities may, over the long-term, increase available habitat for the spotted owl and marbled murrelet. Since dam removal would result in the restoration of chum salmon, the number of bald eagles wintering along the middle of the Elwha River would be expected to increase. Although the reservoirs would be lost, harlequin ducks would be expected to benefit from the recovery of wetland and riparian areas along the restored river.

9. Recreation. In the long-term, the dam removal alternative would greatly benefit both marine and freshwater sport fishing in the area, although harvest restrictions may be necessary during the restoration period. Draining of the reservoirs would eliminate flat water recreational boating opportunities, but it would result in an increase of 5.3 miles of free flowing river for whitewater boating enthusiasts. It should be noted that the Elwha River was reviewed as a prime candidate for a State



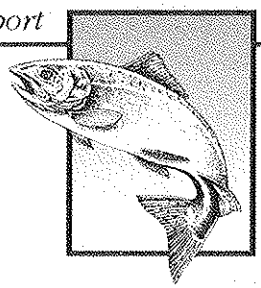
Scenic River but was removed from the list due to the presence of the dams. Public access points from project lands must identified.

With the removal of both dams and the potential connection of trails within Olympic National Park with the City of Port Angeles' waterfront trail, hiking, and possibly biking, opportunities would increase. Such a trail could become an important interpretive corridor that would educate future generations on the history of the pre-dam pristine river, the period of the dams, and the post-dam era, thereby providing significant educational and tourist value. For a further discussion of possible interpretive activities, see Section VI(J).

10. Power. With dam removal, the Daishowa America Mill would have to reduce power needs and/or purchase power elsewhere. Public Law 102-495 provides for replacement power from the Bonneville Power Administration, to be purchased at the same rate as other industrial consumers of Port Angeles City Light (Section 5(b)). Daishowa's levelized cost of power from 1996 through 2025 would increase from the reference case 37.3 mills/kWh to 52.2 mills/kWh. This latter figure equals about 13% more than the levelized cost of power that would be experienced under the dam retention alternative and would have a similar negative effect on the mill's overall operating cost. No estimates of how mill production would be affected by increased operating costs are available, although it is noted that Daishowa America supports the provisions of P.L. 102-495.

11. Tribal Social Effects. The removal of both dams represents the only possible opportunity to fully restore the native anadromous fisheries, which are the Elwha S'Klallam Tribe's most valuable economic and cultural resource. Treaty fishermen would benefit from a long-term restoration of ceremonial, subsistence, and commerical fishing. Traditional fishing sites would again become accessible, thereby avoiding overcrowding at the river mouth and allowing the Tribe to return to traditional grounds. The removal of both dams would also allow the replenishment of shellfish habitat at the river mouth and along reservation beaches because sediment from the river would once again reach these areas. The removal of both dams would have positive impacts on the material and cultural well-being of tribal members through the restored fisheries, return of the free-flowing river, and the revitalization of the S'Klallam culture.

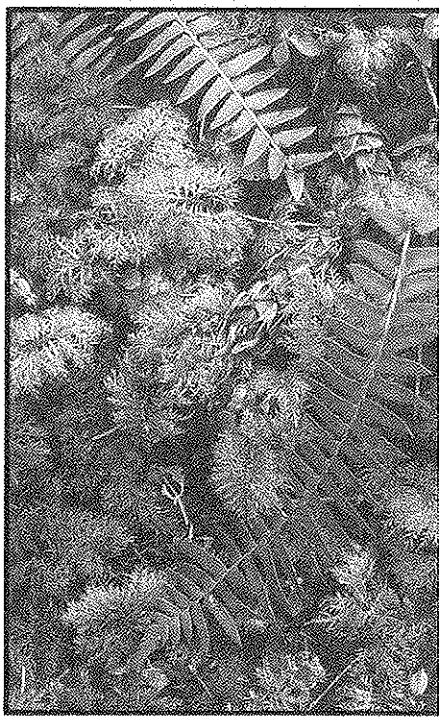
12. Cultural Resources. Restoration of native anadromous fisheries would benefit all tribes that intercept Elwha River fish. Also, recovery of shellfish beds at the Elwha River mouth would be beneficial to the Elwha S'Klallam Tribe. Dam removal would destroy the Elwha and Glines Canyon dams, which are listed on the National Register of Historic Places. However, the National Register notes the adverse impacts the dams have had on the resources of the Elwha River and on the Tribe. Recommended mitigation for removal of the dams is documentation according to Level I standards for the Historic American Engineering Record (HAER) and interpretation of the dams on-site and at other sites to be determined. For a further discussion of impacts to historic and cultural resources, see Section VI.L.



13. Other Effects. Overall effects on recreation and tourism would be positive, offering the greatest potential increase in recreation and tourism based income. The restoration of the natural sediment flow from the river would help restore coastal processes, leading to increased sediment deposition at Ediz Hook after 10 to 20 years. This would eventually reduce, but not eliminate, current beach replenishment costs that average $100,000 annually. Taxes paid on the Projects could drop to zero, a loss of about $257,000 annually (1990 dollars) for Clallam County; however, compensation by the Federal Government in-lieu of tax payments may offset this.

B. Removal of Glines Canyon Dam

This section contains an evaluation of the potential for the full restoration of the ecosystem and native anadromous fisheries associated with the removal of the Glines Canyon Project and the retention of the Elwha Project.

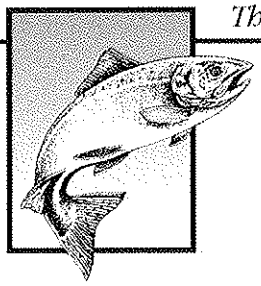


Forest floor. (Pat O'Hara)

1. Restoration of the Ecosystem and Native Anadromous Fisheries. Removal of Glines Canyon Dam and revegetating the area currently inundated by Lake Mills would restore the habitat in that area to near natural conditions. Restoration of chinook and coho salmon provides greater ecosystem benefits than the dam retention alternative but well below the system's potential. Ecosystem benefits are further reduced because of the losses of juvenile and adult fish during passage past the dams and reservoirs. These runs would be expected to benefit wildlife but would not provide the amount of biomass or nutrients needed to fully restore populations. In particular, pink and chum salmon would not be restored. Also, because the Elwha Project would remain, the habitat necessary to fully restore fish and wildlife would not be available. In addition, the natural sediment transport regime and aquatic biology below Elwha Dam would not return to natural conditions. The ecosystem would not be restored.

2. Fluvial Processes and Conditions. With removal of Glines Canyon Dam, temporary silting of the middle and lower river could occur, depending on the dam removal option chosen (see Section VI.C). For the long-term, naturally produced sediments would once again reach the middle reach of the Elwha River resulting in potential flood level increases in that area of 1 to 2 feet. However, a barrier (Elwha Dam) to sediment transport would remain, leaving the lower river, estuary, and coastal zone starved of coarse sediments. The Elwha River would continue to deposit all but the finest sediment in Lake Aldwell, resulting in its filling in 40 to 60 years. Erosion processes in the coastal zone, because of reduced sediment supply, would continue.

3. Water Quantity and Quality. Water quality impacts under this alternative would be very similar to those predicted under the removal of both dams alternative (see Section VI.E), although the presence of Lake Aldwell would ameliorate impacts somewhat by providing for some deposition of sediments. Whereas the project owner has stated that the project is currently operated in a "near run-of-the-river" mode, discharge of the Elwha River would more closely follow a natural, run-of-the-river discharge pattern with removal of Glines Canyon Dam. However, flow augmentation would not be possible during extreme low-flow periods because of the loss of storage



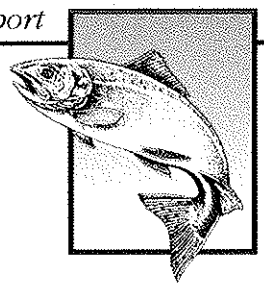
provided by Lake Mills, although flow augmentation has not provided tangible benefits in the past.

High suspended sediment concentrations would occur during storm runoff events for up to several years following removal of the dam but would gradually decline. Following this period, suspended sediment concentrations would be approximately the same as those encountered for glacial rivers in the region. Additional data would be collected during the EIS/advanced planning stage to define turbidity in the upper river.

During the critical summer/fall chinook spawning period, from the middle of August to late October, average and maximum daily water temperatures in the Lake Mills and middle reaches of the Elwha River would be from 2° to 4° C cooler than existing conditions. Cooler water temperatures would result from an absence of heating and heat storage in Lake Mills. Water temperatures in Lake Aldwell and the lower reach would be slightly cooler because of the reduced overall temperatures of inflow waters from the middle reach.

Depending on the dam removal method selected, high levels of sediment and turbidity could occur in the middle and lower reaches of the river during the removal period and for several years following removal. Increases in organic matter concentrations and localized reduction in dissolved oxygen concentrations would occur during the dam removal period. As a result, several state water quality criteria for rivers would be temporarily violated. Criteria for turbidity, pH, and dissolved oxygen could be exceeded. Possible contamination to the water supplies of the City of Port Angeles, Dry Creek Water Association, Elwha Place Homeowners Association, and other private users by fine sediment, glacial colloidal matter, organic matter, and bacteria during dam removal and several years following removal could occur, necessitating mitigation efforts (see Section VI.E). High turbidity levels could require mitigation measures for industrial users and the WDF Rearing Channel.

4. Fisheries and Other Freshwater Aquatic Communities. As under the removal of both dams (Section V.A), removal of Glines Canyon Dam could result in temporary adverse effects on the survival of fish in the river below the dam during removal, although the retention of Lake Aldwell would alleviate turbidity problems somewhat below Elwha Dam. Over the long-term, removal of Glines Canyon Dam and retention of Elwha Dam with fish passage facilities would result in increased potential for restoring spring and fall chinook and coho salmon as well as winter and summer steelhead compared to retaining both dams. Restoration potential for sea-run cutthroat and native char should increase, although prospects are largely unknown because of passage concerns at Elwha Dam (Table 1). The potential of restoring pink and chum salmon would be poor because of passage problems at Elwha Dam and Lake Aldwell. Consequently, the retention of Elwha Dam would not allow for the full restoration of the native anadromous fisheries. Resident trout would decline from the competition with anadromous salmon and trout to the middle and upper reaches of the river as in other alternatives.

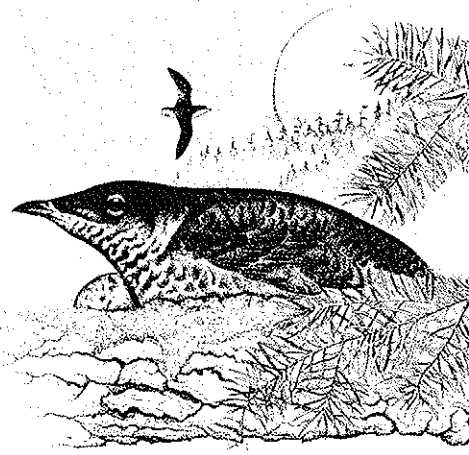


5. Living Marine Resources. No significant impacts would be anticipated under this alternative since the retention of Elwha Dam would continue to prevent sediments from reaching the Elwha River estuary and near-shore marine areas. The local marine environment would continue to be dominated by the plants and animals (e.g., kelp, rock crab, barnacles, and mussels) that require a hard and stable surface for attachment or are adapted to living in a rocky environment.

6. Vegetation. Long-term impacts to vegetation resulting from the removal of Glines Canyon Dam and the retention of Elwha Dam would include (1) reclamation of about 416 acres currently inundated by Lake Mills, (2) the permanent loss of 1.14 acres of vegetation from construction activities at Elwha Dam, (3) changes in vegetation composition resulting from wildlife mitigation at the Elwha Project, (4) reclamation of about 9 acres currently occupied by Glines Canyon Project facilities such as buildings and roads, (5) potential loss of wetlands associated with Lake Mills but which would be mitigated by the recovery of wetlands associated with the restored river, and (6) disturbance from increased recreational activity in the vicinity of Lake Aldwell.

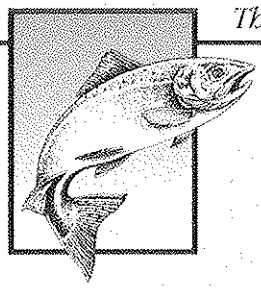
7. Wildlife. The primary long-term wildlife impacts associated with the removal of the Glines Canyon Project and the retention of the Elwha Project would be (1) the loss of the reservoir and the restoration of about 424 acres currently occupied by Lake Mills (415 acres) and project facilities (9 acres), (3) modifications in habitat quality for wildlife from mitigation on James River lands adjacent to Lake Aldwell, (4) partial restoration of salmon runs above Elwha Dam, and (5) disturbance from improved recreation facilities.

This alternative would result in a significant increase in fish biomass from carcasses, eggs, and juvenile salmon but would be far less than that which would occur from the removal of both dams. Wildlife species along the upper reaches of the Elwha and tributaries would increase. However, full restoration of wildlife populations would not occur because pink and chum salmon would not be restored.



Marbled Murrelet

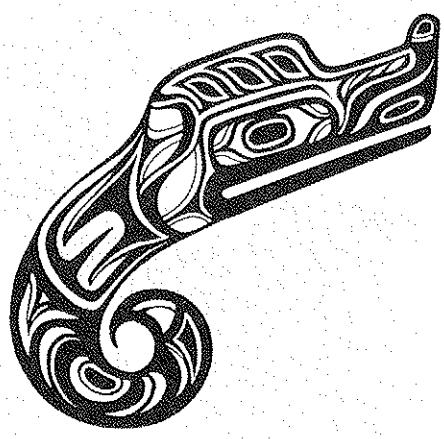
8. Threatened and Endangered Species. Removal of the Glines Canyon Project with retention of the Elwha Project would have no adverse impacts on Federally listed or proposed wildlife species. The primary impact on spotted owls would be the long-term potential increase in available habitat from the eventual restoration of a mixed conifer/deciduous forest in the area of Lake Mills, although the number of nesting pairs would not be expected to increase. The marbled murrelet could also benefit from the restoration of the Lake Mills lands. However, the existing old growth in the area around the lake is not currently used by nesting murrelets because it apparently lacks the characteristics of this habitat found along higher elevation tributaries. Since retention of Elwha Dam would not allow for the restoration of chum salmon, the principal food source for bald eagles wintering on other Northwest rivers, removal of Glines Canyon Dam would not result in a significant increase in the number of bald eagles along the Elwha River.



9. Recreation. During the salmon and steelhead rebuilding period, recreational fishing would be reduced through seasonal and limit restrictions. In the long-term, the partial restoration of anadromous fish runs and the greater river shoreline in the area of Lake Mills would benefit anglers. There would, however, be a reduction in the quality of the resident trout fishery in the middle and upper river from competition between resident and anadromous fish, conditions that were present prior to the dams.

There would be a loss of Lake Mills reservoir boating opportunities, although there would also be 2.5 miles of additional free flowing river boating opportunities. Flat water boaters and anglers would be displaced and would probably turn to using Lake Aldwell, Lake Sutherland, and Lake Crescent for boating.

10. Power. With the loss of the 101 average GWh of power produced by the Glines Canyon Project, the 30-year levelized cost of power to the Daishowa America Mill under the Glines Canyon Project removal alternative would increase to 98.6 mills/kWh (kilowatt hour), a substantial increase over the reference case of 37.3 mills. The data necessary to estimate any loss of the mill's competitive position from this increase are unavailable.



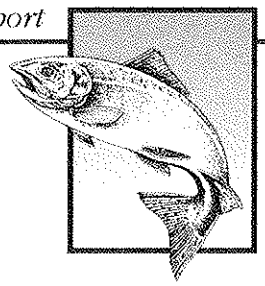
11. Tribal Social Effects. Partial restoration from the removal of Glines Canyon Dam would not provide the fisheries benefits that would accrue with the removal of both dams. Treaty fishermen would continue to experience severely restricted ceremonial, subsistence, and commercial fisheries. In particular, pink and chum salmon would not be restored. Sediment would remain trapped in Lake Aldwell, leading to the continued erosion of reservation beaches and shellfish habitat.

Retention of Elwha Dam would leave the Elwha S'Klallam creation site, and other traditional cultural properties, inaccessible. Traditional locations for gathering plants, berries, bark, and other cultural resources would remain inundated. Use of the river valley for spiritual cleansing and physical healing would not be possible.

12. Cultural Resources. Under this alternative, the National Register Glines Canyon Dam would be demolished, and new construction would adversely affect the Elwha Dam, also on the National Register. National Register properties would be fully documented to Historic American Engineering Record standards. Archaeological sites buried under sediment within Lake Mills could be disturbed during removal. Further details of cultural resources can be found in Section VI.L.

13. Other Effects. Effects on recreation and tourism would be positive, with associated opportunities for increased recreation and tourism related income. Because of modifications to the Elwha Project, taxes paid by the project owner to Clallam County would increase by about 6%, to $272,000 annually (1990 dollars).

The potential for increased flooding for landowners in the middle reach would be similar to the removal of both dams alternative (see Sections VI.B & C). With the



retention of Elwha Dam, there would be no change in flooding frequency below the dam until Lake Aldwell became filled with sediment in 40 to 60 years.

C. Removal of Elwha Dam

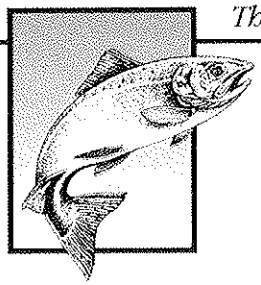
This section contains an evaluation of the potential for the full restoration of the ecosystem and native anadromous fisheries associated with the removal of the Elwha Project and the retention of the Glines Canyon Project.

1. Restoration of the Ecosystem and Native Anadromous Fisheries. Removal of Elwha Dam and revegetating the area currently inundated by Lake Aldwell would restore the habitat in that area to natural conditions. With the removal of Elwha Dam, the likelihood for restoring each of the native anadromous fish runs would significantly improve. However, because the Glines Canyon Project would remain, the habitat necessary to fully restore fish and wildlife populations would not be available. In addition, the natural river hydrology, sediment transport regime, and aquatic biology below Glines Canyon Dam would not be restored. The partial restoration of some of the fish runs to the middle and upper reaches of the river, if successful, would provide additional food, compared to existing conditions, to wildlife and aquatic organisms that feed on salmon carcasses. These fish would be expected to benefit wildlife but would not provide the amount of biomass or nutrients needed to fully restore wildlife populations. The ecosystem would not be restored.

2. Fluvial Processes and Conditions. With removal of Elwha Dam, temporary construction phase silting of the lower Elwha River would occur, depending on the dam removal option chosen (see Section VI.C). For the long-term, naturally produced sediments would continue to be retained in Lake Mills. The Lake Mills delta would continue to grow, eventually filling the lake in about 260 to 300 years. All boulders, cobbles, gravel, sand, about 30% of the silt, 1% of the clay, and all woody debris supplied by the upper Elwha watershed would continue to be trapped in Lake Mills. The middle reach of the river would continue to be armored without the natural upstream bedload (cobbles, gravel, and sand) supply. The lower reach would receive bedload from the Little River and Indian Creek drainages and other areas below Glines Canyon Dam. Erosion processes in the coastal zone, because of reduced sediment supply, would continue.

3. Water Quantity and Quality. The removal of Elwha Dam would not affect water quality upstream of Lake Aldwell. Therefore, water quality impacts for the Lake Mills and middle reaches would be the same as those described under the retention of both dams alternative (Section V.D). For the Lake Aldwell area and lower reaches, water quality impacts would be similar to, but not as intensive as, those described for these reaches under the removal of both dams alternative. Increased turbidity, organic matter concentrations, bacteria densities, and nutrient concentrations would occur following removal of Elwha Dam and would degrade the quality of water for Elwha River water users, requiring mitigation measures (Section VI.E).

Discharge patterns of the river below Glines Canyon Dam would essentially be run-



of-the-river. Lake Mills storage would still be available for flow augmentation during the critical chinook salmon spawning period of August to October, although flow augmentation has not demonstrated tangible benefits.

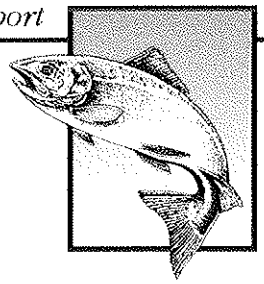
When compared to existing conditions, average temperatures in the lower reach would slightly decrease from the lack of reservoir heating in the absence of Lake Aldwell. Mean daily temperatures would likely be from 0.5° to 1° C less from mid-August to October.

Particulate organic matter (POM) would increase slightly in the lower reach, since leaf matter and woody debris originating from the middle reach would pass unhindered through the Lake Aldwell reach. However, POM loads originating from the middle reach would be very small compared to that originating from the upper watershed, which would continue to settle in Lake Mills.

Depending on the dam removal method selected (Section VI.C), high levels of sediment and turbidity could occur in the lower reaches of the river during the removal period and for several years following removal. Increases in organic matter concentrations and localized reduction in dissolved oxygen concentrations would occur during the dam removal period. As a result, several state water quality standards for rivers would be temporarily violated, although baseline standards would need to be redone to reflect "new" natural flow conditions. Criteria for turbidity, pH, and dissolved oxygen could be exceeded. Possible contamination to the water supplies of the City of Port Angeles, Dry Creek Water Association, Elwha Place Homeowners Association, and other public and private users by suspended sediment, organic matter, and bacteria during dam removal and several years following removal could occur, necessitating mitigation efforts (see Section VI.E). High turbidity levels could require mitigation measures for industrial users and the WDF Rearing Channel.

4. Fisheries and Other Freshwater Aquatic Communities. Depending on the dam removal approach selected, salmon and steelhead production below Elwha Dam could be temporarily impacted from high turbidity levels. Access to riverine habitat unimpacted by removal above Elwha Dam would provide the potential to partially offset those impacts. For the long-term, removal of Elwha Dam generally provides lower restoration potential than removal of Glines Canyon Dam except for pink and chum salmon. Removal of Elwha Dam increases restoration prospects for sockeye (fair/poor) equivalent to the dam removal alternative (Table 1).

Several adverse effects to fish restoration would remain such as the continued trapping of bedload in Lake Mills, occasional high water temperatures in the river below Glines Canyon Dam and the attendant chinook salmon mortalities, and reservoir and dam passage mortalities. Because of these adverse effects and lower reliability in predicting how severe these effects would actually be with removal of the Elwha Dam, the level of certainty for restoration is lower than other alternatives for many stocks. As with all other alternatives, resident trout would decline from competition with anadromous salmon and trout in the middle and upper reaches.



The greatest difference for fisheries between this alternative and the Glines Canyon Dam removal alternative is the improved potential for restoring pink and chum salmon stocks resulting from the restoration of access to the riverine habitat between the two dams and the addition of spawning gravel from the Little River and Indian Creek. However, restoration prospects for pink and chum salmon would be adversely impacted by the continued trapping of bedload in Lake Mills. Historic pink and chum salmon habitat would continue to be inundated by Lake Mills, thereby preventing the full restoration of these fish. Consequently, the retention of Glines Canyon Dam would not result in the full restoration of the native anadromous fisheries of the Elwha River.

5. Living Marine Resources. Removal of Elwha Dam could cause some short-term impacts, depending on the sediment management scenario selected (see Section VI(C)). Further study is needed to determine those impacts and potential measures to mitigate those impacts. For the long-term, the removal of Elwha Dam would allow sediments produced in the Little River and Indian Creek to reach the Elwha River estuary and near-shore marine areas. However, these sediments would not be sufficient to fully restore the estuary or near-shore marine areas. The local marine environment would likely continue to be dominated by the plants and animals (e.g., kelp, rock crab, barnacles, and mussels) that require a hard and stable surface for attachment or are adapted to living in a rocky environment.

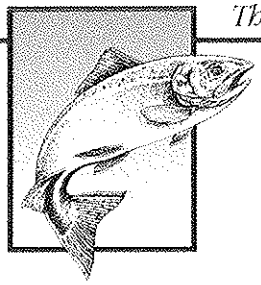
6. Vegetation. Long-term impacts to vegetation resulting from the removal of the Elwha Dam and the retention of the Glines Canyon Dam would include (1) the reclamation of about 268 acres currently inundated by Lake Aldwell, (2) the permanent loss of 0.09 acres of vegetation from construction activities at the Glines Canyon Project, (3) changes in vegetation composition and structure associated with wildlife mitigation on lands owned by James River, (4) reclamation of about 22 acres currently occupied by Elwha Project facilities, and (5) potential loss of wetlands associated with Lake Aldwell but which could be mitigated with the recovery of wetlands associated with the restored river.

7. Wildlife. The primary long-term wildlife impacts associated with the removal of the Elwha Project and retention of the Glines Canyon Project would include (1) the loss of the reservoir and restoration of about 290 acres currently occupied by Lake Aldwell (268 acres) and project facilities (22 acres), (2) permanent loss of 0.09 acres from new construction activities at the Glines Canyon Project, (3) improvements in habitat quality for wildlife on James River land adjacent to Lake Aldwell, and (4) partial restoration of salmon runs above Elwha Dam, if successful.

When compared to the retention of both dams alternative, the removal of Elwha Dam would result in a significant increase in fish biomass from carcasses, eggs and juvenile salmon, but it would be far less than that which would occur from the removal of both dams. Wildlife species along the upper reaches of the Elwha and tributaries would increase. However, lack of habitat (particularly spawning habitat for pink and chum salmon) along the middle and lower reaches would be limiting resulting in restricted effects on wildlife populations, although some increase would be expected.



Townsend's Chipmunk



8. Threatened and Endangered Species. Removal of the Elwha Project with retention of the Glines Canyon Project would have no adverse impacts on federally listed or proposed wildlife species. The primary impact on spotted owls would be the long-term potential increase in available habitat from the eventual restoration of a mixed conifer/deciduous forest in the area of Lake Aldwell, although the number of nesting pairs would not be expected to increase. The marbled murrelet could also benefit from the restoration of the Lake Aldwell area. However, the existing old growth in the area around the lake is not currently used by nesting murrelets because it apparently lacks the characteristics of this habitat found along higher elevation tributaries. Since removal of Elwha Dam would allow at least the partial restoration of chum salmon, some and possibly significant numbers of bald eagles could be attracted to the river during the spawning season. Unfortunately, the lack of perch trees close to the river could limit bald eagle use of the middle and lower river until large trees are established.

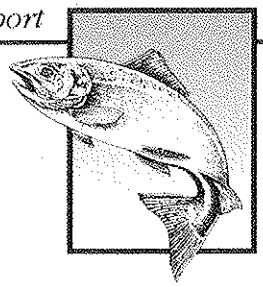
9. Recreation. During the salmon and steelhead rebuilding period (see Section VI.F), recreational fishing would be reduced through seasonal and limit restrictions. In the long-term, the partial restoration of anadromous fish runs and the greater river shoreline in the area of Lake Aldwell would benefit marine and freshwater anglers. There would, however, be a reduction in the quality of the resident trout fishery in the middle and upper river because of competition with anadromous fish and the loss of reservoir habitat in Lake Aldwell.

There would be a loss of Lake Aldwell reservoir boating opportunities, although there would also be 2.8 miles of additional free flowing river boating opportunities. Flat water boaters and anglers would be displaced and would probably turn to using Lake Mills, Lake Sutherland, and Lake Crescent for boating.

10. Power. With the loss of the 67 average GWh of power produced by the Elwha Project, the levelized cost of power to the Daishowa America Mill would increase to 46.9 mills/kWh under the Elwha Project removal alternative, an increase over the reference case estimate of 37.3 mills/kWh. The data necessary to estimate any loss of the mill's competitive position due to this increase are unavailable.

11. Tribal Social Effects. Harvest restrictions during the fish restoration period would adversely impact treaty fishermen. In the long-term, treaty fishermen would benefit somewhat from partial restoration, although not nearly as great as under the removal of both dams alternative. Because full restoration of the salmon runs cannot occur with the retention of Glines Canyon Dam, treaty fishermen would continue to experience severely restricted ceremonial, subsistence, and commercial fisheries. Shellfish habitat would remain degraded because most of the sediment produced in the Elwha would still be trapped in Lake Mills and prevented from reaching the reservation beaches.

Removal of Elwha Dam would allow the Tribe access to some of their traditional cultural properties, including their creation site. However, much of the river would remain inaccessible. Traditional locations for gathering plants, berries, bark, and



other cultural resources would remain inundated by Lake Mills. Use of the upper valley for spiritual cleansing and physical healing would not be possible.

12. Cultural Resources. Under this alternative, the National Register Elwha Dam would be demolished, and new construction associated with fish passage facilities would modify the Glines Canyon Dam, also on the National Register. National Register properties would be fully documented to Historic American Engineering Record standards. Archaeological sites buried under sediment within Lake Aldwell could be disturbed during removal of the dam and sediments. Further details of potential impacts to historical and cultural resources can be found in Section VI.L.

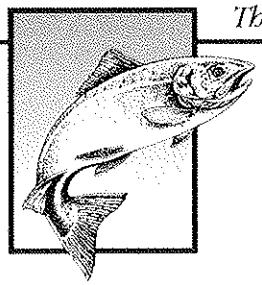
13. Other Effects. Effects on recreation and tourism would be positive, with associated opportunities for increased recreation and tourism related income. However, taxes paid by the project owner to Clallam County would decline to $180,000 annually (1990 dollars), compared with the current payment of $257,000 a year. No change in the frequency or severity of flooding is anticipated.

D. Retention of Both Dams

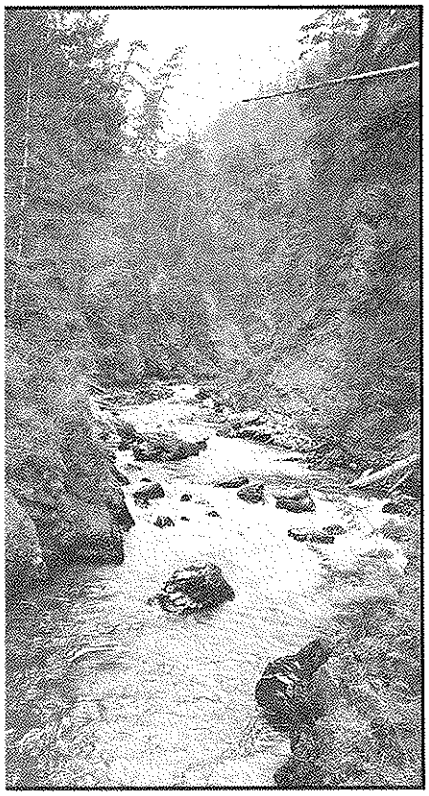
This section contains an evaluation of the potential for the full restoration of the ecosystem and native anadromous fisheries associated with the retention of the Elwha and Glines Canyon projects.

1. Restoration of the Ecosystem and Native Anadromous Fisheries. Restoration of the ecosystem and native anadromous fisheries depends on the restoration of vegetation, fish and wildlife habitats and populations, aquatic biology, nutrient cycling, and river hydrology and morphology in the Glines Canyon and Elwha Project areas to conditions approximate to those that existed prior to Project construction. Restoration of the areas inundated by the reservoirs is necessary to recover 715 acres of prime wildlife habitat that likely used to provide valuable cover, forage, and winter range for large mammals. The restoration of anadromous fish is also necessary to restore wildlife populations, aquatic biology, and nutrient cycling.

In addition to their recreational and commercial value, anadromous fish would provide significant numbers of carcasses, eggs, and juvenile fish that would be distributed throughout the watershed providing a source of prey for wildlife and nutrients needed to fuel the system's productive processes. Each species utilizes a different niche which results in peak production within the watershed. If the dams remain, restoration of salmon is favorable only for coho (restoration prospects are favorable for steelhead, but they do not die on the spawning grounds after spawning and their contribution to wildlife prey and nutrient cycling is not as great). Restoration of coho salmon would provide some ecosystem benefits but far below the potential of the system. Fish passage facilities do not allow the most abundant species, pink and chum salmon, to be restored. These species provide significant inputs of carcasses for prey and nutrients. As a result, this alternative provides only minimal benefits in terms of fish carcasses and nutrients and the ecosystem would remain largely impoverished. The ecosystem could not be restored.



2. Fluvial Processes and Conditions. This alternative would result in status quo conditions with regard to sediment transport. The Elwha River would continue to deposit all but the finest sediment in the Lake Mills and Lake Aldwell reservoirs. The Lake Mills delta would continue to grow, eventually filling the lake in 260-300 years. All boulders, cobbles, gravel, sand, about 20% of the silt supply, 1% of the clay supply, and some of the woody debris supplied from the middle reach of the Elwha River and tributary watersheds would continue to be trapped in Lake Aldwell. Most (80%) of the silt supply and almost all the clay would wash through the reservoirs downstream to the coastal area. As a result, the middle and much of the lower reach of the river would continue to be bedload starved, maintaining the current armored nature of the river.

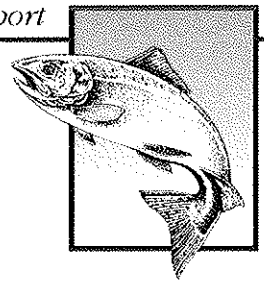


Elwha River from bridge on Long Ridge Trail, 1955. (Gunnar Fagerlund photo, Olympic National Park)

Delivery of reduced quantities of bedload (cobbles, gravel, and sand) to the Elwha delta and coastal zone would continue to aggravate the coastal erosion in the Angeles Point and Ediz Hook area. Supply of sediment from the Elwha River that would be available to the coastal littoral drift has been reduced from about 50,000 to 100,000 cubic yards per year (prior to dam construction) to between 4,000 and 6,000 cubic yards per year currently. This has affected coastal erosion by reducing the sediment supply that is potentially available to the coastal zone by 45,000 to 95,000 cubic yards per year. The balance of the coastal zone sediment supply comes from erosion of the coastal bluffs between the Elwha River and Ediz Hook (estimated at 40,000 cubic yards per year). Between 1977 and 1985, 145,400 cubic yards of beach nourishment has been set along Ediz Hook to protect the armor rock placed for the protection of Ediz Hook (Galster 1989).

3. Water Quantity and Quality. With run-of-the-river operations for both the Elwha and Glines Canyon projects, discharge would nearly approximate natural flow conditions. With retention of the Projects, flow augmentation would allow river flows in the middle and lower river reaches to be supplemented during critical low flow periods, although the amount and duration are limited by the available storage in Lake Mills.

With the retention of both dams, elevated water temperatures in the middle and lower reaches will continue. Lake Mills and, to a lesser extent, Lake Aldwell tend to increase temperatures during the summer due to their relatively large surface area and their long hydraulic residence times. Lake Mills has a flushing time of 32 days with a 500 cfs inflow. Warming of the lower river is most pronounced in late summer and early fall caused by storage of heat in Lake Mills and Lake Aldwell during early and mid-summer. As a result of the combined warming of the river by the two reservoirs, water temperatures in the lower reach of the river are elevated about 2° C in July and August, and 3 to 4° C in September and October (James River II, Inc. 1989). Lake Mills is responsible for most of this warming due to its relatively high volume. The river warming coincides with the annual low flow period in the Elwha River and is greatest in early October. Effects of reservoir warming on the lower reach during the remainder of the year are insignificant.



The two reservoirs trap a large portion of the sediments transported by the Elwha River from the watershed above Lake Mills and from between the Projects. Consequently, retention of the projects would continue the artificial enhancement of water clarity downstream of Elwha Dam.

4. Fisheries and Other Freshwater Aquatic Communities. Over the long-term, there would be fair prospects for restoring winter and summer runs of steelhead and coho salmon, poor prospects for restoring fall and spring races of chinook salmon, poor to no chance of restoring pink, chum and sockeye salmon, and unknown prospects for restoring sea-run cutthroat trout and native char (Table 1). The principal constraints to restoration under this alternative are passage related mortalities resulting from (1) residualism[1] in the reservoirs; (2) predation in the reservoirs and at locations where fish are concentrated and disoriented such as tailraces, fish screen facilities and bypasses, spillways, and fish ladders; (3) passage over spillways, past screen facilities, and through turbines; and (4) delayed effects[2]. Significant prespawning mortalities, particularly for chinook salmon, associated with elevated water temperatures impact natural production. Natural production is also limited by the inundation of 5.3 miles of riverine spawning and rearing habitat and the armoring of the river channel resulting from the trapping of spawning gravels in the reservoirs. Resident trout and char populations in the middle and upper river are expected to decline to some extent due to competition with the partial reintroduction of some anadromous fish stocks.

a. Chinook Salmon. Residualism and predation in Lake Mills and Lake Aldwell, upstream and downstream passage losses at both dams, poor spawning and rearing habitat in the middle and lower river, and disease from elevated water temperatures in the middle and lower river each contribute to the questionable restoration potential for chinook salmon if the dams remain. Studies of juvenile chinook planted in the Elwha River above Lake Mills indicate a high rate of loss of these fish in the reservoirs, probably as a result of predation and residualism.

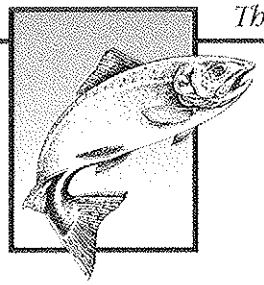
In addition, about 10% of juvenile chinook descend through the reservoir and enter the Glines Canyon turbine intakes located 60 feet below the surface. Of these fish, 60% are killed. Additional fish are lost at the Glines Canyon spillway and at Elwha Dam.

In years of low snow pack in the Olympic Mountains, chinook returning to the Elwha River frequently encounter high water temperatures. These high temperatures are a result of low stream flows, warm air temperatures, and reservoir heating. In 1992, over 60% of the adult chinook salmon that returned to the river died prior to spawning as a result of disease (e.g., *Dermocystidium salmonis* and *Ichthyophthirius*), which is exacerbated by high water temperatures. Juvenile chinook at the WDF Rearing Channel on the Elwha River are also affected by these diseases.

Upstream passage of adult chinook salmon through a ladder and/or trap-and-haul facility would also exact a significant toll. This loss would be particularly severe on spring chinook which are vulnerable to handling stress following their entry into fresh

[1]Residualism refers to the loss of downstream migratory behavior, and can occur when downstream migration is protracted to such an extent that the fish lose the urge to migrate. Slow-moving reservoir water, as opposed to fast-flowing river water, increases the length of downstream migration, so can increase residualism.

[2]Delayed mortality may be caused by increased disease occurrence resulting from the loss of scales or other injuries during passage over spillways, through turbines, or past fish screens.



water. Since the Projects are located close to the river mouth, spring chinook in the Elwha would be particularly vulnerable. Later returning races of summer/fall chinook would also be vulnerable to handling mortality, especially in years of high water temperatures which occur concurrently with the peak of chinook salmon returns to the river.

Elwha River chinook salmon were historically noted for their large size. Some fish were reported to have exceeded 100 pounds. Fish of this size have not been seen for decades in the Elwha River. The Elwha and Glines Canyon dams prevent the chinook from reaching the habitat and environmental conditions that produced these large fish. Hatchery practices may also limit the expression of this trait. Although the native genetic material that resulted in these fish is probably still present (Brannon and Hershberger 1984), the presence of the dams, even if fish passage is provided and restoration of chinook is successful, may not allow the large chinook to develop again.

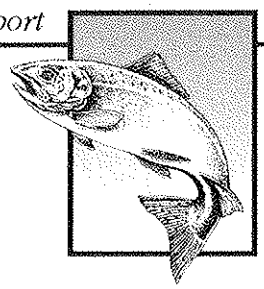
Elwha River chinook salmon were historically noted for their large size. Some fish were reported to have exceeded 100 pounds.

b. Coho Salmon. Coho salmon have higher prospects for restoration than chinook salmon because the juveniles do not experience the same amount of delay in the reservoirs (as long as spill is provided) and the adults, with their later return timing, are not subjected to the same high water temperatures as the chinook. However, the rate of mortality past each Project coupled with the poor habitat conditions in the middle and lower river add uncertainties to restoration of coho salmon if the dams are retained. As with chinook, losses of coho are associated with predation and residualism. In contrast to chinook, however, coho need smaller spawning substrate, which is limited in the middle reach, than do chinook salmon. The lower reach also has limited spawning substrate of the size necessary for coho salmon and the lower river lacks tributaries that are more typically used by coho in systems with chinook runs (Miller and Brannon 1981).

c. Steelhead. Prospects for restoring steelhead, if the dams remain, are better than chinook and comparable to coho salmon. In studies on the Elwha River, steelhead outmigrants tended to have the best survival of the anadromous fish examined. In particular, steelhead smolts tend to be large in size, thereby reducing predation. Also, disease is not known to be a problem for steelhead in the Elwha River.

Although juvenile steelhead may survive at a relatively high rate, steelhead kelts (adult fish that have spawned and are returning to the ocean) would likely suffer significant mortalities during passage past Elwha and Glines Canyon dams. Kelts are important because repeat spawners are generally larger in size so produce more eggs, and they provide an important genetic component to any stock. Repeat steelhead spawners account for about 5% of spawners in harvested stocks in Olympic Peninsula streams.

Although prospects for restoring self-perpetuating runs of steelhead are fair, passage and reservoir mortality plus the loss and degradation of habitat in the lower 16 miles of the river would reduce fishery benefits from this species. Meeting spawning needs would be the first priority for management. Project-related losses would have to be



subtracted from the numbers of fish available for harvest by treaty and nontreaty fishermen.

d. Pink Salmon. Passage survival would not be sufficient to restore pink salmon if the dams remain. Juvenile pink salmon emerge from the gravel at a very small size and begin moving downstream to the ocean almost immediately. These fish are so small that they do not have well-developed swimming ability and are swept along by the river's flow. During the period when they are moving downstream, they do not feed to any appreciable extent but rely on the nutrients remaining in their yolk sac (the egg from which they hatched). They must arrive in the estuary and marine areas at the right time in the spring when food of the appropriate size is in high availability. When they encounter a lake or reservoir, they become disoriented and many do not have the ability to swim through the impoundment. Most individuals die in the reservoir due to starvation, approach the estuary after food availability is past its peak, or arrive when competing species and predators have occupied the area. Retention of either dam would restrict these fish to the area downstream greatly reducing their productive potential and precluding them from contributing to natural ecological processes in the upper river.

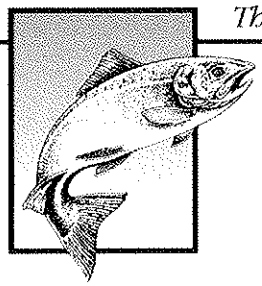
The Projects have also degraded the lower 16 miles of the river by inundation and trapping of gravel and large organic debris. The substrate of the river below both dams has become extremely coarse with very large boulders and cobble, most of which is not suitable for spawning. The lower 16 miles are suspected to have supported the great majority of the historic pink salmon run in the Elwha River system. The degraded condition of this area combined with high reservoir mortality virtually eliminates any chances of restoring this species if the dams are retained.

e. Chum Salmon. Chum salmon would not be restored with the retention of the Elwha and Glines Canyon projects for the same reasons as pink salmon.

f. Sockeye Salmon. Although adult sockeye salmon are observed in the Elwha River each year, a native stock of Elwha River sockeye probably does not exist. Historical accounts identify kokanee as being present in Lake Sutherland prior to the construction of Elwha Dam, but numerous plants of nonnative kokanee and other anadromous fish would have impacted any native stock. The lack of an identified donor stock of sockeye from another system limits restoration potential.

Current habitat conditions also limit the restoration potential for sockeye salmon in the Elwha River basin. Only limited tributary spawning habitat is available while the construction of homes around Lake Sutherland may have impacted shoreline spawning habitat. Fish mortalities during passage past Elwha Dam would also limit restoration prospects for this stock.

g. Sea-run Cutthroat Trout and Native Char. These species return to the ocean after spawning. Juvenile screen systems are not designed to pass adult salmonids increasing the likelihood of downstream passage mortalities. Also, because of their relatively small size, adult cutthroat trout would not be expected to traverse fish



ladders as easily as the larger salmon and steelhead. Continued inundation of important riverine habitat as well as the continued trapping of bedload in Lake Mills and Lake Aldwell contribute to the poor restoration potential.

h. Resident Fish. Resident trout consist of populations of rainbow and cutthroat trout and native char found principally in the middle and upper reaches of the river and tributaries. Resident spawning and rearing habitat in the middle river would continue to be limited by the large substrate size resulting from the trapping of bedload in Lake Mills. Also, competition with anadromous species in the middle and upper river would reduce the abundance of resident trout populations (Bjornn 1978, Wade et al. 1985). The lower river resident trout population would not be affected as it already competes with anadromous fish.

i. Stream Ecology. Overall, the ecology of the river would continue to be degraded with the retention of the Elwha and Glines Canyon projects because the dams and reservoirs would continue to control the middle and lower river. Although the productivity of the Elwha River would improve somewhat with the partial restoration of anadromous fish to the middle and upper river, bedload and nutrients would continue to be trapped in the two lakes and important terrestrial and riverine habitat would continue to be inundated. Natural stream ecology would not be restored.

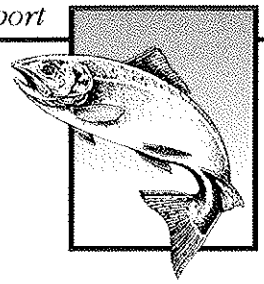
j. Shellfish. The existing population of shellfish in the estuary and nearby marine waters has been reduced by the steepening of beaches and loss of sands and gravels resulting from the trapping of sediments in Lake Mills and Lake Aldwell. With retention of the two dams, this will continue.



5. Living Marine Resources. No significant impacts would be anticipated under this alternative since the retention of both dams would continue to prevent sediments from reaching the Elwha River estuary and near-shore marine areas. The local marine environment would continue to be dominated by the plants and animals (e.g., kelp, rock crab, barnacles, and mussels) that require a hard and stable surface for attachment or are adapted to living in a rocky environment.

6. Vegetation. Retention of the Elwha and Glines Canyon dams would result in the continued loss of 416 acres inundated by Lake Mills and 268 acres inundated by Lake Aldwell. An additional 31 acres would continue to be lost to Project facilities. Vegetation composition could be modified on over 189 acres of land around Lake Aldwell for wildlife mitigation purposes.

7. Wildlife. With retention of the Projects, about 715 acres of wildlife habitat would remain inundated by Lake Mills and Lake Aldwell or occupied by associated project facilities. The inundated lands were probably prime wildlife habitat by providing valuable cover, forage, and winter range. Although about 189 acres around Lake Aldwell would be modified for the benefit of wildlife, the continued inundation of valuable lowland habitat by Lake Mills and Lake Aldwell and only the partial



restoration of native anadromous fisheries would prevent the full restoration of wildlife populations.

Partial restoration of some of the native anadromous fish stocks would supply eggs, juvenile fish, and carcasses to the Elwha River system, thereby providing a source of food and nutrients to wildlife. Any increased production would likely benefit species that consume live small fish, such as the belted kingfisher and common merganser. Adult salmon carcasses would benefit at least 22 species of birds and mammals (Cederholm et al. 1989).

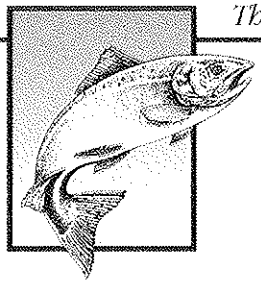
The benefits to wildlife from partial fish restoration would depend primarily on four factors: (1) the total number of fish returning to the river; (2) the retention of carcasses in the river and tributaries; (3) the location and timing of spawning; and (4) the length of time carcasses are available for food. Consequently, the extent of the beneficial effects to wildlife depends on the success of the fisheries restoration program.

With the partial restoration of some of the native anadromous fish runs, food for wildlife that consume carcasses would increase resulting in population gains, particularly along the upper reaches and tributaries of the Elwha where lack of food during the winter is probably the most limiting factor. Historically, coho carcasses were probably a significant source of winter food, and their restoration, if it succeeds with the dams in place, would be expected to benefit wildlife populations in these areas. Along the lower and middle reaches, wildlife populations would be less likely to respond to additional biomass provided by the partial restoration of chinook salmon, if it is successful with the dams in place, because (1) carcasses would only be available through the end of January so would not provide food in late winter when food would be most limited, (2) fewer carcasses are likely to be retained because of the large size and flow of the river in these areas, and (3) disturbance of habitat might be as or more limiting than food availability. Also, pink and chum salmon historically provided much more biomass to this area than did chinook salmon. Since retention of the two dams would not allow the restoration of pink and chum salmon, wildlife populations would not be restored along the middle and lower river.

. . . the extent of the beneficial effects to wildlife depends on the success of the fisheries restoration program.

8. Threatened and Endangered Species. Retention of both dams would have no effects on spotted owls since additional old growth areas would not be impacted. Marbled murrelets would not be impacted because use of the Elwha Valley by this species is confined to the tributaries and higher elevations. Although fish passage measures would partially restore some of the native anadromous fish runs, retention of the dams would not allow chum salmon, the principal food source for bald eagles wintering on Northwest rivers, to be restored. Consequently, significant numbers of bald eagles would not be attracted to the Elwha River. Continued inundation of over 5 miles of riverine habitat by Lake Mills and Lake Aldwell would further limit carcass availability and the establishment of roost trees.

9. Recreation. During the salmon and steelhead rebuilding period (see Section VI.F), recreational fishing would be reduced through seasonal and limit restrictions. Because of passage losses at each Project, long-term restrictions could also be



necessary for those fish stocks passed upstream of the dams. There would also be a reduction in the quality of the resident trout fishery in the upper river as a result of competition with anadromous fish.

The retention of both dams would continue to provide reservoir boating and fishing opportunities on Lake Mills and Lake Aldwell. It would also continue the loss of opportunities associated with 5.3 miles of free flowing river.

10. Power. The combined average annual energy output of the Projects would be about 160 gigawatt hours (GWh), about 5.0% less than status quo. The decrease would be associated with the nonpower releases required for fish passage and run-of-the-river operation at the Glines Canyon Project. If the full range of mitigation measures are included in the cost of generating power for the dam retention alternative, the levelized costs of power would likely exceed the cost of purchasing power through the local public utility.

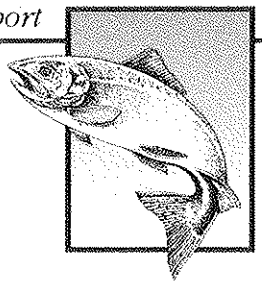
11. Tribal Social Effects. Because full restoration of the Elwha River salmon runs cannot occur with the retention of the dams, treaty fishermen would continue to suffer severely restricted ceremonial, subsistence, and commercial fisheries. The primary economic and cultural resource of the Elwha S'Klallam would remain unavailable. Sediment needed to maintain reservation beaches would remain trapped in the reservoirs leading to the continued erosion of reservation beaches. Shellfish habitat would remain degraded because of beach starvation. Further, retention of the dams would leave the S'Klallam creation site, and other sites of great cultural significance, inaccessible, thereby restricting the Tribe's religious practices. Traditional locations for gathering plants, berries, bark, and other cultural resources would remain inundated. Use of the river valley for spiritual cleansing and physical healing would not be possibile.

12. Cultural Resources. Under this alternative, the National Register Elwha and Glines Canyon dams would be retained. Archaeological and cultural sites would continue to be buried under sediment within each reservoir. A further discussion of historical and cultural resources can be found in Section VI.L.

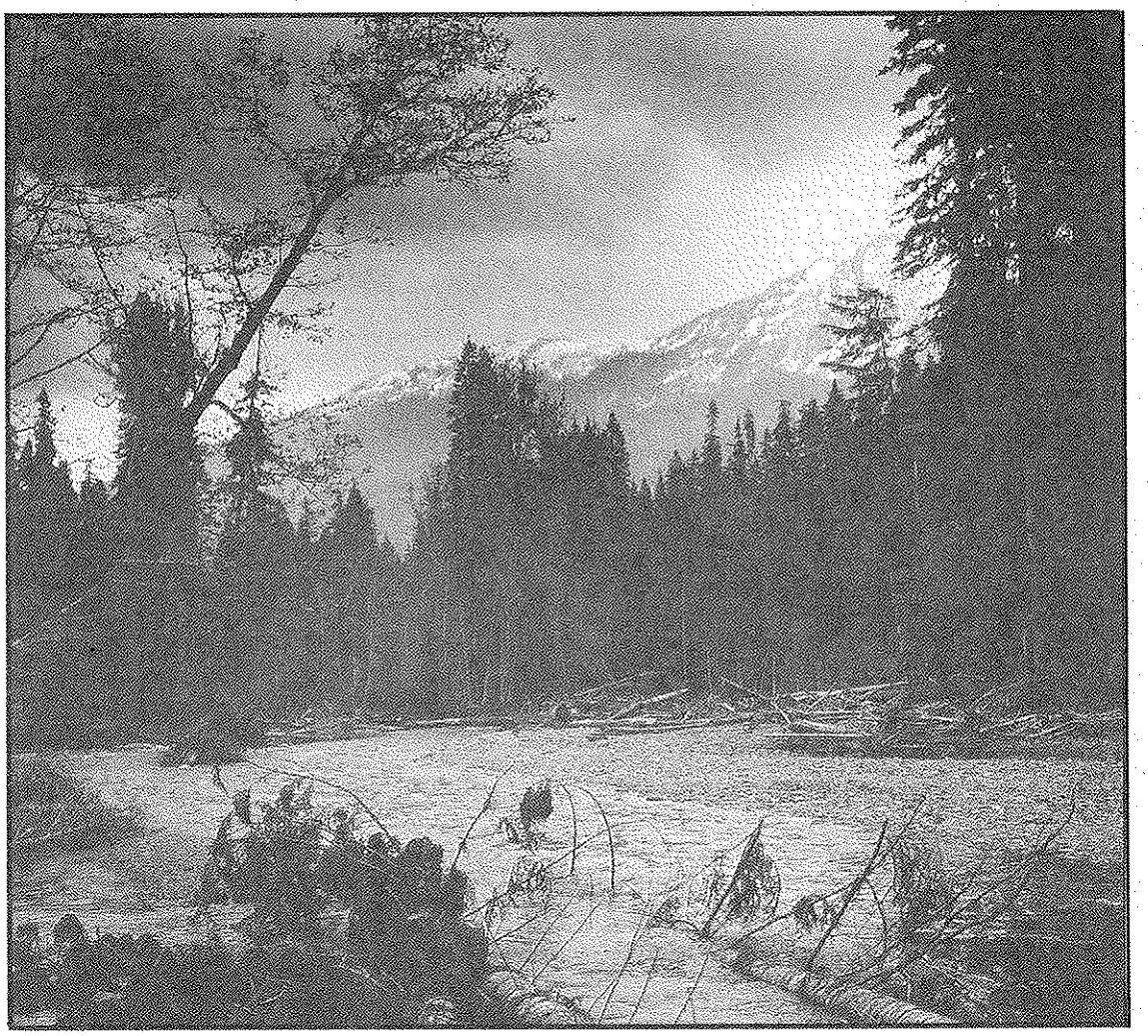
13. Other Effects. Overall effects on recreation and tourism would be at least slightly negative, with a corresponding negative effect on tourist and recreation-based income. In contrast, facility modifications would increase taxes paid by the Projects to Clallam County by about 78%, to $457,000 annually.

E. Summary of Consequences

The removal of the Elwha and Glines Canyon dams is the only alternative that would result in the "full restoration of the Elwha River ecosystem and native anadromous fisheries" (P.L. 102-495, Section 3(c)). Retention of either or both dams, even with the provision of fish passage facilities and other measures, would not allow for the full restoration of native anadromous fisheries such as chinook, pink, and chum salmon, among others (Table 1). In addition, retention of either or both dams would



prevent the restoration of natural sediment transport processes resulting in the continued degradation of the middle and lower river, estuary, and near coastal areas. Retention of either or both reservoirs would prevent the restoration of important bottom land wildlife habitat and riverine habitat for anadromous fish, as well as prevent full nutrient transport downstream impacting freshwater ecology and the organisms that are dependent thereon. The ecosystem cannot be restored with the retention of either or both dams (Table 3).



Elwha River - Island Camp, May 27, 1907. (Asahel Curtis photo, Washington State Historical Society)

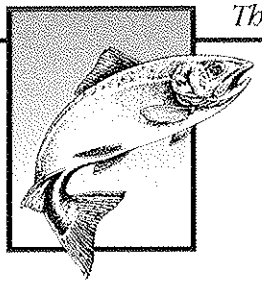
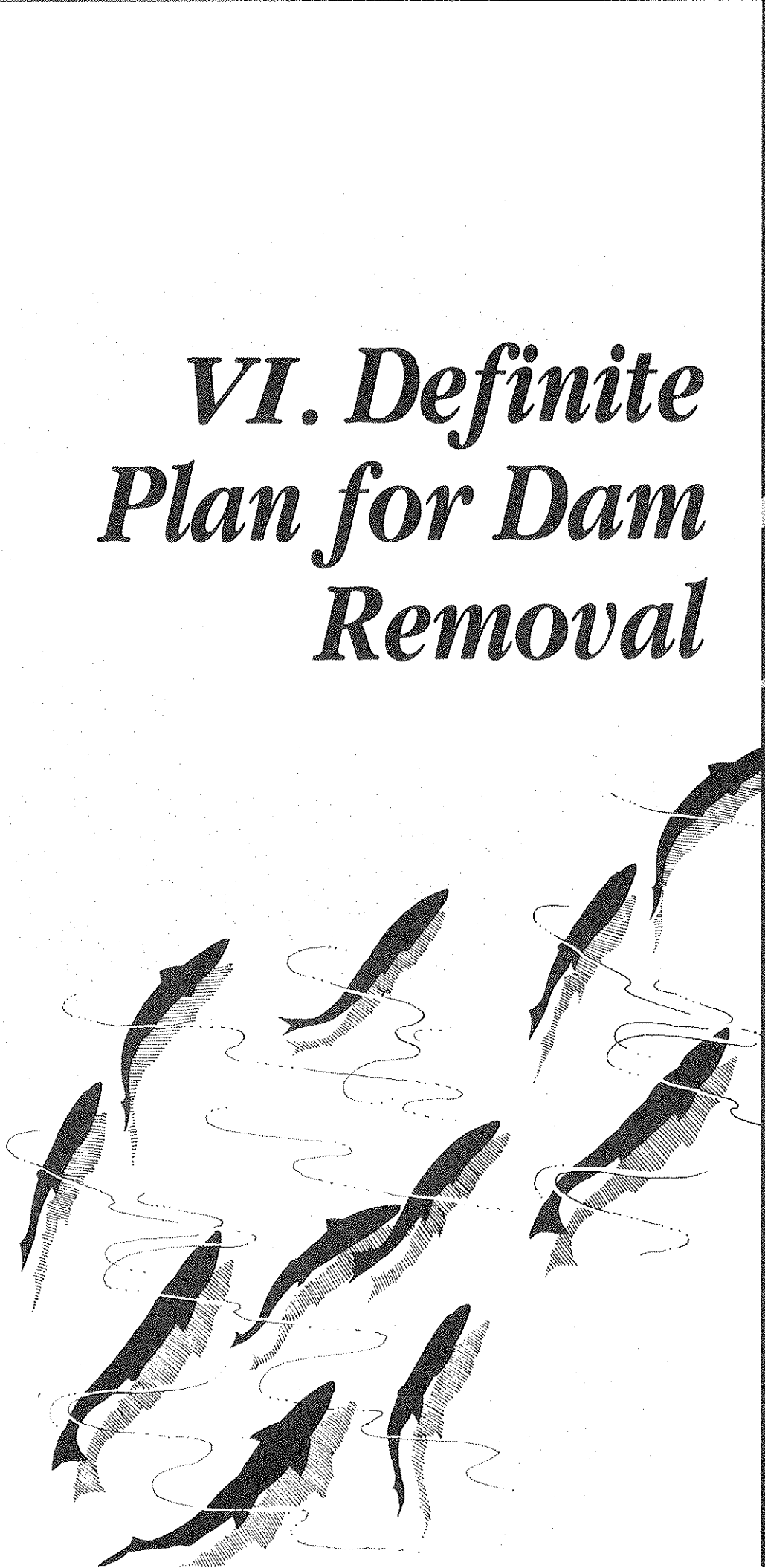
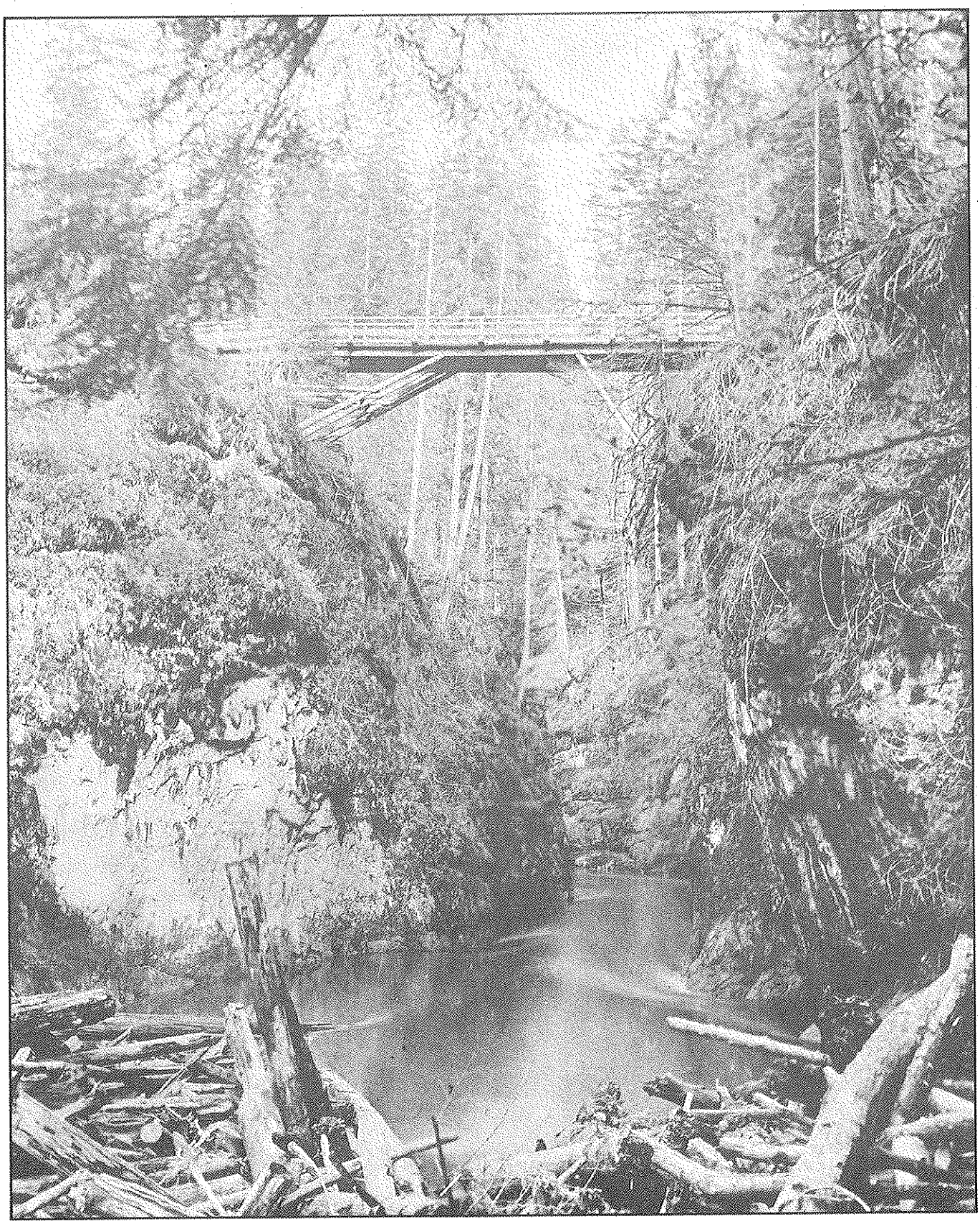


Table 3. *The long-term consequences of various restoration alternatives.*

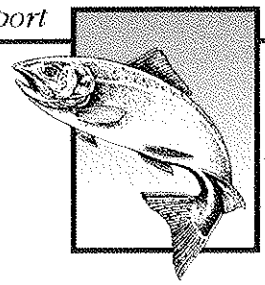
	Remove Both Dams	Remove Glines Dam	Remove Elwha Dam	Retain Both Dams
Restore Ecosystem	Can be accomplished	Cannot be accomplished	Cannot be accomplished	Cannot be accomplished
Fluvial Processes	Recovery of river and near-shore habitat	No notable improvement over status quo	No notable impovement over status quo	Status quo loss of river and near-shore habitat
Water Quality	Erase lake warming, increased turbidities	Beneficial reduction in water temps	Beneficial reduction in water temps	Status quo water quality
Anadromous Fisheries	See Table 1	See Table 1	See Table 1	See Table 1
Living Marine Resources	Near-shore shift back to sandy bottom species	Status quo maintenance of rocky substrate species	Status quo maintenance of rocky subtrate species	Status quo maintenance of rocky susbtrate species
Vegetation	Recover 715 acres	Reover 425 acres	Recover 290 acres	Status quo loss of 715 acres
Wildlife	Wildlife can be fully restored	Wildlife cannot be fully restored	Wildlife cannot be fully restored	Wildlife cannot be fully restored
Threatened and Endangered Species	Increase in bald eagles	Continued impacts to bald eagles	Potential increase in bald eagles	Continued impacts to bald eagles
Recreation	Loss of both lakes, recover 5.3 miles of river	Loss of Lake Mills, recover 2.5 miles of river	Loss of Lake Aldwell, recover 2.8 miles of river	Retain both lakes, status quo loss of 5.3 miles of river
Power	Loss of 18.7 average MW	Loss of 11.1 average MW	Loss of 7.6 average MW	Retain 18.7 average MW
Cultural Resources	Loss of both dams, potential recovery of cultural sites	Loss of Glines Dam, inundation of important sites	Loss of Elwha Dam, potential recovery of some sites	Status quo inundation of cultural sites and resources

VI. Definite Plan for Dam Removal





Canyon site where Elwha Dam was built, 1910. (Olympic National Park photo)



VI. Definite Plan for Dam Removal

Public Law 102-495 directed the Secretary of the Interior to include in his report a "definite plan" for removal of the Elwha and Glines Canyon dams. Removal of the dams would constitute a major Federal action, thereby requiring compliance with the National Environmental Policy Act (NEPA). The Secretary's report demonstrates that dam removal is feasible and is necessary for the full restoration of the ecosystem and native anadromous fisheries. The report describes plans consisting of four options for removal of the dams, nine scenarios for managing the accumulated sediments, and a process for analysis of these alternatives consistent with full restoration of the ecosystem and native anadromous fisheries. A preferred alternative would be selected during the Environmental Impact Statement/advanced planning stage, to be initiated following submission of the report to Congress.

The Secretary's report demonstrates that dam removal is feasible and is necessary for the full restoration of the ecosystem and native anadromous fisheries.

A. Precise Terms of Acquisition

Public Law 102-495 authorizes the Secretary to acquire the Elwha and Glines Canyon Projects, together with all rights of the owner and local industrial consumer therein, under specific terms and conditions set forth in P.L. 102-495. In addition, Section 3(c)(1) of P.L. 102-495 requires that the Secretary's Report contain the precise terms of acquisition of the Projects. To the extent not superseded by or inconsistent with P.L. 102-495, the precise terms of acquisition will be in accordance with existing Federal law and agency procedures for property acquisitions.

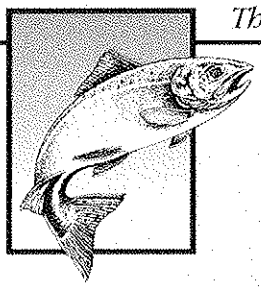
1. Preacquisition Work.

a. Title Evidence. Procurement of title evidence and title insurance with respect to all Project lands will be obtained in accordance with the revised Department of Justice Title Standards. The U.S. Department of the Interior will issue title opinions and review for possible title defects and encumbrances.

b. Appraisals. Inasmuch as P.L. 102-495 fixes the amount of consideration to be paid to the owner and local industrial consumer for the Projects as $29.5 million and no more, the need for a fair market value appraisal and offer is superseded by the legislated compensation.

c. Environmental Survey. The U.S. will perform a "Level II Contaminant Survey" to investigate for the potential presence of hazardous materials and the appropriate remediation measures to be taken, if any (see Section VI. B.1.).

d. Assets to be Acquired. The assets to be acquired include the Elwha and Glines Canyon Projects. Assets include the dam structures and related machinery and equipment, the Project lands, personal property located on the Project sites and used in connection with the dams, the transmission facilities running from the Projects, all fanchises, easements and rights-of-way associated with said transmission facilities, and various contract rights, permits, and entitlements associated therewith. A detailed property inventory will be prepared by the parties indicating all property to be



conveyed and any equipment or materials to be removed prior to conveyance. Negotiation with the appropriate parties concerning the various contract rights, permits and authorizations will be needed to ensure that the United States does not take on liabilities for unspecified and/or open-ended obigations.

2. Acquisition Terms.

a. Consideration. Section 3(b) of P.L. 102-495 provides that the Secretary shall pay to the owner and local industrial consumer at the time of acquisition the sum of $29.5 million and no more. The consideration will be allocated between the owner and local industrial consumer as they shall determine by agreement.

b. Conveyance. An escrow shall be established with a title or escrow company acceptable to the parties to handle the exchange of funds and documents. The owner and local industrial consumer shall convey title and all other rights and interests they may have in the Projects to the Secretary by appropriate deeds and assignment documents.

c. Timber Rights and Resolution. It has recently been discovered through preliminary title review that preceding grantors of most of the Project lands reserved timber rights over approximately 85% of the Project lands. The status of these reserved interests is presently being investigated, as acquisition of Project lands and appurtenant interests without these timber rights could significantly impact the river restoration effort. The Project owner believes that these reservations can be legally extinguished through quiet title proceedings. The Project owner has indicated a willingness to extinguish the timber reservations prior to federal acquisition, but has not indicated that it will institute a quiet title action or that these rights will be extinguished prior to Federal acquisition. If Federal acquisition proceeds before the reserved interests are extinguished, it is likely that the Federal government will need to condemn the reserved interests to fulfill the purposes of P.L. 102-495.

d. Transaction Costs and Relocation Benefits. Under the Uniform Relocation and Land Acquisition Policies Act, P.L. 91-646 (42 U.S.C. 4601 et seq.) as amended, the Secretary may be obligated to pay or reimburse the owner and local industrial consumer for certain costs associated with the acquisition. Such costs could include recording fees, transfer taxes, a pro rata portion of real estate taxes subsequent to conveyance, moving costs and similar expenses attributable to the acquisition. P.L. 102-495 may supercede certain or all of these benefits to the Project owner. Regardless of the applicability to the Project owner, it is likely that some third party lessees and permitees residing or doing business on the Project lands will be eligible for such benefits.

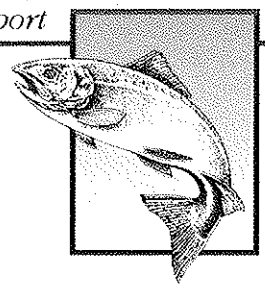
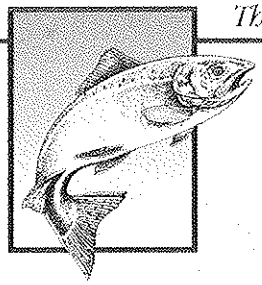


Table 4. *Estimated possible costs associated with Project acquisition.*

	Action	Cost
1.	Acquisition of the Projects (legislated by P.L. 102-495)	$29.5 million
2.	Timber Rights*	$0 to $4 million
3.	Title Insurance & Escrow	$24,000 to $46,000
4.	Level II Contaminant Survey (possible additional costs if a Level III survey is indicated)	$25,000
5.	Settlement of Existing Land Contracts Associated with the Projects (includes assumption of annual fees and possible site restoration costs related to various company contracts)	$31,000 one-time possible payment and $60,000 to $200,000/yr. dependent on continuation of dams and contract facilities (eg. powerlines)
6.	Relocation Act Benefits Under P.L. 91-646 as Amended (Lower estimate contemplates payment only to applicable third parties. Higher estimate reflects maximum payments to third parties *and* the companies *if* determined eligible.)	$115,000 to $1,240,000
7.	Property Conversion Tax** (paid to counties when forest/open space tax classification lands are converted or sold for other purposes)	$0 to $1 million (reflects 7 yrs. of highest and best use assessment recovery by county)
8.	a. Payment in Lieu of Taxes (31 U.S.C. 6901-6907; made to counties to offset tax base loss in National Park Service acquisitions)	$260,000 to $295,000 annually for five years following acquisition
	- or -	
	b. Refuge Revenue Sharing (made to counties to offset tax base loss in Fish & Wildlife Service acquisitions)	$195,000 annually in perpetuity

* Cost is based on timber value should Federal condemnation of timber interests be necessary.

** Cost may not be applicable if the forest/open space tax classification for the Project lands can be maintained.



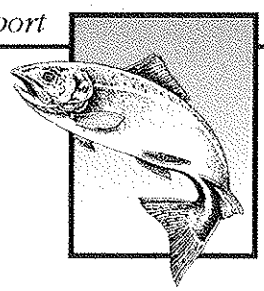
B. Responsibilities and Liabilities

Section 3(c)(1) of P.L. 102-495 specifies that the Report contain a description of "potential liabilities and benefits, if any, to the Federal Government resulting from the acquisition and all other actions authorized under this Act." Responsibilities and liabilities associated with or resulting from the acquisition of the Projects may include the following:

1. Elwha Channel Agreement (James River/Daishowa with Washington Department of Fisheries).
2. Elwha Resort Lease Agreement (Daishowa/James River with Cargo and Barber).
3. Electric Power Credit Agreement (Daishowa with Port Angeles City Light).
4. Water right permits and certificates (James River with Washington Department of Ecology).
5. Timber right acquisition.
6. Property conversion tax.
7. Transmission line easement (James River with Bonneville Power Administration).
8. Driveway and signage easement for recreational vehicle park (James River with J. D. White).
9. Removal of poles and lines from Glines Canyon and Elwha Project transmission corridor (multiple easements).
10. Joint maintenance of transmission line (James River with Public Utility District).
11. Cleanup of contaminants, if any.
12. Operation and maintenance of the projects during the period between their acquisition and removal.
13. Increased flood potential.
14. Water quality mitigation.
15. Uniform Relocation Assistance and Land Acquisition Policies Act implications, P.L. 91-646, as amended.
16. Refuge Revenue Sharing Act and/or Payment In-Lieu of Taxes (PILOT) implications.
17. Permits for removal (e.g., Department of the Army Section 404).

This list will be further evaluated to determine which liabilities or obligations, if any, are appropriate for the Federal Government to assume.

1. Contaminants. The U.S. Fish and Wildlife Service conducted a Level I preacquisition environmental contaminants survey of the Elwha and Glines Canyon Project lands. As a result of the initial survey, a "Level II" survey has been recommended to determine the potential clean-up costs associated with (1) a former service station (underground tanks), (2) piping with asbestos insulation, and (3) a few localized areas with soils contaminated with petroleum hydrocarbons, and potentially polychlorinated biphenyls (PCB's). Although data provided by the project owner indicated that the project transformers are currently free of PCB's, additional testing is necessary to satisfy the Federal government's preacquisition requirements. Confirmation of the presence of significant levels of PCB's or petroleum hydrocarbons



could necessitate the development of a "Level III" survey to determine the full extent of the contamination and appropriate remediation.

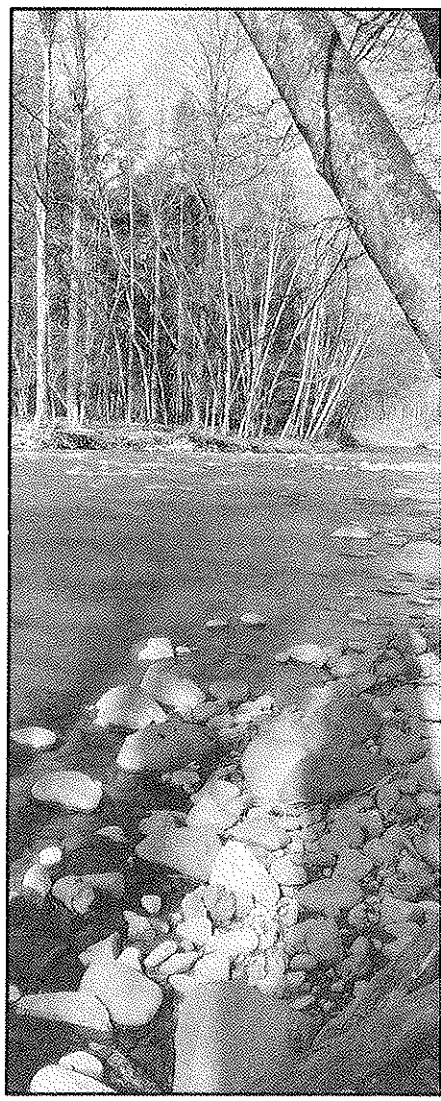
2. Dam Safety. There is no indication that any safety problems are likely to occur at either facility in the short-term (3-5 years). However, given the age of both structures, it is possible that safety of dams work may be needed over a longer time span (more than 5 years).

The Federal Energy Regulatory Commission (FERC) has issued annual licenses for the Glines Canyon Project since 1976. Accordingly, FERC inspects the project annually. In addition, FERC requires the project owner (currently James River Paper) to have an Independent Safety Consultant conduct a comprehensive study of the project every 5 years (the resulting study report is classified by FERC as a Part 12 Report). FERC policies require the owner to have any deficiencies identified by the Part 12 Report corrected within 5 years (before the next study). Major safety of dams work was conducted on Glines Canyon Dam as a result of the 1987 Part 12 Report. The gravity sections of the dam were post-tensioned with construction completed in 1989. These modifications were in response to concerns about the stability of the dam if overtopped during a Probable Maximum Flood (PMF). The last Part 12 Study of Glines Canyon Dam was conducted in March of 1992. Although the resulting report is still under review, FERC has informally indicated that there are no outstanding safety of dams deficiencies.

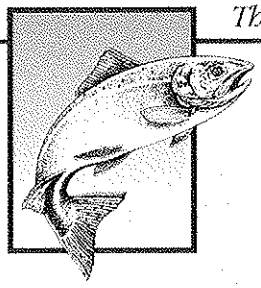
Crown Zellerbach Corporation (former owner of the Elwha and Glines Canyon projects) applied for a Federal Power Commission License in 1968 for the Elwha Hydroelectric Project. This application is still pending. Since the Elwha Project is not a licensed project, it has not been subject to Part 12 Studies. However, the Seattle District of the U.S. Army Corps of Engineers (Corps) has inspected Elwha Dam under the authority of the National Dam Safety Inspection Act (Public Law 92-367). The Corps' August 1978 inspection report raised concerns over the stability of Elwha Dam in the event it is overtopped by a PMF. The dam owner completed post-tensioning modifications to the dam in 1986. The Washington State Department of Ecology's Office of Dam Safety and FERC were involved with overseeing this work.

The Washington State Department of Ecology Office of Dam Safety indicated that the two dams currently meet State safety standards. Also, FERC-approved emergency action plans are in place for both dams and would be maintained. Dam safety aspects of dam removal are addressed in Appendix F.

3. Elwha Channel Agreement. The Project owner has entered into an agreement with the State of Washington Department of Fisheries pursuant to which it has agreed to contribute annually a portion of the operating costs of a salmon-rearing channel developed by the Department on the Elwha River. This agreement is terminable at the option of the Project owner if the Elwha Project is acquired by the federal government; however, the Secretary may negotiate with the State to keep this arrangement in effect or may make other accommodations.



Winter on the Elwha, near Elwha Ranger Station. (Janis Burger)



4. Other Liabilities. Obligations and liabilities related to dam removal and sediment stabilization can be found in Section VI.C. Water supply protection costs can be found in Section VI.E. Fish restoration costs are located in Section VI.F while habitat restoration costs are provided in Section VI.H. Additional costs are associated with the disposal of project lands (Section VI.I), interpretation of dam removal (Section VI.J), studies documenting restoration of the ecosystem and native anadromous fisheries (Section VI.K), and mitigating impacts to cultural properties (Section VI.L). An analysis of impacts to regional power can be found in Section VI.M. A discussion of the operation and maintenance of the Projects following acquisition but prior to removal is located in Appendix F.

C. Dam Removal and Sediment Management

The following section deals with the two major construction tasks in restoring the Elwha River. First, the structures that block the path of the river must be removed, and the river must be diverted during the removal. Second, a new river channel must be created in the lakebed where large quantities of sediments have accumulated. The first task is discussed under DAM REMOVAL AND RIVER DIVERSION ALTERNATIVES (1) and refers to completely removing the dam structures. The second task is discussed under SEDIMENT MANAGEMENT ALTERNATIVES (2) and refers to removing, stabilizing or relocating material that has accumulated in the reservoirs since dam construction. Requirements of downriver water users and revegetation of the reservoir areas are discussed in Section VI.E and VI.H, respectively.

Dam Removal and Sediment Management are considered independently. Dam removal involves creating an alternate path for the river thereby removing the water pressure on the dam structures. The dam structures could then be removed. Sediment Management involves establishing locations and methods for moving and storing sediments and creating a new path for the river after the dams have been removed.

1. Dam Removal and River Diversion Alternatives. Four plans for diverting the river and demolishing the dam structures were investigated.

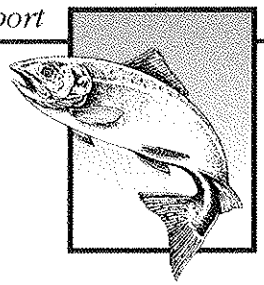
a. **PLAN 1 - Diversion Tunnel.** The river is diverted around the dams in tunnels.

b. **PLAN 2 - Surface Diversion Channel.** The river is diverted around the dams in a surface channel.

c. **PLAN 3 - Low Level Diversion through the Dam Structure.** The river is diverted through the dam structure.

d. **PLAN 4 - Notch through Dam, Top Down Removal.** The river is diverted over the dam by creating a notch through the structure.

Each of the identified plans and associated cost estimates is compared in the following sections. Each option allows control of the reservoir levels during the Sediment Management process.



Design criteria used for these investigations include two principal features: (1) the capability of river diversion during removal and (2) structural stability of the dam if overtopped during a flood event. All 4 plans meet both criteria.

The demolition plan must provide for the capability to safely pass a flood without endangering the workers or the dam structure. Ideally, any diversion facility would be able to divert a peak flow that might occur during the removal process. However, because of the disproportionately increasing cost associated with diverting the maximum potential flow, a smaller flow for the design capacity of the diversion facility was assumed.

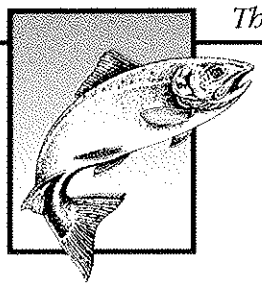
Average daily flows for the river at the McDonald gauge station were computed to be approximately 1,500 cfs. Average daily flows exceeding 5,000 cfs would occur only for short periods of time (about 10% of the time) during the removal process. Based on these considerations, 5,000 cfs was chosen as the design criterion for diversion flow. Handling the larger flows could be accomplished by storage or by ensuring that the flood waters overtop the intact dam and that partially demolished dam sections be structurally stable if overtopped.

a. PLAN 1 - Diversion Tunnel: Diversion tunnels could be used to divert the river away from the dam demolition site allowing removal activities to be conducted under dry conditions. The primary advantage tunnel construction would offer is better control of reservoir levels. The primary disadvantage would be higher associated construction cost. Diversion tunnel options were investigated and would be feasible at both dam sites. However, the specific geology of these sites has not been investigated and assumptions were made in the assessment of feasibility.

Glines Canyon Dam. For this alternative, the diversion tunnel is assumed to be constructed in the west abutment (Appendix F, Figure F-3). The tunnel inlet would be located near the existing power tunnel intake and would exit into the river about 100 feet downstream of the powerhouse.

The diversion tunnel would be approximately 800 feet long and would have a concrete-lined inside diameter of 13 feet. The principal elements of the diversion tunnel are the lake tap, gate shaft with bonnetted gate, the tunnel, and energy dissipating structure. The lake tap would provide for a surface-level inlet, to help minimize turbidity of diverted flows. The bonnetted roller gate would provide for control of discharges through the tunnel. The energy dissipation structure would prevent outlet discharges from scouring the river bank. After completion of the diversion tunnel, reservoir levels would be lowered and river flow would bypass the dam demolition work area.

Elwha Dam. For this plan, the diversion tunnel would be constructed in the south abutment because access for excavating the tunnel is more practical from the south side. Additionally, the south side abutment area appears to be more desirable for excavating the intake portal (lake tap) in rock (Appendix F, Figure F-4).
The first stage of construction would use the north spillway to regulate river flows and



control the reservoir pool level between normal maximum pool elevation (El.) 195 mean sea level (msl) and El. 180. When the diversion tunnel has been completed, it would be used to control reservoir elevations below El. 180 to streambed (approximately El. 105).

The tunnel inlet would be located upstream of the fill material behind the concrete gravity structure and would exit a point about 250 feet downstream of the dam. An additional 220-foot pipe extension would convey the water beyond the downstream cofferdam.

The diversion tunnel would be approximately 900-feet long and would have a concrete-lined inside diameter of 13 feet. The principal elements of the diversion tunnel are the lake tap, gate shaft with bonnetted gate, the tunnel itself, and energy dissipating structure.

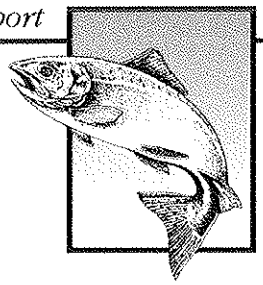
b. PLAN 2 - Surface Diversion Channel: A surface diversion channel would allow river flow to pass around the side of the dam structures. Reservoir water elevations would be controlled by diversion channel elevations. Water pressure on the back of the dam would remain as the dam is removed in the dry from the top down. The major advantage to this approach would be the potential for reduced construction cost when compared to the tunnel approach. A disadvantage would be loss of the ability to raise reservoir levels.

Glines Canyon Dam. Creating a river surface diversion at Glines Canyon Dam, which would be used in conjunction with the existing power tunnel, was investigated. However, difficulty with construction staging and cost make this approach infeasible. A preliminary estimate indicates the diversion channel would likely cost between $40 and $90 million, depending on diversion capacity and the extent of rock excavation.

Elwha Dam. This plan incorporates three stages. The first stage would lower the reservoir by about 14 feet below normal pool to permit construction of second-stage diversion facilities. During first stage diversion, water would pass through the powerplants and the south spillway. Flow rate and reservoir level would be controlled through the operation of the power plant and five spillway gates. No structural modifications are necessary.

When the reservoir has been lowered to about El. 185, the cofferdam would be constructed. At this pool elevation, water would pass only through the south spillway. With reservoir inflow passing through the south spillway, the second-stage diversion would permit dismantling the north spillway gates, demolition and removal of the north spillway concrete crest structure down to rock, and excavation of much of the diversion channel. Third-stage diversion would include removal of the remaining cofferdams and returning the river to its natural channel.

c. PLAN 3 - Low Level Diversion through Dam Structure: The low level concept would allow water to pass through the dams near the bottom of the structures, rather



than allow it to pass over or around them. Glines Canyon Dam was constructed with a small outlet containing a valve near the bottom of the structure. This valve has not been used in a long time and is considered nonfunctional.

The volume of earth fill material deposited upstream of Elwha Dam precludes construction of a low level outlet structure through the dam embankment. However, the concrete arch design of Glines Canyon Dam makes enlargement of the existing low level outlet works feasible. Plan 3 is comprised of three diversion stages, with the low-level outlet as the primary diversion stage.

The first stage would use the existing powerhouse to regulate flow until the low-level outlet enlargement was completed. The second stage would enlarge the existing low-level outlet to permit lowering of the reservoir to about El. 460. The final stage of diversion, which would permit lowering of Lake Mills to streambed, uses gated notches through the remaining portion of the structure in a progressive stepped approach.

Construction of an enlarged hole through the dam would alter stress concentrations in the structure. A computer analysis (finite element method) was conducted which concluded that a 10-foot-diameter conduit constructed through the arch dam would not overstress the concrete or cause a rupture of the structure.

d. PLAN 4 - Notch through Dam - Top Down Removal: The "notched" approach creates notches in the dam structure from the top down and allows water to pass through a gated notch in the dam structure, allowing reservoir level to be lowered. After lowering reservoir levels, portions of the structure above the reservoir water level would be demolished and removed.

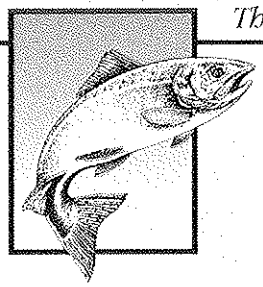
The major advantage to this approach would be a potential cost savings when compared to the tunnel diversion approach. Plan 4 is feasible only at Glines Canyon Dam. Earth fill behind the concrete structure at Elwha Dam precludes notching.

Plan 4 is comprised of four stages, with a series of notches through the concrete arch as the primary stage. The first stage would use the existing west spillway to regulate flow through its gated spillway down to El. 575. This stage would be used until the power tunnel has been appropriately modified. The second stage, allowing the river to flow through the power tunnel, would permit lowering the reservoir to about El. 515. Below El. 515 to streambed, diversion notches through the dam structure under stage 3 would be used. The fourth stage would occur after the river was restored to its final channel elevation. During this stage, all remaining debris from the dams would be removed.

A stability analysis of the dam structure was performed. In the analysis a 25,000-cfs flood was assumed to flow through a 17-foot-wide by 25-foot-deep notch, with 15 feet of surcharge over the dam crest. For this analysis, flow through the power tunnel was ignored. Analysis shows that in this worst case loading scenario, the structure would not fail from hydrostatic loading, nor from the pressure induced by the flowing water.



Glines Canyon Dam Spillway



e. Cost Comparison of Alternative Diversion Plans: While cost comparisons of the Dam Removal alternatives are an important consideration in selecting the preferred alternative, other qualitative features relating to performance and flexibility must also be considered to provide a fair comparison. These include (1) the degree of outlet flow regulation to control reservoir pool levels, (2) the degree of turbidity control through the outlet to maintain water quality suitable for fisheries and water supplies, and (3) the adequacy of diversion capacity during the flood season, which is necessary to maintain high production rates in reservoir dredging.
The diversion features as described in this report not only facilitate dam demolition and removal work but also permit effective dredging and other mechanical methods for removal of reservoir sediments to be performed through controlling the pool levels of the reservoirs.

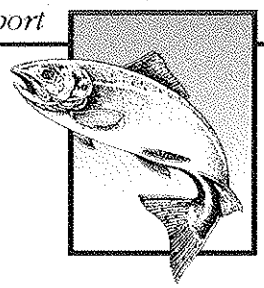
Comparisons of estimated construction costs are presented below for the three Glines Canyon Dam diversion plans and for the two plans developed for Elwha Dam.

	Cost* Glines Canyon $million	Cost* Elwha $million
Plan 1 - Diversion Tunnel	12.37	14.53
Plan 2 - Surface Diversion Channel	-------	8.59
Plan 3 - Low Level Diversion	8.44	-------
Plan 4 - Notch Through Dam	9.12	-------

*Estimated cost in 1992 dollars

2. Sediment Management Alternatives. For nearly 80 years the Elwha River reservoirs have acted as large settling basins, slowing river flow velocities and trapping material transported by the river behind the dams. As a result, large quantities of material are now trapped in the lakes behind the dams. Most of this material has been trapped in the upstream reservoir, Lake Mills. Lake Mills contains about 11.3 million cubic yards while Lake Aldwell estimates vary between as little as 2.6 million cubic yards to over 4 million cubic yards of accumulated sediments.

Trapped material can be roughly divided into two categories. Coarse material ranging in size from small sand to large gravel has been deposited at the heads of the reservoirs and the river to form the deltas. The coarse material comprises the majority of the trapped material, with approximately 8 mcy forming a delta about 70 feet deep at Lake Mills. Fine material consisting of smaller clay and silt sized particles is fairly evenly deposited throughout the beds of the reservoirs.



This section discusses three alternatives for reconstructing the river channel through the regions where this trapped material is now located. Nine scenarios are developed with a brief description listing possible advantages and disadvantages. A more detailed discussion is provided in Appendix F. The three approaches are defined below.

a. The **"Removal"** alternative would remove and relocate all trapped material from the inundated regions to a new location outside of the reservoir areas. The material could be relocated to a terrestrial site or be deposited in saltwater. Excavation of trapped material would be conducted using mechanical equipment or hydraulic dredges.

b. The **"Erosion"** alternative would allow river flow to erode or cut a new channel through the trapped material. Erosion would occur as a result of lowering the water elevations in the reservoirs and eroded material would be washed downriver. Fine material would be suspended in the river flow and transported to the Strait of Juan de Fuca. Coarse material would be eroded to the extent possible and supplemented with mechanical excavation as needed.

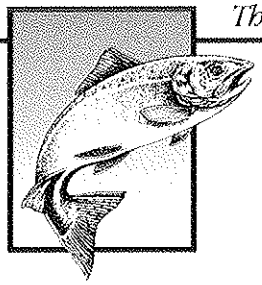
c. Trapped material has been deposited over the width of the reservoirs. The **"Retention"** alternative would remove only material in the path of the river and relocate it adjacent to the new channel. In this approach, much of the trapped material would remain in place undisturbed. Material removed from the path of the river would be stabilized adjacent to the river channel. Removing and relocating material could be accomplished either by using mechanical equipment including hydraulic dredges or by allowing river flow to erode material and relocate it.

Sediment Material Characteristics

Sediment material is conventionally divided into coarse (sand and gravel) and fine (silt and clay) material (MacDonald et al. 1991). Coarse material roughly corresponds to *bed load*, material transported by rolling along the river bed (particles >1 mm). Fine material roughly corresponds to *suspended sediment* (particles <.1 mm), material transported in the river flow.

The rate of coarse material erosion is controlled by the transport energy of the river. For this reason, the *Erosion* approaches would result in the erosion of coarse material over many years. In effect, coarse material would be "metered" through the system at rates controlled by the transport capacity of the river (which increases as river discharge increases), if only river flow were used to remove coarse trapped material.

Fine material would tend to flow when deposited and would not be stable at steep slopes. However, this material would easily erode and would stay in suspension when introduced into the river flow. The *Erosion* approaches consider the possibility of eroding this material into the river where it would wash into saltwater.



Both reservoirs contain both fine and coarse material. For convenience each scenario is shown in the following matrix (Figure 2) with the ultimate destination of coarse or fine material indicated by a black square.

Sediment Management Design Criteria
The criteria of the *Sediment Management* and *Dam Removal* effort are (1) achieve full ecosystem and native anadromous fisheries restoration, (2) minimize detrimental environmental impacts, and (3) keep project costs reasonable. Some of the issues considered are discussed below.

Revegetation Potential of Relocated Sediments
For the *Retention* approaches, delta sediments capable of supporting vegetation would be placed on the surface of all relocated material. This material would be placed over silt sized material relocated along the river to enhance revegetation. For the *Erosion* and *Removal* approaches it was assumed that the trapped material would be removed entirely and preexisting material would support vegetation.

Water Quality During Sediment Relocation
Water quality criteria would depend on the actions taken to protect water supplies and fisheries that depend on the Elwha River. The *Retention* approaches were developed to provide the highest level of water quality protection for domestic, municipal, industrial and fisheries water users. Using this approach, river turbidity levels would remain low during construction and use of water downriver would be possible during construction. The *Removal* approach would probably experience only slightly higher levels of turbidity during removal than the *Retention* approach. The *Erosion* approaches would increase turbidity and potentially require temporary relocation of fish production. Measures to protect industrial, domestic and private water users during the removal process would also be necessary.

Channel Configuration
For the *Retention* approach, contours were developed to meet stability requirements for static conditions with a factor of safety of approximately 1.3 (resistance to movement of relocated material is 30% greater than potential for movement). Contours were also developed with the objective of providing the widest possible flood plain for a given volume of relocated material.

Sediment Management has been grouped into three generalized approaches and combinations of these as discussed above. From the generalized approaches, nine detailed scenarios were developed to a level that would allow the determination of feasibility and relative cost. These scenarios are briefly discussed below while Appendix F provides a more detailed discussion and cost estimates. Figure 2 provides a synopsis of each scenario by showing the current and proposed final location of trapped material.

Because the methods of transporting, stabilizing and handling coarse and fine materials are distinctly different, proposed final locations for these trapped materials are shown separately. For instance, in *Removal* Scenario 2, fine material from Lake

General Approach	Scenario	Location of Trapped Material: Type of Material / Final Location of Material	Lake Mills: Coarse: Saltwater	Lake Mills: Coarse: Upland Disposal	Lake Mills: Coarse: Relocate to Lake Aldwell	Lake Mills: Coarse: Retained in Lakes	Lake Mills: Fine: Saltwater	Lake Mills: Fine: Upland Disposal	Lake Mills: Fine: Retained in Lakes	Lake Aldwell: Coarse: Saltwater	Lake Aldwell: Coarse: Upland Disposal	Lake Aldwell: Coarse: Retained in Lakes	Lake Aldwell: Fine: Saltwater	Lake Aldwell: Fine: Upland Disposal	Lake Aldwell: Fine: Retained in Lakes	$Mill. Construction Cost	Years Construction Time	mg/l Average River SSC Levels
Removal	1	FERC Licensee Approach-Mech.[1]		■				■			■					97.3	8	[2]
	2	FERC Licensee Approach-Dredge[1]	■				■			■			■			193.7	8	[3]
Erosion	3	Complete Washout	■				■			■			■			94.7	10-20	1000
	4	Erode to Lake Aldwell			■		■					■	■			166.9	6	1500
Retention	5	Retain All Material in Lake Area				■			■			■			■	62.9	4	[3]
	6	Erode Delta - Retain in Lake				■			■			■			■	55.2	4	800
Combination	7	Erode Delta - Washout Silt & Clay				■	■					■	■			50.2	3	1500
	8	Remove & Washout		■			■				■		■			97.1	6	1500
	9	Remove & Washout	■				■			■			■			192.9	6	1500

[1] Hosey Report, Dec. 1, 1989

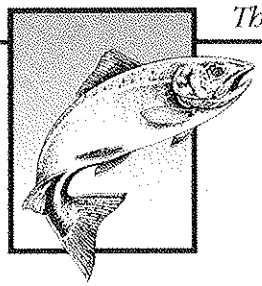
[2] Projected to be approximately 800 mg/l during lake drawdown.

[3] Similar projects have achieved construction within 25 mg/l above background.

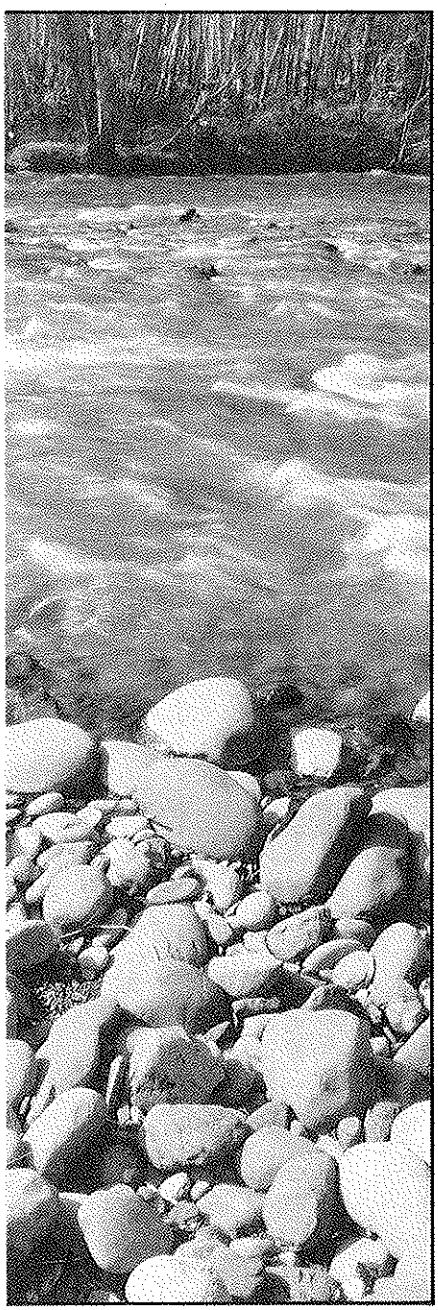
FIGURE NO. 2

ELWHA RIVER RESTORATION APPROACH ALTERNATIVE MATRIX FOR SEDIMENT MANAGEMENT

SUMMIT TECHNOLOGY
CONSULTING ENGINEERS, INC. P.S.
615 SECOND AVENUE
SUITE 580
SEATTLE, WA 98104
(206) 622-0222
FAX (206) 622-4754



Mills would be relocated to saltwater, indicated by the black square beneath the saltwater heading under Lake Mills across from Scenario 2 in Figure 2.



Elwha River below Glines Canyon Dam. (Janis Burger)

a. REMOVAL

As previously discussed, the *Removal* scenarios, Scenarios 1 and 2, would completely remove all trapped materials accumulated in the lakes since dam construction. A preliminary investigation of these scenarios was conducted by the dams' owner during the relicensing process.

SCENARIO 1 - Complete Removal

Lake Mills

Coarse material excavated to terrestrial site.
Fine material excavated to terrestrial site.

Lake Aldwell

Coarse material excavated to terrestrial site.
Fine material excavated to terrestrial site.

SCENARIO 2 - Complete Removal

Lake Mills

Coarse material excavated and transported to saltwater.
Fine material excavated and transported to saltwater.

Lake Aldwell

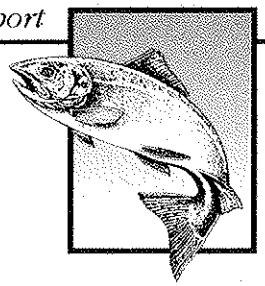
Coarse material excavated and transported to saltwater.
Fine material excavated and transported to saltwater.

In the *Removal* approach, river sediments would be hydraulically dredged or mechanically excavated as the lake levels were lowered. All trapped material would be transported to a distant disposal site, either terrestrial or in saltwater. In Scenario 1 material would be excavated, placed on barges for transportation to the lake shores and hauled by truck to a terrestrial site. Scenario 2 investigates transporting material to the Strait of Juan de Fuca by truck or pipeline, loading it on barges and depositing it in approved dredge disposal sites. Both Scenarios are feasible from a construction perspective. Other scenarios might be feasible if beneficial uses of the sediment are identified.

Advantages

This approach uses techniques that have been used in the past on other similar projects and are relatively predictable and controllable.

The final configuration in Olympic National Park after all removal would be achieved relatively quickly and would closely approximate natural conditions. Spawning habitat in the lake regions could be restored. Most of the material would be removed from the affected areas.



Disadvantages

The *Removal* approach is the most costly of all approaches considered. Higher construction costs result mainly because this approach requires that greater quantities of material be relocated.

Environmental effects of this approach would be comparatively greater for air and noise quality at the construction site due to the large number of vehicles required to transport the material to a new location. Impacts on the land at the disposal site would also be the greatest of all approaches considered.

Water users would need to be adequately protected during lake level drawdown. Drawdown and construction could cause large quantities of suspended sediment to be washed downriver. Both hydraulic dredging and mechanical excavation approaches would temporarily affect fish and wildlife.

The applicant's construction schedule predicted a long construct time, up to nine years for construction activities. However, with more equipment and staffing this schedule might be reduced.

b. EROSION

The *Erosion* approach investigates the ability of the natural transport capacity of the river to remove and/or relocate sediments. Numerous variations on this approach are possible and many were investigated. The major investigations include (1) complete erosion of all trapped material through the river system to salt water using river flow (Scenario 3), (2) using the river to erode Lake Mills' delta to a 'stable' configuration (Scenarios 4, 6 and 7), and (3) washing only fine material through the river system (Scenarios 8 and 9). For clarity, a brief description is given at the beginning of each of scenarios 3 through 7 showing the method and location of trapped coarse and fine material removed from the reservoirs.

SCENARIO 3 - Complete Erosion

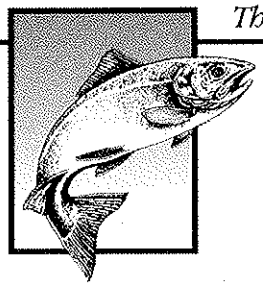
Lake Mills

Coarse material eroded to saltwater
Fine material eroded to saltwater

Lake Aldwell

Coarse material eroded to saltwater
Fine material eroded to saltwater

An investigation, using computer modelling, was conducted to determine the ability of the river system to transport all trapped material out of the reservoir areas. These simulations indicate that fine material could be removed and transported as quickly as the material could be introduced into the river flow. This could be accomplished most efficiently by using submersible dredges to pump fine material into the river. Depending on the type and number of dredges and the constraints imposed on turbidity, fine material could be removed and suspended in approximately 1 to 3 years. Coarse material would be more difficult to transport by river flow. Estimates indicate



that only about 1/2 of the delta material could be eroded before armoring of the eroded channel would occur. Consequently, some form of mechanical equipment would be necessary to augment the erosion process.

Additional coarse material in the lower reaches of the river would be desirable for fish spawning. However, the quantities of material now trapped in the reservoirs could cause localized flooding, changes in river course, and increases in river bed elevation. The need for continued monitoring and intervention in the process of removing coarse material would increase costs when compared to other approaches.

Advantages

Long-term, the river could return to a stable condition similar to that prior to dam construction. River bed material would be replenished, which would be beneficial for fish spawning habitat.

Less mechanical equipment would required compared to the *Removal* scenarios resulting in lower impacts on air and noise quality.

Disadvantages

This approach produces the highest levels of suspended sediments and bed load levels of all approaches investigated. It would greatly increase suspended sediment levels over natural (background) levels during the fine material removal. Depending on the approach used, levels could be elevated for approximately 3 years.

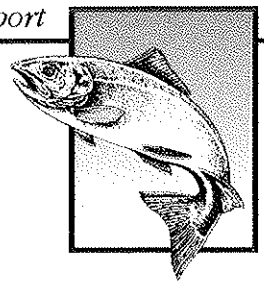
The ability to predict and control the effects of material moving through the river system is poor.

Impacts to river morphology could cause localized flooding. Flood protection levees would need to be modified, improved and extended.

Increased bedload and suspended sediment levels could severely impact fish health and habitat during the sediment removal period.

Depending on solutions implemented for water user protection, this approach might impact or limit the ability to use river water for pulp mills. Domestic water supplies would need to be modified or relocated.

An investigation of the impacts on marine biology was not conducted. However, the possibility is high that some marine life destruction would occur due to rapid introduction of larger than normal amounts of sediment into the marine system. Concern has been expressed that the sudden large quantities of material might also negatively impact coastal morphology.



This approach would require the greatest amount of time for material removal. Reintroducing fish rearing in the river might not be possible for 3 years after the start of construction. Increased levels of turbidity would be possible for over 20 years.

SCENARIO 4 - Partial Erosion - Temporarily Store Material in Lake Aldwell
Lake Mills
Limited amounts of coarse material eroded to Lake Aldwell
Fine material eroded to saltwater

Lake Aldwell
Coarse material relocated in Lake Aldwell
Fine material eroded to saltwater

Scenario 4 investigates using Lake Aldwell as a relocation site for Lake Mills delta material. In this scenario, the river would erode and carry the fine material downstream where approximately 1/3 of this material would be trapped in Lake Aldwell by Elwha Dam. Due to the length of time and the difficulty projected with using river flow to transport coarse material, this investigation transported coarse sediment from the delta using a pipeline to Lake Aldwell.

The amount of coarse material relocated from Lake Mills would be limited by the storage capability in Lake Aldwell. Insufficient storage is available for all of the coarse material trapped in Lake Aldwell and Lake Mills. Dredging the lakebed sediments in Lake Aldwell and the redeposited fine sediments from Lake Mills would be necessary to allow room for even partial relocation of coarse Lake Mills material.

Advantages

Accumulation of coarse sediments in the river and the resultant potential for flooding, course changes, and habitat destruction downstream of Elwha Dam would be avoided by trapping material in Lake Aldwell.

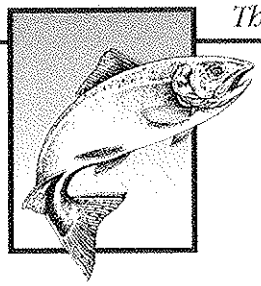
The lakebed region of Lake Mills would be free of sediment. This region could potentially be used for spawning habitat.

Compared to the *Retention* approach, more material is removed from the Lake Mills region which is located in the Olympic National Park. This approach would allow more area to be returned to conditions similar to those before dam construction.

Disadvantages

During the process of eroding fine material, suspended sediment levels would be increased significantly over natural (background) levels. Depending on the sediment removal schedule, levels would be elevated for approximately 3 years.

Depending on solutions implemented for water user protection, this approach might impact or limit the ability to use river water for pulp mills during the construction process. Domestic water supplies would probably need to be modified or relocated.



Increased suspended sediment levels could severely impact fish habitat and health during the removal of fine material. However, construction activities might be confined to periods during the year in which effects would be minimum.

Constructing and maintaining a pipeline from Lake Mills to Lake Aldwell would be expensive and could have negative environmental impacts along the river.

Final configuration of the affected areas would be stable, but this approach would not completely restore pre-dam conditions.

Reaching the 'stable' configuration in Lake Mills would be difficult to predict and maintain.

c. RETENTION

Numerous variations of this approach are possible. Scenarios 5 and 6 illustrate two of the least expensive feasible approaches. The essential feature of the *Retention* option is that material is relocated from the river channel to a new location in the lake areas. Scenario 5 allows the greatest control and lowest levels of suspended sediments during construction because construction activities are conducted with the reservoirs in place to act as settling basins. Both Scenarios 5 and 6 are among approaches which are the least expensive and the least disruptive to downriver water users. Cost savings result because these approaches disturb and/or relocate the least volume of material and because material is moved relatively short distances.

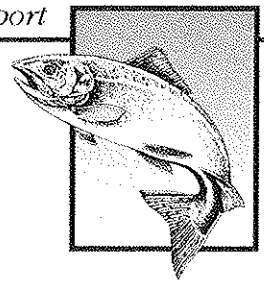
SCENARIO 5 - Use Mechanical Equipment or Submersible Dredges to Relocate Coarse and Fine Material Adjacent to New Channel

Lake Mills
Coarse material relocated in reservoir
Fine material relocated in reservoir

Lake Aldwell
Coarse material relocated in reservoir
Fine material relocated in reservoir

Scenario 5 uses mechanical earth moving equipment or hydraulic dredges to relocate sediments in the path of the river channel. Sediment would be removed down to pre-dam riverbed elevation. Embankments (berms) would be constructed of granular materials taken from the deltas, along the length of the river bank to help stabilize relocated material. Stabilization (i.e., riprap, bioengineering) would protect relocated material from future erosion after construction and help reduce potential impacts to water quality and river aggradation.

Material could be relocated using mechanical equipment or submersible dredging equipment. Both were investigated and appear feasible. Using mechanical equipment lake levels would be lowered before excavation. Using submersible equipment,



lake water levels would remain at about their present elevations during dredging and redeposition of material. Submersible dredging offers the best potential for conducting "clean" construction because full reservoirs would recapture most of the resuspended sediment from the construction process.

Revegetation of relocated material would be assisted by placing coarse material over fine material. Natural revegetation in the delta regions of Lake Mills and Lake Aldwell since dam construction has shown that revegetation on this material is feasible.

Scenario 5 assumes a new channel width of approximately 500 feet would be created in both lakes (see Figures 3 and 4). The pre-dam river channel width varies, but in the region now covered by lakes the pre-dam flood plain width was as much as 2000 feet.

Advantages

This approach would produce the least amount of suspended sediment of the approaches investigated and would allow the greatest protection of water quality in the short-term.

Costs are moderate compared to other options. However, uncertainties presented in the *Erosion* approaches make cost estimations and comparisons difficult.

Construction time required is relatively short. With adequate manpower and equipment construction could be conducted simultaneously at both dams and completed in 3 to 5 years.

This approach has been used on other similar projects. Cost, schedule, configuration of the final project and water quality estimates would be based on past performance. Results would be predictable.

Disadvantages

Material would remain near present locations in Olympic National Park restricting the natural river meander and reducing the aesthetic quality of the area.

Heavy equipment (dredging) would be required to conduct the work. This could result in minor temporary impacts to noise and air quality.

Over the long-term, all of the sediments may not remain in place. Natural channel meander and flood events would likely erode the material in pulses.

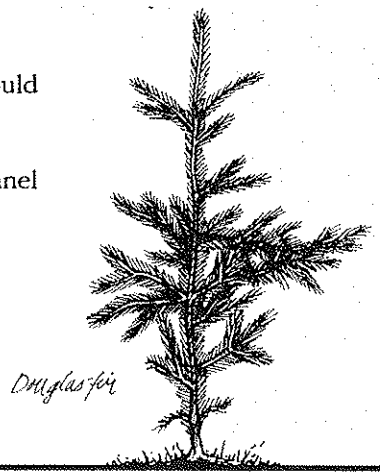
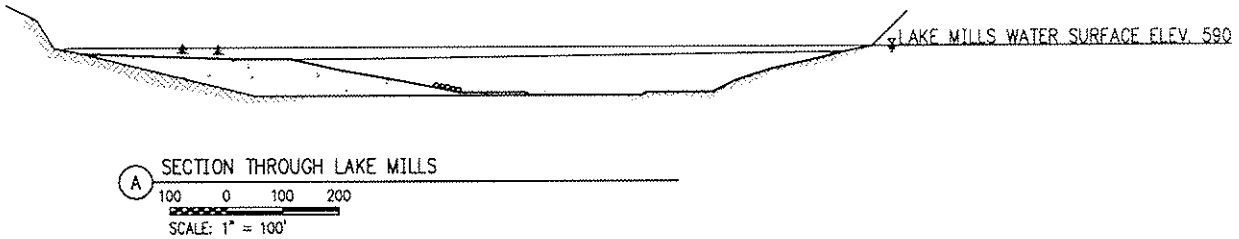


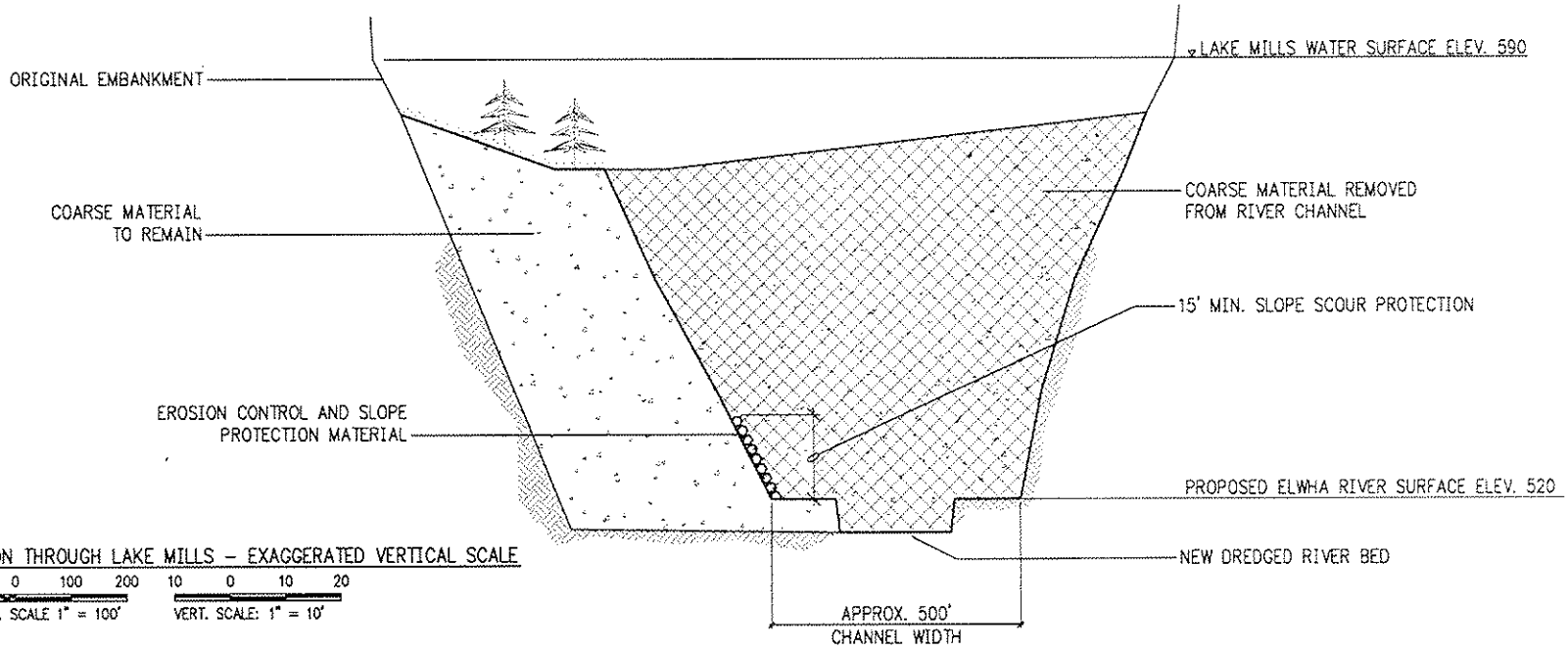
FIGURE NO.
3

ELWHA RIVER RESTORATION
LAKE MILLS - SCENARIO 5
SECTION THROUGH LAKE MILLS

SUMMIT TECHNOLOGY
CONSULTING ENGINEERS, INC. P.S.
615 SECOND AVENUE
SUITE 290
SEATTLE, WA 98104
(206) 622-0272
FAX (206) 622-1754



A SECTION THROUGH LAKE MILLS
100 0 100 200
SCALE: 1" = 100'



A SECTION THROUGH LAKE MILLS – EXAGGERATED VERTICAL SCALE
100 0 100 200 10 0 10 20
HORIZ. SCALE 1" = 100' VERT. SCALE: 1" = 10'

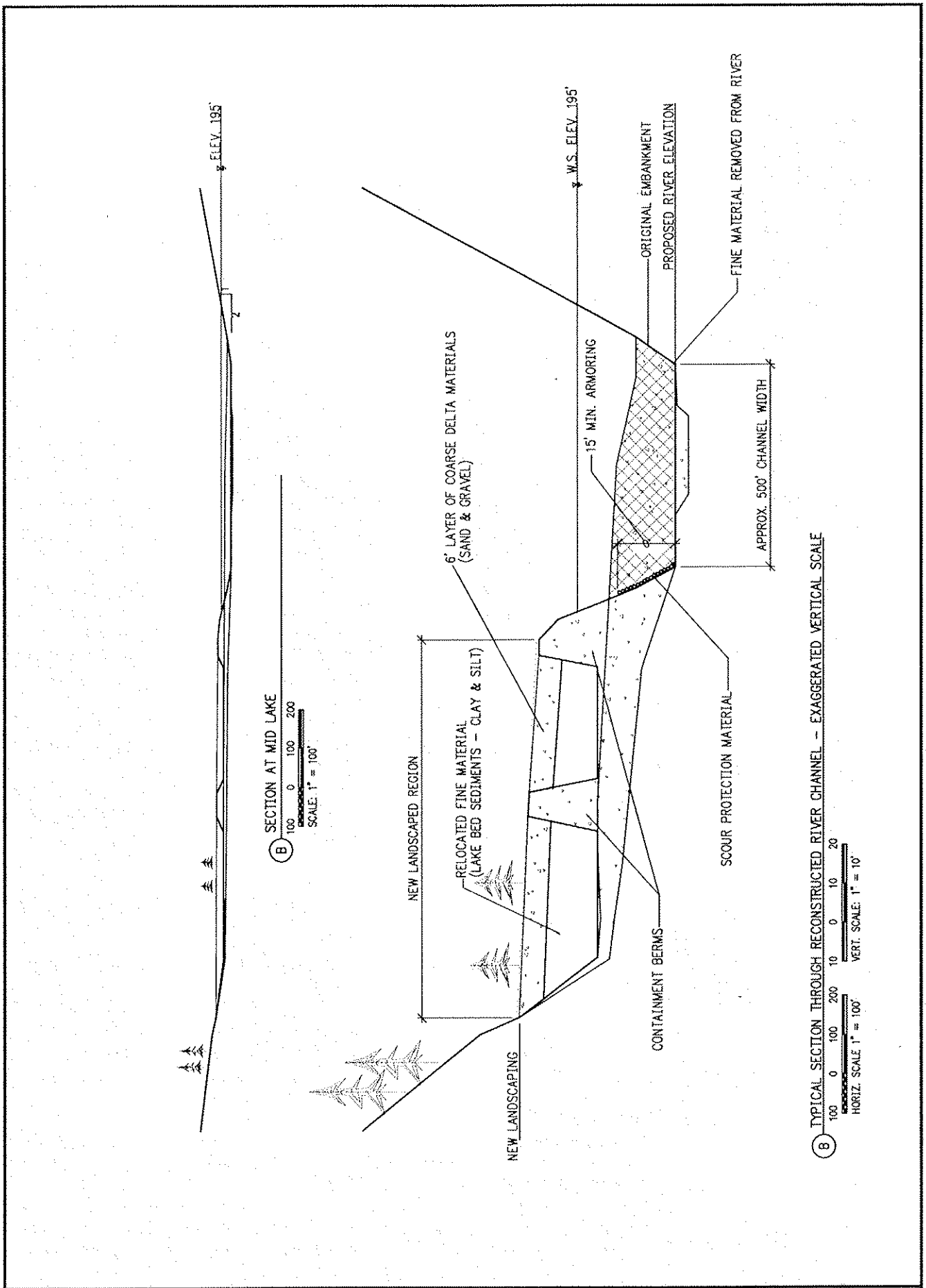
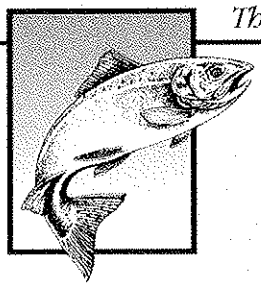


FIGURE NO.

4

ELWHA RIVER RESTORATION
LAKE ALDWELL - SCENARIO 5
SECTION THROUGH LAKE ALDWELL

SUMMIT TECHNOLOGY
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SCENARIO 6 - Erode Delta to Stable Profile, Retain and Relocate Coarse Material, Fine Material in Lake Area

Lake Mills
Naturally erode coarse material in delta to stable slopes; use hydraulic dredges to relocate in reservoir.
Fine material relocated in reservoir.

Lake Aldwell
Use hydraulic dredges to relocate coarse and fine material in reservoir.

Scenario 6 would allow the river to erode a channel to a stable bed elevation from the mouth of Rica Canyon to the end of the delta. Operations at Lake Aldwell and for relocating fine sediments in Lake Mills would be the same as the approach described in Scenario 5.

This approach would leave more of the delta material in place at Lake Mills (3.34 million cubic yards vs. 4.0 million cubic yards would be relocated in Scenarios 5 and 6 respectively) and require less material to be relocated. While this riverbed elevation would not be stable indefinitely (as no feature of the river is), it was assumed for this investigation that change would occur slowly after armoring the bottom and rip-rapping the side slopes in the delta area.

However, Scenario 6 would also increase downstream turbidity levels during the erosion process. While reservoirs would remain in place to capture resuspended sediments, the increased amount of resuspension and the decreased size of the reservoirs would reduce the trapping capability of the reservoirs and increase turbidity levels downriver during construction.

Advantages

Less delta material is relocated than in other approaches. Relocating less material would result in lower costs.

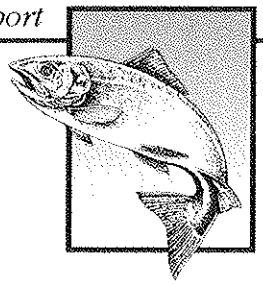
Turbidity levels in the downstream river would be smaller than those for the *Erosion* approaches.

Erosion might relocate some material permanently so that dredging would not be required. The quantity, and therefore, the associated cost savings would be very difficult to predict.

Disadvantages

Accurate location of the stable river channel is difficult. Although analytical tools are available to assess the ultimate location of the eroded river channel, cost and construction estimates are difficult to develop.

Erosion would inherently increase the levels of turbidity during construction. When compared to Scenario 5, approximately 500,000 (due to silt and clay



trapped in the delta area of Lake Mills) cubic yards more of material would be introduced into suspension and potentially impact fish.

No certain method (without artificially armoring the channel) is available to ensure the proper river profile. Upon achieving the predicted "stable" channel profile, construction personnel would probably be required to be on standby for some time to help secure banks from unanticipated erosion caused by shifts in the channel.

d. COMBINATION APPROACHES

The previous discussions delineate several approaches to *Sediment Management.* Combinations of these approaches are also possible. While there are many possible combinations, not all would be practical from construction, cost and environmental perspectives. Scenarios 7 through 9 suggest other combinations that are feasible and in the same economic range as the previous options.

SCENARIO 7

Lake Mills
Coarse material eroded to stable condition and relocated in reservoir.
Fine material eroded to saltwater.

Lake Aldwell
Coarse material relocated in reservoir.
Fine material eroded to saltwater.

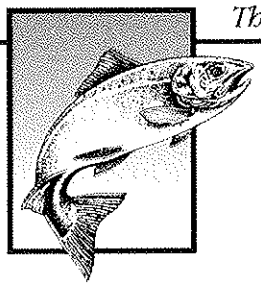
The elements of this approach have been previously discussed. This Scenario would use river flow to carry fine material to the Strait of Juan de Fuca. Dredges would remove fine material in the lakebed areas and pump it directly into the river for transport. Coarse material in Lake Mills delta would be eroded to a stable profile. Coarse material transported into the lakebed areas would be relocated by hydraulic dredges or mechanical equipment. Coarse material in Lake Aldwell would be relocated using hydraulic dredges.

Advantages

Less delta material is relocated than in other approaches. Relocating less material should result in lower costs.

Except for the total removal approaches (Scenarios 1, 2, 8, and 9) this approach would produce the widest floodplain in the Lake Mills area. This wider area would result from removing all silt and clay and relocating smaller quantities (approximately 3.3 million cubic yards) of delta material.

Erosion might relocate some material permanently so that dredging would not be required. The quantity, and therefore, the associated cost savings would be very difficult to predict.



Disadvantages

Although analytical tools are available to help predict the location of the eroded river profile, accurate prediction, cost and construction effort estimates would be very difficult to develop.

Turbidity levels would be high during removal of the silt and clay, so water users would require temporary protection.

No certain method (without artificially armoring the channel) is available to ensure the proper profile. Upon achieving the predicted "stable" channel profile, construction personnel would probably be required to be on standby for some time to help secure banks from unanticipated erosion caused by shifts in the channel.

SCENARIO 8 - Remove Delta Material to Terrestrial Site, Erosion of Fine Material

Lake Mills
Remove all coarse material in reservoir to terrestrial site.
Fine material eroded to saltwater.

Lake Aldwell
Remove all coarse material in reservoir to terrestrial site.
Fine material eroded to saltwater.

Scenarios 8 and 9, like Scenarios 1 and 2, remove all trapped material from the lake areas. Mechanically removing material is expensive, but costs can be reduced by washing part of the material downriver (silt and clay). Relocating the silt and clay material, either by hydraulic dredging or by mechanical excavation, is difficult due to the nature of the material.

Before the material could be mechanically excavated, some time would be required to allow the fine material to drain and stabilize. This approach would eliminate the need to handle this material except to introduce it into suspension. A variation of this approach would relocate only a portion of the delta material upland. Cost estimates were prepared by combining information developed by James River and estimates made as part of this report.

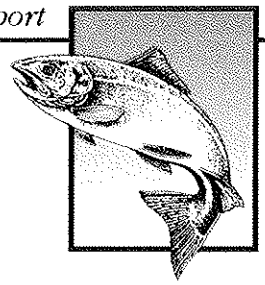
Advantages

This approach uses techniques that have been used in the past on other similar projects so they are predictable and controllable.

The final configuration in Olympic National Park after all removal would closely approximate pre-dam conditions. Spawning habitat in the lake regions could be restored. Most of the material would be removed from the affected areas.

Disadvantages

Although analytical tools are available to help predict the location of the eroded



river profile, anticipating construction effort and developing cost estimates would be very difficult.

Erosion would inherently increase the levels of turbidity during construction. Turbidity levels are predicted to be as high as 1500 mg/l during the erosion process. Increased suspended sediment levels could severely impact fish habitat and health during the removal period, cause impacts to marine resources, and limit the ability to use river water for pulp mills. Domestic water supplies would probably need to be modified or relocated.

SCENARIO 9 - Remove Delta Material to Saltwater Site, Erosion of Fine Material

Lake Mills
Remove all coarse material in reservoir to saltwater site.
Fine material eroded to saltwater.

Lake Aldwell
Remove all coarse material in reservoir to saltwater site.
Fine material eroded to saltwater.

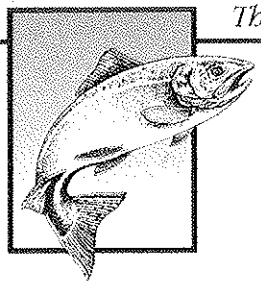
Scenario 9 is identical to Scenario 8 except that delta material would be deposited in saltwater. Cost for this approach would increase when compared to Scenario 8 because of the additional handling effort required. However, if an acceptable deposition site could be found, impacts might be decreased.

e. COST COMPARISON OF ALTERNATIVE SEDIMENT MANAGEMENT SCENARIOS

As a basis for comparison, reconnaissance level cost estimates based on 1992 dollars were prepared for all of the *Sediment Management* scenarios discussed in this report, and include minimum 25% contingency factors. Contingencies are higher for approaches using erosion because the process is inherently more difficult to control and estimate. Although the data are incomplete, the best available information was used in approximating sediment characteristics, gradations and volumes. Accurate estimates of the composition and volume of trapped sediment are not available at this time. Results from HEC-6 analysis were used to estimate volumes based on river erosion capabilities, suspended sediment levels, sediment transport potential and aggradation locations in the river.

Itemized costs for Scenario 1 and Scenario 2 were taken from Hosey (1989). However, total sediment removal costs, summarized below, are different from those in Hosey due to exclusion of revegetation cost and differences in the estimated quantities of material required to be removed. All estimates include engineering, construction management, profit and contingencies. Permitting and river revegetation costs were not included in these estimates.

Costs for the Erosion approaches, Scenarios 3 and 4, were based on the assumption that material trapped between the dams or downstream of Elwha Dam would need to be managed with dredges or mechanical equipment. Contingencies for these



approaches were high due to uncertainties that exist when predicting flows and sediment transport capabilities of the river. No cost for future river maintenance is included in the cost estimates. No maintenance should be required for *Removal* scenarios. The extent of future river maintenance will depend on the level of erosion protection incorporated into the design for *Retention* approaches.

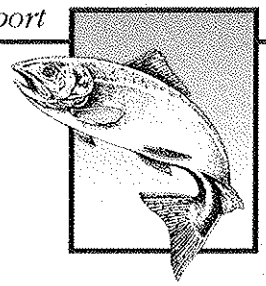
Construction procedures and costs for *Retention*, Scenario 5, were investigated in the greatest detail. Construction costs are based on current dredging technology. The applicability of these methods for this application is supported by the results obtained from similar projects. Unit costs for equipment and operation were taken from discussions with dredging contractors, equipment suppliers, and estimating manuals. Scenarios 6 through 9 combine unit costs developed for the previous five scenarios.

3. Recommendations. Four plans for *Dam Removal* and nine approaches to *Sediment Management* have been presented and discussed. These approaches present the range of practical solutions to dam removal and to river restoration on the Elwha River. When these approaches are combined, the cost of *Dam Removal* plus *Sediment Management* ranges from $66.7 to $236.1 million. The higher cost is associated with total removal of trapped material (Scenario 2). The significant cost savings associated with Scenarios 5, 6 or 7 for *Sediment Management* would appear to justify further investigation of these approaches. Assuming one of these approaches is coupled with the least expensive approaches to *Dam Removal*, the cost range for both activities should be $66.7 to $80 million.

Without specific design criteria and objectives, final recommendations for a specific *Sediment Management* solution cannot be made. However, based on the considerations discussed above, three approaches for *Sediment Management* appear to provide the most desirable results.

Scenario 7 is the least cost approach, and it retains the least amount of trapped sediment in the Lake Mills area, except for the *Removal* approach. However, further study of impacts to and potential mitigation options for river water users and fisheries resources during construction is necessary. To a lesser extent, Scenario 6 would also be limited by these same issues. If protection of downstream water users could be provided, Scenarios 6 and 7 should be investigated further.

Scenario 5 potentially offers the greatest protection to water users during construction. However, this scenario would not restore the Lake Mills and Lake Aldwell areas to their pre-dam condition since large quantities of sediment would remain in the lake areas. On the other hand, the river channel created under Scenario 5 would be sufficient to safely accommodate flood flows, allow the passage of fish, support revegetation, and remain relatively maintenance free. Long-term stability of the channel would depend on the objectives. Erosion and scour protection of relocated sediments is included as part of the cost estimates presented.



D. Compliance with the Wild and Scenic Rivers Act

Section 3(c)(3) of Public Law 102-495 requires that lands in which the federal government acquires both banks as a result of this Act, and that are external to the boundaries of Olympic National Park, be managed "... in accordance with the declared policy of section 1(b) of Public Law 90-542, except that modifications necessary to restore, protect, and enhance fish resources and to protect the existing quality of water supplied from the river are hereby authorized." Section 1(b) of Public Law 90-542 states:

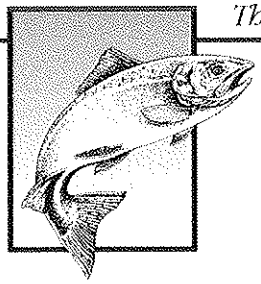
> It is hereby declared to be the policy of the United States that certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations. The Congress declares that the established national policy of dam and other construction at appropriate sections of the rivers of the United States needs to be complemented by a policy that would preserve other selected rivers or sections thereof in their free-flowing condition to protect the water quality of such rivers and to fulfill other vital national conservation purposes.

The restoration of fish and wildlife habitat within the 265 acre Lake Aldwell inundation zone, the restoration of the former river channel through the lakebed following dam removal, the sediment stabilization efforts needed to protect water quality, as well as the future management of the riparian corridor and the adjacent forest lands that occur on steep slopes as a preservation or conservation zone are either authorized by P.L. 102-495 or would be consistent with the declared policy of section 1(b) of the Wild and Scenic Rivers Act. Some of the project lands located upslope from the anticipated preservation/conservation zone (e.g., Elwha Dam site or the former gravel pit near Highway 101) have been identified by the Tribe as suitable for transfer to the Lower Elwha S'Klallam Tribe for tribal housing, cultural, or economic development (see Section VI(I)).

E. Water Quality Protection

1. Water Quantity. Precipitation in the Elwha River drainage is influenced by a strong rainshadow effect produced by the Olympic Mountains. Precipitation is greatest in the upper river drainage and occurs as rain during the fall and early winter and as heavy snow during the winter. Average annual precipitation in the upper Elwha drainage exceeds 220 inches. Precipitation is substantially less in the lower Elwha drainage, averaging 56 inches per year at the Elwha Ranger Station (El. 360 feet) near the northern boundary of Olympic National Park. The rainshadow effect is most apparent near Port Angeles, which has an average precipitation of only 26 inches per year.

The average instantaneous discharge of the Elwha River at the McDonald gauge,

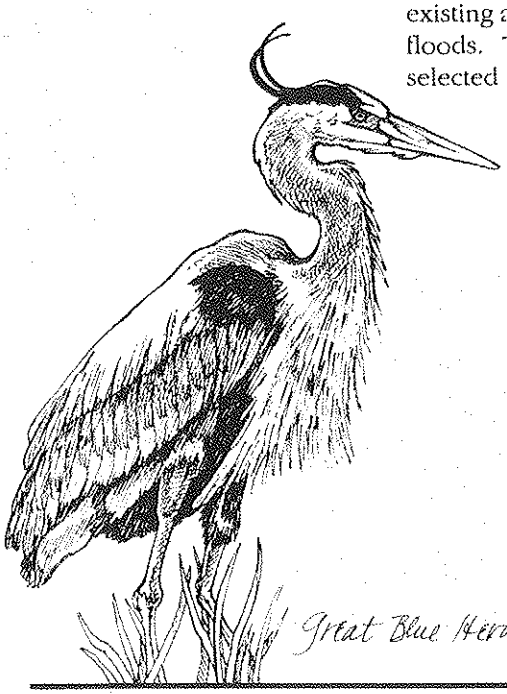


representing the upper 269 square miles (84%) of the drainage basin, is 1,507 cubic feet per second (cfs). The annual discharge pattern of the Elwha River is influenced by heavy Pacific tract storms in the early winter, snowmelt during spring months, and low precipitation conditions during late summer. Baseflow conditions reflect groundwater discharge, and melting of glaciers and residual snowpacks at the higher elevations. Lowest discharge occurs from August to October, with daily average discharge ranging from 618 to 952 cfs.

Prior to operating the Projects in run-of-the-river mode, minimum daily flows were influenced by storage in Lake Mills. Average monthly data (Table 5) provide a more realistic description of minimum flow conditions existing under present operation of Lake Mills and Lake Aldwell. Minimum values for monthly average discharges are lowest during September (330 cfs), October (252 cfs), and November (219 cfs).

Two high-runoff periods are observed on the Elwha River. The greatest discharge occurs during December due to heavy winter rain with the second peak occurring during June due to snowmelt. Average daily discharge during these 2 months averages about 2,100 and 2,300 cfs, respectively. November and March have the greatest potential for extreme precipitation events.

Instantaneous flood discharge at the McDonald gauge has ranged from 4,680 cfs in 1936 to 41,600 cfs in 1898. The greatest recorded instantaneous discharge in recent years was 28,700 cfs on November 23, 1990. Frequency analysis of yearly peak discharges indicates that a 5,000 cfs discharge corresponds to a flood event having a 1-year return interval. A 2-year flood event, which represents bankfull flooding conditions, corresponds to a discharge of approximately 14,400 cfs. The 41,600 cfs flood of 1897 has a 71-year return period, as calculated by peak discharge records existing as of 1984. The dams do not appreciably affect the peak discharge of major floods. Table 6 shows estimated flood flows at the mouth of the Elwha River for selected flood frequencies.



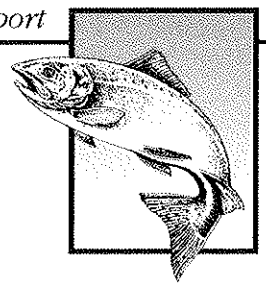


Table 5. *Daily and monthly average discharge for the Elwha River (1898 to 1902, 1920 to 1988), from: USGS gaging station located at McDonald Bridge below Lake Mills (269-square-mile drainage area). Extreme average daily low flows resulted from reservoir operations in the 1930s and 1940s.*

Discharge (cfs)

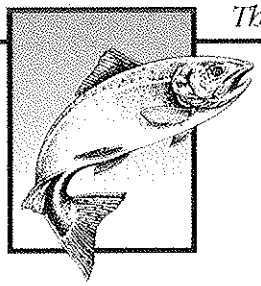
Month	Average Daily			Average Monthly	
	Mean	Maximum	Minimum	Maximum	Minimum
October	952	11,100	10	2,800	252
November	1,655	24,400	40	4,667	219
December	2,092	19,700	31	5,111	642
January	1,863	18,600	218	4,033	424
February	1,708	12,300	90	3,826	476
March	1,300	22,400	133	3,307	511
April	1,265	10,100	54	2,210	689
May	1,935	6,720	499	3,333	962
June	2,293	8,738	746	4,096	922
July	1,559	4,540	76	2,917	595
August	846	3,320	30	1,642	434
September	618	3,680	11	1,331	330

Table 6. *Estimated Elwha River flood flows measured at the river's mouth (U.S. Army Corps of Engineers).*

Flood Frequency (Years)	Peak Flow (cfs)
2	14,400
50	41,000
100	49,000

2. Water Quality. The Elwha River, its tributaries, Lake Mills, and Lake Aldwell are classified by the Washington Department of Ecology (DOE) as having Class AA waters, a classification given to surface waters having "extraordinary" water quality. Water quality degradation is limited to nonpoint sources of pollution, primarily sediment input, bank erosion, and elevated water temperatures, resulting from logging and agriculture which occur in the lower portion of the watershed outside of Olympic National Park. Increased water temperatures also occur in the lower Elwha River in late summer and early fall due to storage of heat in Lake Mills and Lake Aldwell.

From an ecological perspective, the lower and middle reaches of the Elwha River are significantly affected by loss of particulate organic matter (POM) transported from the upper river to Lake Mills and Lake Aldwell. Because of the heavily forested nature of the upper Elwha River drainage, relatively large amounts of organic detritus (i.e.,



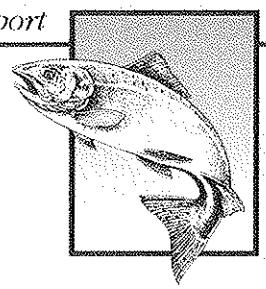
leaf material from riparian hardwoods, needle material from conifers, and woody debris) are deposited in the upper river channel and ultimately settle in Lake Mills and Lake Aldwell. Reservoirs trap POM lowering downstream POM levels. Low POM levels generally limit aquatic invertebrate diversity and production in rivers below reservoirs.

Lake Mills and, to a lesser extent, Lake Aldwell tend to increase temperatures during summer due to their relatively large surface area and their long hydraulic residence time. Lake Mills has a flushing time of 32 days with a 500-cfs inflow. Warming of the river by Lake Mills and Lake Aldwell is estimated to increase water temperatures in the lower Elwha River by approximately 2° C in July and August, and 3° to 4° C in September and October. Warming has recently been cited as a contributor to the occurrence of *Dermocystidium salmonis*, a disease which has caused mortality in anadromous fish in the lower Elwha.

Water temperatures in the Elwha River are lowest during January and February and highest during August and September (Table 7). Seasonal patterns in water temperature are highly influenced by yearly discharge and climatic conditions. This is exemplified by the years 1987 through 1989. River discharges during 1987 were extremely low, were moderate during 1988, and were relatively high in 1989. During 1987, water temperatures were substantially higher for all months when compared to those observed during the higher flow years of 1988 and 1989. During the 1987 drought year, maximum daily water temperatures in the lower reach had mean monthly values of 17.5° C in August, and 17.0° C in September (Table 7). Maximum water temperatures during the same year were 18.9° C in August and 19.4° C in September.

Table 7. *Monthly statistics for maximum daily water temperature (°C) in the lower reach of the Elwha River at river mile 3.3 (from Washington Department of Fisheries fish hatchery records).*

	1987			1988			1989		
Month	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**
January	5.0	7.2	4.4	2.8	3.3	2.2	3.3	4.4	2.8
February	5.9	6.7	5.0	4.2	5.0	2.8	1.3	2.2	0.0
March	6.6	7.8	7.1	5.9	6.7	5.6	3.2	5.0	1.1
April	8.5	8.9	7.8	7.1	8.3	5.6	6.5	7.8	5.0
May	10.4	11.1	10.0	8.8	9.4	8.3	8.8	9.4	8.3
June	12.1	14.4	10.6	10.9	12.2	9.4	10.9	12.2	9.4
July	14.7	16.1	13.3	11.3	13.9	9.4	11.7	12.8	10.6
August	17.5	18.9	15.6	14.5	16.1	13.3	12.3	13.3	11.1
September	17.0	19.4	15.6	14.3	16.1	11.7	12.6	13.9	11.7
October	15.5	17.8	13.3	11.3	13.3	8.3	10.0	12.2	6.1
November	10.8	13.3	8.9	7.3	8.9	5.6	4.5	6.1	2.8
December	5.2	8.9	2.8	4.4	6.1	2.2	3.2	5.0	2.2



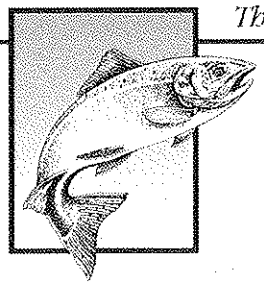
Values for pH, turbidity, dissolved oxygen, hardness, and alkalinity indicate high quality water (Table 8). Values for Ph and alkalinity indicate neutral to slightly alkaline conditions typical of oligotrophic (low biological productivity) waters. Dissolved oxygen values are very close to saturation at all times of the year, indicating high quality water conditions for cold-water fish. Most water quality parameters other than temperature vary little with time except for turbidity and suspended sediments, which increase during high discharge periods. Increased turbidity is also observed during glacial melt periods in the spring.

Nutrient concentrations in the Elwha River are relatively low, reflecting the pristine condition of the Elwha watershed. Nitrate, ammonia, total phosphorous, and orthophosphorous concentrations, as shown in Table 8, are at levels known to limit algal production. Total phosphorous concentrations for most uncontaminated lakes range from 0.01 to 0.03 mg/l as elemental phosphorous (P). The Elwha River has an average total phosphorous concentration (as P) of 0.01 mg/l. As a result of these low nutrient concentrations, Lake Mills has very low phytoplankton production and can be considered oligotrophic. Because of low algae production, Lake Mills and Lake Aldwell exert a minimal influence on water quality downstream.

Table 8. *Water quality statistics for the Elwha River, October 1985 to September 1986, from U.S. Geological Survey gaging station at McDonald Bridge, river mile 8.6.*

Parameter (Units)	Mean	Min.	Max.	Std. Dev.
Discharge(cfs)	1,171	631	1,900	473
Conductance(mhos/cm)	93	80	108	11
pH	7.7	7.2	7.9	.3
Temperature (°C)	7.8	3.0	13.5	4.7
Turbidity (NTU)	2.3	1.5	3.8	1.0
Oxygen, Dissolved (mg/l)	11.8	9.8	13.3	1.5
Percent D.O. Saturation	98	97	100	2
Hardness (mg/l as $CaC0_3$)	41	37	46	4
Alkalinity (mg/l as $CaC0_3$)	37	32	40	3
Dissolved Solids (mg/l)	57	49	68	3
Suspended Sediments (mg/l)	4	1	7	2
Nitrate Nitrogen (mg/l as N)	.1	<.1	.1	-
Ammonia Nitrogen (mg/l as N)	.02	.01	.04	.01
Phosphorous, Total (mg/l as P)	.01	<.01	.04	-
Orthophosphorous (mg/l as P)	.01	.01	.02	.0

Existing surface water rights on the mainstem Elwha River total 206 cfs; 200 cfs of these rights are held by the City of Port Angeles with the remaining 6 cfs divided amongst individual property owners along the river. This water is diverted for municipal, industrial, domestic, and agricultural use and fish rearing. In addition to these water righted diversions, about 7 cfs is normally diverted from the river to supply the fish



hatchery operated by the Lower Elwha S'Klallam Tribe (Tribe). Existing water rights, recorded and quantified under State law on the mainstem of the Elwha River, do not include unquantified Federal reserved water rights.

3. Water Use

a. Surface Diversions. City of Port Angeles - The City diverts a total of up to 200 cfs from two locations. A Ranney well[1] located on the east side of the river near RM 2.8 (adjacent to the outlet of the WDF fish rearing channel) supplies up to 50 cfs to meet current municipal needs, including the Clallam County PUD (about 0.6 cfs peak demand). A diversion dam located near RM 3.3 directs flows of up to 150 cfs into a canal on the east side of the river. This canal conveys up to 100 cfs in raw water to various entities served by the City, primarily the ITT Rayonier Mill (about 70 cfs peak demand) and the Daishowa America Mill (about 30 cfs peak demand). The remaining flow of about 50 cfs is supplied to the WDF fish rearing channel.

Tribal Fish Hatchery - A perforated PVC pipe buried approximately 10 feet under the riverbed near RM 1.5 collects about 7 cfs for diversion into the Tribal hatchery. This water is mixed with approximately 4.5 cfs of water from a well field (2 wells) to meet hatchery fish-rearing needs. A third, smaller well is used for domestic needs and to supply water to the egg incubation facilities.

WDF Rearing Channel - As noted above, the rearing channel receives its water from the City of Port Angeles diversion facility. The hatchery flow is returned to the Elwha River after passing through the rearing channel. During extreme drought conditions, this flow represents the minimum flow in the river below the diversion dam.

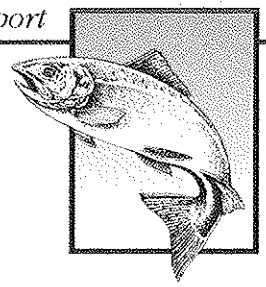
Miscellaneous Diversions - Approximately 6 cfs is diverted from the river by a number of users for both domestic and irrigation use. Additional work is required to identify the locations of these diversions and determine if they would be impacted by dam removal.

b. Groundwater Diversions. Elwha Place Homeowners Association - The Homeowners Association supplies water to 16 customers from 2 wells located on the west side of the Elwha River near RM 1.0. The combined capacity of these wells is about 186 gallons per minute (gpm) or about 0.4 cfs. The water is not treated before delivery. Representatives of the Homeowners Association have indicated that there does not appear to be a link between turbidity levels in the river and the wells.

Dry Creek Water Association - The Association supplies water to about 373 municipal and industrial customers from a well field approximately 230 feet east of the Elwha River near RM 4.2. The wells supply about 280 gpm (about 0.6 cfs) to the Association's distribution system. The water is chlorinated before delivery.

While the water right for the wells lists them as groundwater, the Washington State Department of Health considers at least two of the wells to be "groundwater under the influence of surface water." A representative of the Water Association has

[1] *A Ranney well consists of a vertical caisson located on one bank of a river connected to perforated pipes located under the river bed. Although the City's Ranney well operates on a surface water right issued by the State, it provides filtration and exhibits many characteristics of a groundwater supply.*



indicated that there appears to be a link between turbidity levels in the river and those in at least two of the wells.

Miscellaneous Wells - There are a number of individual and multiple use wells located along the river. Additional work is required to identify the locations of these wells and determine if they would be impacted by removal of the dams.

4. Flood Control Protection. The U.S. Army Corps of Engineers built Lower Elwha Levee extends from about RM 0.4 to about RM 2.9. The levee has a 12-foot wide crest, a 45-foot bottom width, and is about 8 feet high. It is designed to be 3 feet above the current 200-year flood level.

5. Impacts of Dam Removal on Water Quality. Turbidity - An increase in turbidity both in the near-term (0-10 years) and in the long-term (11 years plus) would be the primary water quality impact associated with removal of the Elwha River dams. The magnitude of the near-term impact would be controlled by the method selected for restoration of the river channel and stabilization/storage of the sediment currently trapped in Lake Aldwell and Lake Mills (see Section VI.C). During and subsequent to dam removal, depending on the sediment stabilization method used, turbidity levels could be expected to exceed the current State standard established for the Elwha River since the current standard is based upon historic data with the dams in place.



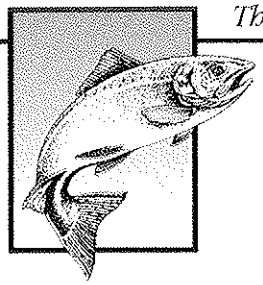
Doug Houston, Olympic National Park, marking fish to help identify parts which may remain along stream banks. (Janis Burger)

The long-term impact would be an increase in the background turbidity level since the river would be returned to a "natural" condition. The two reservoirs trap suspended sediment and organic material, but essentially all of the colloidal material (glacial flour) remains suspended and passes downstream. Thus, the portion of the turbidity level associated with the colloidal material would remain essentially unchanged by dam removal. There are no reliable estimates of the turbidity levels upstream of Lake Mills, so estimates would be developed based on data collected during the EIS/advanced planning stage.

River Channel - Alluvial materials moving down the river channel after dam removal will build up the channel bottom. As the channel cross section changes, the river meander can change. These changes combined with the above-noted changes in flood flows could endanger the Lower Elwha Levee and affect the productivity of the City of Port Angeles' Ranney well and the collection pipe of the tribal hatchery.

Temperature - Removal of Elwha and Glines Canyon Dams would eliminate the late summer/early fall warming of the river that occurs because of the reservoirs (see previous discussion on temperature).

Miscellaneous - Near-term organic matter concentrations, bacterial levels, and nutrient concentrations would increase as a result of dam removal. This would cause an increase in biological oxygen demand and a corresponding decrease in dissolved oxygen. While these near-term impacts would affect water quality, they have not



been identified as major concerns by any of the entities involved in the current study effort.

Increases in particulate organic matter as a result of dam removal would increase aquatic invertebrate diversity and production in the middle and lower Elwha River. In the long-term, this effect would facilitate restoration of the native anadromous fisheries.

6. Mitigation of Water Quality Impacts. General - The Elwha River Ecosystem and Fisheries Restoration Act (P.L. 102-495) specifies that the dam removal plan "must include all actions reasonably necessary to maintain and protect existing water quality for the City of Port Angeles, Dry Creek Water Association, and the industrial users of the Elwha River against adverse impacts of dam removal. The cost of such actions, which may include as determined by the Secretary [of the Interior], if reasonably necessary, design, construction, operation and maintenance of water treatment or related facilities, shall be borne by the Secretary. Funds may not be appropriated for removal of the dams, unless, at the same time, funds are appropriated for actions necessary to protect existing water quality" (Section 4(b)). The Act does not provide for treatment capability to meet projected future needs resulting from system expansion or more intensive treatment needs resulting from changes in regulatory requirements. Responsibility for near-term and long-term operation, maintenance, replacement, and power (OMR&P) costs would be evaluated during the EIS/advanced planning stage.

A number of methods have been identified that could protect the major Elwha River water users from the impacts of dam removal. Additional work would be required during the EIS/advanced planning stage to confirm the viability of each of the alternatives, to identify any additional alternatives, and to work with the affected entities to develop a broad consensus as to which alternative is preferred for each diversion. Project reports and construction documents for all public water supply system modifications would be subject to the review and approval authority of the Washington State Department of Health, pursuant to the Washington State Board of Health Drinking Water Regulations. Water rights for any change in sources would have to be approved by the Washington State Department of Ecology.

The Act is silent with respect to protecting other, smaller Elwha River water users from the water quality impacts of dam removal. Project costs would likely have to include some costs to protect these other water users. However, additional work would be required during the EIS/advanced planning stage to identify those users and the associated mitigation measures that might be needed.

City of Port Angeles Municipal Water Supply - Two alternatives have been evaluated to mitigate impacts to the municipal supply (existing Ranney well), including (1) construct a second Ranney well and (2) construct a well field (five wells) to replace the existing Ranney well. The anticipated capital and annual costs of these alternatives are shown in Table 9.

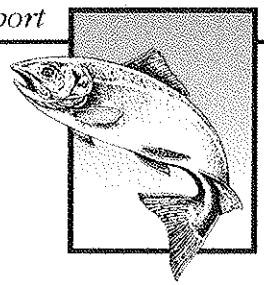


Table 9. *Anticipated mitigation costs for municipal water supplies (April 1992 price level).*

Alternative	Capital Cost	OMR&P Cost
New Ranney Well	$2,700,000	$200,000
New Well Field	$3,000,000	$220,000

The City has expressed concerns that these alternatives may not be adequate. Detailed evaluations would be made during development of the EIS/advance planning document to provide an adequate basis to develop a consensus on the appropriate mitigation plan.

City of Port Angeles Industrial Supply - A number of alternatives have been considered to meet the needs of the City's primary industrial water users (Daishowa America and ITT Rayonier). Of these, only three meet the test of providing for remaining industrial water users. These three alternatives are (1) modification of the existing river diversion (to facilitate fish passage and sediment transport past the diversion dam) and construction of a new concrete settling basin, (2) construction of five Ranney wells to replace the existing diversion[2], and (3) modification of the existing river diversion and construction of a new geotextile/clay lined settling basin with chemical pretreatment. Table 10 shows the anticipated capital and annual costs of these alternatives.

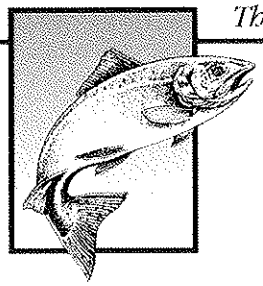
Table 10. *Anticipated mitigation costs for industrial water supplies (April 1992 price level).*

Alternative	Capital Cost	OMR&P Cost
New Inlet & Settling Basin	$9,690,000	Not estimated
Ranney Wells	$10,140,000	$348,000
New Inlet with Pretreatment and Settling Basin	$9,000,000	Not estimated

It is important to note that the City of Port Angeles and the mills have expressed concerns that these alternatives may be inadequate to protect them from the impacts of dam removal. Detailed evaluations would be made during development of the EIS/advanced planning document to provide an adequate basis to develop a consensus on the appropriate mitigation plan.

Tribal Fish Hatchery - Several concepts were considered to protect the hatchery infiltration pipe. These included relocating the current infiltration pipe, construction of a Ranney well to replace the pipe, and enlarging an existing dike to control channel changes in the vicinity of the pipe (cost estimates have not been prepared). The Tribe's preferred alternative provides for adding buried pipe laterals to the existing pipe to provide increased infiltration capacity to offset capacity loss caused by changes in the river's meander. Preliminary evaluations suggest that the capital cost

[2]In the event alternative (2) is selected, inlet modifications would still be needed to supply the WDF Rearing Channel.



of these improvements would total $220,000 (April 1992 price level). The OMR&P costs for this alternative are expected to be comparable to current costs.

Elwha Place Homeowners Association - Representatives of the Homeowners Association have expressed concerns that river channel changes would imperil their well field and subject them to flooding. Potential impacts and the capital and annual costs of any justified mitigation measures would be identified and evaluated during the advanced planning stage.

WDF Rearing Channel - Two measures are needed to protect the rearing channel. First, the diversion facilities at the river would be reconstructed to facilitate fish passage and downstream sediment transport.[3] The anticipated cost of this measure would be $1.01 million (April 1992 price level). An estimate of annual costs for this measure has not been prepared. Second, a flood protection barrier would be constructed between the channel and the river. The estimated cost of this measure is $280,000 (April 1992 price level). An estimate of annual costs for the flood protection measure has not been prepared.



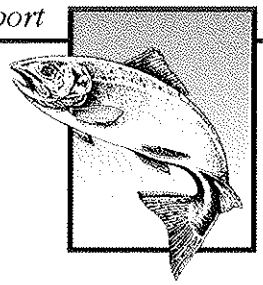
Dry Creek Water Association - The initial mitigation proposal for the Water Association involves drilling two new wells to replace the two wells closest to the river. The well houses would be located on built-up pads to place them above the 100-year flood level. The estimated cost of replacement wells is $350,000 (April 1992 price level). The total anticipated annual costs for this measure would be $13,000 (April 1992 price level).

Lower Elwha Levee - Initial estimates indicate that the levee should be raised 4 feet to maintain the existing flood control protection if the dams are removed. In addition, the quarry spalls protecting the face of the levee would need to be augmented with larger diameter riprap. Initial estimates suggest that at least 18 inches of large diameter riprap should be added to the existing quarry spalls. Preliminary evaluations suggest that the capital cost of these levee improvements would total $2.1 million (April 1992 price level). Annual operation and maintenance costs associated with the levee enhancements are likely to be comparable to those for the current levee.

F. Fish Restoration

This plan provides a description, timeline, and cost estimate to achieve full restoration of the native anadromous fisheries of the Elwha River following the removal of both dams. Upon Congressional approval, the Elwha River fish restoration process would begin in 1994 and continue for an estimated 18 years to complete stock assessment, brood development, juvenile outplanting, and evaluation of adult salmon returns. Within this time period, fish restoration would be expected to be completed. However, it is recognized that anadromous fish released in currently inaccessible habitat may require varying amounts of time and variable levels of outplanting before full utilization of the habitat occurs. Estimated capital costs for improvements to existing fish facilities to support fish restoration total $4.1 million, and operational

[3] *This measure is the same as the inlet reconstruction element in the first and third municipal water supply mitigation alternatives.*



costs for fish restoration activities over the entire 18-year restoration period total $5.3 million. For further details on these cost estimates, see Appendix G.

Key assumptions in the restoration plan are as follows (1) fish passage through the dam sites would be hazardous until dam removal is completed; (2) the viability of lower river fish habitat and fish facilities during dam removal depends on the sediment management scenario employed, although there are some potential measures (i.e., the development of "clean" water sources for the fish facilities, captive broodstock collection for affected species) to mitigate temporary impacts (e.g., high turbidity, sediment deposition); and (3) juvenile outplanting would significantly speed fish restoration and allow reintroduction of fish stocks best adapted to the Elwha River's unique environment.

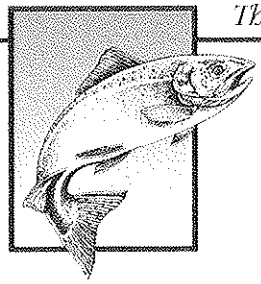
Stock assessment and brood development has already begun to ensure that fish are available for outplanting at the first opportunity when access to the upper river is restored. Stock status assessments will continue and will be expanded to identify the most promising sources of broodstock for restoration. Indigenous stocks would receive first priority in brood development and restoration because they are best adapted to the river's natural environment and would provide the maximum sustained adult return. However, alternative fish stocks would be developed if necessary.

Hatchery support will be required to develop and maintain broodstock for outplanting. For this purpose, the two existing fish production facilities in the lower river (those of the Washington Department of Fisheries and the Lower Elwha S'Klallam Tribe) would be modified to produce juvenile fish for outplanting. Use of these facilities would reduce logistical costs in fish transfer and limit the possibility of future transfer restrictions due to fish health concerns. Facility modifications would include improvements to water supplies and upgrades in incubation and support capabilities. Specific modifications for each facility would be identified during the EIS/advanced planning stage.

Juvenile outplanting would occur when safe downstream passage at the dam sites is assured. Outplanting would occur up to two generations at levels consistent with the carrying capacity of the habitat and the ability to effectively reintroduce each stock to the upper river at its target time and size of release.

For outplanting purposes, the Carlson Canyon Falls at RM 34 would separate spring and summer/fall chinook salmon and summer and winter steelhead introductions (spring chinook and summer steelhead above RM 34 with other stocks below), while the entrance to Rica Canyon (RM 16) would be used as the upper limit of chum and pink salmon introductions (Figure 5). Helicopter transport would be used to outplant above RM 16, the limit of road access in the basin.

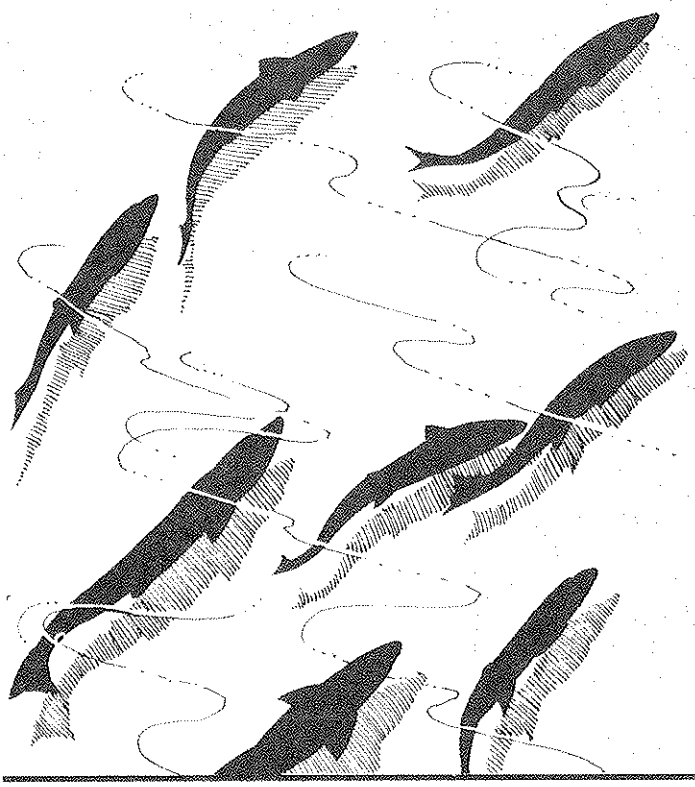
Conditioning ponds would be used, where feasible, to acclimate presmolt outplants and increase survival and adult returns. Conditioning ponds would consist of side channels fitted with temporary water control structures to allow short-term holding and rearing before downstream migration. Adult salmon returns to the upper river



and harvests would be evaluated throughout the restoration period to ensure that restoration objectives are met.

Although not considered a primary restoration option for most Elwha stocks, natural recolonization would be expected to significantly contribute to fish restoration. Once access is reestablished, adult fish could be expected to penetrate the upper river and establish themselves over an indefinite time. In the South Fork of the Skykomish River, adult chinook and pink salmon were provided access to 90 stream miles of new habitat above Sunset Falls (a natural barrier) with peak returns about 10 years later for chinook and 25 years later for pink salmon.

This plan is expected to restore the 10 anadromous fish stocks historically present in the Elwha River basin: winter and summer steelhead, sea-run cutthroat trout and native char (Dolly Varden and bull trout), spring and summer/fall chinook, coho, pink, chum, and sockeye salmon. The primary options for restoring these stocks are described below and in Appendix G.



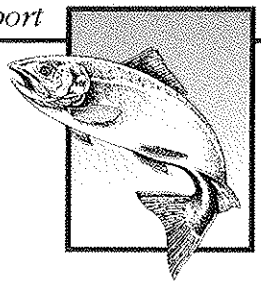
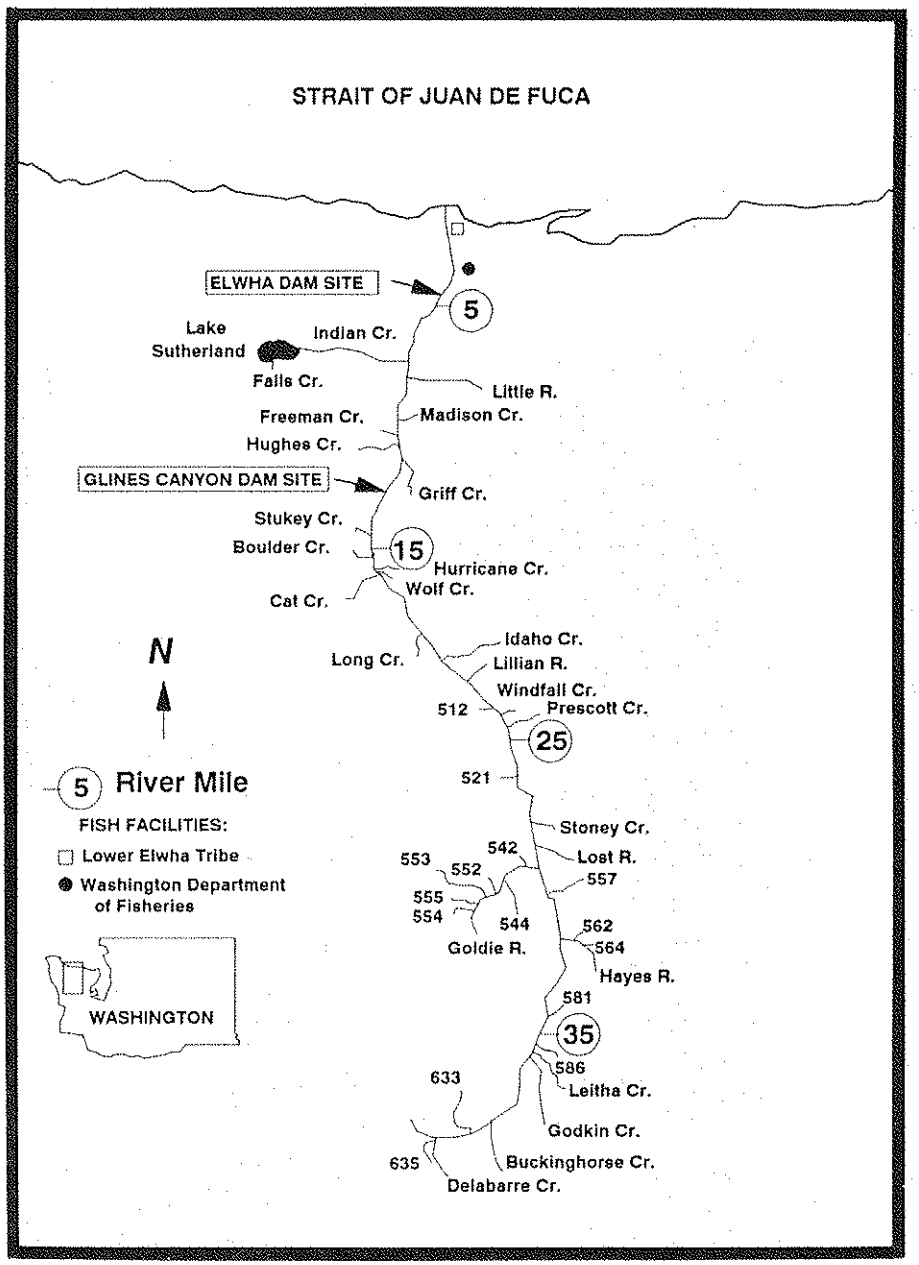
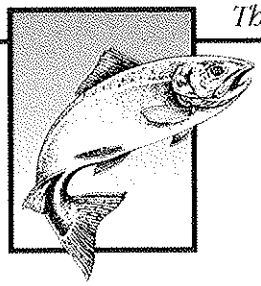


Figure 5. *Lineal extent of anadromous salmonid habitat in the Elwha River basin following removal of the Elwha and Glines Canyon dams.*





1. Summer/Fall Chinook Salmon Restoration. The native Elwha River summer/fall chinook population is healthy, being sustained by both wild and hatchery production in the lower Elwha River. As planned for spring chinook, summer/fall chinook restoration would involve collecting eggs across the range of Elwha spawning timing, then outplanting presmolts during the spring. However, outplanting would occur below RM 34 (the assumed historic range of Elwha summer/fall chinook). Given the healthy condition of this stock and the existence of the lower river hatchery program, brood should be readily available for this program.

2. Spring Chinook Salmon Restoration. Elwha spring chinook salmon, if present, are undoubtedly few in number. Loss of access to upriver habitat due to the dams, coupled with possible spawning with other chinook in the lower river, have likely reduced their numbers and perhaps their genetic distinction from summer/fall chinook. Limited numbers of nonnative chinook stock have also been released in the lower Elwha River.

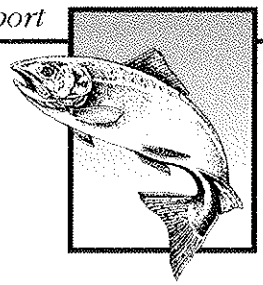
Spring chinook restoration would involve collecting eggs across the range of the existing Elwha chinook spawning timing, then outplanting presmolts in the upper basin in early spring within their assumed historic range (above RM 34). Over time, this approach would be expected to stimulate earlier return among Elwha chinook exposed to the upper river environment. Presmolt outplanting would minimize interference with natural emigration (which can negatively affect marine migration and survival) and promote imprinting on the upper river.

Prior to dam removal, efforts would also be made to identify and enhance any remnant spring chinook stock in the lower river. A live capture gill-net sampling program is currently being conducted to assess run strength and potential brood collection techniques. If brood is collected during spring entry, specific measures would be taken to reduce prespawning mortality at the hatchery by improving water quality and brood holding facilities. Outplanting would occur as noted previously.

3. Coho Salmon Restoration. Elwha coho salmon have Dungeness River and Elwha River parentage and are sustained by both wild and hatchery production. Coho restoration would use existing Elwha stock. Outplants would occur above RM 16 to reduce predation on pink and chum salmon (which will be introduced below that point). Because all outplanting would be by helicopter, fingerling releases would be more cost effective than smolt releases. Based on prior experience in the Puget Sound region, a fingerling outplant program can be an effective reintroduction measure. The existing Elwha stock should be readily available in the future given its healthy status and the existing hatchery program.

4. Winter Steelhead Restoration. The early portion of the Elwha River winter steelhead run is heavily supported by hatchery production of nonnative stock. The late portion of the run is wild, but its status is unknown and the population is considered depressed due to habitat loss related to the two dams.

Restoration of winter-run steelhead would primarily focus on use of Elwha wild stock



from one or more possible sources. Genetic research has revealed that the existing rainbow trout population in the upper river may be descendant from native Elwha steelhead trapped in the upper river since construction of Elwha Dam. Supporting this view is the recent capture of steelhead smolts at Elwha Dam, which apparently originated from the upper river rainbow trout population. In addition, analogous rainbow/steelhead populations are now reported to exist above man-made barriers in the mid-Columbia River, where headwater rainbow trout populations are also believed to produce steelhead smolts.

To develop a native Elwha run from the upper river rainbow population, adult trout in the headwaters of the Elwha are being captured and transferred to the tribal hatchery for one or more cycles. These trout will be spawned at the hatchery and their progeny coded-wire-tagged and released as smolts. If returns are adequate, progeny of these fish would be used to outplant the upper river.

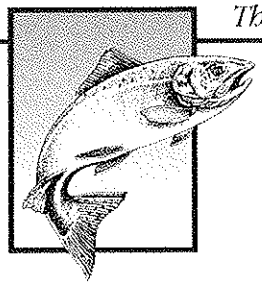
Concurrently with resident trout brood development, smolt output from the upper river will be assessed to determine potential for reestablishing a native winter run without enhancement. Smolts will be trapped at (or above) Elwha Dam, examined for migratory readiness, and compared to the upper river rainbow trout population by means of electrophoretic analysis. If smolts appear to be native Elwha and sufficient numbers are available, subsequent collections will be coded-wire-tagged to determine survival and return timing. Depending on smolt output and return timing, natural recolonization may be relied upon to establish a winter run following dam removal.

The status of the late-run stock in the lower river will also be evaluated to determine whether its enhancement could meet restoration objectives. A live capture gill-net sampling program will assess run strength, and nonlethal electrophoretic sampling will be used to assess genetic makeup. If the stock is suitable, an enhancement effort will be undertaken, dependent on the outcome of the resident fish investigations.

5. Summer Steelhead Restoration. Although their number are unknown, Elwha River summer run steelhead are considered depressed due to habitat loss related to the dams. Restoration of summer steelhead would emphasize use of wild stock, if possible. Efforts directed at winter steelhead restoration using the upper river rainbow trout population could also address native summer-run restoration if a component of the upper river rainbow trout population displays summer return timing.

Natural recolonization by lower river stock would occur after dam removal. To reduce nonnative hatchery influence in the lower river stock prior to dam removal, nonnative hatchery releases would be discontinued beginning in 1994.

6. Pink Salmon Restoration. Elwha pink salmon are a native, wild stock whose status is critical, as evidenced by chronically low escapements. Only four individuals were observed in extensive surveys in 1989 compared to estimates of over a thousand in the early 1970s. Pink restoration would entail either rebuilding the existing Elwha population (if feasible) or importation of an outside stock. Enhance-



ment of Elwha stock could be difficult due to its critical status, but further evaluation is necessary.

Despite low escapements, pink salmon can rebound quickly given their 2-year life cycle. For example, when access to new habitat was made available in the upper Skykomish River above Sunset Falls in 1959, the initial pink spawning escapement was only 150 individuals. Escapements remained low until 1981, when over 2,000 fish returned. Pink numbers then trebled over each of the next two cycles and escapement exceeded 20,000 by 1985.

If use of Elwha stock is not feasible, Dungeness River stock would be obtained from either the Dungeness River or from a hatchery egg bank (Finch Creek) in Hood Canal. The Dungeness River pink run has several desirable traits as a donor in that it has an "upper river" component that returns early and penetrates high in the system. Importing this stock would encourage colonization throughout available habitat in the Elwha and minimize risk of adversely affecting any remnant Elwha pink in the lower river.

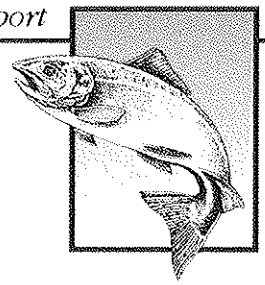
Unfortunately, the Dungeness River stock is chronically underescaped, so importing pink salmon from the WDF Finch Creek Hatchery program in Hood Canal may be necessary if Dungeness pinks do not rebound. The Finch Creek stock is desirable because it originated from the Dungeness River in the 1950s and hatchery egg takes approach 2 million.

Under any brood development program, initial incubation and rearing would occur at the tribal hatchery, but final incubation and rearing would occur at satellite facilities below RM 16. Smolts would be mass planted to reduce predation loss.

7. Chum Salmon Restoration. Elwha chum salmon are a native, wild stock whose status is unknown. Nonnative chum were cultured at the tribal hatchery, but the program was discontinued about 1987 due to limited hatchery returns.

Chum salmon restoration would focus on stabilization and rebuilding of the Elwha stock, followed by outplanting after dam removal. Additional surveys of Elwha spawner abundance will determine availability of chum for brood development. Emphasis would be placed on identification of any significant remaining native component through spawner surveys and electrophoretic analysis. Brood collection would focus on any identifiable native component as a first priority. Initial incubation and rearing would occur at the tribal hatchery with final incubation and rearing at satellite facilities below RM 16, or in appropriate locations for remote site incubation. Lower river habitat surveys would be conducted to develop habitat modification measures to stabilize and increase the existing stock prior to the dam removal period.

8. Sockeye Salmon Restoration. The native lower river sockeye salmon stock no longer exists because Elwha Dam blocks access to Lake Sutherland (Figure 1), which is needed to complete the freshwater phase of the sockeye life cycle. Sockeye restoration would involve either enhancing the anadromous component of Lake



Sutherland kokanee (assuming it retains a significant genetic element of the original Elwha sockeye) or importing a suitable outside stock. Kokanee, even though landlocked for many generations, may produce anadromous offspring which, through captive rearing, might be used to restore depleted sockeye stocks (as is proposed for recovery of endangered Snake River sockeye). Following this strategy, smolts would be trapped at the outlet weir of Lake Sutherland, captive reared to maturity, and their offspring returned to Lake Sutherland over one or more cycles prior to removal of Elwha Dam.

Concurrently, potential sockeye donor stocks would be screened. If use of Lake Sutherland kokanee is not feasible, sockeye fingerlings from a suitable donor stock would be introduced in Lake Sutherland beginning one year prior to Elwha Dam removal.

9. Sea-run Cutthroat Trout and Native Char Restoration. The status of Elwha sea-run cutthroat and native char (Dolly Varden and bull trout) is unknown, although no past enhancement has occurred. Restoration of these species would occur by natural recolonization from lower river stocks. However, remnant landlocked forms of both species may exist in the upper watershed in an analogous manner to rainbow/steelhead as noted above. These resident populations could significantly contribute to reestablishment of native anadromous populations after dam removal.



G. Wildlife Restoration

It is expected that the restoration of native anadromous fish runs to the Elwha River basin and the restoration of terrestrial and riverine habitat currently inundated by Lake Mills and Lake Aldwell would provide the conditions necessary for the natural recovery of wildlife populations. However, the preservation of project lands, as identified in Section VI(I), is also necessary for the full restoration of wildlife populations. If the surrounding habitat around Lake Aldwell (project lands) is allowed to be significantly developed or degraded, the full habitat potential in the restored reservoir area would not be achieved. No other activities would occur to achieve full wildlife restoration.

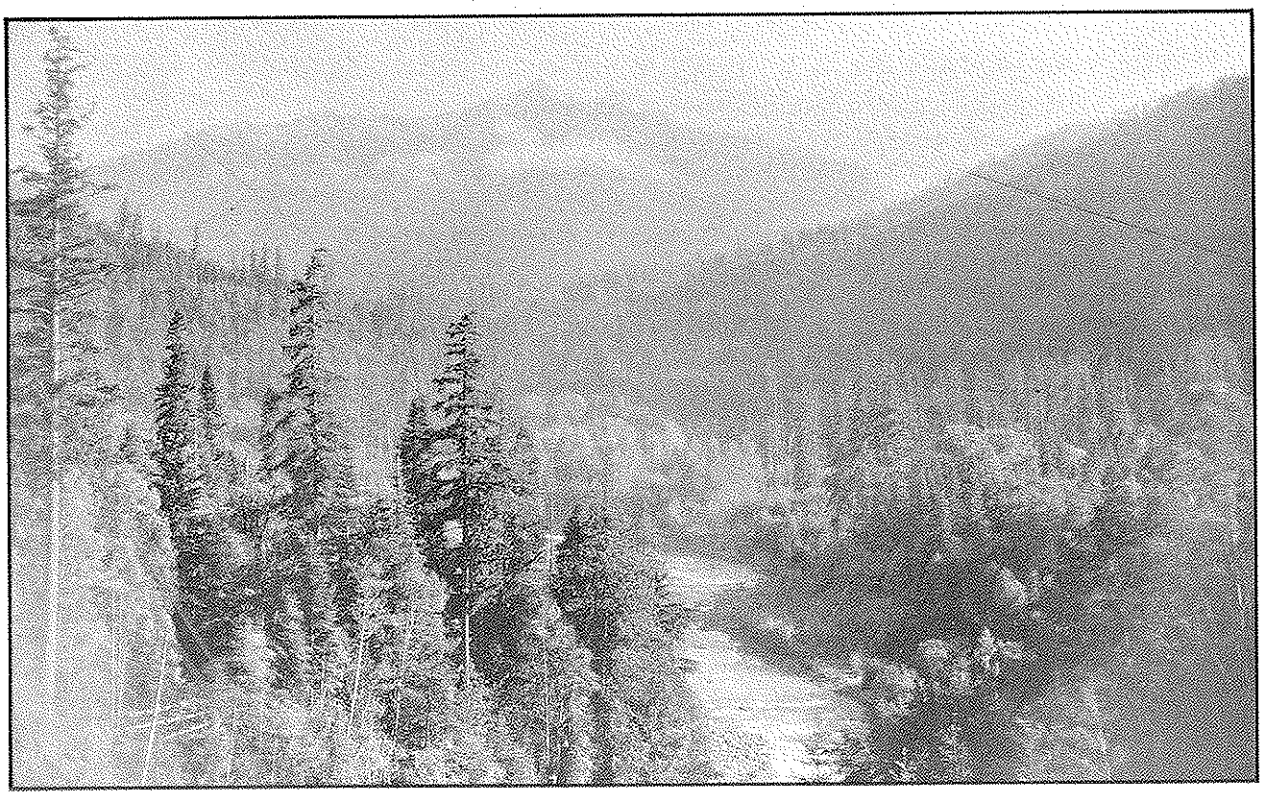
H. Habitat Restoration

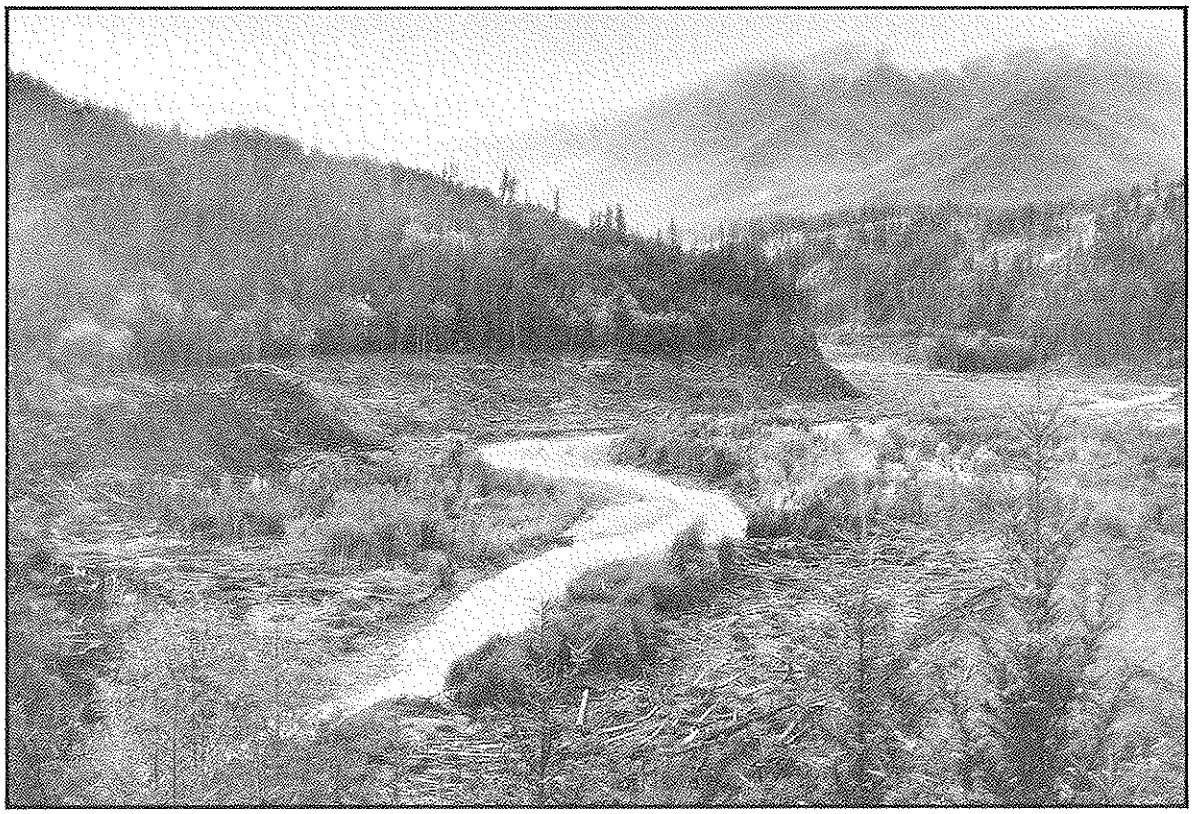
1. Restoration Objectives for the Glines Canyon Project Area. Unlike other management agencies in the Elwha watershed, the National Park Service (NPS) is mandated to conserve and protect native species of plants and animals and to perpetuate natural processes. Consequently, NPS restoration objectives for the Glines Canyon Project involve unique issues or concerns in addition to those shared by other planning agencies. Consistent with NPS mandates and policies, design standards and methodologies for restoration of the Glines Canyon Project (including the Lake Mills reservoir) will be determined based on landscape- or ecosystem-level principles.

Resources unique to Olympic National Park, or those which are limited in their extent on the Olympic Peninsula due to human-induced changes (such as old-growth forest), are of particular concern. Over time, the restored area would attain characteristics of the surrounding area now managed as wilderness and could eventually be proposed for inclusion in wilderness. The restoration process would be carefully designed to meet objectives of full ecosystem restoration and perpetuation of natural processes, and would not preclude an opportunity for eventual wilderness designation. A full description of NPS restoration objectives can be found in Appendix H.

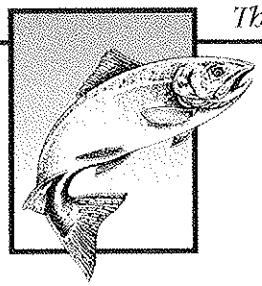
Although precise replication of past conditions is impossible, written records, historic photographs, and rich oral history provide a guide for restoration of the area. Prior to inundation, the area flooded by Lake Mills was a broad alluvial valley (historically known as Smoky Bottom) bordered by steep forested slopes.

Elwha River Valley at "Smoky Bottom," June 1926, prior to construction of Glines Canyon Dam. (F.W. Cleator photo, U.S. Forest Service)





Lake Mills area after logging and prior to inundation. (Date and photographer unknown, Clallam County Historical Society photo)

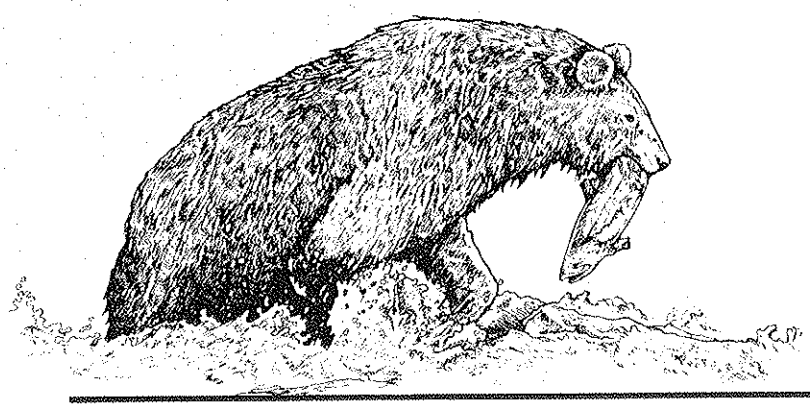


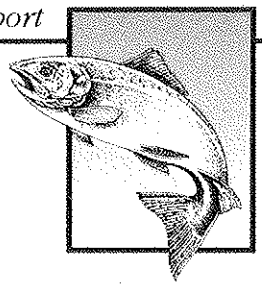
Historical descriptions of the river during this period depict a broad, slightly meandering and locally braided river channel with gravel and cobble bars. The average river gradient in this reach was 1% and channel sinuosity was about 1:1.18 (valley to stream length). The channel was bordered by extensive, level to gently sloping terraces up to 800 feet wide.

Preceding dam construction, the valley was logged. Typical logging practices of the era left much of the "lower-value" softwoods and virtually all of the hardwoods within the reservoir. These logs, other woody debris, and some standing trees, remain on the reservoir floor beneath accumulated silts.

Our Creator gave us this fish to live on . . . and we cherished it, and we respected it . . . we didn't waste it, we used every bit of it . . . I may not see the abundance of fish come back in my lifetime, but I would like to see it come back for my grandchildren, my great-grandchildren, and the rest of my people, the following generations to come. It was a gift from our Creator, it was our culture and heritage.

-Beatrice Charles, tribal elder





2. Restoration Objectives for the Elwha Project Area. The primary objective of the habitat restoration plan for the Elwha Project lands and appurtenant facilities is to restore and protect the ecosystem, including the anadromous fish runs that were affected by the construction of the Elwha Project. To achieve this objective, the plan would include measures to restore the project area's biological, hydrologic and physical processes that occurred prior to the construction of the hydroelectric project. The habitat plan, however, would also include measures to preserve certain biologically important habitats (e.g., wetlands and backwater sloughs) that may have resulted because of the hydroelectric project. See Appendix H for a more detailed discussion of the habitat restoration objectives.

3. Proposed Actions For Reservoir Restoration. The habitat restoration plan must be integrated with the plan for the management of sediments (see Section VI.C(2)). Both plans would be developed in detail and in conjunction with each other during the Environmental Impact Statement (EIS) process. In broad terms, three basic but very diverse approaches have been developed and would be refined, in addition to intermediate options, in the EIS process:

1. The ***Removal*** alternative would mechanically relocate accumulated sediments to a terrestrial or saltwater disposal site.

2. The ***Erosion*** alternative would allow river flow to erode the sediments downstream.

3. The ***Retention*** alternative would relocate and stabilize the sediments in the confines of the existing reservoir areas.

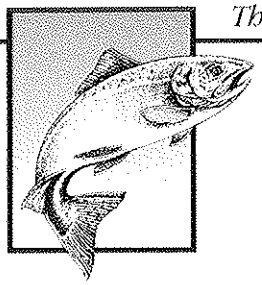
All of these are discussed in Sediment Management Alternatives (Section VI.C(2)).

4. Actions Prior to Dam Removal

a. Initial surveys. Field surveys for sensitive plant species, protected wildlife, and patterns of wildlife use in the reservoir area would be conducted prior to dam removal. These surveys could be completed, in one or two field seasons. Additional investigations, including comprehensive testing of the reservoir's sediments as a growing medium, would also be conducted.

b. Determination of substrate fertility requirements. At least two types of substrate exist in the reservoirs. Coarser delta sediments consist of alternating layers of sand, gravel, and cobbles with organic material, such as tree litter and leaves. This substrate can successfully regenerate vegetation without serious problems or amendments, as evidenced by early successional species (e.g., red alder, willow, sedges, grasses) now established on upland areas of the deltas.

Fine sediments found throughout the remainder of the reservoir basin are more challenging. This material is approximately 75% dark gray and soft silt, 15% clay, and 10% fine sand particles. Laboratory tests demonstrate that overall fertility of this material is low, suggesting that augmentation with organic material and fertilizers would be needed.



Addition of woody debris to the basins during restoration efforts would provide some of the needed organic material for fertility, slope stabilization, and for fish restoration efforts. A potential source of this woody debris is that which remains on the lake bottoms from pre-dam construction logging. This material would become available if washout or silt export scenarios are selected. Otherwise, other sources in the area would be required.

Table 11 shows an analysis of the sediment's chemical composition as compared to typical values of forest soils in Douglas-fir vegetation types. The lake sediments represent a subsoil material type. Comparison values for adjacent forested sites represent samples obtained in the topmost soil layers in the zone of tree root growth. Additional, more comprehensive, soil fertility testing of lake sediments must be completed before the final restoration scenario is selected.

Table 11. *Fertility of Lake Mills fine sediments.*

	Test Values[a]		Mean Values[b]
pH	6.0-6.5		5.4-5.6
Phosphorus [P]	1.0-2.0	PPM	7.4-9.2
Potassium [K]	27-35	PPM	60.8-82.6
Calcium [Ca]	2.3-3.4	MEQ/100g	3.96-10.06
Magnesium [Mg]	0.18-0.44	MEQ/100g	0.35-2.26
Boron	0.18-0.44	PPM	0.62-0.99
Total Nitrogen [N][c]	0.09-0.11	%	0.15-0.22
Organic Matter [OM]	1.5-1.8	%	10.25-10.28
Cation Exchange Capacity [CEC]		MEQ/100g	
Total Bases	2.6-3.9	MEQ/100g	N/A

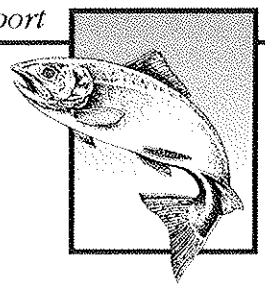
Notes: PPM = parts per million; MEQ = milliequivalents.

[a]Based on samples obtained March 13, 1993 from Boulder Terrace on west side of reservoir; analysis by Central Analytical Laboratory, Corvallis, Oregon.

[b]Within adjacent forested sites, from Henderson et al. (1989). Forested Plant Associations of the Olympic National Forest. *USDA Forest Service, Pacific Northwest Region, Ecological Technical Paper 001-88. Data based on Western hemlock/ Oregongrape/Swordfern and Western hemlock/Salal/Swordfern types. [c]The minimum standard of total N in topsoil needed for conifers is about 0.08% (J. H. Stoeckeler and G.W. Jones. 1957. Forestry nursery practices in the Lake States. U.S. Dept. of Agriculture Handbook 110)*

c. Determination of substrate physical requirements. Physical characteristics of the silt now within the reservoir basins present inherent challenges and limitations to revegetation efforts. The silt has a very uniform particle size, minimizing the likelihood of compaction. However, the use of "chunkwood" to construct temporary haul roads and low pressure central-tire-inflation (CTI) systems on vehicles and heavy equipment would further minimize problems associated with compaction.

When dried, the fine silt forms a crust which is resistant or impervious to water uptake. Completely dried material may be susceptible to wind erosion if redisturbed by vehicles or machinery. The texture of this material when piled to any depth greater than 2 to 3 feet may be physically incapable of supporting larger trees and woody shrubs, and it may be quite unstable on slopes. These factors suggest that silt left in the basins must be mixed with larger particle sizes (sand, gravels) to sustain stabilizing vegetation. Additional testing would be conducted to determine optimal distribution



and ratios of coarse-to-fine sediments within the basins, and optimal slopes for the purposes of revegetation.

d. Plant propagation. Sufficient quantities of seeds, cones, and cuttings from native species would be necessary. Within Olympic National Park, National Park Service policy would limit collection of these materials to the Elwha Valley, with adherence to appropriate elevation zone boundaries to protect the integrity of native gene pools. While a less restrictive policy would be possible for the Elwha Project, a similar approach using native plant species and Elwha basin stock is anticipated. The use of native plant stock from outside the drainage would be possible, however, if sufficient quantities of seeds, cones, and cuttings were not available. A minimum of 2 to 3 years lead time prior to when plantings are needed would be necessary to ensure adequate inventories.

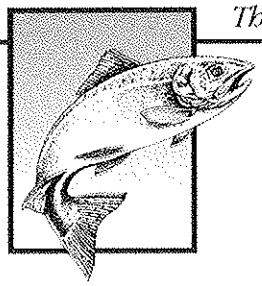
Modifications to support the revegetation program may include adaptive use of existing sites or facilities in the Elwha Subdistrict of Olympic National Park. For example, a 23-acre meadow just south of the Elwha entrance to the Park could be used as a nursery for propagation of plant materials. In addition to supporting the restoration effort, this site could be used for interpreting native plant propagation techniques to the public.

e. Exotic plant species control. To address concerns regarding control of exotic plant species, an aggressive program to control or eradicate high-threat exotic species in the vicinity of the reservoirs and along access roads would be initiated. Steps to prevent new introductions could also be implemented, such as vehicle and equipment wash areas, and contract requirements regarding use of clean materials from weed-free sources. Exotics that may become established on newly exposed substrate of the reservoir after dewatering would be eradicated. Noxious exotics, such as Scot's broom, can prevent tree establishment. Their occurrence and spread would compromise success of revegetation efforts. The seriousness of this potential, and effects on seemingly unrelated issues such as fish restoration, must not be underestimated.

f. Operational modifications. A preliminary plan for managing visitor use and access to recreational facilities would be developed. Area closures, some for extended periods, would likely be required.

g. Costs - Actions prior to dam removal. Costs for habitat restoration preparation activities within the park may range up to $197,000 (Appendix H). For the Elwha Project, a lower level of funding (about $50,000) would be needed for this activity because of the smaller acreage involved and the sharing of research information.

5. Actions During Dam Removal. Habitat restoration actions during dam removal would occur in two phases: (1) immediate, short-term measures to provide erosion control and form a suitable substrate and organic layer for native species regeneration, and (2) initiation of a sequential, recurring revegetation program designed to provide permanent establishment of natural vegetation cover (described



in the next section). The feasibility and success of each phase is predicated on establishment of a naturally functioning but relatively stable river channel within the valley floodplain.

a. Timing. The timing of dam removal would greatly influence success of the initial revegetation program, and other projects associated with river restoration. Most revegetation activities must be accomplished in the spring, or in time to allow plant establishment prior to exposure to winter rains. Timing would be included as a primary factor to be addressed in the EIS.

b. Erosion control techniques, short-term. As dewatering of the reservoir proceeds, immediate erosion control techniques would be employed to stabilize newly exposed sediments in areas that have achieved their final contouring, either by active dredging or through river washout. Characteristics of these sediments would determine the choice of techniques.

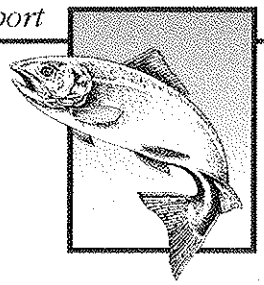
As the material is exposed, but prior to drying, boat-based hydroseeding would apply seed of an approved exotic *sterile* species, such as crested wheatgrass, or a common native grass such as western fescue. These species grow quite rapidly and would provide immediate, short-term sediment stabilization. Helicopter hydroseeding would be required on areas inaccessible by boat. Seeds of selected native plant species could be added to the hydroseed mix as available. Clovers, woolly vetch, and other rapidly growing, nitrogen-fixing species would also be appropriate. Repeat treatments of hydroseeding would likely be required as some seeding failure and unavoidable mortality is expected.

Additionally, in erosion-prone areas, such as the mouths of tributary creeks or the base of slopes beneath cliffs and rock outcrops, the use of mulches, geotextiles, or approved synthetic soil stabilization chemicals may be necessary, perhaps augmented by "bioengineered" slope protection techniques. Bioengineering combines engineering and horticulture principles in an integrated and environmentally compatible way, to prevent erosion and soil loss. Plant materials, initially or over time, become the main sustaining structural element to establish a living, earth-reinforcing native plant community capable of self repair and self support. Techniques such as contouring, wattling, brush layering, live-staking, brush matting, geotextiles, and various earth-retaining structures (geocells, gabions, crib walls, revetments) could all be used as appropriate.



Bioengineered slopes have a self-sustaining nature that can provide immediate stream bank stability, and they are designed to be effective even before plants become fully established. The plants also assist in dewatering soil masses as they grow, thus the structures become increasingly stable over time. Bioengineering may also be integrated with more traditional "hard" erosion control structures such as riprap.

c. In-stream measures. In addition to revegetation of terrestrial areas, some rehabilitation within the river channel could be employed to meet objectives for



creation of fluvial habitat. This could include creating bank overhangs, installing logs or large boulders to break streamflow, anchoring root wads or snags within the stream channel, placing substrate materials (spawning gravels), installing tree revetments along banks to reduce water velocity and scouring, and other measures to provide fish rearing and resting areas. These techniques would be particularly appropriate near the mouths of tributary streams at the junction with the main river channel.

Some measures to accelerate recovery of macroinvertebrates could also be desirable. Suitable habitat for in-stream fauna can be created through the introduction of organic matter (litter). Otherwise, recovery is expected to occur through natural recolonization.

d. Powerline corridors. The powerline corridors will be restored by removing electrical lines and utility poles followed by hand-planting of trees. The used poles can be recycled into the reservoir restoration process as a source of woody debris. Below-ground portions of the poles, which have been creosoted, will be cutoff and separated for disposal following hazardous material guidelines.

e. Costs - Actions during dam removal. Depending on the final design of the restored river channel and the sediment management scenario, up to 370 acres would require treatment at an estimated cost of $2.013 million, of which $758,000 would be required for preparatory work. For Lake Aldwell, up to 200 acres would require treatment at an estimated cost of $1.488 million, including $450,000 for preparatory work.

6. Actions Following Dam Removal. The second phase of reservoir restoration would occur after dam removal; it would involve planting early successional species on areas stabilized using short-term measures described above. Nitrogen-fixing and typical pioneering species would be used for this phase of restoration, including red alder, willow, black cottonwood, several shrub species, and native herbs and forbs of natural seral successional stages.

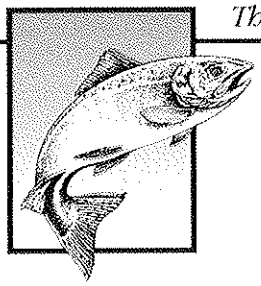
a. Habitat restoration. Planting density and plant spacing would be designed to replicate natural community species composition and structure over time. For each habitat type, a specific planting prescription would be developed using species selected for ease of seed collection, propagation, and ability to withstand handling and transplanting stress. Preliminary stocking requirements have been developed as follows.

(1) Lowland/Montane Forest

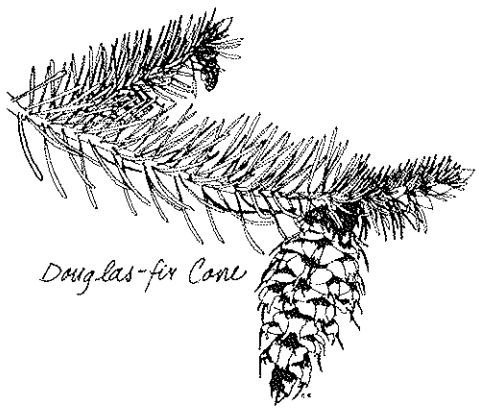
Uneven-age Douglas-fir seedlings mixed with smaller quantities of grand fir, western red-cedar, and western hemlock at a variable stocking rate of approximately 400-500 seedlings per acre for 270/55 acres (Lake Mills/Lake Aldwell).

(2) Mixed Conifer/Hardwood Forest

Douglas-fir, grand fir, red alder, black cottonwood, and bigleaf maple seedlings at highly variable stocking rates between 100 and 600 seedlings per acre for 50/100 acres (Lake Mills/Lake Aldwell).



(3) Riparian/Streamside
Willow/shrub and sedge/rush communities; these species are expected to naturally invade the area in a manner similar to pioneering vegetation on the delta. Supplemental planting might be used if natural establishment is slow on 35/35 acres (Lake Mills/Lake Aldwell).



(4) Rock Outcrops
Planting is not feasible on these steep areas totaling 10/5 acres (Lake Mills/Lake Aldwell).

(5) Special Communities
Narrow strip planting of red alder, sitka alder, willow, vine maple, or other moist-site tree, shrub, and herb species. Variable stocking rates depending on site characteristics for 15/5 acres (Lake Mills/Lake Aldwell).

Minus the 15 acres associated with rock outcrops, revegetation is expected to occur on a total of 570 acres within the currently inundated areas of Lake Mills and Lake Aldwell. Hand planting of these species is expected to occur over 1 year initially, followed by up to two additional years, if required. Overseeding by helicopter of some hand planted areas using other native species could be required to obtain near natural stocking levels. Natural stocking levels would help prevent invasion by exotic species and ensure that representative "indicator" species are reestablished. Additionally, this intensive planting effort would be supplemented by natural seeding of the area from adjacent undisturbed forests on the former reservoir shoreline, although this natural seeding would not substitute for active planting efforts.

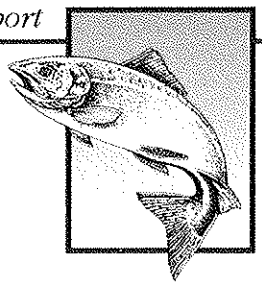
Aerial fertilization, broadcast applications of mycorrhizal inoculants, and measures to protect new seedlings from elk, deer, and rodent predation could be required. Control of exotic species invasion would also continue, as necessary.

b. Costs - Actions following dam removal. Costs for habitat restoration activities following dam removal are estimated to be $370,000 and $200,000 for Lake Mills and Lake Aldwell, respectively.

7. Long-Term Actions. Long-term actions would primarily involve monitoring of revegetation and potential follow-up treatment of problem areas. As vegetation becomes established and recovery proceeds, most areas of the former reservoir would become inaccessible except by foot. This would limit opportunities to repair areas of revegetation failure.

Restoration of haul roads, parking, and staging areas used during sediment stabilization would be necessary. Continued monitoring for and control of exotic plant species would also be required. The fate of planted areas and potential problems arising from disease, insects, or pest animals would require some level of monitoring and active management into the future.

Surveys to document recolonization of the former inundated areas by wildlife species



would also be conducted. Documentation of recovery and cooperation with research projects would continue throughout the restoration program.

a. Costs - Long-term actions. Totals of $265,000 and $108,000 would be needed for this phase for Lake Mills and Lake Aldwell, respectively. Additional details on these costs can be found in Appendix H.

b. Total costs. Total habitat restoration costs for the Lake Mills and Lake Aldwell areas are $3.6 million and $2.3 million, respectively.

I. Disposition of Project Lands

Pursuant to P.L. 102-495, the Secretary of the Interior was directed to identify:

> Specific proposals for management of all lands or interests therein acquired pursuant to this Act which are located outside the exterior boundaries of the Olympic National Park. The Secretary shall specifically address the suitability of such lands, or portions thereof, for addition to the National Wildlife Refuge System; National Park System; transfer to the Lower Elwha Klallam Tribe in trust for tribal housing, cultural, or economic development purposes in accordance with a plan developed by the Lower Elwha Klallam Tribe in consultation with the Secretary; and development and use by the State.

The Act further directs that all lands and interests within the exterior boundaries of Olympic National Park (approximately 160 acres) shall be managed pursuant to authorities otherwise available to the Park.

The following options for the disposition of the Elwha Project lands have been considered.

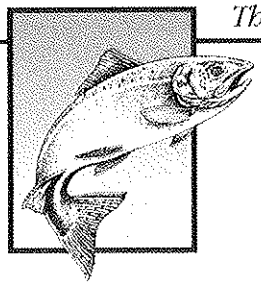
1. Addition to the National Wildlife Refuge System. The U.S. Fish and Wildlife Service (USFWS) has conducted a feasibility study on the suitability of the Elwha Project lands for the establishment of a National Fish and Wildlife Refuge. The conclusion of the USFWS feasibility study was that the Elwha Project lands do not encompass enough of the Elwha River corridor to support a refuge on Project lands. However, the USFWS is interested in pursuing a cooperative management arrangement whereby the USFWS would assist other entities (e.g., Federal and State agencies, the Lower Elwha S'Klallam Tribe, local governments, and other organizations) in fisheries and habitat management on Project lands.



Bald Eagle

2. Addition to the National Park System. Public Law 101-628 requires the National Park Service to apply certain specific criteria to proposed or potential boundary adjustments. For the Elwha Project lands to be added to Olympic National Park, the following conditions would need to be applied to determine appropriateness:

a. The lands provide significant resources or opportunities for public enjoyment related to the purposes of the park.



b. The lands address operational and management issues such as access and boundary identification by topographic or other natural features or roads.

c. The lands would protect park resources critical to fulfilling the park's purposes.

d. The added lands would be feasible to administer considering size, configuration, ownerships, costs, and other factors.

e. Other alternatives for management and resource protection are not adequate.

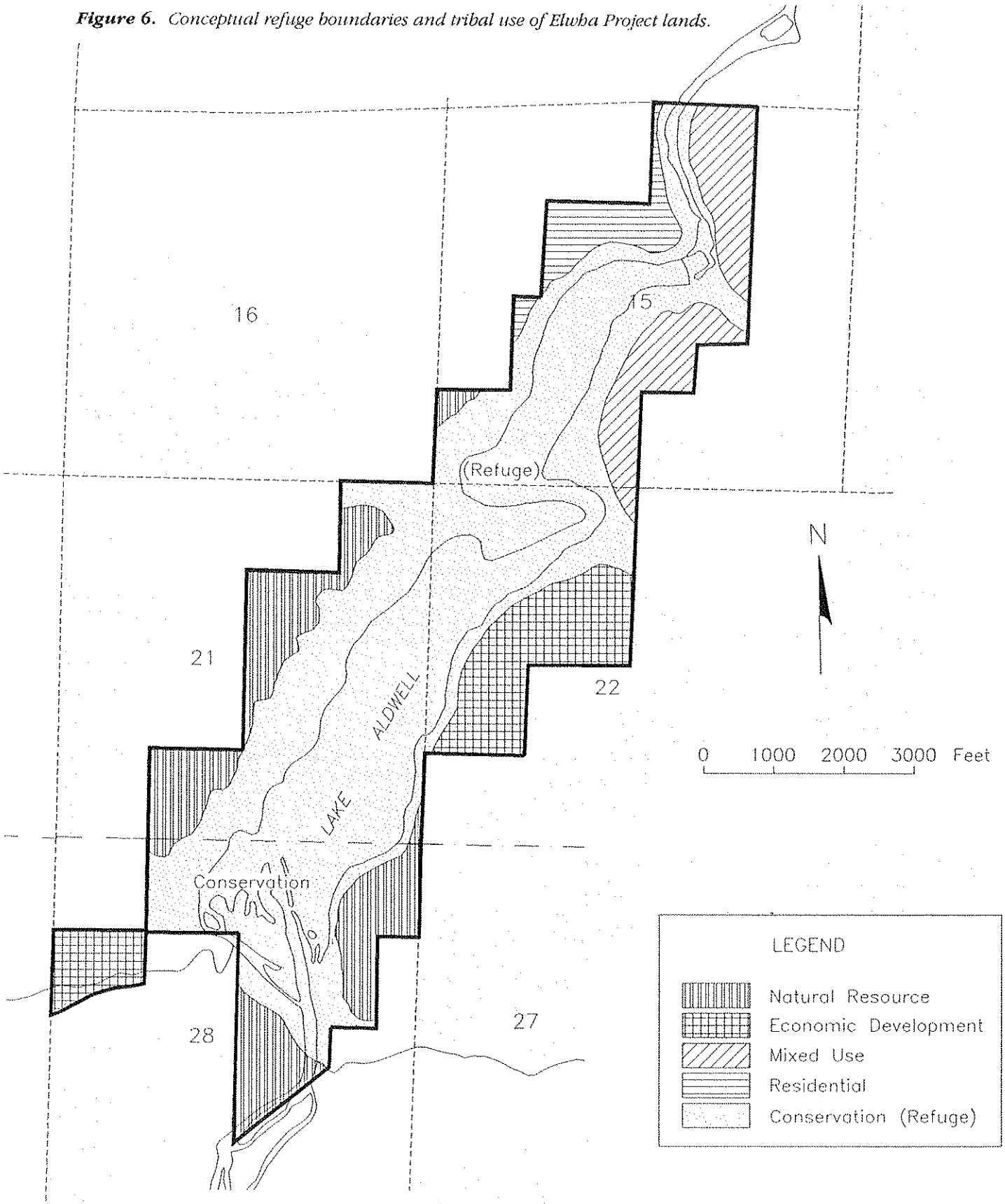
Based on the above criteria, it appears that the Elwha Project lands would be suitable for addition to Olympic National Park, provided full timber rights are also acquired. Such a boundary adjustment would require an act of Congress.

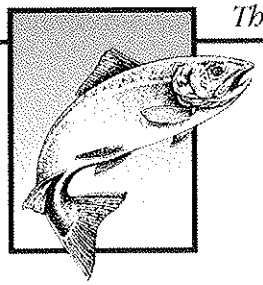
3. Transfer to the Lower Elwha S'Klallam Tribe. The Lower Elwha S'Klallam Tribe is interested in trust ownership of land that will sustain limited development for badly needed housing and economic development. Residential and economic development of project lands outside of the central river corridor (and outside of the external boundaries of Olympic National Park) could help meet long-term Tribal objectives without adversely impacting restoration of the ecosystem and the fisheries. The Tribe has proposed general land use designations for the Lake Aldwell project lands, based on environmental constraints, natural, environmental and cultural resources, environmental carrying capacity and tribal development objectives (Figure 6). Development activities on these lands would be guided by a tribal land use plan currently in progress. Land use planning efforts would focus on methods to determine and manage an appropriate quantity and density of development, while protecting the river ecosystem and maintaining the scenic attraction of the area.

Protection of the river and restoration of the fishery is of the utmost importance to the Elwha Tribe. The Tribe fully supports management of the central river corridor to protect the fish and wildlife resources of the Elwha River. These lands also contain traditional and cultural properties of great significance to the Elwha Tribe. The Tribe is interested in management of these lands for cultural purposes, including hunting, fishing, spiritual practices and sustainable gathering of resources. Creation of a conservation or refuge area would preserve the area and help to fulfill river restoration objectives. At this time, the Tribe does not have sufficient financial or technical resources to assume full responsibility for restoration and management of conservation lands. However, the Tribe is willing to explore the possibility of a cooperative venture to restore and manage the river corridor, and could eventually assume management responsibility for the project lands outside the park. Additional information on the Tribe's proposal is provided in Appendix I.

4. Development and Use by the State. The Washington State Department of Natural Resources (WDNR) has stated that WDNR is "disinterested in acquiring or managing the upland that would be exposed when the existing reservoirs are drained." No other State agency has formally commented, although

Figure 6. *Conceptual refuge boundaries and tribal use of Elwha Project lands.*





informal discussions indicate that the State is not interested in managing or using the Elwha Project lands.

The above analyses focused on the suitability of managing the Elwha Project lands, consistent with the provision that the "Federal investment in restoration" be protected, by a single entity. Cooperative management approaches with multiple entities (i.e., National Park Service, Fish and Wildlife Service, Tribe, and/or State) may be more practical. Further analysis and discussion would be necessary during the EIS/advanced planning stage to identify the preferred option.

5. Management of Glines Canyon Project Lands. In contrast to the Elwha Project, the Glines Canyon Project lies within Olympic National Park. Public Law 102-495 specifies that,

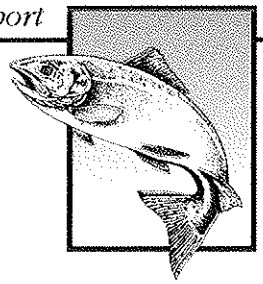
> Upon acquisition, all lands and interests therein within the exterior boundaries of the Park shall be managed pursuant to authorities otherwise applicable to the Park.

A number of options for the management of lands associated with the Glines Canyon Project, consistent with National Park Service authorities, are available and can be found in Appendix I. Generally, these lands would be managed for natural processes while accommodating recreational interests. Ultimately, restored areas could receive Wilderness designation by Congress.

J. Interpretation of Dam Removal

1. Need for Interpretation. Removal of the Elwha and Glines Canyon dams would be of national interest resulting in wide publicity. For years to come, curiosity could increase visitation to the park by people who want to get a firsthand view and the inside story of this historic event.

2. Interpretive Themes. Interpretation of the removal of the dams would be complex, incorporating viewpoints of several agencies, governments, and public interest groups at several sites. Consequently, the interpretive program should consist of diverse biological, cultural, governmental, and technical information. Issues to address could include (1) a description of the physical and operational characteristics of the dams, (2) a description of the processes associated with the removal of the dams, (3) an objective and nonjudgmental discussion of society's changing values as scientific knowledge has increased and resources have become more scarce, (4) the cultural impacts, especially the Tribe's traditional dependence upon the Elwha River for subsistence, the S'Klallam Creation site under Lake Aldwell, the history of S'Klallam Village at the confluence of Indian Creek and the Elwha River, (5) the hydrological and geological dynamics and changing landscape associated with the construction and removal of the dams, (6) the interdependent biological responses of fish, wildlife, and plants to the foregoing, (7) the obligations and objectives of the agencies managing these resources, and (8) the extensive interagency cooperation and coordination required for this effort.



3. Scale of Interpretation. To achieve the objectives in an effective manner, interpretive design and duties must be shared between the various participating agencies and governments. Towards that end, a single, comprehensive interpretive plan should be cooperatively developed.

Interpretation of the Elwha Project would involve programs at several sites. Because individual visitors may not visit each site, interpretation at each site should include elements of each of the points enumerated above. However, each site would have a unique message.

4. Benefits of Interpretation. Development of a program and facilities to provide interpretation of dam removal and river restoration would provide important information to local citizens and visitors to the Olympic Peninsula. An interpretive program would contribute to environmental education efforts surrounding river restoration, and provide an opportunity to foster public awareness, understanding, and support for restoration and the many reasons behind it.

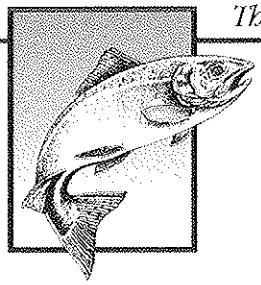
5. Costs. Capital costs would vary from $600,000 to $7 million depending upon the facility options selected (see Appendix J). Ongoing salary and benefits and 5% support operating costs would be $135,000 in 1992 dollars.

K. Living Laboratory

Removal of the Elwha and Glines Canyon dams provides a unique opportunity to study and evaluate the physical removal of two large dams and the resulting restoration of physical, hydrological, and biological processes. Although a number of dams have been removed in the Pacific Northwest, they were not as tall as the Elwha and Glines Canyon dams (Winter 1990). Even though no efforts were made during the removal of those dams to manage the accumulated sediments (the structures were simply dynamited), the removals had less potential for impacts, positive or negative, to anadromous fish.

There is great interest in making use of the Elwha River basin as a "Living Laboratory" because it provides a unique opportunity to develop and evaluate watershed and ecosystem restoration techniques that would have value elsewhere. This would be expected to lead to greater efficiencies in restoration efforts throughout the Pacific Northwest. To fully explore this concept, an expert panel consisting of fish and wildlife biologists, ecologists, silviculturists, hydrologists, soil scientists, and other specialists would be convened to develop a study plan to monitor changes to the ecosystem resulting from dam removal. The expert panel would be drawn from, among others, the National Biological Survey, U.S. Fish and Wildlife Service, National Park Service, National Oceanic and Atmospheric Administration, Forest Service, Bureau of Reclamation, universities, Washington State agencies, and Tribes. The National Park Service and/or Fish and Wildlife Service would provide oversight for this effort and would disseminate the information collected.

Given the interest in studying the restoration of the Elwha River following dam



removal, cost-sharing could be available for many studies. Although further identification of needed studies and the associated costs is necessary, a preliminary estimate of the costs to the Federal Government to oversee this effort and provide some level of financial support for participants is in the range of $400,000 to $500,000 per year. Ideally, the study program would continue for about 10 years following dam removal. A general list of proposed studies is provided in Appendix K.

L. Impacts to Cultural Resources



1. Types of Cultural Resources. The Elwha and Glines Canyon projects are both listed on the National Register of Historic Places. Additional cultural sites include Indian homesteads, seasonal camps, and the remains of a cable ferry. These sites have not been evaluated for the National Register.

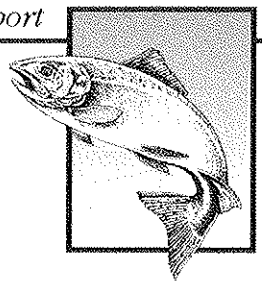
The Elwha S'Klallam lived in and utilized the Elwha River basin for thousands of years. Villages and fish camps, archaeological treasures, traditional cultural properties, tribal history and tribal culture are all integrally connected to the watershed and river system. Although there are several areas of particular significance to the S'Klallam within the Elwha valley (and particularly within the Lake Aldwell project area), the S'Klallam inhabited the entire area and have strong cultural and spiritual ties to the entire ecosystem. The river system was accorded immense respect. In addition to providing the resources necessary for daily living, it formed the S'Klallam's ceremonial, cultural and spiritual values. Because it was the heart of the culture and the economy, the whole river is a cultural resource. See Appendix L for a further discussion of cultural resources.

Significant archeological and ethnographic resources include homesteads, village sites, seasonal camps, and spiritual places. Anthropologists contracted by the National Park Service and the Lower Elwha S'Klallam Tribe are conducting further site identifications.

2. Status of Cultural Resources. The river ecosystem itself is a cultural resource of immense value to the Elwha S'Klallam. Restoration of the free-flowing river and its attendant wildlife and fish habitat would mean a revival of the cultural values that were impaired by dam construction. The cultural resource that is the Elwha River ecosystem would be restored as restoration projects are implemented, and as the Elwha S'Klallam are able to return to the area to practice traditional activities upon which their culture was formed, including fishing, gathering of natural resources and the practice of their traditional, resource based spirituality.

The majority of known archeological and ethnographic resources have been severely impacted by the Elwha and Glines Canyon projects as they are either inundated or buried by the silt that has accumulated behind the dams. The rapid release of water in 1912, as a result of the failure of the Elwha Dam foundation, would have further reduced the number and integrity of sites in the valley.

Both Projects were listed on the National Register because they retained a high degree



of integrity from the original construction. They would be destroyed during dam removal, an "adverse effect" under the 36CFR800 regulations implementing Section 106 of the National Historic Preservation Act.

3. Recommendations for Treatment/Mitigation. If the dams are removed, an initial archeological survey and ethnographic survey and ethnohistorical study would be needed to document resources within the Project area. Following this work, the recommended course of action to protect archeological sites during and after dam removal would be to monitor the reservoir as the river cuts through the sediments that layer the bottoms of the reservoirs. Archeological materials would be tested if they are encountered. Recommended mitigation for removal of the dams is documentation according to Level I standards for the Historic American Engineering Record (HAER) and interpretation of the dams on-site and at other sites to be determined. Also recommended is documentation of the dam removal by regular-interval photographs. Additional details are provided in Appendix L.

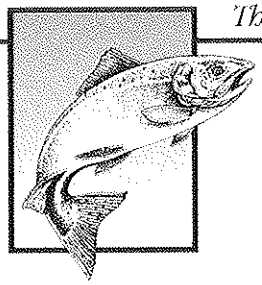
Ethnographic sites would be documented and evaluated for National Register eligibility. Those areas that are significant would be nominated to the National Register, pending approval by the Tribe. Those sites that have the potential to be affected by dam removal would be avoided. Any mitigation would be carried out in full consultation with the Tribe.

Restoring traditional cultural properties is a different task than conducting archaeological surveys or documenting characteristics of a physical entity such as the dams. It is an undertaking that would occur as the area itself recovers from the ravages of the last century of development and habitat destruction. Interpretive programs that help foster a cultural exchange among visitors to the area, tribal members, and other local residents would also help to increase recognition of the diversity of values represented by the river.

4. Costs. The total costs for an initial archeological survey, an ethnographic survey and ethnohistorical study, documentation of the dams to HAER standards, and documentation of dam removal is estimated at $204,400. The costs of monitoring during dam removal would be $15,000 per year for about 5-10 years.

M. Impacts on Regional Power Supply

The Pacific Northwest is currently facing an electric power deficit. Though future loads are not known with certainty, current load forecasts show new resource requirements in 1997 of 1,700 average megawatts (aMW) under medium-low load growth rates to about 2,900 aMW under medium-high load growth (1991 baseline). These firm energy deficits are a result of recent economic growth, early shutdown of the Trojan nuclear plant, and reductions in the generating capability of the Columbia River hydropower system to support fishery mitigation. Because of this continuing need for new resources, replacement resources will need to be acquired if the dams are removed. Hence, the value of lost power from removal of the Elwha Projects would be equal to the cost of replacement power. In order to meet the Pacific Northwest's future need



for firm energy, Northwest utilities and the Bonneville Power Administration (BPA) are aggressively pursuing conservation and generating resources.

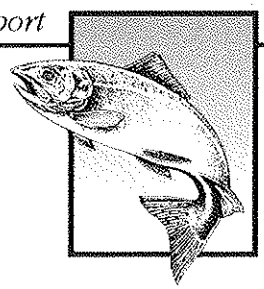
1. Available Replacement Resources. The Northwest Power Planning Council (Council), BPA, and the major Northwest utilities use least-cost integrated resource planning methods to determine future resource needs. These planning efforts, and actual resource acquisition experiences consistently indicate that energy-efficiency improvements (conservation), certain renewable resources and natural gas generation and cogeneration are the most promising resources for meeting future Northwest electrical needs. The cost and availability of these and other resources are described in the following paragraphs. These estimates are from the regional power council and are based on economic potential adjusted for constraints to development (i.e., the actual amount of the resource expected to be available for development over the next two decades):

End-use Conservation: Measures to improve the efficiency of residential, commercial, industrial and agricultural end uses of electricity. Included are building thermal shell improvements and high efficiency lighting, refrigeration, motors and pumps. From 1,500 to 3,000 megawatts of energy is available from end-use conservation at 2.6 to 11 cents per kilowatt-hour. Incentive programs, codes and standards are used to secure end-use conservation because the acquisition decision is generally in the hands of the end user, not the utility, and the benefits are often spread between the end user and the utility. Though the process of conservation acquisition is difficult, Northwest utilities have been successful in meeting regional end-use conservation goals.

Utility System Efficiency Improvements: Measures to improve the efficiency of power generation, transmission and distribution. These include improved hydropower turbine runners and governors, improved steam turbine blading, high-efficiency transformers, higher-capacity transmission and distribution circuits and improved voltage regulation. An estimated 370 megawatts of energy is available from such measures at 0.1 to 13 cents per kilowatt-hour. Utilities have been successful in meeting regional goals for system efficiency improvements.

Biomass: Combustible organic residues of forest products and agricultural operations, and energy crops. Small (5 to 50 megawatt) boiler-steam turbine generation or cogeneration plants are typically used to generate electricity from biomass. An estimated 670 megawatts of energy is available from biomass at costs of 5.9 to 15 cents per kilowatt-hour. Few new biomass plants are being developed, largely because of the low cost of competing gas-fired combined-cycle power plants and more productive use of materials formerly considered as residue.

Geothermal: Heat contained within the earth, often available as hot water or brine. Various technologies, many well-established, are used to generate electricity from geothermal fluids. Considerable geothermal potential is thought to exist in the Northwest, but the extent and nature of specific resources are not well understood. Though the environmental effects of geothermal development can be managed, the



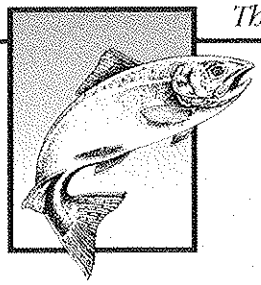
environmental sensitivity of the areas in which geothermal resources are located is expected to add to the difficulty of development. Pilot generation projects are underway to improve understanding of the resource and effects of its use. An estimated 350 megawatts of energy is available from geothermal power plants at costs averaging 11 cents per kilowatt-hour. Low temperature geothermal fluids are used for space and water heating in several Northwest communities.

Hydropower: Expansions of existing hydropower projects, small (one to five megawatt) projects on irrigation and other offstream water systems and small headwater diversion projects. From 120 to 900 megawatts of energy is available from new hydropower projects at 2.4 to 13 cents per kilowatt-hour. Hydropower licensing is prolonged and difficult because of public concerns arising from the environmental effects of existing hydropower development. However, utilities and developers have been successful in meeting regional goals for new hydropower development.

Natural Gas: Combustion gas turbines (similar to jet engines) in simple cycle or the more efficient combined-cycle configuration are used to generate electricity from natural gas. In a combined-cycle plant, the hot gas turbine exhaust is used to generate steam to drive a secondary steam turbine-generator. Combined-cycle plants range from about 100 to 500 megawatts capacity. Continued low gas costs, low capital costs, high efficiency, short development times, operational flexibility and modest environmental impacts have led to natural gas-fired combustion turbines becoming the generating resource of choice in the Northwest and elsewhere. To date, little difficulty has been experienced in developing gas-fired power plants, particularly cogeneration plants jointly producing electricity and useful thermal energy for industrial processes. There is no obvious limit on the number of gas-fired plants that could be built, but utilities hesitate to rely exclusively on natural gas for new energy requirements because of fuel price risk, air quality considerations and global warming concerns. An estimated 4,200 megawatts of energy could be secured from natural gas-fired power plants at 5.9 to 12 cents per kilowatt-hour.

Nuclear Power: An estimated 1,700 megawatts of energy could be secured from the partially-completed WNP-1 and WNP-3 at 8.5 to 9.3 cents per kilowatt-hour. These units have been preserved as insurance against high load growth, rapid increases in fossil fuel prices or other conditions requiring large new resources. Because of the continuing availability of competitively priced natural gas, moderate load growth rates, the economic risk associated with these large plants, and recent retirement of the Trojan nuclear plant, it is increasingly unlikely that WNP-1 or WNP-3 would be considered when seeking new power supplies. It is highly unlikely that new nuclear plants would be considered until nuclear waste disposal issues are resolved and smaller, less expensive and more reliable nuclear designs are available. These issues will be not resolved for many years.

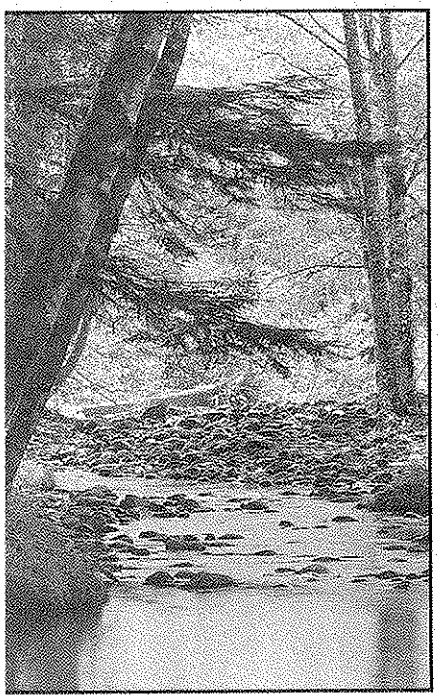
Ocean: Various forms of ocean energy, including that of waves, tides, currents and salinity and thermal gradients have been proposed for generating electric power. Only wave energy currently offers significant potential in the Northwest, perhaps several hundred megawatts of energy. The commercial development of wave energy power



plants is limited by immature technology, harsh maritime conditions and likely aesthetic objections to coastal wave power plants.

Refuse Fuels: Combustible solid refuse and landfill gas. Small (5 to 25 megawatt) boiler-steam turbine power plants are used to generate electricity from solid refuse. Small (1 to 5 megawatt) engine-generators are used to generate power from landfill gas. Although fuel is available in the region to support several hundred megawatts of solid waste generation, these plants have been exceedingly difficult to develop because of public concerns regarding air quality and local waste transportation. In contrast, development of generating plants using recovered landfill gas has been relatively easy. An estimated 120 megawatts of energy are available from new solid refuse power plants at costs averaging 8.1 cents per kilowatt-hour.

Solar: Electricity can be generated from solar energy using boiler-turbine thermal power plants or by photovoltaics. Photovoltaics is commercially available, but expensive (15 to 30 cents per kilowatt-hour). It is widely used for kilowatt-scale remote applications. Some solar thermal technologies are in commercial service and others are under development. Costs range upward from 16 cents per kilowatt-hour. Good solar potential is available in southern Idaho and Eastern Oregon, but is more limited elsewhere in the Northwest. Solar development in the Northwest is complicated by the non-coincidence of the summer solar peak and the winter peak electric loads.

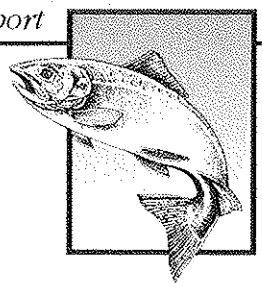


Side channel of Elwha River. (Janis Burger)

Wind: Electricity is generated from wind by tower-mounted wind turbines in groups of up to several hundred machines. This is an established technology, but one that has economic difficulty competing with gas-fired combined-cycle power plants. Some proposed windpower plants have met with significant public opposition, primarily becaue of aesthetic concerns. An estimated 660 average megawatts of energy is available from new wind power plants at costs ranging from 9.5 to 17 cents per kilowatt-hour. Because of recent technology improvements, these costs are thought to have declined by 15 percent or so.

One of the ways BPA is addressing the uncertainty associated with resource development is its Resource Contingency Program. This program will allow BPA to complete the permitting and environmental work on a selected number of resources so they will be available to the region for development in a more timely fashion. Unfortunately, Northwest utilities and BPA are in the early stages of their generating resource development plans and it will only become clear what types of projects and how many megawatts are actually feasible at a reasonable cost and in a reasonable time frame as the region gains more experience.

Because of cost-effectiveness and environmental attributes, acquisition of cost-effective conservation has been accorded the highest priority by the Council, BPA, and the region's utilities. The Council's goal for regionwide acquisition of at least 1,500 aMW of conservation over a 10 year period has been adopted by BPA, the state utility commissions, and the principal regional utilities. Evidence to date indicates that actual rates of conservation acquisition are consistent with this goal. However,



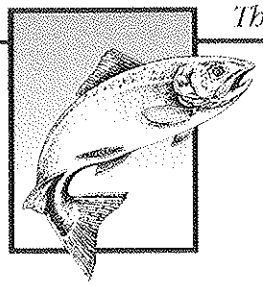
conservation resources, though abundant, are not sufficient to meet expected regional needs. To meet needs in excess of that provided for by energy-efficiency improvements, utilities are acquiring generating resources either through development of utility-owned generating projects or by contracting for independently-owned facilities. Overall, these efforts have been successful to date, leading to the conclusion that replacement of power output of the Elwha Projects is feasible.

Electricity lost due to the retirement of one or both of the Elwha Hydroelectic Projects could be supplied by either Daishowa or Port Angeles City Light. Daishowa could choose to develop replacement resources itself, or to purchase from independent power producers, other utilities or power brokers. Port Angeles, likewise, could choose to develop replacement resources itself, to purchase from independent power producers, other utilities or power brokers or to place additional load on the BPA. Because P.L. 102-495 requires the BPA to deliver replacement power through the local preference customer (Port Angeles City Light), this study assumes that replacement power would be supplied by the BPA.

The replacement energy could be supplied by locally-developed conservation and generating resources to the extent that cost-effective local resources are available, or could be supplied from BPA general system resources. Because locally-developed resources may offer distributed system benefits, it would be prudent for BPA to assess avoided transmission costs and other distributed system benefits, and to undertake an assessment of local opportunities for development of replacement resources, considering distributed system benefits. Resources that should be considered include end-use and utility conservation measures, biomass generation and cogeneration, direct-use geothermal, small hydropower, solid refuse generation, landfill gas generation and wind power.

If replacement energy is secured from BPA's system, it is unlikely that BPA would undertake specific actions to replace the lost power. Rather, the ongoing acquisition of projects would be slightly advanced in time to cover the need created by the Elwha retirements. These acquisitions would likely include conservation, natural gas generation and cogeneration, small hydropower, and other renewables and would be secured through BPA's Customer Billing Credits Program, negotiated exchanges and other interregional transactions, BPA's Resource Contingency Program, or unsolicited proposals.

2. Cost of Replacement Power. The cost of securing replacement power for the Elwha Projects was estimated by calculating the present value of future costs of the Northwest power system for two cases. The base case assumed continued operation of both Projects until 2047. The alternative case assumed retirement of both Projects in 1997. The present value difference in costs between these two cases is the estimated cost of securing replacement power. Uncertainties regarding future load, fuel price, and annual hydropower were explicitly modelled. Replacement resources were drawn from the stack of resources expected to be available to regional utilities in order of cost-effectiveness. No mitigation costs for licensing Elwha or Glines Canyon were included in the base case and no decommissioning costs or foregone



operation and maintenance costs were included in the alternative case. The present value of these costs can be separately calculated (using a 7.12% (nominal) discount rate) to determine the net cost of a specific alternative.

The present value cost of replacement power for the two projects over a 50 year period following retirement is estimated to range from $20 to $300 million (1990 dollars), with an expected value of $125 million. The range is attributable to the uncertainties cited in the above paragraph.

Mean annual incremental replacement power costs are estimated to be $4.1 million (1990 dollars) immediately following retirement. Annual replacement power costs will likely gradually increase over the life of replacement resources because of anticipated natural gas price escalation. The average mean annual replacement power cost over the 50 years following retirement of the Elwha Projects is estimated to be $6.3 million. Year-to-year variations will occur because of short-term fluctuations in load growth, fuel prices, and hydropower availability.

3. Environmental Consequences. The environmental consequences of securing replacement power for the Elwha Projects, other than conservation, includes the incremental air, water, and land effects of constructing and operating replacement resources. The resulting releases of key air pollutants and carbon dioxide can be estimated. Other environmental effects would be largely project-specific and can only be generally described prior to the identification of specific replacement resources. Potential adverse environmental impacts could be offset by the positive environmental consequences of removing the Elwha Projects (see Section V(D)). The quantitative estimates of environmental effects that follow are based on replacement power being secured through ongoing BPA resource acquisition activities. Replacement through local resource development may result in a greater proportion of energy efficiency, renewables and cogeneration. This might reduce the resulting magnitude of environmental effects.

a. Air Quality Effects. The estimated annual average incremental air emissions from replacement resource development, other than conservation, are shown in Table 12. These emissions are attributable to the combustion of natural gas in replacement generation or cogeneration plants and the interaction of new plants with existing combustion-based power plants. These estimates of air pollutant emissions (particulates, nitrogen oxides, sulfur dioxide, and carbon monoxide) were based on typical mid-1980s pollution control technology. Newer control practice is expected to substantially reduce pollutant emissions. Similar to replacement resource costs, year-to-year variations in estimated air emissions would occur because of short-term fluctuations in load growth, fuel prices, and hydropower availability.

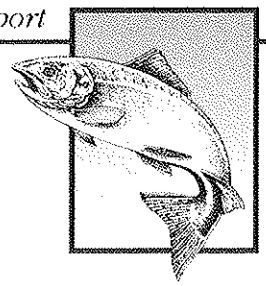


Table 12. *Annual average air emissions from replacement resource development.*

Emission	Quantity (tons/year)
Total suspended particulates	3.2
Nitrogen oxides	61
Sulfur dioxide	38
Carbon monoxide	34
Carbon dioxide	47,300

Though not a regulated pollutant, carbon dioxide is of concern because of its role in contributing to possible global climate change. The carbon dioxide estimate (Table 12) assumes no carbon offsets. The cost and effectiveness of carbon offsets through biotic sequestering are being explored.

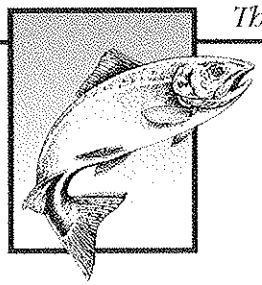
Since Elwha River fish are harvested from Alaska to Oregon, restoration of the runs will benefit numerous fishermen, but perhaps none more than the Elwha S'Klallam Tribe located at the mouth of the river.

b. Water-Related Effects. Replacement thermal resources would consume large amounts of water, largely through evaporation in condenser cooling towers. The consumption of water has the potential of being the most controversial aspect of thermal resources given the current concerns in the region over water supplies and discharge. Makeup water would be obtained from ground or surface water sources. Other water impacts could result from the damming or diversion of streams for new hydropower development. Because of the project-specific nature of these impacts, specific water quality effects cannot be described in advance of identifying specific replacement projects. However, current policy and regulation largely precludes the development of new hydropower facilities at sensitive sites, and closely regulates the impact of any new facility on water flows and quality. For this reason, the water quality effects of replacement resource development can be expected to be acceptable.

c. Land Effects. Because most thermal plant development now occurs at sites dedicated for industrial use, significant land-related impacts from these resources are not expected (though incremental land impacts will occur in areas of natural gas production). The land-related impacts of new hydropower and other renewable resources are highly project-specific. New hydropower development could result in displacement of non-critical habitat. Wind or geothermal development could result in the conversion of fairly large areas of land from rural to power plant-related uses. Some aesthetic impacts could result from wind or geothermal development and from transmission interconnections of new power plants to the grid.

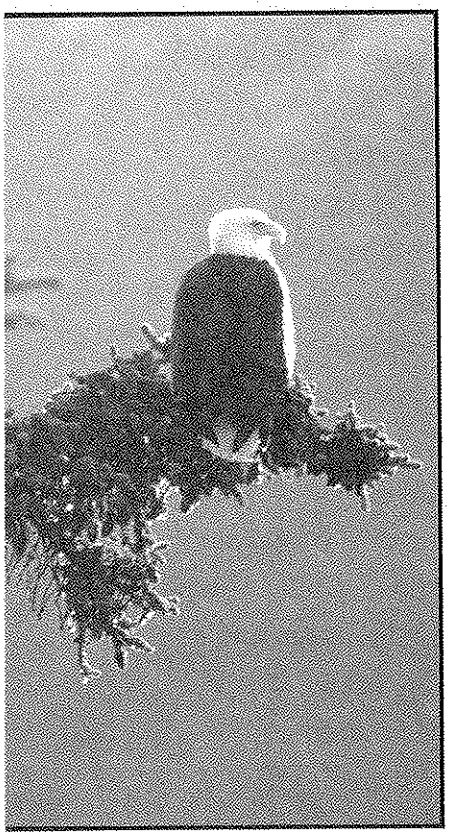
N. Cost-sharing

Restoration of the Elwha River ecosystem and native anadromous fisheries would result in benefits to a broad spectrum of public and private interests. Consequently, P.L. 102-495 directed the Secretary of the Interior to identify cost-share possibilities among the various beneficiaries, ". . . if the Secretary believes that such parties or entitites should assume some portion of the cost involved in the restoration, together with the specific cost-share provisions which the Secretary deems necessary and reasonable."



The reduction of anadromous fish runs in the Elwha River following construction of the Elwha and Glines Canyon dams resulted in fewer fish for treaty and nontreaty fishermen. Since Elwha River fish are harvested from Alaska to Oregon, restoration of the runs will benefit numerous fishermen, but perhaps none more than the Elwha S'Klallam Tribe located at the mouth of the river. However, Section 3(c)(5) specifically excludes any "Federally recognized Indian tribes" from cost-share provisions.

Other potential harvesters of restored Elwha River anadromous fish include non-Indian recreational and commercial fishermen, primarily within the State of Washington. Harvest rates of anadromous fish in marine areas can be estimated for many Elwha fish stocks, but they are based on current hatchery releases. Harvest rates would have to be refined once natural stocks are restored to better estimate benefits to Washington fishermen. Also, harvest benefits accruing from each stock will vary according to the amount of time required for restoration of that stock.



Bald eagle. (Pat O'Hara)

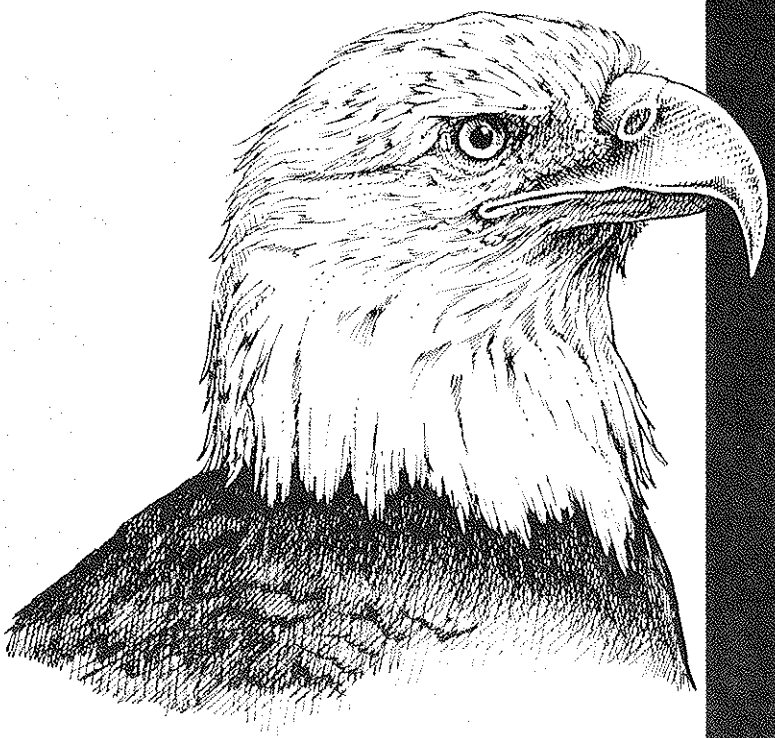
Tourists visiting Olympic National Park (designated a World Heritage Site and International Biosphere Reserve by the United Nations) will be attracted by the actual removal of the dams and the resulting habitat, wildlife, and fish restoration. These tourists would provide much needed economic stimulus to Port Angeles and Clallam County. Cost-shares could arise from the participation and contributions of public and private entities, similar to that stipulated in P.L. 100-406 (Section 7).

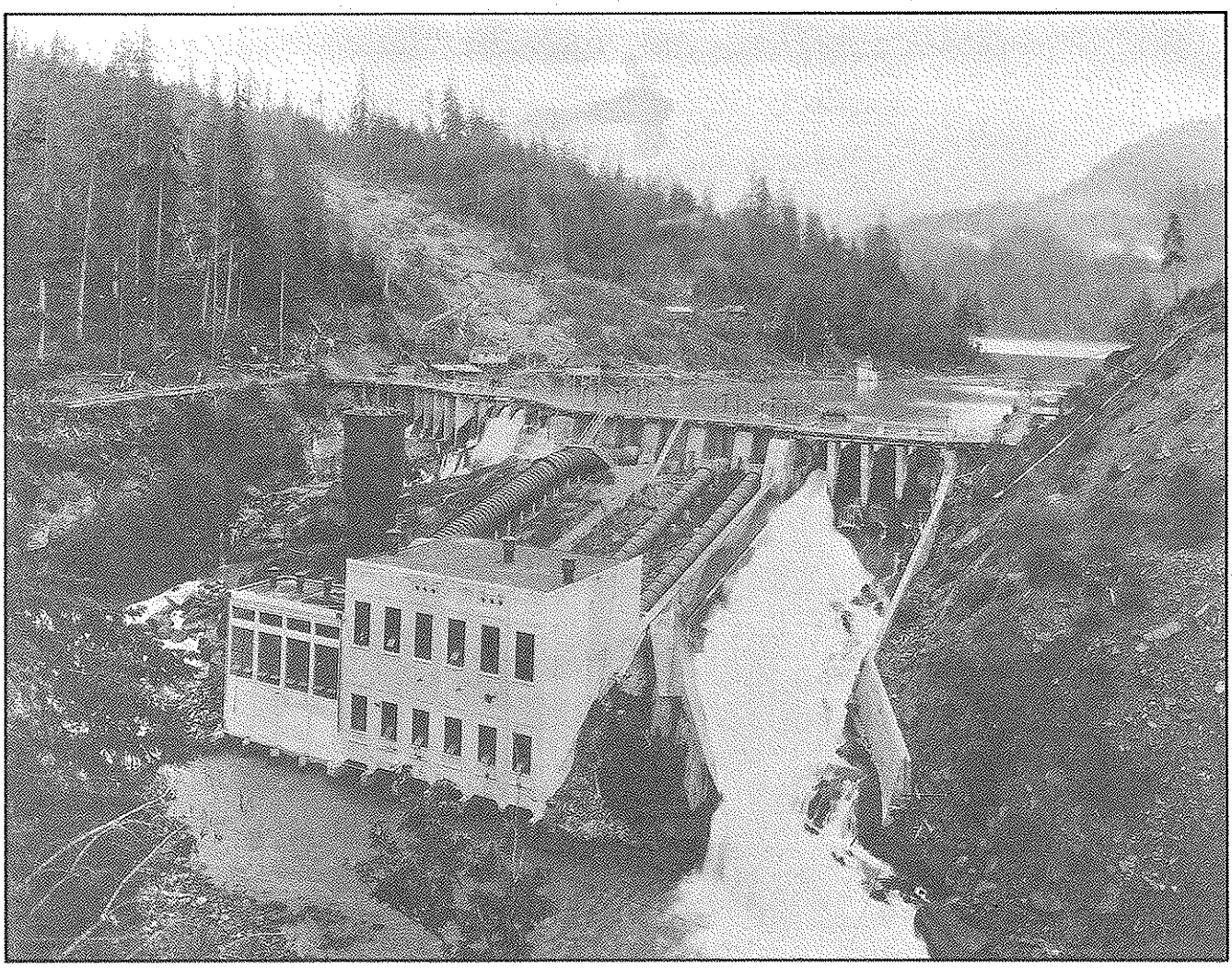
There are a number of Federal statutes -- both generic and project-specific -- that address the issue of cost-sharing for fish and wildlife mitigation, enhancement, or restoration at Federal water resources development projects of the Army Corps of Engineers, Interior's Bureau of Reclamation, and the Department of Agriculture's Soil Conservation Service.

While these statutes do not apply directly to the removal of the Elwha and Glines Canyon dams, there is certainly precedent to require as much as 25 percent non-Federal cost-sharing for certain fish and wildlife resource activities.

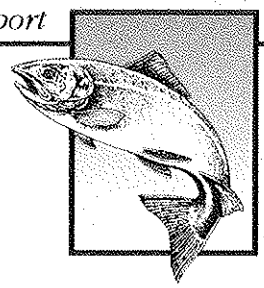
Appropriate cost-sharing terms will be explored during the development of the advanced planning report and NEPA compliance process. Based on the results of this review, a formal cost-sharing agreement would be negotiated prior to initiation of the selected alternative.

VII. Summary & Conclusions





Lake Aldwell and Elwha Dam soon after dam construction. (Asahel Curtis photo, Olympic National Park)



VII. Summary and Conclusions

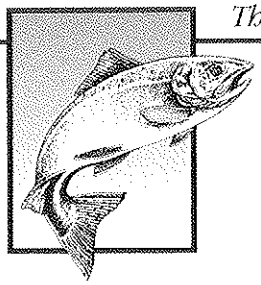
The removal of the Elwha and Glines Canyon dams is the only alternative that would result in the "full restoration of the Elwha River ecosystem and native anadromous fisheries" (P.L. 102-495, Section 3(c)). Retention of either or both dams, even with the provision of fish passage facilities and other measures, would not allow for the full restoration of native anadromous fisheries such as chinook, pink, and chum salmon, among others. In addition, retention of either or both dams would prevent the restoration of natural sediment transport processes resulting in the continued degradation of the middle and lower river, estuary, and near coastal areas. Retention of either or both reservoirs would prevent the restoration of important bottom land wildlife habitat and riverine habitat for anadromous fish, as well as prevent full nutrient transport downstream impacting freshwater ecology and the organisms that are dependent thereon. The ecosystem cannot be restored with the retention of either or both dams.

The removal of the Elwha and Glines Canyon dams, while providing for ecosystem and fisheries restoration and the protection of water users, is feasible. Several options are available for the demolition of the structures. Three general removal approaches are also available for managing the sediments that have accumulated in each reservoir: (1) the mechanical *Removal* of the sediments to a terrestrial location or marine disposal site; (2) the *Erosion* of the material downstream; or (3) the *Retention* and stabilization of the material within the confines of the existing reservoirs. Numerous scenarios are available within each approach and in the combination of approaches. Although higher cost options are available (e.g., the total removal of all sediments), significant cost savings are available for other approaches and justify further investigation. If one of these approaches is coupled with the least expensive approach to dam removal, the cost range for both activities is $66.7 to $80.0 million (in 1992 dollars).

The removal of the Elwha and Glines Canyon dams is the only alternative that would result in the "full restoration of the Elwha River ecosystem and native anadromous fisheries."

The sediment management approach ultimately selected would influence the approaches and costs associated with fisheries and habitat restoration and water quality protection. Nevertheless, it is estimated that fisheries restoration would include capital and operational costs of $9.7 million for an estimated 18-year restoration planning period. Since it is assumed that wildlife populations would recover on their own, no costs have been identified for wildlife restoration. Restoration of the habitat currently inundated by Lake Mills and Lake Aldwell is estimated to cost $5.9 million. Water quality protection activities need additional investigation, but they are estimated to range from $13.6 to $15 million, not including increased annual operation and maintenance costs. Additional costs are associated with the following: modifications to the Army Corps of Engineers constructed levee on the Lower Elwha Reservation to maintain the existing level of flood protection would cost $2.1 million; costs for documentation of historic and cultural sites (up to $350,000); interpretation activities and facilities (options ranging from $0.6 to $7 million); and costs for the acquisition of the Projects ($29.5 million and no more). If the cleanup of hazardous materials (e.g., PCBs) is identified as a need, another $1.5 million, more or less, could be required.

Decommissioning the powerplants could occur upon acquisition by the Federal Government or delayed until removal of the dams is imminent. Regardless, the dams would have to be operated and maintained during an interim period. The cost of



decommissioning the powerplants is estimated to be $500,000, although some of this cost could be recovered by selling the equipment. Operation and maintenance (O&M) costs would be $500,000 to $600,000 per year if the powerplants are decommissioned upon acquisition. O&M costs are estimated at $1.2 to $1.4 million annually if power is produced. The marketing of the power could offset those costs.

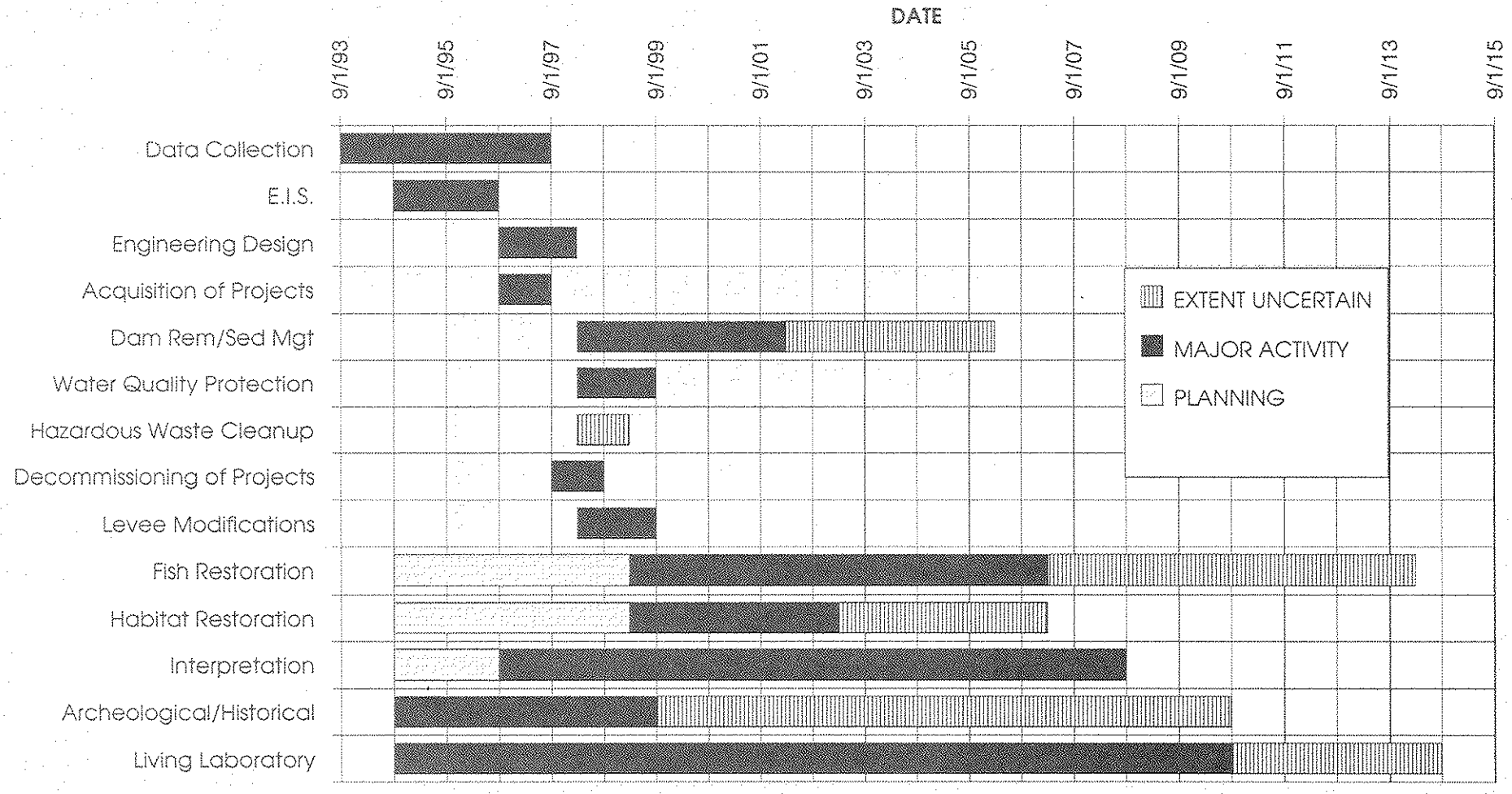
The removal of dams of this scale with benefits of this magnitude have not occurred before. Consequently, removal of the dams would attract considerable national and international interest. It would be beneficial to document the ecosystem and fisheries resources pre- and post-dams to learn as much as possible about such a restoration effort. Preliminary estimates indicate Federal costs would be about $400,000 to $500,000 per year for approximately 10 years, though cost-shares for much of the research may be possible. Such a research program would be expected to lead to greater efficiencies in restoration efforts throughout the Pacific Northwest.

Additional analyses are necessary to identify a preferred sediment management option. The option ultimately selected would influence other activities associated with the restoration effort, and some cost savings could be identified. However, additional water users needing protection, although not specifically listed in P.L. 102-495, could be identified requiring additional protection measures. Other costs might also be uncovered. If Congress chooses to fully implement the Elwha River Ecosystem and Fisheries Restoration Act, the selection of a preferred sediment management option would occur during development of an Environmental Impact Statement (EIS)/advanced planning report, following submission of the Elwha Report to the Congress.

The total cost of removing the Elwha and Glines Canyon dams is most influenced by the sediment management option selected. Options 1, 5, and 7 provide a realistic cost range for sediment management activities. If all related restoration costs are included with each of these options, total costs would range from $147.59 to $203.28 million (Tables 13, 15, and 16) for the 20 year restoration period (Figures 7 to 9). For comparison purposes, total costs associated with sediment management option 2 (total removal of all accumulated sediments) would be $307.36 million (Table 14). Although option 2 is not recommended at this time, it would be evaluated, along all other sediment management options, in the EIS/advanced planning report.

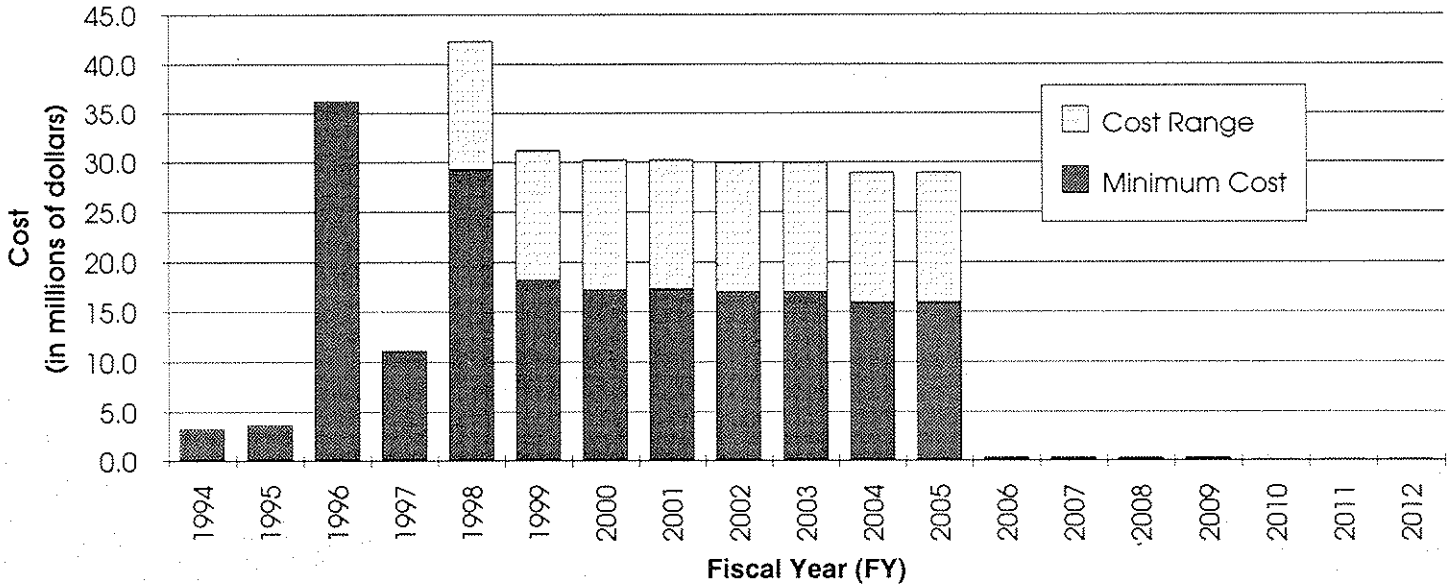
The costs to fully restore the Elwha River ecosystem and native anadromous fisheries are generally on a par with salmon restoration activities elsewhere in the region. However, it is important to note that restoration of the Elwha River would be essentially complete following removal of the Elwha and Glines Canyon dams and the completion of associated activities, whereas habitat impacts in other Pacific Northwest basins are likely to continue. Also, implementation of P.L. 102-495 would negate lengthy and costly litigation and provide significant benefits to an economically depressed region. Removal of the dams and full restoration of the ecosystem and native anadromous fisheries would promote tribal fisheries and the Federal trust responsibility to affected Indian Tribes. Because it is a negotiated solution rather than a litigated decision, P.L. 102-495 provides a rare "win-win" opportunity for all affected parties.

Figure 7
ELWHA RIVER RESTORATION
Project Schedule



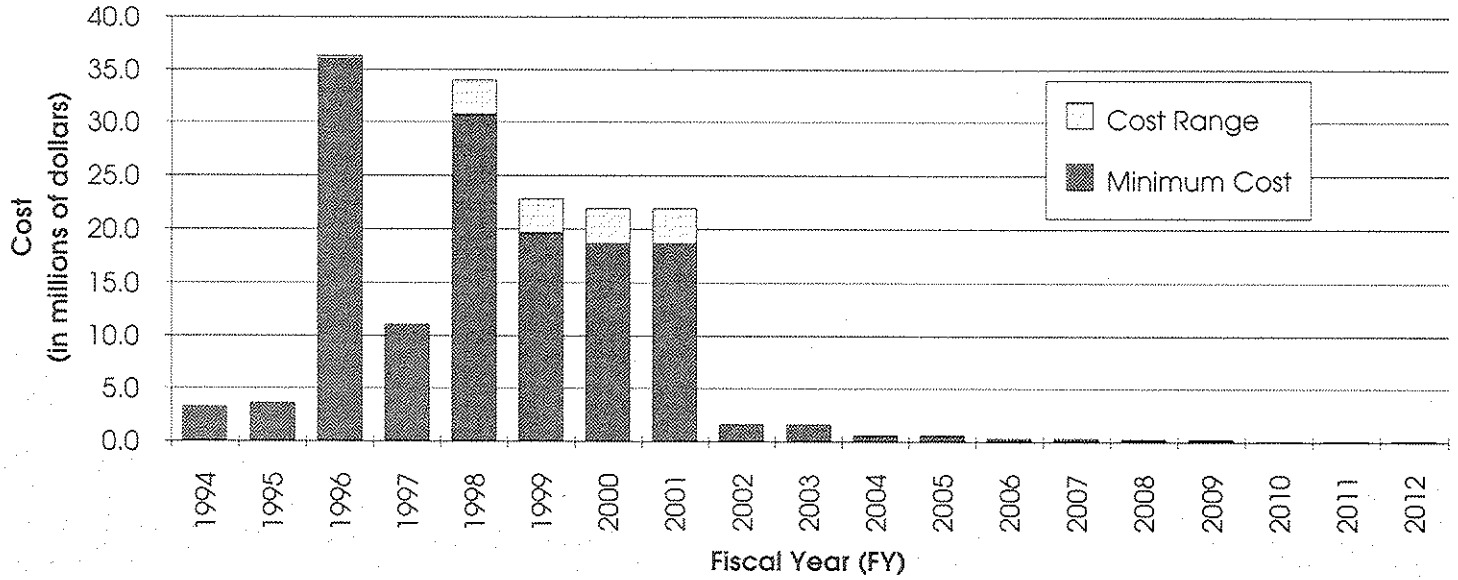
Extent of uncertain activities will be defined in EIS/advanced planning process.

Figure 8
TOTAL PROJECT COST*
Sediment Management 'Removal' Option
Summary of Annual Capital, Operating, and Maintenance Costs
FY 1994 - FY 2012



*Total project cost includes cost for activities shown in Tables 13 and 14.

Figure 9
TOTAL PROJECT COST*
Sediment Management 'Retention' Option
Summary of Annual Capital, Operating, and Maintenance Costs
FY 1994 - FY 2012



*Total project cost includes cost for activities shown in Tables 15 and 16.

Table 13
TOTAL PROJECT COST SUMMARY
for
Sediment Management Option #1

Activity	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	Totals
Data Collection	0.47	0.51	0.40	0.40																1.78
E.I.S. *	2.10	1.94																		4.04
Engineering Design			3.20	1.80																5.00
Acquisition of Projects			29.50																	29.50
Dam Rem/Sed Mgt					15.27	15.27	15.27	15.27	15.27	15.26	15.26	15.26								122.13
Water Quality Protection				7.15	7.15	0.57	0.57	0.57	0.57	0.57										17.15
Hazardous Waste Cleanup					1.50															1.50
Decommissioning of Projects					1.00															1.00
Levee Modifications					2.10															2.10
Fish Restoration	0.39	0.35	1.94	0.22	0.23	0.36	0.36	0.38	0.38	0.38	0.38	0.37	0.20	0.17	0.11	0.10	0.10	0.10	0.08	6.60
Habitat Restoration	0.06	0.11	0.76	0.96	0.96	0.96	0.37	0.37	0.12	0.12	0.12	0.12								5.03
Interpretation					0.50	0.50	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14				2.40
Archeological/Historical	0.08	0.13		0.10	0.10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.69
Restoration/Scientific Studies	0.18	0.60	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45										4.38
ANNUAL TOTAL, ALL ACTIVITIES	**3.27**	**3.63**	**36.25**	**11.08**	**29.26**	**18.13**	**17.18**	**17.20**	**16.95**	**16.94**	**15.92**	**15.91**	**0.36**	**0.33**	**0.27**	**0.26**	**0.12**	**0.12**	**0.10**	**203.28**

***All 1994 and 1995 activities are necessary for EIS/advanced planning.**

Table 14
TOTAL PROJECT COST SUMMARY
for
Sediment Management Option #2

Activity	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	Totals
Data Collection	0.47	0.51	0.40	0.40																1.78
E.I.S. *	2.10	1.94																		4.04
Engineering Design			3.20	1.80																5.00
Acquisition of Projects			29.50																	29.50
Dam Rem/Sed Mgt					28.28	28.28	28.28	28.28	28.28	28.27	28.27	28.27								226.21
Water Quality Protection				7.15	7.15	0.57	0.57	0.57	0.57	0.57										17.15
Hazardous Waste Cleanup					1.50															1.50
Decommissioning of Projects					1.00															1.00
Levee Modifications					2.10															2.10
Fish Restoration	0.39	0.35	1.94	0.22	0.23	0.36	0.36	0.38	0.38	0.38	0.38	0.37	0.20	0.17	0.11	0.10	0.10	0.10	0.08	6.60
Habitat Restoration	0.06	0.11	0.76	0.96	0.96	0.96	0.37	0.37	0.12	0.12	0.12	0.12								5.03
Interpretation					0.50	0.50	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14				2.40
Archeological/Historical	0.08	0.13		0.10	0.10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.69
Restoration/Scientific Studies	0.18	0.60	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45										4.38
ANNUAL TOTAL, ALL ACTIVITIES	3.27	3.63	36.25	11.08	42.27	31.14	30.19	30.21	29.96	29.95	28.93	28.92	0.36	0.33	0.27	0.26	0.12	0.12	0.10	307.36

***All 1994 and 1995 activities are necessary for EIS/advanced planning.**

Table 15
TOTAL PROJECT COST SUMMARY
for
Sediment Management Option #5

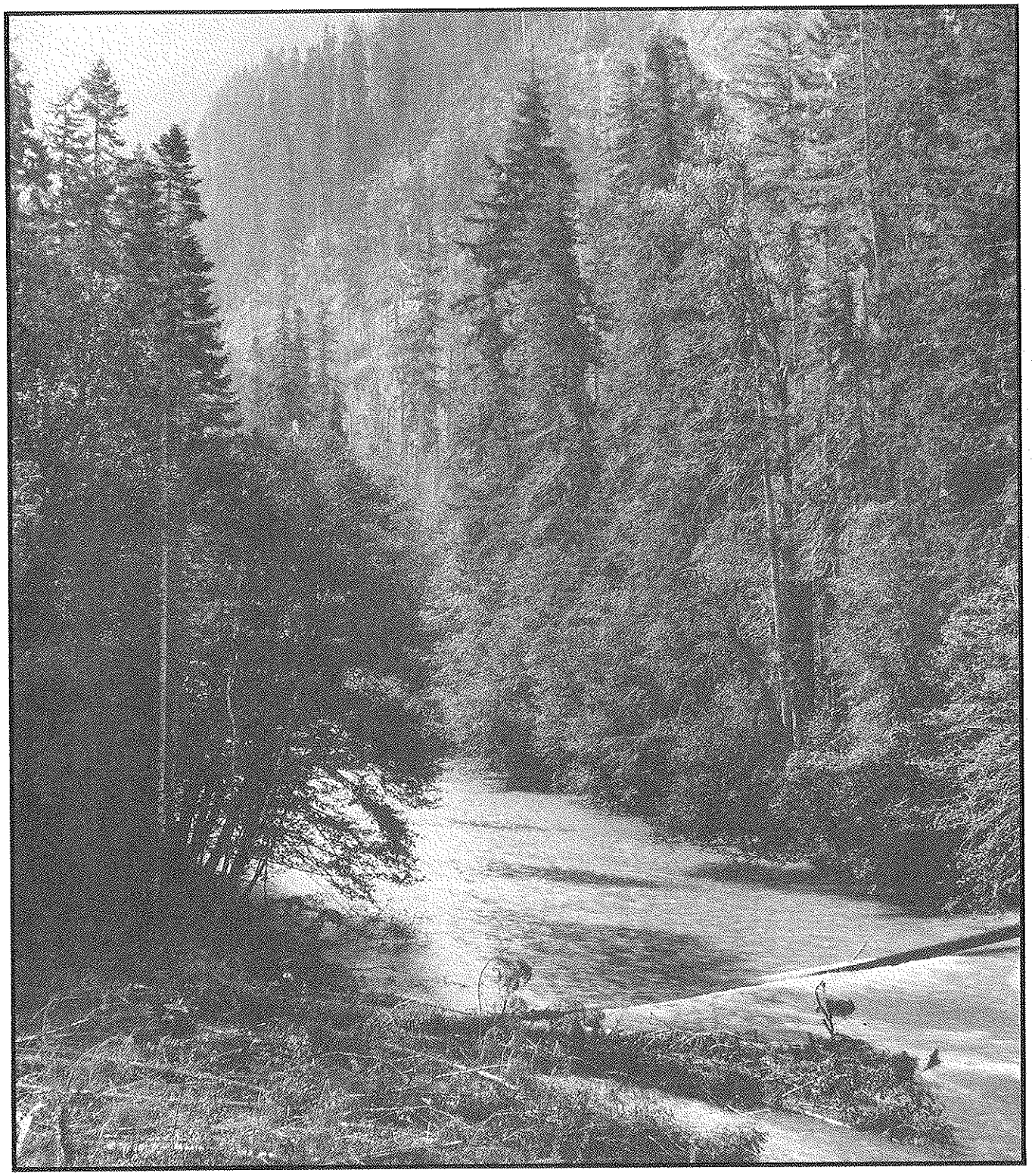
Activity	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	Totals
Data Collection	0.47	0.51	0.40	0.40																1.78
E.I.S. *	2.10	1.94																		4.04
Engineering Design			3.20	1.80																5.00
Acquisition of Projects			29.50																	29.50
Dam Rem/Sed Mgt					19.99	19.98	19.98	19.98												79.93
Water Quality Protection				7.15	7.15	0.57	0.57	0.57	0.57	0.57										17.15
Hazardous Waste Cleanup					1.50															1.50
Decommissioning of Projects					1.00															1.00
Levee Modifications					2.10															2.10
Fish Restoration	0.39	0.35	1.94	0.22	0.23	0.36	0.36	0.38	0.38	0.38	0.38	0.37	0.20	0.17	0.11	0.10	0.10	0.10	0.08	6.60
Habitat Restoration	0.06	0.11	0.76	0.96	0.96	0.96	0.37	0.37	0.12	0.12	0.12	0.12								5.03
Interpretation					0.50	0.50	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14				2.40
Archeological/Historical	0.08	0.13		0.10	0.10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.69
Restoration/Scientific Studies	0.18	0.60	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45										4.38
ANNUAL TOTAL, ALL ACTIVITIES	3.27	3.63	36.25	11.08	33.98	22.84	21.89	21.91	1.68	1.68	0.66	0.65	0.36	0.33	0.27	0.26	0.12	0.12	0.10	161.08

***All 1994 and 1995 activities are necessary for EIS/advanced planning.**

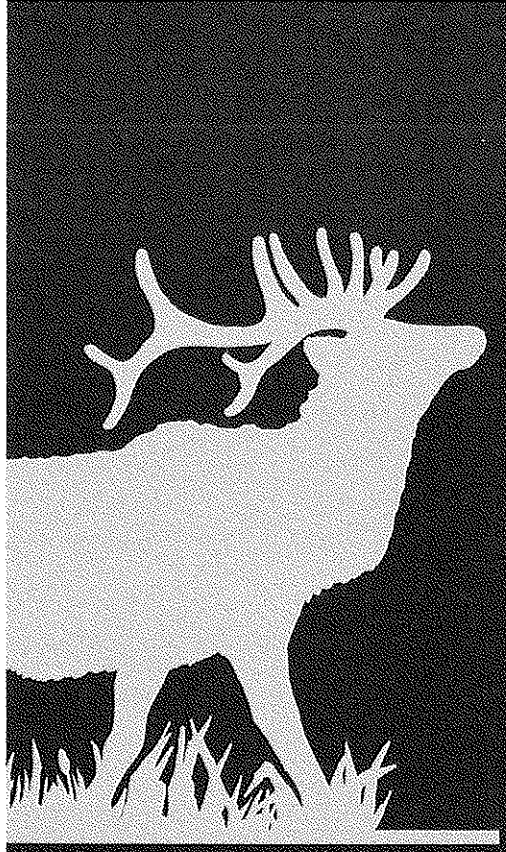
Table 16
TOTAL PROJECT COST SUMMARY
for
Sediment Management Option #7

Activity	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	Totals
Data Collection	0.47	0.51	0.40	0.40																1.78
E.I.S. *	2.10	1.94																		4.04
Engineering Design			2.94	1.80																4.74
Acquisition of Projects			29.50																	29.50
Dam Rem/Sed Mgt					16.68	16.68	16.67	16.67												66.70
Water Quality Protection				7.15	7.15	0.57	0.57	0.57	0.57	0.57										17.15
Hazardous Waste Cleanup					1.50															1.50
Decommissioning of Projects					1.00															1.00
Levee Modifications					2.10															2.10
Fish Restoration	0.39	0.35	1.94	0.22	0.23	0.36	0.36	0.38	0.38	0.38	0.38	0.37	0.20	0.17	0.11	0.10	0.10	0.10	0.08	6.60
Habitat Restoration	0.06	0.11	0.76	0.96	0.96	0.96	0.37	0.37	0.12	0.12	0.12	0.12								5.03
Interpretation					0.50	0.50	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14				2.40
Archeological/Historical	0.08	0.13		0.10	0.10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.69
Restoration/Scientific Studies	0.18	0.60	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45										4.38
ANNUAL TOTAL, ALL ACTIVITIES	**3.27**	**3.63**	**35.99**	**11.08**	**30.67**	**19.54**	**18.58**	**18.60**	**1.68**	**1.68**	**0.66**	**0.65**	**0.36**	**0.33**	**0.27**	**0.26**	**0.12**	**0.12**	**0.10**	**147.59**

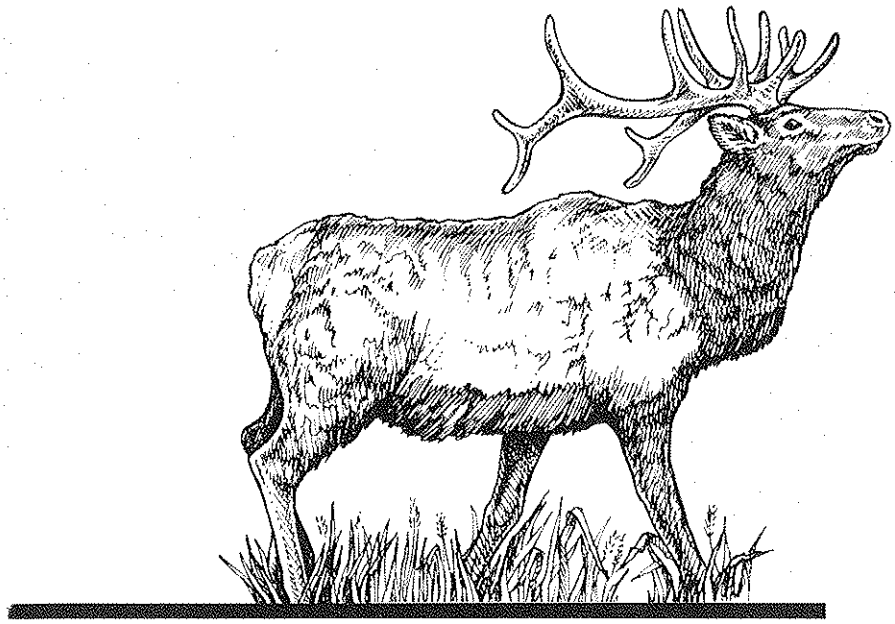
***All 1994 and 1995 activities are necessary for EIS/advanced planning.**



Elwha River at Geyser Valley, May 27, 1907. (Asahel Curtis photo, Washington State Historical Society)

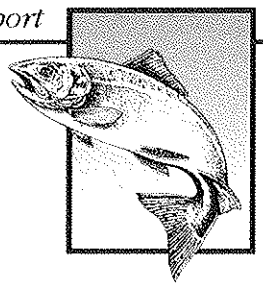


VIII. References & Appendices A through D





The Mountaineers cross the Elwha, August 1, 1907. (Asahel Curtis photo, Washington State Historical Society)



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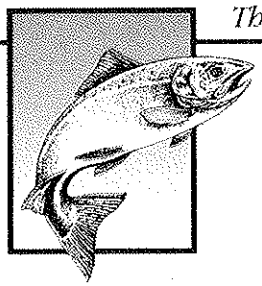
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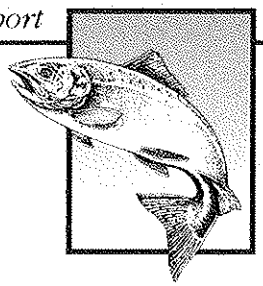
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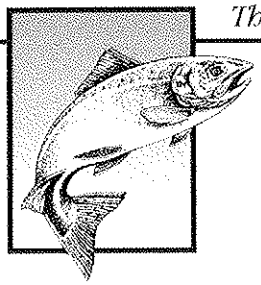
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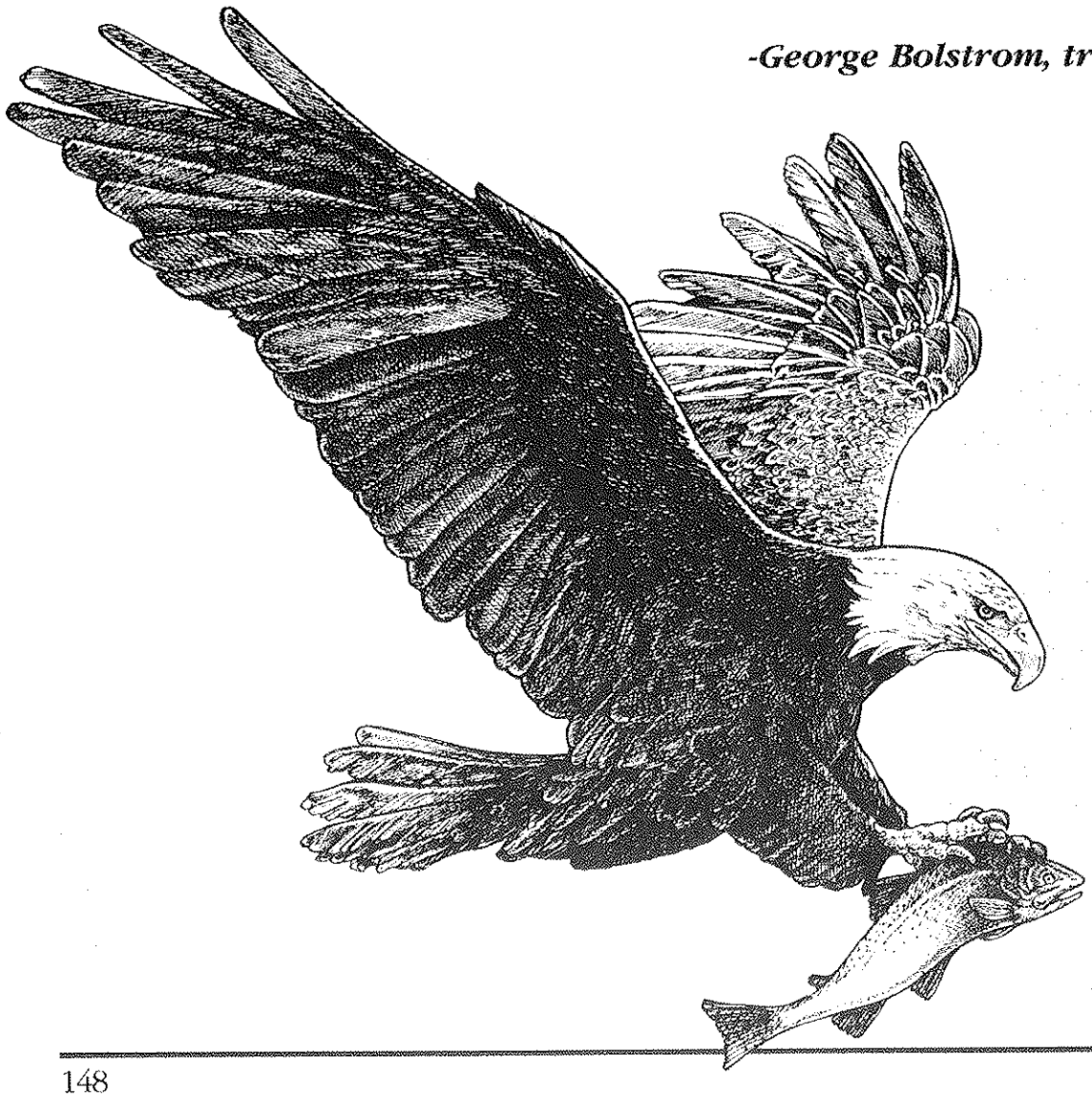
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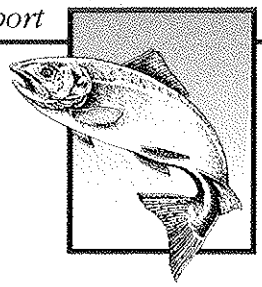
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It's not just about taking the dams out, or even just putting the fish back. It's about the whole picture, the human population, marine predators, overfishing, the works. If the whole system is addressed, then maybe restoration will work.

-George Bolstrom, tribal member





Appendix A:

Public Law 102-495

Public Law 102-495
102d Congress

An Act

To restore Olympic National Park and the Elwha River ecosystem and fisheries in the State of Washington.

Oct. 24, 1992
[H.R. 4844]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Elwha River Ecosystem and Fisheries Restoration Act.
Conservation.

SECTION 1. SHORT TITLE.

This Act may be referred to as the "Elwha River Ecosystem and Fisheries Restoration Act".

SEC. 2. DEFINITIONS.

For the purposes of this Act:

(a) The term "Administrator" means the Administrator of the Bonneville Power Administration.

(b) The term "Commission" means the Federal Energy Regulatory Commission.

(c) The term "electric power" means electric peaking capacity or electric energy or both.

(d) The term "Elwha Project" means the Elwha River Hydroelectric Project, Federal Energy Regulatory Commission Project Number 2683, including appurtenant works and project lands, located on the Elwha River in Clallam County, Washington.

(e) The term "Glines Project" means the Glines Canyon Hydroelectric Project, Federal Energy Regulatory Commission Project Number 588, including appurtenant works and project lands, located on private and public lands both within and without the exterior boundaries of Olympic National Park on the Elwha River in Clallam County, Washington.

(f) The term "local industrial consumer" means the owner of the pulp and paper mill located on Ediz Hook in Port Angeles, Washington, that, on the date of enactment of this Act, receives and consumes the electric power produced by the Projects, or its successors or assignees.

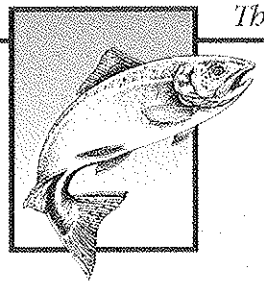
(g) The term "local preference customer" means Port Angeles City Light.

(h) The term "owner" means the current owner of the Projects or its successors or assignees, but shall not mean the Secretary, the United States, or any other entity acquiring title to the Projects or features thereof pursuant to the terms of this Act.

(i) The term "Park" means Olympic National Park.

(j) The term "Project" or "Projects" means either or both the Elwha Project and the Glines Project, including project works and appurtenant lands.

(k) The term "project replacement power" means electric power delivered to the local industrial consumer to replace losses of electric power generation from the Projects following their acquisition by the Secretary pursuant to this Act, in



an amount not to exceed 172.088 gigawatthours of energy in any year.

(l) The term "Secretary" means the Secretary of the Interior.

(m) The term "State" means the State of Washington, including its agencies and departments.

SEC. 3. ACQUISITION OF PROJECTS.

Effective date.

(a) Effective sixty days after submission to the Congress of the report referred to in section 3(c), the Secretary is authorized to acquire the Elwha and Glines Canyon Projects, and all rights of the owner and local industrial consumer therein, subject to the appropriation of funds therefor: *Provided,* That the Secretary shall not acquire the projects unless he has determined pursuant to subsection (c) that removal of the Project dams is necessary for the full restoration of the Elwha River ecosystem and native anadromous fisheries and that funds for that purpose will be available for such removal within two years after acquisition.

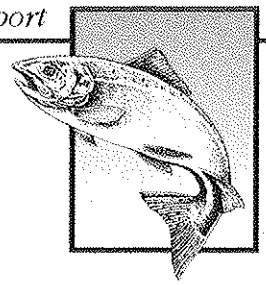
(b) The consideration for acquisition of the Projects shall be $29.5 million and no more, to be paid by the Secretary to the owner and local industrial consumer at the time of acquisition, and shall be conditioned on a release of liability providing that all obligations and liabilities of the owner and the local industrial consumer to the United States arising from the Projects, based upon ownership, license, permit, contract, or other authority, including, but not limited to, project removal and any ecosystem, fish and wildlife mitigation or restoration obligations, shall, from the moment of title transfer, be deemed to have been satisfied: *Provided,* That the United States may not assume or satisfy any liability, if any, of the owner or local industrial consumer to any federally recognized Indian Tribe nor shall such liability to the Tribe, if any, be deemed satisfied without the consent of such Tribe.

Reports.

(c) The Secretary shall prepare a report on the acquisition of the Projects and his plans for the full restoration of the Elwha River ecosystem and the native anadromous fisheries and submit such report on or before January 31, 1994, to the Appropriations Committees of the United States Senate and the United States House of Representatives, as well as to the Committee on Energy and Natural Resources of the Senate and the Committees on Energy and Commerce, Interior and Insular Affairs, and Merchant Marine and Fisheries of the United States House of Representatives. The report shall contain, without limitation:

(1) The precise terms of acquisition of the Projects, with an analysis of the costs, in addition to the consideration set out in section 3(b), and potential liabilities and benefits, if any, to the Federal Government resulting from the acquisition and all other actions authorized under this Act;

(2) Alternatives, in lieu of dam removal, for the restoration of the Elwha River ecosystem and the native anadromous fisheries and wildlife of the Elwha River Basin, consistent with the management plan of the Park, the rights of any Indian tribe secured by treaty or other Federal law, and applicable State law. The report shall include feasibility studies for each alternative considered and a definite plan for removal. Such definite plan shall include the timetable after conveyance for removal of the dams and the plans for removal and disposal of sediment, debris, and other materials consistent with all



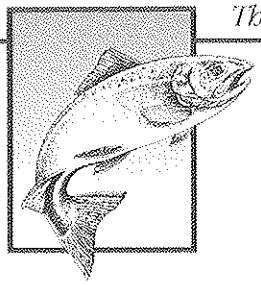
applicable environmental laws and a detailed explanation of all costs of removal. In conducting the feasibility studies and in the preparation of the definite plan, the Secretary is authorized to use the services of any Federal agency on a reimbursable basis and the heads of all Federal agencies are authorized to provide such technical and other assistance as the Secretary may request. For each alternative considered, the Secretary shall estimate total costs, environmental risks and benefits, the potential for full restoration of the Elwha River ecosystem and native anadromous fisheries, and the effect on natural and historic resources (together with any comments made by the Advisory Council on Historic Preservation for any properties which are listed, or eligible for listing, on the National Register of Historic Places).

(3) Specific proposals for management of all lands or interests therein acquired pursuant to this Act which are located outside the exterior boundaries of the Olympic National Park. The Secretary shall specifically address the suitability of such lands, or portions thereof, for addition to the National Wildlife Refuge System; National Park System; transfer to the Lower Elwha Klallam Tribe in trust for tribal housing, cultural, or economic development purposes in accordance with a plan developed by the Lower Elwha Klallam Tribe in consultation with the Secretary; and development and use by the State. Upon acquisition, all lands and interests therein within the exterior boundaries of the Park shall be managed pursuant to authorities otherwise applicable to the Park. For the purposes of protecting the Federal investment in restoration, that portion of the river outside the Park on which the Federal Government will acquire both banks shall, upon such acquisition, be managed in accordance with the declared policy of section 1(b) of Public Law 90–542, except that modifications necessary to restore, protect, and enhance fish resources and to protect the existing quality of water supplied from the river are hereby authorized.

(4) Specific proposals and any Federal funding and the availability of that funding that may be necessary to protect the existing quality and availability of water from the Elwha River for municipal and industrial use from possible adverse impacts of dam removal.

(5) Identification of any non-Federal parties or entities, excluding Federally recognized Indian tribes, which would directly benefit from the commercial, recreational, and ecological values that would be enhanced by the restoration of the Elwha River ecosystem and fisheries, if the Secretary believes that such parties or entities should assume some portion of the cost involved in the restoration, together with the specific cost-share provisions which the Secretary deems necessary and reasonable.

(d) In preparing his report, the Secretary shall consult with appropriate State and local officials, affected Indian tribes, the Commission, the Environmental Protection Agency, the Secretary of Energy, the Administrator, the Pacific Northwest Power Planning Council, the Secretary of Commerce, and of the Advisory Council on Historic Preservation, as well as interested members of the public. In addition, the Secretary shall afford an opportunity for



public comment on the report prior to its submission to the Congress.

(e) Upon the appropriation of the sum provided for in section 3(b) for the acquisition of the Projects and the determination that dam removal is necessary, the owner and local industrial consumer shall convey to the United States, through the Secretary, title to the Projects, including all property and all other rights and interests. Upon such conveyance and payment of the consideration as provided in section 3(b), and without further action by the United States, title shall transfer and vest in the United States, the owner and local industrial consumer shall be released from any further liability to the United States, as provided in section 3(b), and the acquisition from the owner and local industrial consumer shall be deemed to be completed.

Effective date.

SEC. 4. ECOSYSTEM AND FISHERIES RESTORATION.

(a) Effective sixty days after submission of the report referred to in section 3(c) and following the conveyance in section 3(e), the Secretary is authorized and directed, subject to the appropriation of funds therefor, to take such actions as are necessary to implement—

(1) the definite plan referred to in section 3(c)(2) for the removal of the dams and full restoration of the Elwha River ecosystem and native anadromous fisheries;

(2) management of lands acquired pursuant to this Act which are located outside the exterior boundaries of the Park; and

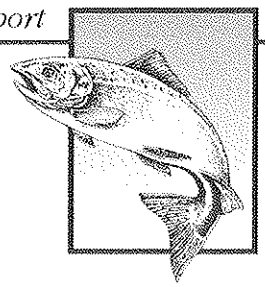
(3) protection of the existing quality and availability of water from the Elwha River for municipal and industrial uses from possible adverse impacts of dam removal.

(b) The definite plan referred to section 3(c)(2) must include all actions reasonably necessary to maintain and protect existing water quality for the City of Port Angeles, Dry Creek Water Association, and the industrial users of Elwha River water against adverse impacts of dam removal. The cost of such actions, which may include as determined by the Secretary, if reasonably necessary, design, construction, operation and maintenance of water treatment or related facilities, shall be borne by the Secretary. Funds may not be appropriated for removal of the dams, unless, at the same time, funds are appropriated for actions necessary to protect existing water quality.

(c) Nothing in this section shall be construed as an entitlement for which a claim against the United States may be made under the Tucker Act.

SEC. 5. PROJECT OPERATION AND REPLACEMENT POWER.

(a) Notwithstanding any other provision of law, neither the Federal Energy Regulatory Commission nor any other agency of the Federal Government shall have the authority or jurisdiction to issue a permanent license or similar order with respect to either Project prior to conveyance as provided in section 3(e), except that the Commission shall have jurisdiction under the Federal Power Act and is hereby authorized and directed to issue or maintain in effect annual licenses or authorizations for both Projects, authorizing continued operation of both Projects by the owner and local industrial consumer, such operation to be under such terms and conditions and in accordance with such practices as existed on September 1, 1992, until (1) the date the Secretary has acquired



title to the Projects or (2) if the Secretary's report required in section 3(c) does not provide for dam removal, five years after the expiration of the current annual license or authorization then in effect, after which time the Commission shall have authority under the Federal Power Act to issue appropriate licenses with respect to such Projects to the extent the Commission has jurisdiction over such Projects under such Act on the date of enactment of this Act.

(b) To ensure the availability of adequate electric power supplies to the operating facilities of the local industrial consumer, the Administrator shall, following acquisition of the Projects pursuant to this Act, deliver all project replacement power required by the operating facilities of the local industrial consumer through the local preference customer at a rate equal to the priority firm rate, or the rate which is then the equivalent of the priority firm rate if that designation is no longer used by the Administrator, as such rate is fixed by the Administrator from time to time, without regard to any new large single load determinations or similar factors. The local industrial consumer shall pay the local preference customer for such project replacement power at the same rate as all other industrial consumers of the local preference customer.

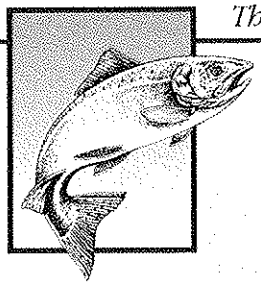
(c) Upon conveyance of the Projects to the United States, the Secretary shall maintain the dams in a safe condition for the period prior to their removal.

SEC. 6. LEASE OF FEDERAL LANDS.

(a) LEASE OF LANDS TO THE CITY OF PORT ANGELES.—After the Secretary makes the determination to remove the dams and actually acquires the projects and funds are appropriated for such conveyance and removal, the Secretary is authorized to issue a lease to the City of Port Angeles, Washington, for those lands situated on Ediz Hook, Clallam County, Washington, currently leased to the City under Lease No. DOT–CG13–4811–72, dated April 4, 1972, as amended, except for that parcel of land described in subsection (b)(2). Such lease shall be issued pursuant to the Act of June 14, 1926, as amended (43 U.S.C. 869), for a period of 99 years, beginning on a date to be determined by the Secretary, without right of patent.

(b) LEASE OF LANDS TO THE LOWER ELWHA KLALLAM TRIBE.—(1) After the Secretary makes the determination to remove the dams and actually acquires the Projects and funds are appropriated for such conveyance and removal, the Secretary is authorized to lease to the Lower Elwha Klallam Tribe that parcel of land situated on Ediz Hook, Clallam County, Washington, described in paragraph (2) for the purposes of the construction and operation of a tribal cultural facility, such as a longhouse or a museum, and associated interpretive and parking facilities. Such lease shall be issued pursuant to the Act of June 14, 1926, as amended (43 U.S.C. 869), for a period of ninety-nine years beginning on a date determined by the Secretary, without right of patent.

(2) The parcel of land to be leased to the Lower Elwha Klallam Tribe is that parcel of land lying south of the existing roadway and extending southward to the southern boundary of the land currently leased to the City of Port Angeles (Lease No. DOT–CG13–4811–72, dated April 4, 1972, as amended) and beginning at the north-south line 200 feet east of the western boundary



of Out Lot 6 and running easterly 600 feet to the north-south line 300 feet west of the eastern boundary of Out Lot 6.

(3) In addition to the general terms and conditions applicable under the Act of June 14, 1926, as amended (43 U.S.C. 869), the lease to the Tribe shall be subject to the following terms and conditions:

(A) There shall be public access to the beach along the south side of the parcel at all times.

(B) The City of Port Angeles shall have the right to construct and maintain a waterfront trail adjacent to the existing roadway along the north side of the parcel, the location of which shall be determined in conjunction with the Secretary.

(C) Parking facilities on the parcel shall be open to the public at all times.

(c) In addition to the terms and conditions described in this section for the leases to the City and the Tribe, the Secretary shall incorporate by reference into each lease the Agreement entered into on August 11, 1992, between the City and the Tribe regarding the use of the adjacent leaseholds.

SEC. 7. TRIBAL LAND ACQUISITION AND DEVELOPMENT.

(a) After the Secretary makes the determination to remove the dams and actually acquires the Projects and funds are appropriated for such conveyance and removal, the Secretary is authorized to acquire by purchase, and hold in trust in reservation status for the benefit of the Lower Elwha Klallam Tribe, lands in Clallam County, Washington, for housing, economic development, and moorage for the Tribal commercial fishing fleet.

Appropriation authorization.

(b) There is authorized to be appropriated an amount not to exceed $4,000,000 to carry out the land acquisition purposes of this section.

SEC. 8. SAVINGS.

(a) Nothing in this Act shall abridge or modify existing rights to Elwha River water.

(b) Nothing in this Act shall affect the rights of any Indian Tribe secured by Treaty or other law of the United States.

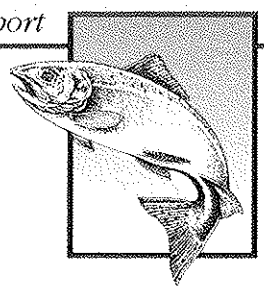
(c) This Act does not modify any of the Administrator's obligations or require the Administrator to take any actions regarding the protection, mitigation, or enhancement of fish and wildlife or expand those provided for under the Pacific Northwest Power Planning and Conservation Act, Public Law 96–501. Notwithstanding any other provision of law, the Administrator shall not be required to make any expenditures from the Bonneville Power Administration fund for the operation, maintenance, rehabilitation, improvement, or removal, breach, or bypass of the Projects.

SEC. 9. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to the Secretary of the Interior for expenditure through the Assistant Secretary for Fish, Wildlife, and Parks and to the Secretary of Commerce for expenditure through the National Marine Fisheries Service such sums as may be necessary to carry out the purposes of this Act: *Provided,* That such authorization shall not become effective until sixty days following submission of the report provided for in section (3)(c) of this Act.

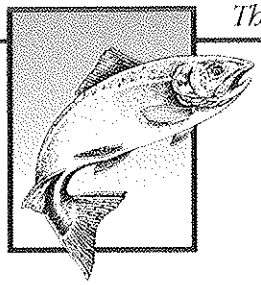
Effective date.

Approved October 24, 1992.



Appendix B:
Federal Licensing Chronology

1910	Construction begins on Elwha Dam.
1913	Elwha project becomes operational.
Mar 23, 1926	Northwestern Power & Light Co. files license application for Glines Canyon Project.
Jun 6, 1926	Federal Power Commission (FPC) issues 50-year license for Glines Canyon Project.
1927	Glines Canyon Project becomes operational.
May 8, 1934	FPC approves transfer of Glines license to Washington Pulp & Paper Corp.
Feb 24, 1937	FPC approves transfer of Glines license to Crown Zellerbach Corporation.
Jun 1938	Olympic National Park established.
Jan 2, 1940	Olympic National Park boundary is expanded to include the Glines site and previous Forest Service lands.
Jul 22, 1968	Crown Zellerbach Corporation files license application for the constructed Elwha Project.
Nov 20, 1970	FPC issues notice of expiration of original Glines Canyon license.
Jun 1, 1973	Crown Zellerbach Corporation files application for relicense for Glines Canyon.
Jan 16, 1976	FPC issues notice of Elwha license application.
Mar 24, 1976	Crown Zellerbach Corporation requests a declaratory order that the FPC is without jurisdiction to license the Elwha project, and seeks permission to withdraw its application.
Sep 22, 1976	Secretary of the Interior is granted intervenor status in the Elwha proceeding.
Feb 3, 1977	FPC provides for hearing on issue of its jurisdiction over the Elwha Project.



May 23, 1978 Federal Energy Regulatory Commission (FERC) issues notice of Glines Canyon relicense application. Various agency comments are filed throughout 1978. Washington State Department of Game is granted intervenor status.

Dec 11, 1978 Administrative Law Judge's (ALJ) initial decision finds licensing jurisdiction over Elwha project.

Mar 16, 1979 FERC issues order finding Glines Canyon and Elwha Projects hydraulically, electrically, and operationally interconnected and affirming the ALJ's decision finding jurisdiction over the Elwha project. From this point on, the FERC staff processes the two license applications together.

May 23, 1979 Crown Zellerbach files an updated license application for Elwha.

May 12, 1980 FERC accepts for filing updated license application for Elwha.

Feb 13, 1986 Department of the Interior asserts that the FERC lacks jurisdiction to license Glines Canyon.

May 15, 1986 Seattle Audubon Society, Friends of the Earth, Olympic Park Associates, and Sierra Club, file motion for intervention and call for dam removal and full restoration of ecosystem.

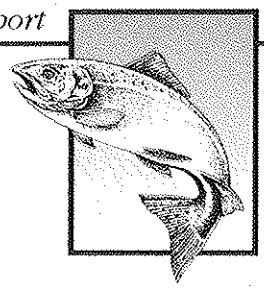
Nov 20, 1986 National Marine Fisheries Service, Lower Elwha S'Klallam Tribe, Seattle Audubon Society, Friends of the Earth, Olympic Park Associates, and Sierra Club, are granted intervenor status in Elwha proceeding.

Dec 15, 1986 FERC staff visits site to review the status of information on both Elwha and Glines Canyon projects and gives agencies opportunity to comment regarding the need for additional information.

Feb 17, 1987 Joint Fishery Agencies file petition for additional data and interim relief.

May 28, 1987 FERC staff sends additional information request to Crown Zellerbach concerning anadromous fish protection, wildlife studies, recreation study, cultural resources report, and need for power on both projects.

Jun 17, 1987 National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Wildlife, National Park Service, Lower Elwha S'Klallam Tribe, and Point No Point Treaty Council (Joint Fishery Agencies) file comments on Applicant's answer to Joint



Fishery Agencies' February 18, 1987, petition for additional data and interim relief.

Aug 17, 1987 Joint Fishery Agencies file supplemental petition for interim relief.

Nov 16, 1987 Joint Fishery Agencies filing comments on new issues raised by the applicant.

Nov 30, 1987 Crown Zellerbach files notice of change of its name to James River Corp. of Nevada.

Mar 17, 1988 James River Corp. of Nevada files to be replaced as applicant for Glines license to James River II.

Mar 25, 1988 Olympic Park Associates, Seattle Audubon Society, Friends of the Earth, and Sierra Club (the Conservation Intervenors) file petition for declaratory order finding that Glines cannot be relicensed by the FERC because it does not have jurisdiction.

Apr 13, 1988 FERC approves transfer of Glines license to James River II, Inc.

May 31, 1988 James River II files additional information concerning anadromous fish protection, wildlife studies, recreation study, cultural resources report, and need for power on both projects, but without agency comments.

June 1, 1988 Joint Fish and Wildlife Agencies (formerly the Joint Fishery Agencies) request information on the economic relationship between James River II and Daishowa America.

Aug 29, 1988 Joint Fish and Wildlife Agencies file their comments on the additional information filed on May 31, 1988.

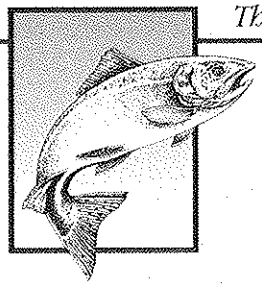
Oct 28, 1988 Joint Fish and Wildlife Agencies file supplemental petition regarding application and information deficiencies.

Nov 2, 1988 The Joint Fish and Wildlife Agencies file a request describing outstanding information needs and seeking interim protection measures on both projects.

Dec 2, 1988 James River II files its response to agency comments.

Jan 13, 1989 Joint Fish and Wildlife Agencies submit comments on Applicant's December 2, 1988 supplemental response.

Jan 26, 1989 National Marine Fisheries Service requests, for the Joint Fish and Wildlife Agencies, that FERC begin development of EIS.



Mar 21, 1989 National Marine Fisheries Service files study evaluating scope of dam removal/fish restoration on both projects.

Mar 24, 1989 Lower Elwha Tribal Council files comments regarding James River II's response to information request.

Apr 14, 1989 Joint Fish and Wildlife Agencies provide proposed EIS outline.

May 3, 1989 Friends of the Earth, for the Conservation Intervenors, submits comments on the Joint Fish and Wildlife Agencies' March 21, 1989 filing.

May 17, 1989 FERC staff meets in Port Angeles, Washington with the National Park Service concerning the NEPA process and Glines jurisdictional issue.

Jun 1, 1989 FERC staff meets in Washington, D.C. with the staff of National Park Service concerning NEPA process and Glines jurisdictional issue.

Jun 7, 1989 FERC issues notice of June 26, 1989 technical meeting in Seattle and June 27, 1989 public meeting in Sequim, Washington, on both projects.

Jun 12, 1989 Representative John Dingell requests General Accounting Office conduct an investigation regarding legal issues of project relicensing and dam removal.

Jun 27, 1989 Joint Fish and Wildlife Agencies file supplemental petition regarding remaining information deficiencies on both projects.

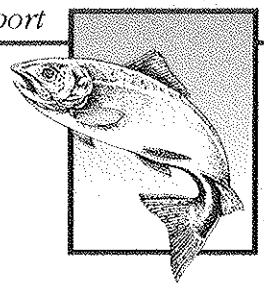
Jun 26, 1989 FERC staff conducts technical meeting in Seattle, Washington, and public meeting in Sequim, Washington, to discuss the status of the projects, explores alternatives to be assessed in the EIS, and define additional information requirements.

Jul 24, 1989 Washington Department of Wildlife submits comments on alternatives review and additional study needs necessary to complete EIS.

Jul 31, 1989 National Marine Fisheries Service submits comments on alternatives review and additional study needs necessary to complete EIS.

Aug 24, 1989 FERC responds to Representative John Dingell.

Aug 29, 1989 Representative John Dingell requests additional information regarding relicensing of Glines Dam.



Oct 4, 1989 The Conservation Intervenors file comments on Applicant's May 28, 1987 additional information and supplemental responses.

Oct 12, 1989 Joint Fish and Wildlife Agencies file supplemental petition for interim relief for fish and wildlife.

Oct 17, 1989 Conservation Intervenors file petition for interim relief.

Oct 24, 1989 FERC staff conducts technical meetings in Seattle on 1989 interim mitigation measures and establishes December 18 and 19 as the dates for further meetings to resolve interim mitigation issues.

Dec 18, 1989 FERC staff conducts a second round of meetings to resolve interim mitigation measures.

Dec 20, 1989 EIS scoping meetings held in Port Angeles and Seattle.

Feb 1990 General Accounting Office determines that FERC does not have authority to license the Glines Canyon Project, it being within the boundaries of Olympic National Park.

May 10, 1990 Trout Unlimited granted intervenor status in Elwha proceedings.

May 24, 1990 Conservation Intervenors file a request that FERC rule on their March 25, 1988 petition.

Jul 16, 1990 Department of the Interior files a Motion to File Late Intervention, Motion to Intervene, and Petition for Declaratory Order that FERC does not have authority to license the Glines Canyon Project.

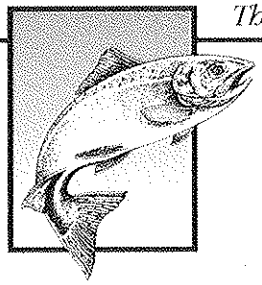
Oct 19, 1990 FERC issues order denying petitions seeking an order that FERC lacks jurisdiction to license the Glines Canyon Project.

Nov 16, 1990 Department of the Interior, National Marine Fisheries Service, and Tribe file requests for rehearing of FERC's October 19, 1990, order.

Nov 19, 1990 Conservation Intervenors file request for rehearing of FERC's October 19, 1990, order.

Dec 4, 1990 FERC denies Department of the Interior's request for rehearing stating that the request was received one day late.

Dec 17, 1990 National Marine Fisheries Service and Tribe file supplement to November 16, 1990, request for reconsideration incorporating Department of the Interior's request for reconsideration.



Dec 19, 1990 FERC grants rehearing of October 19, 1990, order "for purpose of further consideration."

Feb 1991 FERC releases Draft Environmental Impact Statement concluding that (1) dam removal is feasible, (2) only dam removal will result in the full restoration of the Elwha River ecosystem and anadromous fish, and (3) the cost of power produced by dam retention would equal or exceed the cost of power from the Bonneville Power Administration.

Mar 27, 1991 General Accounting Office concludes that "dam removal offers the best prospects for fish restoration" and decides that the selection of an alternative is essentially a public policy decision.

Apr 5, 1991 FERC issues order denying requests for rehearing and reconsideration of its October 19, 1990, order, claiming jurisdiction over the Glines Canyon Project.

Apr 22, 1991 Pacific Fishery Management Council commented that only dam removal would provide restoration of anadromous fish at levels that would support increased recreational and commercial fishing, and requested FERC consult with the Council.

May 31, 1991 Conservation Intervenors and Tribe file Petitions for Review with Ninth Circuit for court review of FERC orders exerting licensing jurisdiction over Glines Canyon Project within Olympic National Park.

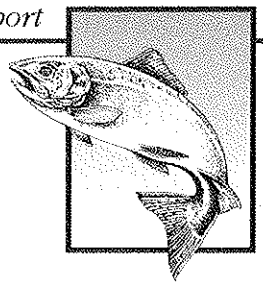
Jun 4, 1991 Department of Justice, on behalf of the Department of Commerce and Department of the Interior, files Petition for Judicial Review of FERC's October 19, 1990, and April 5, 1991 orders.

Jun 27, 1991 Ten additional conservation organizations file motion for intervention.

Jun 28, 1991 In a letter to the Department of Justice, Department of Energy recommends that Petition filed with Ninth Circuit be dismissed citing agreement with FERC's position that it has authority to license the Glines Canyon Project.

Aug 6, 1991 Pacific Fishery Management Council requested a response to its April 22, 1991 letter.

Nov 13, 1991 FERC requested information from the Joint Fish and Wildlife Agencies, including fish restoration and harvest management plans, and provided less than 30 days for a response.



Dec 13, 1991 National Marine Fisheries Service questioned assumptions contained in FERC's November 13, 1991, request for information, but agreed with the FERC assessment that much information is needed. However, National Marine Fisheries Service noted that FERC had not ordered the studies requested by the Joint Fish and Wildlife Agencies that would have provided that information.

Jan 23, 1992 FERC claims that National Marine Fisheries Service December 13, 1991, response is "irresponsible."

Jan 31, 1992 ITT Rayonier, Inc. filed motion for late intervention.

Feb 24, 1992 Congressman Dingell requests that FERC explain the basis of a dispute over information requested by FERC from the National Marine Fisheries Service.

Mar 5, 1992 City of Port Angeles filed motion for late intervention.

Mar 11, 1992 National Marine Fisheries Service documented information currently available that would assist FERC in its efforts and listed studies requested by the Joint Fish and Wildlife Agencies that FERC had not ordered.

Apr 7, 1992 FERC responds to Congressman Dingell's February 24, 1992, letter asking for clarification of a dispute over information requested by FERC from the National Marine Fisheries Service.

Jun 2, 1992 Congressman Dingell characterizes FERC's April 7, 1992, response as inadequate.

Jun 5, 1992 General Accounting Office concluded that who should pay for dam removal is undecided, although the dam owner could be required to bear the cost if the dams are unlicensed.

Aug 10, 1992 FERC responds to Congressman Dingell's letter of June 2, 1992.

Oct 24, 1992 President Bush signs the Elwha River Ecosystem and Fisheries Restoration Act as Public Law 102-495, staying the FERC licensing process.

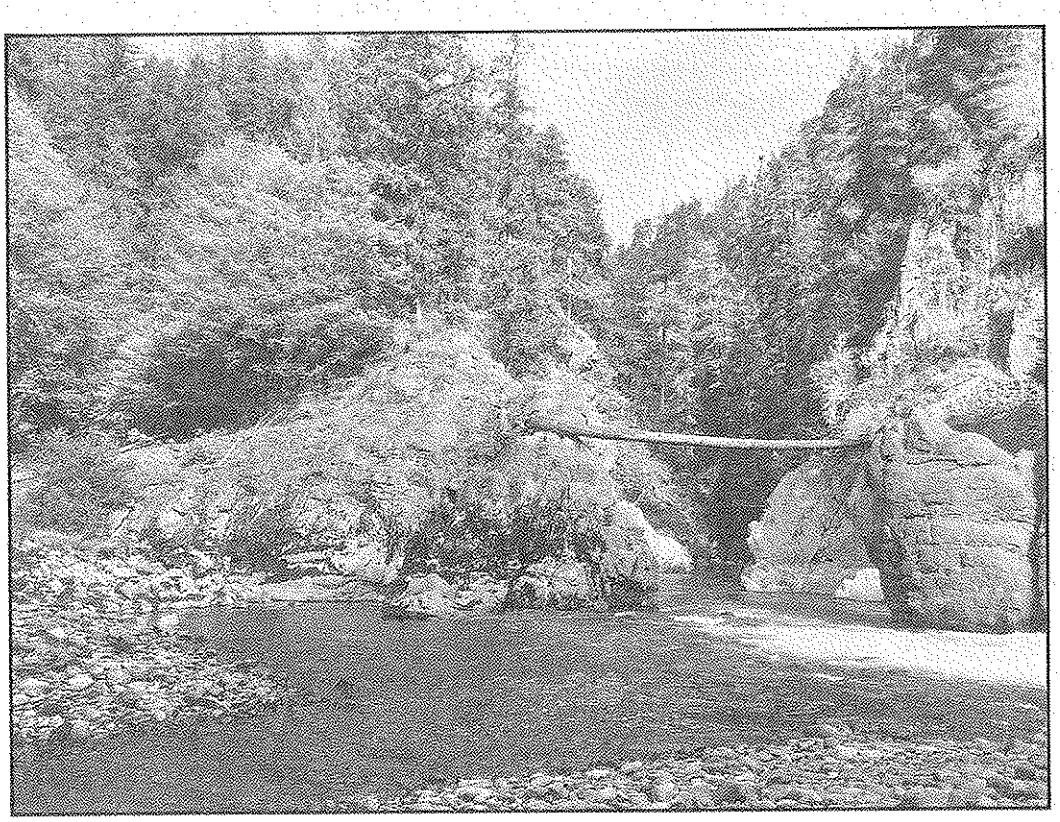
Oct 27, 1992 James River II, Inc. requests license transfer to James River Paper Company, Inc.

Nov 18, 1992 Conservation Intervenors file motion for FERC to stay its licensing proceedings citing Public Law 102-495.

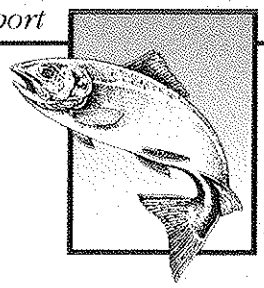
Dec 22, 1992 FERC issues order approving transfer of Glines Canyon annual license from James River II, Inc. to James River Paper Company, Inc.

Dec 23, 1992 Joint Motion by Olympic Park Associates, Friends of the Earth, Seattle Audubon Society, Sierra Club, Department of Commerce, Lower Elwha S'Klallam Tribe, FERC, and James River requesting Ninth Circuit issue stay of jurisdiction case.

Feb 1, 1993 Ninth Circuit granted stay of jurisdiction case.



Goblin Gates on the Elwha River, 1955. (Gunnar Fagerlund photo, Olympic National Park)



Appendix C:

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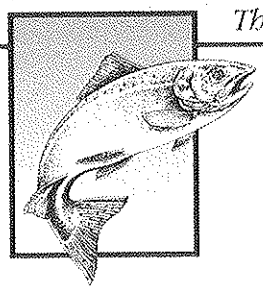
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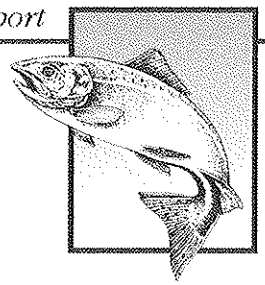
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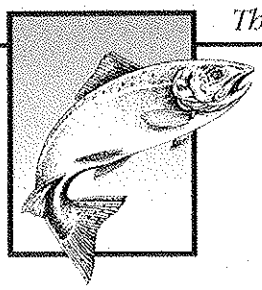
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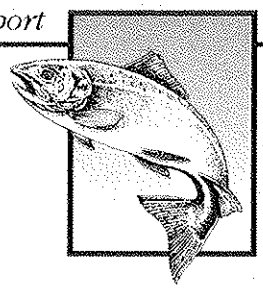
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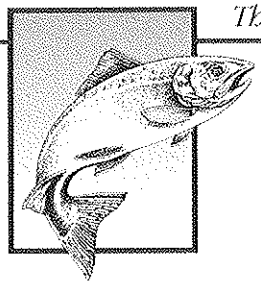
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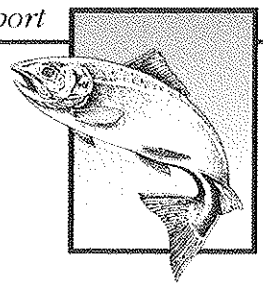
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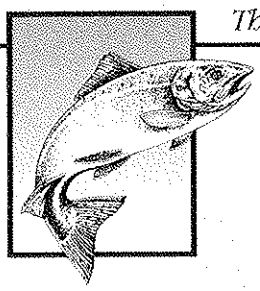
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Carole Kahler - pages 51, 73, 116, 172
Fred Sharpe - page 47

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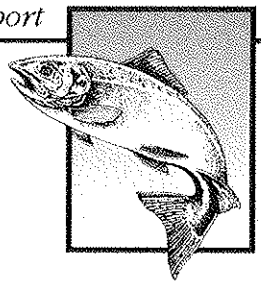




Our tribe has lived along the Elwha River for countless generations. The river and the salmon are at the center of our way of life.

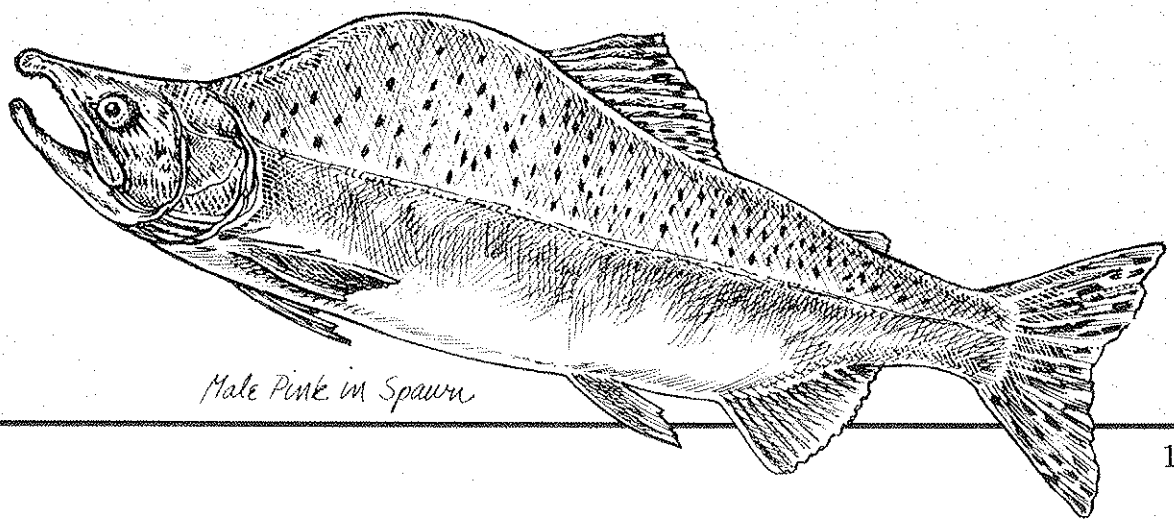
-Carla Elofson, former tribal chairperson

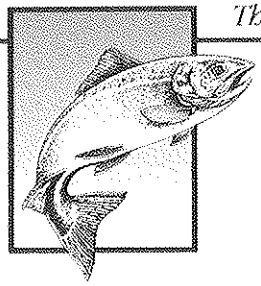




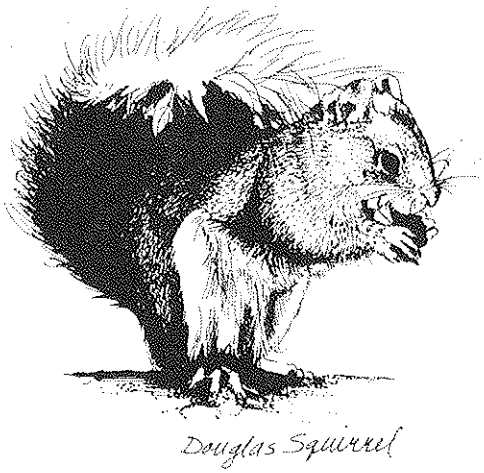
Appendix D:
List of Common and Scientific Names of Fish Found in the Elwha River

Common name	Scientific name
Brook trout	*Salvelinus fontinalis*
Chinook salmon	*Oncorhynchus tshawytscha*
Chum salmon	*Oncorhynchus keta*
Coho salmon	*Oncorhynchus kisutch*
Cutthroat trout	*Oncorhynchus clarki*
Dace	*Rhinichthys* spp.
Largescale sucker	*Catostomus macrocheilus*
Dolly Varden	*Salvelinus malma*
Bull Trout	*Salvelinus confluentus*
Peamouth	*Mylocheilus caurinus*
Pink salmon	*Oncorhynchus gorbuscha*
Sculpin	*Cottus* spp.
Smelt	*Thaleichthys pacificus*
Sockeye salmon	*Oncorhynchus nerka*
Squawfish	*Ptychocheilus* spp.
Steelhead rainbow trout	*Oncorhynchus mykiss*
Threespine stickleback	*Gasterosteus aculeatus*
Whitefish	*Prosopium williamsoni*
White Sturgeon	*Acipenser transmontanus*

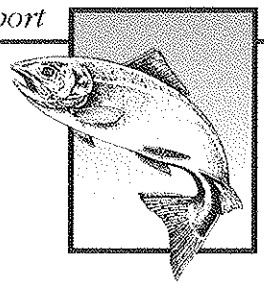




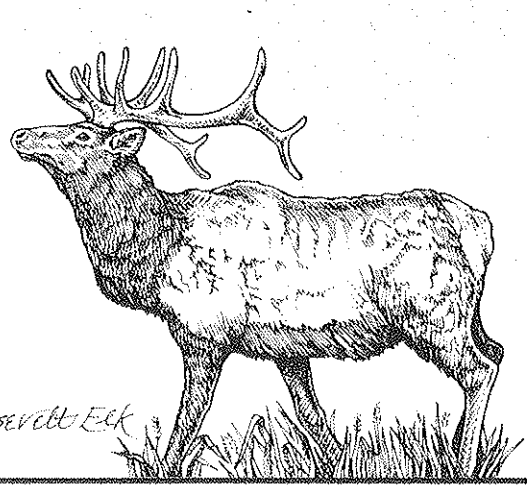
List of Common and Scientific Names of Wildlife Found in the Project Area

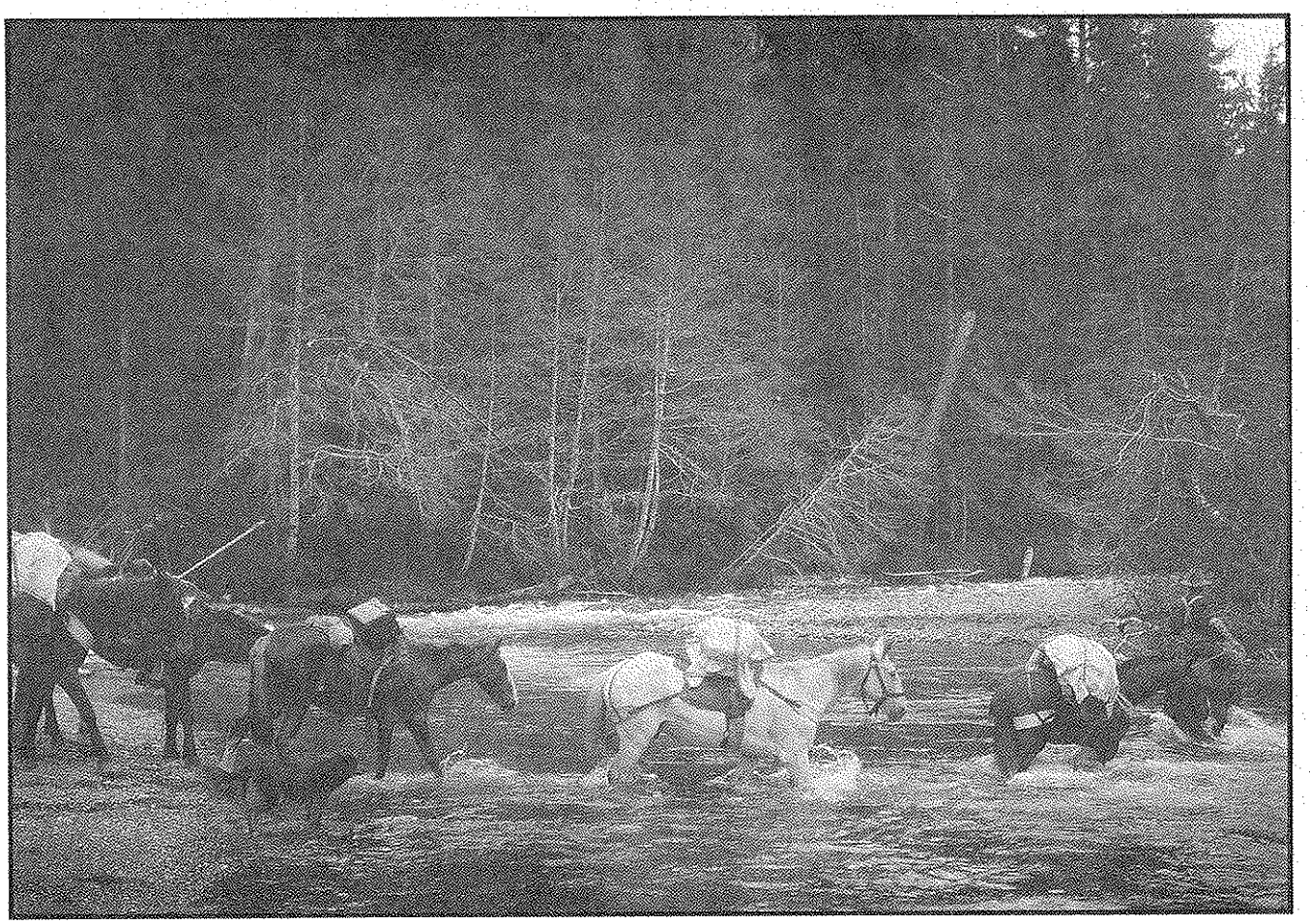


Common name	Scientific name
American crow	*Corvus brachyrhynchos*
American dipper	*Cinclus mexicanus*
Bald eagle	*Haliaeetus leucocephalus*
Band-tailed pigeon	*Columba fasciata*
Barred owl	*S. varia*
Bat	*Myotis* spp.
Beaver	*Castor canadensis*
Belted kingfisher	*Ceryle alcyon*
Black bear	*Ursus americanus*
Black-tailed deer	*Odocoileus hemionus* ssp. *columbianus*
Blue grouse	*Dendragapus obscurus*
Bobcat	*Felis rufus*
Brown creeper	*Certhia americana*
Bufflehead	*B. albeola*
Bushy-tailed woodrat	*Neotoma cinerea*
Chesnut-backed chickadee	*Parus rufescens*
Common goldeneye	*Bucephala clangula*
Common loon	*Gavia immer*
Common merganser	*Mergus merganser*
Cougar	*Felis concolor*
Coyote	*Canis latrans*
Dark-eyed junco	*Junco hyemalis*
Deer mouse	*Peromyscus maniculatus*
Double-crested cormorants	*Phalacrocorax auritus*
Douglas squirrel	*Tamiasciurus douglasii*
Ensatina	*Ensantina eschscholtzii*
Evening grosbeak	*Coccothraustes vespertinus*
Fisher	*Martes pennanti*
Golden-crowned kinglet	*Regulus satrapa*
Gray jay	*Perisoreus canadensis*
Great blue heron	*Ardea herodias*
Gulls	*Larus* spp.
Hairy woodpecker	*Picoides villosus*
Harlequin ducks	*Histrionicus histrionicus*
Horned grebe	*Podiceps auritus*
Long-tailed weasel	*Mustela frenata*
MacGillivray's warbler	*Oporornis tomiei*
Mallard	*Anas platyrhynchos*
Marbled murrelet	*Brachyramphus marmoratus*
Mink	*Mustela vison*
Mountain beaver	*Aplodontia rufa*



Common name	Scientific name
Muskrat	*Ondatra zibethicus*
Northern flying squirrel	*Glaucomys sabrinus*
Northern goshawk	*Accipiter gentilis*
Northern spotted owl	*Strix occidentalis caurina*
Northwestern salamander	*Ambystoma gracile*
Olive-sided flycatcher	*Contopus borealis*
Olympic torrent salamander	*Rhyacotriton olympicus*
Osprey	*Pandion haliaetus*
Pacific chorus frog	*Pseuacris regilla*
Pileated woodpecker	*Dryocopus pileatus*
Pine marten	*Martes americana*
Raccoon	*Procyon lotor*
Raven	*Corvus corax*
Red-breasted nuthatch	*Sitta canadensis*
Red-legged frog	*Rana aurora*
River otter	*Lutra canadensis*
Robin	*Turdus migratorius*
Roosevelt elk	*Cervus elaphus* ssp. *roosevelti*
Rough-skinned newt	*Taricha granulosa*
Ruffed grouse	*Bonasa umbellus*
Rufous hummingbird	*Selasphorus rufus*
Shrew	*Sorex* spp.
Shrew-mole	*Neurotrichus gibbsii*
Snowshoe hare	*Lepus americanus*
Spotted sandpipers	*Actis macularia*
Spotted skunk	*Spilogale putorius*
Stellar's jay	*Cyanocitta stelleri*
Striped skunk	*Mephitis mephitis*
Tailed frog	*Ascaphus truei*
Townsend's chipmunk	*Tamias townsendii*
Townsend's warbler	*Dendroica townsendi*
Trumpeter swans	*Cygnus buccinator*
Turkey vulture	*Cathartes aura*
Van Dyke's salamander	*Plethodon vandykei*
Varied thrush	*Ixoreus naevius*
Vaux's swift	*Chaetura vauxi*
Violet-green swallows	*Tachycineta thalussina*
Warbling vireo	*Vireo gilvus*
Western garter snake	*Thamnophis sirtalis*
Western grebe	*Aechmophorus occidentalis*
White-crowned sparrow	*Zonotrichia leucophrys*
Winter wren	*Troglodytes troglodytes*





Fording the Elwha at the Godkin, May 27, 1907. (Asahel Curtis photo, Washington State Historical Society)