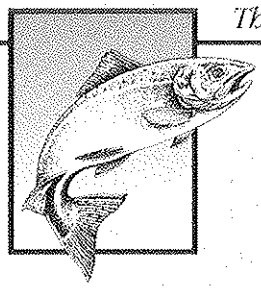
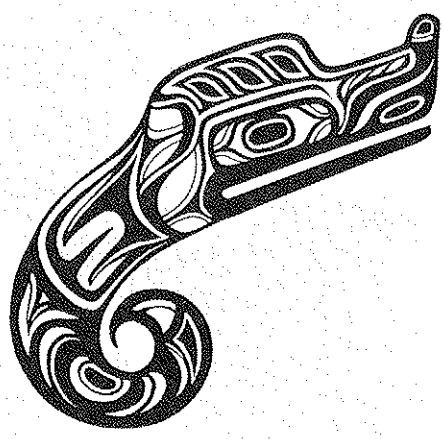


9. Recreation. During the salmon and steelhead rebuilding period, recreational fishing would be reduced through seasonal and limit restrictions. In the long-term, the partial restoration of anadromous fish runs and the greater river shoreline in the area of Lake Mills would benefit anglers. There would, 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.



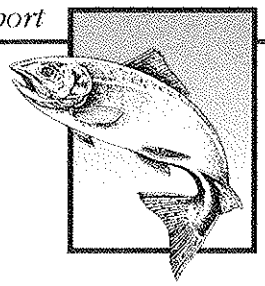
11. Tribal Social Effects. Partial restoration from the removal of Glines Canyon Dam would not provide the fisheries benefits that would accrue with the removal of both dams. Treaty fishermen would continue to experience severely restricted ceremonial, subsistence, and commercial fisheries. In particular, 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

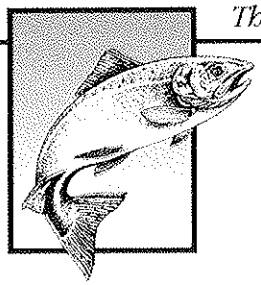
This section contains an evaluation of the potential for the full restoration of the ecosystem and native anadromous fisheries associated with the removal of the Elwha Project and the retention of the Glines Canyon Project.

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.

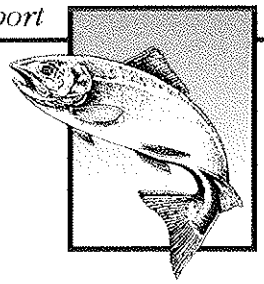
When compared to existing conditions, average temperatures in the lower reach would slightly decrease from the lack of reservoir heating in the absence of Lake Aldwell. Mean daily temperatures would likely be from 0.5° to 1° C less from mid-August to October.

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.

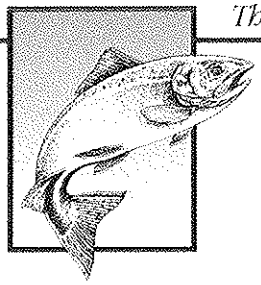
5. Living Marine Resources. Removal of Elwha Dam could cause some short-term impacts, depending on the sediment management scenario selected (see Section VI(C)). Further study is needed to determine those impacts and potential measures to mitigate those impacts. For the long-term, the removal of Elwha 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.

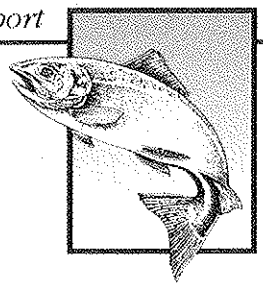
9. Recreation. During the salmon and steelhead rebuilding period (see Section VI.F), recreational fishing would be reduced through seasonal and limit restrictions. In the long-term, the partial restoration of anadromous fish runs and the greater river shoreline in the area of Lake Aldwell would benefit 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.

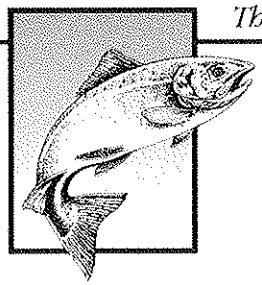
13. Other Effects. Effects on recreation and tourism would be positive, with associated opportunities for increased recreation and tourism related income. However, taxes paid by the project owner to Clallam County would decline to $180,000 annually (1990 dollars), compared with the current payment of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

D. Retention of Both Dams

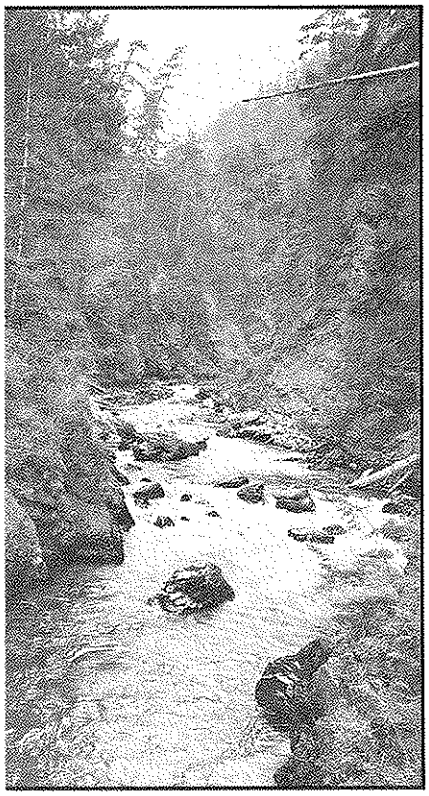
This section contains an evaluation of the potential for the full restoration of the ecosystem and native anadromous fisheries associated with the retention of the Elwha and Glines Canyon projects.

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.

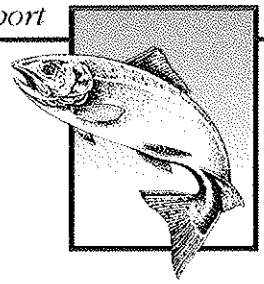


Elwha River from bridge on Long Ridge Trail, 1955. (Gunnar Fagerlund photo, Olympic National Park)

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.

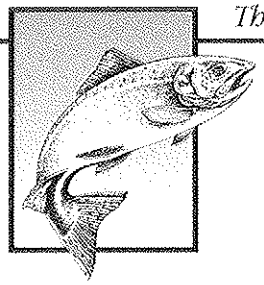
In addition, about 10% of juvenile chinook descend through the reservoir and enter the Glines Canyon turbine intakes located 60 feet below the surface. Of these fish, 60% are killed. Additional fish are lost at the Glines Canyon spillway and at Elwha Dam.

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.

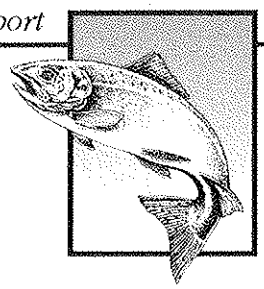
Elwha River chinook salmon were historically noted for their large size. Some fish were reported to have exceeded 100 pounds.

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.

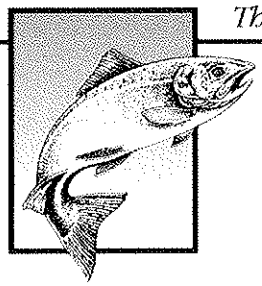
The Projects have also degraded the lower 16 miles of the river by inundation and trapping of gravel and large organic debris. The substrate of the river below both dams has become extremely coarse with very large boulders and cobble, most of which is not suitable for spawning. The lower 16 miles are 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.

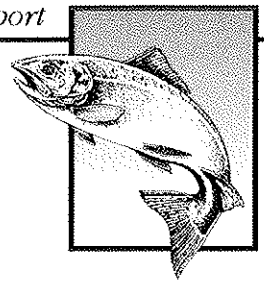
i. Stream Ecology. Overall, the ecology of the river would continue to be degraded with the retention of the Elwha and Glines Canyon projects because the dams and reservoirs would continue to control the middle and lower river. Although the productivity of the Elwha River would improve somewhat with 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).

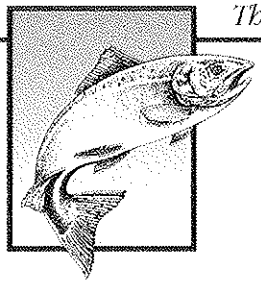
The benefits to wildlife from partial fish restoration would depend primarily on four factors: (1) the total number of fish returning to the river; (2) the retention of carcasses in the river and tributaries; (3) the location and timing of spawning; and (4) the length of time carcasses are available 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.

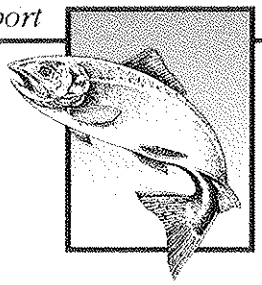
11. Tribal Social Effects. Because full restoration of the Elwha River salmon runs cannot occur with the retention of the dams, treaty fishermen would continue to suffer severely restricted ceremonial, subsistence, and commercial fisheries. The primary economic and cultural resource of the Elwha S'Klallam 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.

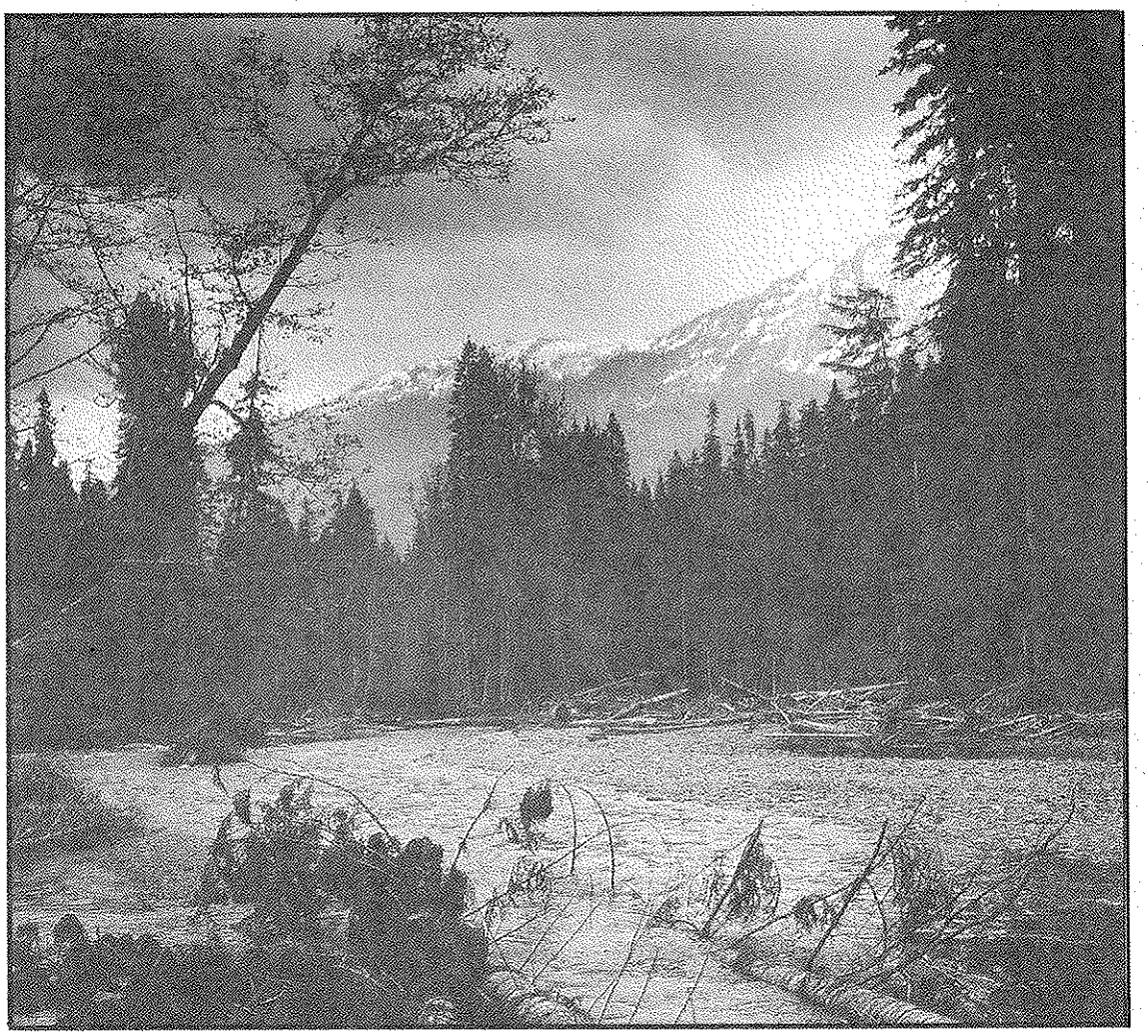
13. Other Effects. Overall effects on recreation and tourism would be at least slightly negative, with a corresponding negative effect on tourist and recreation-based income. In contrast, facility modifications would increase taxes paid by the Projects to Clallam County by about 78%, to $457,000 annually.

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)

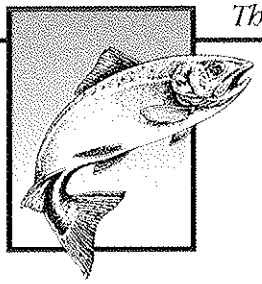


Table 3. *The long-term consequences of various restoration alternatives.*

	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