SALMONID AVAILABILITY AND MIGRATION IN THE MIDDLE ELWHA RIVER SYSTEM

Prepared for the

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ABSTRACT

Two hydropower dams now block anadromous fish passage on the Elwha River on Washington's Olympic Peninsula. Fish and wildlife agencies desire rapid restoration of anadromous fish in the approximately 110 km (70 mi) of tributaries and mainstem above the dams, in the event of dam removal. Restoration methods will depend largely on availability of local fish stocks for captive rearing and release above the dam sites.

To assess broodstock potential for reestablishing steelhead (*Oncorhynchus mykiss*), rainbow trout were collected by scoop trap, gillnet, and electroshocker at 5 locations in the Elwha River basin in or between the reservoirs. Lake Mills, which is the upper reservoir, and upper Little River, which is a tributary between the reservoirs, provided the highest catch per day. However, Lake Mills fish were much larger and could be expected to have higher fecundity. The mainstem Elwha trap, which was just downstream of the upper reservoir, captured only 30 downstream migrant rainbow trout in 34 nights of fishing. Broodstock capture there would be feasible only in years of relatively high stream discharge, and not in a relatively dry year such as 1994. The total rainbow emigration at this site was approximately 350-700 fish. Emigration may have been reduced by low streamflow conditions in 1994.

Rainbow trout adaptability to saltwater in 17 downstream migrant rainbow trout captured from the mainstem Elwha below Glines Canyon Dam was assessed by saltwater challenge and ATPase assay. All individuals over 160 mm were fully adapted to saltwater.

To assess broodstock potential for reestablishing sockeye salmon (*O. nerka*) in Lake Sutherland, which is the source of Indian Creek (another tributary between the reservoirs), a fyke trap was placed at the lake's outlet. The object was to capture kokanee salmon that may have been attempting to migrate downstream via Indian Creek. At present, a fish screen immediately below the trap site blocks downstream migration. Nearly all kokanee captured entered the trap on 18-19 April, the first night of fishing, although the trap remained in place until 3 June. Either most kokanee attempted to migrate before the trap was in place, or very few fish tended to seek the lake outlet. It is also possible that the trap and site combination did not allow efficient capture of kokanee.

Incidental catch included bull trout (*Salvelinus confluentus*) in the mainstem Elwha and Lake Mills, cutthroat trout (*O. clarki*) in Lake Mills, Indian Creek, and Little River, and brook trout (*S. fontinalis*) in Indian Creek and Little River.

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Mr. Orville Campbell, hydropower officer of Daishowa America Port Angeles Mill, and power plant supervisor Joe Michalczik arranged the assembly of a temporary laboratory at the Elwha Dam; a cable ladder to the scoop trap site; and a special spill schedule at Glines Canyon Dam to facilitate trapping and provide for our inspection of the plunge basin. All dam operators, in particular Mark Lomax, cooperated in these efforts.

Steve Dilley of this office directed the installation and removal of the mainstem Elwha scoop trap, aided by Steve Hager, Jeff Chan, Chris Mendoza, Roger Peters, Dave Zajac, and Catherine Pantaleo of this office. Wilson Construction Company of Port Angeles, Washington provided an industrial crane for trap installation. Messrs. Chan and Mendoza, aided by Charlie Buchanan, operated the scoop and fyke traps and assisted in the gillnetting and most of the electroshocking. Roger Wiswell assisted in weekend trap operation. Mr. Sammy Sampson and Ms. Verna Sampson of the Lower Elwha Tribe and volunteer Joel Magat assisted in the Little River electroshocking.

Dr. Wally Zaugg of Cook, Washington generously provided laboratory analysis of the gill ATPase samples. Ms. Nancy Elder of the Marrowstone Island Laboratory, National Biological Survey, provided freezer space for our samples and generously performed the laboratory analysis for plasma sodium. The Washington Department of Fish and Wildlife provided access to the Lake Sutherland trap site.

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GLOSSARY

ATPase	Adenosine triphosphatase
cfs	Cubic feet per second
FERC	Federal Energy Regulatory Commission
FL	Fork length
GSI	Genetic stock identification
LET	Lower Elwha Tribe
Lower Elwha	The Elwha basin downstream of Elwha Dam
meq/L	Millequivalents per liter
Middle Elwha	The Elwha river basin between the head of Lake Mills, downstream to the Elwha Dam.
NBS	National Biological Survey
ONP	Olympic National Park
ppt	Parts per thousand
RKm	River kilometer, beginning at the mouth of a river or tributary and proceeding upstream.
RM	River mile, beginning at the mouth of a river or tributary and proceeding upstream.
SL	Standard length
Upper Elwha	The Elwha Basin upstream of Lake Mills
USDI	United States Department of the Interior
WDFW	Washington Department of Fish and Wildlife
WWFRO	Western Washington Fishery Resource Office of the U.S. Fish and Wildlife Service, Olympia, Washington

INTRODUCTION

The Elwha River Ecosystem and Fisheries Restoration Act (Public Law 102-495) of 1992 established in Section 3(d) the goal of full restoration of the Elwha River's ecosystem and native anadromous fisheries. Dams at RKm 8 (RM 5) and 21 (RM 13) have blocked all upstream fish migration since 1914. If the dams are removed, federal, state, and tribal fishery agencies plan to accelerate restoration by releasing hatchery-reared juvenile salmonids into the river upstream of the existing dam sites for 8 to 10 yr after safe fish passage is assured (USDI et al. 1994).

The agencies have identified rainbow trout (*Oncorhynchus mykiss*) among the candidates for hatchery-assisted restoration (USDI et al. 1994). Trout from the upper Elwha, that is, RKm 32 (RM 20) and upstream may represent native Elwha steelhead (Reisenbichler and Phelps 1987). However, a scarcity of upper Elwha trout coupled with the occurrence of outmigrants at Elwha Dam indicates that the relatively accessible lower and middle Elwha may be suitable for broodstock capture.

Collection of sufficient broodstock to support a hatchery operation from the upper Elwha would be costly since the upper Elwha is only accessible by footpath. Moveover, upper Elwha trout catches have been low, and hatchery rearing has not been very productive due to small fish size and consequent low fecundity (John Meyer, ONP, pers. comm.).

In contrast, 47 naturally-migrating steelhead smolts were captured incidental to the 1991 Eicher fish screen tests at Elwha Dam (Winchell 1991), although no steelhead plants have been made above the dam in recent years. The author observed that the fish appeared fully smolted and had excellent fin quality indicative of wild-reared fish. He concluded that they represented a portion of the resident trout population that undergoes smoltification and outmigrates in the spring. Based on this observation, the USDI et al. (1994) suggested that outmigrants from the resident trout population might serve as either a source of hatchery brood (through captive rearing) or that natural recolonization would occur after dam removal, depending on their abundance.

The agencies have also considered Lake Sutherland kokanee salmon (*O. nerka*) for broodstock development (USDI et al. 1994). This species is believed to have historically spawned and reared in Lake Sutherland (FERC 1993). Landlocked *O. nerka*, or kokanee, reside in Lake Sutherland, and may be composed of remnant Elwha sockeye. The USDI et al. (1994) proposed to enhance the anadromous component of Lake Sutherland kokanee, assuming it retained a significant genetic element of the original Elwha sockeye. Kokanee, even though landlocked for many generations, may produce anadromous offspring (USDI et al. 1994) which through captive rearing might be used to restore depleted sockeye stocks, as is proposed for recovery of the endangered Snake River sockeye. Smolts would be trapped at the outlet weir, captive reared to maturity, and their offspring returned to Lake Sutherland over one or more cycles prior to removal of the Elwha Dam.

These considerations led to several research goals, including assessment of the anadromous potential of Lake Sutherland kokanee by fyke netting kokanee "smolts" during spring at the lake outlet for ATPase and saltwater challenge, and assessment of smolt production from the upper Elwha basin's rainbow trout population.

Study Area

The Elwha River (Figure 1) originates in the Olympic Range of western Washington state and flows northward into the Strait of Juan de Fuca. The Glines Canyon Dam is located at RKm 21 (RM 13.2) of the Elwha River. It generally diverts 31 m^3/sec (1,100 cfs) from Lake Mills into the powerhouse located about 0.5 km downstream of the dam. Since the hydropower intake is approximately 15 m below the reservoir surface, few rainbow trout are expected to enter, as this species tends to migrate near the surface. Rather, nearly all trout exit the dam over the spillway. When river flow into the lake exceeds 31 m^3/sec (1,100 cfs), the spillway exit is available. When river flow falls below that level, the powerhouse normally uses all the available water and the bypass reach receives no spill flow. During most springs, however, river flow exceeds turbine capacity by a significant margin so spill flow occurs most days. However, in spring 1994, reservoir drawdown and refill (for special testing related to dam removal studies) reduced spill flows available to pass fish at Glines Canyon Dam. Thus, to provide for downstream fish passage throughout the trapping period, Daishowa agreed to reduce power generation from 10:00 PM to 5:00 AM each night when the trap was operated, thereby providing a minimum flow of 4.2 m^3/sec (150 cfs) at the dam's spill exit.

Two main tributaries enter the Elwha between the dams: Little River and Indian Creek. Little River originates some 8 km (5 mi) east of the Elwha and enters at the head of Lake Aldwell. There is a logjam at approximately RKm 4.8 (RM 3.0) which blocks fish migration upstream, at least during most flow conditions. Indian Creek originates at Lake Sutherland 8.8 km (5.5 mi) west of the Elwha River and also enters at the head of Lake Aldwell. WDFW maintains a fish screen at RKm 8.5 (RM 5.3) which blocks fish migration in both directions at all flows.

Salmonid Stocks

The river system upstream of the Elwha Dam supports resident populations of rainbow trout, cutthroat trout (*O. clarki*), bull trout char (*Salvelinus confluentus)*, brook trout (*S. fontinalis*), several non-salmonid families, and Dolly Varden (*S. malma*). In addition, Lake Sutherland supports kokanee salmon, rainbow trout, and cutthroat trout. The Middle Elwha char populations are native; the rainbow, cutthroat, and kokanee may be of mixed native and introduced origin; and the brook trout are an exotic species.

Ongoing Studies

Samples of rainbow trout from each study site in this report, plus steelhead from the lower Elwha River tribal fishery, are being analyzed by means of protein electrophoresis. Comparison to past years' analyses of upper Elwha resident rainbow trout will allow evaluation of suitability of the middle or lower Elwha locations for broodstock collection. A final WWFRO report is expected in late 1994 when laboratory results become available.

Samples of *O. nerka* from Lake Sutherland and four other lakes in western Washington are being analyzed by means of DNA typing. Data on Lake Sutherland nutrients, chlorophyll, and zooplankton are also being collected monthly to estimate the potential sockeye productivity. Results of these studies will aid in deciding whether hatchery involvement in restoring Lake Sutherland sockeye should be pursued. A final WWFRO report is expected in early 1995 when all laboratory results become available.

Objectives

The objectives of middle Elwha fish collections addressed in this paper are:

(1) Determine the availability of middle Elwha rainbow trout for broodstock, in terms of abundance, distribution, migration timing, length frequency, and sex ratio.

(2) Estimate the abundance of rainbow trout migrating downstream through the mainstem Elwha.

(3) Assess the smolt readiness of these fish by ATPase and saltwater challenge.

(4) Determine the availability of Lake Sutherland kokanee salmon for broodstock by trapping at Indian Creek.

(5) Describe the fish species composition of the middle Elwha basin.

METHODS

Fish Collection

Scoop Trapping

A floating scoop trap was installed in the mainstem Elwha between the Glines Canyon Dam and the Altair Bridge (Figure 2). The trap remained in place from 18 April until 8 June 1994. The trap is of standard design (Seiler et al. 1984) and capable of capturing juvenile salmonids up to the size of steelhead smolts under ideal current velocities. The trap was attached to the shore by cables which allowed the trap to be moved to the point of optimum current velocity.

Generally, each Monday the scoop was lowered into fishing position, and each Friday was lifted for the weekend. During peak smolt migration the trap remained fishing all weekend. Each fishing day the current velocity was measured with a Swoffer (R)[1] meter at the midpoint of the scoop entrance, and the trap was repositioned to provide the best velocity. The trap was fished a total of 34 d.

To examine the catch we lifted the trap, removed fish from the bin with a dipnet, and transferred them to a basin on the trap. We sorted rainbow trout into two groups, one with fish less than 130 mm, the other with larger fish. Larger fish were considered outmigrant smolts, based on the review of Winter (1992), and were taken to a laboratory at Elwha Dam for saltwater challenge. Smaller trout were released in the Elwha River far enough downstream from the trap to prevent immediate re-entry.

Char were anesthetized and examined with a magnifying glass to determine the species, according to the method of Haas (1988) as cited by Johnson (1990). We counted the branchiostegal and anal rays, and measured the maxillary and standard lengths to the nearest mm. Following these measurements, fish were held for recovery and then released with the smaller rainbow trout.

Total smolt emigration at the scoop trap (and from the upper basin) was estimated by applying efficiency estimates measured in previous years of trapping at this site, then expanding for days not fished during the season. Table 1 shows previous estimates of scoop trap efficiency at this site for LET hatchery steelhead smolts. Based on these data, we assumed scoop trap efficiency for wild smolts ranged from 6% to 13%, and expanded the total observed catch (30 fish) by 1/0.06 and 1/0.13 to obtain season high and low estimates, respectively. These estimates were further expanded to account for days not fished (51 d of study / 34 d of fishing = 1.5). Assumptions in these estimates were:

(1) Trap efficiency (season average) for wild steelhead smolts ranged from 6% to 13%.

(2) The trapping period encompassed the total period of smolt emigration in the middle Elwha River.

(3) Smolts passed Glines Canyon Dam and the bypass reach without significant delay or mortality.

Gillnetting

Up to four variable-mesh horizontal sinking gillnets were set in Lake Mills (Figure 2) between 22 June and 21 July 1994. Each net was 30.5 m (100 ft) long, 1.8 m (6 ft) deep, and consisted of 5 panels of white polyfilament mesh. Stretched mesh size ranged from 1.9 to 8.9 cm (0.75 to 3.5 inches). The head rope was buoyant polypropylene line without floats, and the foot rope was made of woven lead-core rope. Each end of the foot rope was anchored with a 5-kg concrete weight. Each end of the head rope was marked

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[1] Mention of product names does not constitute endorsement.

at the surface with a float. Nets were set at various angles from the shore to cover as wide a range of depth as possible.

One end of each net was tied to a tree on shore while the other end was anchored at a depth ranging from 2 to 27 m (6 to 90 ft). Nets were set at dusk and recovered between midnight and early morning the following day. We fished a total of five nights.

Upon net retrieval we counted each fish caught and determined the species. We sacrificed rainbow trout with a blow to the head, measured fork length to the nearest mm, took scales, and determined the sex in conjunction with dissection for GSI (protein electrophoresis). Char were anesthetized if still alive, and all char were examined for meristic counts as at the mainstem Elwha trap. Live fish were then allowed to recover and were returned to the lake.

Electroshocking

We electroshocked all readily accessible reaches of Indian Creek and Little River between 28 June and 11 August 1994 (Figures 3 and 4). We used a Smith-Root[2] Model 12 backpack electroshocker equipped with a 24-v battery and adjusted to produce 400 VDC at 60 Hz. The negative electrode consisted of a bare trailing cable; the positive electrode was a hoop fitted with a flat nylon net. One or two persons with hatchery-style dipnets assisted in capturing shocked fish.

All fish under approximately 90 mm were allowed to drift downstream and out of the range of the electrofisher. Fish over that length were netted and the species determined. Maxillary length and hyoid makings were used to separate rainbow from cutthroat. Rainbow trout were retained for later examination. Fish of other species were returned to the stream just downstream of the pool being fished. Rainbow trout were measured, scales were taken, and sex was determined in the same manner as at Lake Mills.

Fyke Trapping

We operated a trap at the Lake Sutherland outlet, just upstream from the fish screen at Indian Creek (Figure 3) to capture fish presumably attempting to move downstream out of Lake Sutherland. The trap rested on the stream bottom in about 0.5 m of water and was supported by lines attached to trees on shore. The trap mouth was a 1.8-m square iron frame supporting a funnel of 6-mm mesh nylon web approximately 5 m long. The funnel tapered to a width of about 15 cm, where it joined a floating live box approximately 0.5 m deep, 1 m wide, and 1.5 m long. The box was framed in plastic pipe and covered on all sides with the same type web as the funnel. The top was zippered to allow fish removal. Mesh wings of 6-mm nylon mesh were draped over the support ropes and anchored to the stream bottom with rocks, so that the entire stream was sampled. We operated the

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[2] Mention of product name does not constitute endorsement.

trap from 18 April to 3 June 1994, Monday through Friday, for a total of 26 nights.

After a few days of operation it became apparent that low stream velocity was allowing most salmonids to leave the trap, and on 21 April we modified the live box to retain more fish. We installed a pair of perforated aluminum baffles, each about 40-cm square, at the upstream end of the live box. The baffles were oriented in a "v" pattern, with the point downstream, to constrict the flow to a vertical slot about 5 cm in diameter.

To examine the catch, we lifted the live box from the water and removed the fish with a dipnet. Fish were identified to species and counted. Salmonids large enough for species determination were anesthetized, measured for fork length, and allowed to recover. All fish were then released into Lake Sutherland just above the mouth of Indian Creek.

Rainbow Trout Smolt Readiness

Saltwater Challenge

All rainbow trout taken to the Elwha Dam laboratory were held for 1 to 5 d, until at least 8 control and 8 test fish were present. Fish were kept in 150-L (40-gal) plastic buckets of Lake Aldwell water, with up to 4 or 5 fish per bucket. To duplicate river temperatures, each bucket was immersed in a 750-L (200-gal) fiberglass tank with continuous flow of pumped Lake Aldwell surface water. Buckets received aeration from a large aquarium-style piston pump and airstones.

When enough fish were present, two saltwater test buckets and two control buckets were prepared. Each contained about 150 L (40 gal) of water. The test buckets received aquarium-type artificial sea salt to maintain specific gravity of 1.020 to 1.022 or 28 to 30 ppt. All buckets were immersed in the circulating tanks, and aerators were inserted as before. Fish from the acclimation buckets were randomly transferred to test or control buckets.

After 24 h, fish were individually removed from test and control tanks and sacrificed by immersion in MS-222. We measured length and weight, and classified appearance as "parr", "smolt", or "intermediate."

We then sampled for plasma sodium following the general procedure of Blackburn and Clarke (1987), with details specified by Nancy Elder (NBS, pers. comm.). Fish were dried with a paper towel and cut at the caudal peduncle with a scalpel at a 45° angle just behind the adipose fin. Blood was collected in a Caraway-type, ammonium-heparinized capillary tube, with the tube held horizontally to avoid trapping air bubbles. The capillary tube was capped and inserted into a hematocrit centrifuge and spun for 5 min to separate red blood cells from plasma. Plasma was then transferred to a 2-ml polypropylene vial and stored over ice. Samples were delivered within 24 h to the NBS, Marrowstone Island Laboratory in Nordland, Washington for sodium determination according to standard procedures.

ATPase Assay

Gill tissues were dissected from each control fish for Na^+-K^+ ATPase analysis and preserved according to the method of Zaugg (1982). The sample consisted of the lamellae from two arches on each side of the fish. Vials were placed on dry ice and shipped to Wally Zaugg, Inc., of Cook, Washington for standard assay of ATPase activity.

Determination of Char Species

Meristic data from char were entered into the discriminant function given by Johnson (1990), citing Haas (1988):

$$D = 0.63B + 0.18A + 37.31(ML/SL) - 21.8$$

Where: D = discriminant function
B = branchiostegal number
A = anal fin rays
ML = maxillary length, and
SL = standard length.

Fish with values over zero were considered bull trout while fish with values less than zero were considered Dolly Varden.

RESULTS

Rainbow Trout

Distribution

Rainbow trout were most available, in terms of daily catch, by electroshocking in upper Little River (Table 2). Lower Little River was second in catch per day. Lake Mills was third in daily catch. Indian Creek produced few rainbow trout compared to other electroshocking areas. The mainstem Elwha catch per day was the lowest of any method.

Rainbow trout from Indian Creek were most available between Lake Aldwell and Indian Creek RKm 0.64 (RM 0.4) (Figure 3) and less abundant from there to RKm 1.9 (RM 1.2) (Table 3). Most of the potential trout habitat between RKm 3.4 (RM 2.1) and RKm 8.0 (RM 5.0) is inaccessible by foot or boat due to beaver ponds. Rainbow trout were very scarce between RKm 8.0 (RM 5.0) and the fish screen at RKm 8.5 (RM 5.3).

Rainbow trout from Little River were most available in the South Branch near the bridge at RKm 1.3 (RM 0.8) (Table 3). The South Branch site upstream of that point, as well as the lower mainstem Little River, were less productive in electroshocking.

Trout from Lake Mills were about equally available from either the east or west banks (Table 4, Figure 2). Catch per net was too low to compare catch among individual sites.

Migration Timing and Abundance

Mainstem Elwha below Glines Canyon Dam. Smolt-sized rainbow trout were present from 6 May to 2 June, with peak abundance from 10-12 May (Figure 5, top panel). Smaller trout were present in the first week of trapping but decreased in abundance over the study period. Weekly average catch of smolt-sized trout coincided with the high weekly average of current velocity at the trap (Figure 5, center panel). However, daily catch of large trout was more strongly correlated with total river discharge downstream of the Glines Canyon powerhouse (Figure 5, bottom right panel) than with the current velocity at the trap (Figure 5, bottom left panel).

Over the season a total of 30 steelhead smolts were captured at the scoop trap. By expanding this observed catch, the total estimated smolt emigration at the scoop trap ranged from approximately 350 to 750 fish during the study period (Table 1).

Lake Sutherland Outlet. Rainbow trout, although not the target species at that location, were the most common salmonid captured. They occurred in the fyke trap between 20 April and 25 May, and were most abundant during the first, fourth, and fifth study weeks (Figure 6).

Length Frequency and Sex Ratio

Lake Mills provided larger rainbow trout than any other site (Figure 7). Lake Sutherland trout were intermediate in length compared to all other locations. The smallest mean size came from the South Branch Little River. Sex ratio was about even at all collection sites except Lake Mills, where females outnumbered males by a ratio of about 3:2 (Table 5).

Saltwater Readiness

Saltwater Challenge. After the 24 h challenge, all test fish over 160 mm FL had plasma sodium levels remaining under 170 meq/L (Figure 8, top panel), which is the usual criterion for smolt readiness (Blackburn and Clarke 1987). Control fish held in fresh water over the same period had plasma sodium levels in the same range. Two of the three test fish below 160 mm had elevated levels of sodium after the challenge.

ATPase. The five control fish over 160 mm FL had ATPase activity of over 16 units (Figure 8, bottom panel), which is the criterion for smolt readiness (W. Zaugg, pers. comm.). The three control fish under 160 mm had activity units below that criterion.

Kokanee Salmon

Catch Timing at Lake Sutherland Outlet

Eight kokanee salmon were captured in the fyke trap on 19 April after the first night of fishing. These were not removed, as we expected more fish to accumulate and considered it more efficient to handle them as a group at the end of the week. However, by 20 April all kokanee had left the trap, and none entered thereafter, with the single exception of one fish on the third study week. For this reason an ATPase sample could not be taken. However, all kokanee captured appeared very silvery and had no apparent parr marks.

Incidental Salmonid Catch

Cutthroat Trout

Cutthroat trout ranged throughout accessible reaches of Indian Creek and Little River (Table 6), but were most abundant in relation to other species in the upper reaches of each (Table 3). Only at Lake Sutherland were cutthroat trout measured for length. Out of 15 fish, FL ranged from 95 to 145 mm, with a mean of 116 mm.

Bull Trout

Bull trout occurred only in the Lake Mills and mainstem Elwha River catches (Table 6). Glines Canyon bull trout clustered about 90-130 mm SL (Figure 9, upper panel), but Lake Mills fish ranged up to 404 mm (Figure 9, bottom panel). Mainstem Elwha bull trout were most abundant in the first two weeks of trapping, but became scarce thereafter (Figure 5, top panel).

Brook Trout

Brook trout occurred predominantly in Indian Creek although a few were caught in the lower mainstem of Little River (Table 6). Indian Creek brook trout were most abundant around RKm 3.2 (RM 2.0), although they were caught at all downstream sites as well (Table 3).

DISCUSSION

Rainbow Trout

Distribution

The 1994 fishing effort suggested that middle Elwha rainbow trout might be efficiently captured for broodstock only in Little River and Lake Mills. The mainstem Elwha trap failed to provide more than a few trout despite the extensive fishing effort. Velocities at the trap (Figure 5) were usually at the low end of the range over which the trap most efficiently catches steelhead smolts (approximately 2 to 2.5 m/sec (7 to 8 ft/sec)). For this reason, broodstock collection by scoop trap in the mainstem Elwha should be attempted only during years with relatively high springtime spill.

Migration Timing and Abundance

Mainstem Elwha below Glines Canyon Dam. Rainbow trout large enough to be smolts, based on river systems reviewed by Winter (1992), migrated down the mainstem Elwha during a period typical of smolts elsewhere. However, the low 1994 flows and consequent intermittent daily spill may have compressed most of the migration into an unnaturally short period. This would happen if the amount of spill affected outmigrant fish mortality. Our observations of the plunge pool on 2 and 8 June (Appendix E) indicate that lower levels of spill may kill more fish passing out of the plunge basin than higher spill. This is because the spill water passes over a falls about 100 m downstream of the dam. At spill of around 4.2 m^3/sec (150 cfs) the water leaves the plunge basin under pressure through a subsurface gap in a logjam at the crest of the falls. The resulting water jet impinges on a log before falling onto a boulder field. The observed velocities seem intuitively high enough to kill or abrade fish. At spill of 12.7 m^3/sec (450 cfs), water leaves the plunge basin over the surface of the logjam as well as through it. The resulting increase in turbulence of the falls and increased depth over the boulder field seem to provide fish with a softer fall.

The low abundance of smolts (30 observed; 350-750 expanded catch) implies that scoop trap collection may not provide sufficient fish for a captive brood program. Moreover, even in a high flow year, outmigrant catches would not be sufficient for coded-wire tagging to assess rum timing as outlined in the fish restoration plan (USDI et al. 1994). As well, natural reestablishment following dam removal would likely be a very slow process with outmigration of such apparent low magnitude.

Lake Sutherland Outlet. The occurrence of rainbow trout at the lake outlet coincided with peak migration at the mainstem Elwha trap. Lake Sutherland rainbow were at the large end of the range for smolts (Winter 1992), but our technicians stated these fish by all accounts appeared to be smolts. The likelihood of a native rainbow trout stock occurring in Lake Sutherland is low due to the very low availability of streams for natural spawning. Moreover, the lake has received numerous recent releases of non-native rainbow trout.

Length Frequency and Sex Ratio

Lake Mills provided larger rainbow trout than any other site (Figure 7). If Lake Mills resident trout represent upper Elwha stock, broodstock from this site would provide a shortest captive rearing time and a higher fecundity than fish from other sites. The apparent abundance of females, if it is not due to sampling error, would also facilitate broodstock development.

Saltwater Readiness

Saltwater challenge and ATPase assays confirm the conclusion that rainbow trout migrating through the mainstem Elwha below Glines Canyon are smolts.

This supports Winchell's (1991) observation that the outmigrant rainbow trout incidentally caught at Elwha Dam were wild smolts. Smolts from resident parents would not be unique to the Elwha. Peven et al. (1994) give evidence of varying degrees of anadromy within the mid-Columbia rainbow trout stock. The authors suggest that progeny of rainbow trout have the potential to become anadromous; that is, as juveniles continuously move downstream in search of more adequate food supplies, smoltification of individual fish results as a threshold length is approached. At least one other salmonid species can produce anadromous offspring from resident parents. Kokanee salmon may continue to produce offspring that adapt to potential saltwater life even if physical barriers prevent migration to sea (Foote et al. 1994; Kaeriyama et al. 1992).

The apparent anadromous tendency in mainstem Elwha rainbow trout encourages further development of a captive broodstock program to restore an upper Elwha steelhead run. Unfortunately, only 20 of the 30 smolt-sized steelhead collected were sampled for GSI, due to logistic difficulties. It is not certain that mainstem Elwha fish can be treated as a separate group in statistical analysis. Therefore, this sample will be pooled with Lake Mills fish if separate analysis shows no clearly distinctive traits (Steve Phelps, WDFW, pers. comm.).

Kokanee Salmon

Catch Timing at Lake Sutherland Outlet. The occurrence of silvery kokanee at the start of trapping in mid-April suggests we may have begun too late and missed most attempted outmigration, although the period of trap operation coincided with expected emigration of sockeye salmon (M. LaRiviere, Tacoma Public Utilities, pers. comm.). Alternatively, the catch may represent kokanee milling in the lake without attempting to emigrate. While it is known that landlocked kokanee physiologically adapt to saltwater in the spring (Foote et al. 1992), we are not aware of a corresponding attempt to migrate downstream. In either case, the small catch numbers may indicate that the trap and site combination were inefficient in capturing smolt-sized kokanee.

Bull Trout

The discriminant function gave a bimodal distribution, with two groups centered around positive values (Figure 10, top panel). The group with the larger discriminant function contained larger fish, all of which were from Lake Mills, while the group with the lower function contained smaller fish from both collection sites. The function gave unambiguous results for char over 160 mm SL (Figure 10, bottom panel) but gave results very close to zero for some smaller fish. This distribution could be explained by (1) counting error, especially with smaller fish; (2) changing body proportions as fish grow, or (3) bias in the function itself for this locality, in which case the cutoff point might be close to one, rather than zero.

There was no strong evidence for downstream migration of this species. Bull trout from the mainstem Elwha trap were obviously parr, based on markings and generally gray body color. Bull trout from Lake Mills were generally larger than the size normally associated with salmonid smolts.

SUMMARY AND CONCLUSIONS

1. The most promising location for brood collection in the middle Elwha was Lake Mills, based on the relatively high catch per day and large fish size. The South Branch Little River could also provide large numbers of fish, but of much smaller size. Low catch per day at the mainstem Elwha trap indicated the 1994 trap site may be useful only in years of relatively high river flow.

2. Juvenile rainbow trout over 160 mm FL migrating downstream through the mainstem Elwha below Glines Canyon were ready to enter saltwater, based on their size, timing pattern, high gill ATPase activity, and low serum sodium concentration following saltwater challenge. Total emigration at this point was approximately 350-750 smolts.

3. Juvenile kokanee catch at the Lake Sutherland trap suggested either that most kokanee attempting to leave the lake did so before the third week of April, or that very few kokanee attempted to leave the lake at any time. In any case, our trap may not have detected most attempts at outmigration.

4. Bull trout were common residents in the mainstem Elwha and in Lake Mills, and may represent a healthy population. Cutthroat trout were abundant in Indian Creek and upper Little River, but infrequent at other sites studied. Introduced brook trout were abundant in upper Indian Creek but rare or absent at other study sites.

RECOMMENDATIONS

1. Focus rainbow trout broodstock collection primarily on Lake Mills and secondarily at upper Little River if genetic stock identification shows that fish from these locations represent upper Elwha native stock.

2. Investigate the feasibility of operating the scoop trap in normal flow (or high flow) conditions to capture smolts for captive rearing, if GSI data indicate that these fish are native Elwha stock and no other source exists in the middle Elwha basin.

3. Discontinue efforts to capture outmigrant kokanee unless ongoing research on reservoir productivity indicates a high potential sockeye production per lake area, or if DNA typing indicates a stronger affinity to local sockeye runs than to kokanee populations.

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TABLES

Table 1. Mainstem Elwha scoop trap efficiency at RKm 21.2 (RM 13.2) as measured for Elwha hatchery steelhead, and estimation of 1994 wild outmigrant rainbow trout population.

Trap year	Trapping efficiency (%)	Discharge m^3/sec	Discharge cfs	Source
1987	12.9	39.6	1,400	Wunderlich and Dilley (1988)
	9.2	46.7	1,650	"
	7.5	72.2	2,550	"
	6.2	73.6	2,600	"
1988	11.6	56.1	1,980	Wunderlich et al. (1989)
	10.9	73.6	2,600	"
	10.1	76.5	2,700	"
Range	6.2 - 12.9			
Mean	9.8			

Estimation of total 1994 rainbow trout migrant population

Observed trap catch = 30 fish
Expanded at 6% efficiency = 500 smolts
Expanded at 13% efficiency = 230 smolts
Expanded for days not fished (51 d/34 d) = 1.5 x 500 = 750
1.5 x 230 = 345

Table 2. Target species catch summary. Trap data from Appendixes A and B.

Target species	Gear type	Location	Catch	Days fished	Catch/ day	Mean length (mm)
Rainbow trout	Scoop trap	Mainstem Elwha	33	34	1.0	176
	Gillnet	Lake Mills	60	5	12.0	241
	Shocker	Indian Creek	34	4	8.5	144[A]
		Lower Little R.	25	1	25.0	
		Upper Little R.	52	1	52.0	125
Kokanee salmon	Fyke trap	Lake Sutherland	9	36	0.3	N/A

[A] Indian Creek and lower Little River combined.

Table 3. Electroshocking catch data.

Stream	River km (mi) Start	Stop	Date	Salmonids over 90 mm FL Rainbow trout	Cutthroat trout	Brook trout
Indian Creek and lower Little River						
Indian Creek	0.0	0.16 (0.1)	0629	7	13	3
	0.16 (0.1)	0.32 (0.2)	0628	7	22	8
	0.16 (0.1)	0.64 (0.4)	0719	11	28	8
	0.64 (0.4)	1.8 (1.1)	0720	8	75	10
	1.8 (1.1)	1.9 (1.2)	0629	0	16	3
	3.1 (1.9)	3.4 (2.1)	0629	0	17	15
	8.0 (5.0)	8.4 (5.2)	0629	0	7	0
	8.4 (5.2)	8.5 (5.3)	0628	1	26	0
Subtotal (4 da)				34	204	47
Little River	0.0	0.48 (0.3)	0810	9	0	5
	0.48 (0.3)	0.64 (0.4)	0810	16	1	2
Subtotal (1 day) Days				25	1	7
Total (5 days)				59	205	54
Upper Little River and South Branch Little River						
Little River	6.0 (3.7)	6.1 (3.8)	0811	0	16	0
South Branch	1.3 (0.8)	1.4 (0.9)	0811	41	0	0
	3.1 (1.9)	3.2 (2.0)	0811	6	0	0
	3.2 (2.0)	3.4 (2.1)	0811	5	0	0
Total (1 day)				52	16	0

Table 4. Lake Mills gillnet catch data.

Site group	Date	No. nets	Hr fished	Rainbow trout	Bull trout	Cutthroat trout
East	23-24 JUN	1	4	4	0	0
	27-28 JUN	2	2	4	1	0
	17-18 JUL	4	10	14	3	1
	18-19 JUL	4	9	16	3	1
	Subtotal		25	38	7	2
West	23-24 JUN	1	4	2	0	0
	19-20 JUL	4	8	20	4	0
	Subtotal		12	22	4	0
Total			47	60	11	2

Table 5. Rainbow trout sex ratio by collection site. Data from Appendix C.

Location	Male	Female	Immature	Undet.
Indian Creek + lower Little River	16	13	4	16
South Fork Little River	20	18	11	1
Mainstem Elwha below Glines Canyon	2	2	0	18
Lake Mills	19	34	2	0

Table 6. Species composition of catch from trapping, electroshocking, and gillnetting in the middle Elwha basin, 1994. Data summarized from Tables 2 and 3 and Appendixes A and B.

Salmonids

Location	Rainbow trout	Cutthroat trout	Bull trout	Brook trout	Kokanee salmon
Mainstem Elwha	33	0	23	0	0
Lake Mills	60	2	11	0	0
Indian Creek	34	204	0	47	0
Lower Little River	25	1	0	7	0
Upper Little River	52	16	0	0	0
Lake Sutherland	28	24	0	0	9

Other families

Location	Minnow	Sculpin	Stickleback
Mainstem Elwha	0	2	0
Lake Mills	0	0	0
Indian Creek	10	4	0
Lower Little River	0	0	2
Upper Little River	0	0	0
Lake Sutherland	2	2,028	0

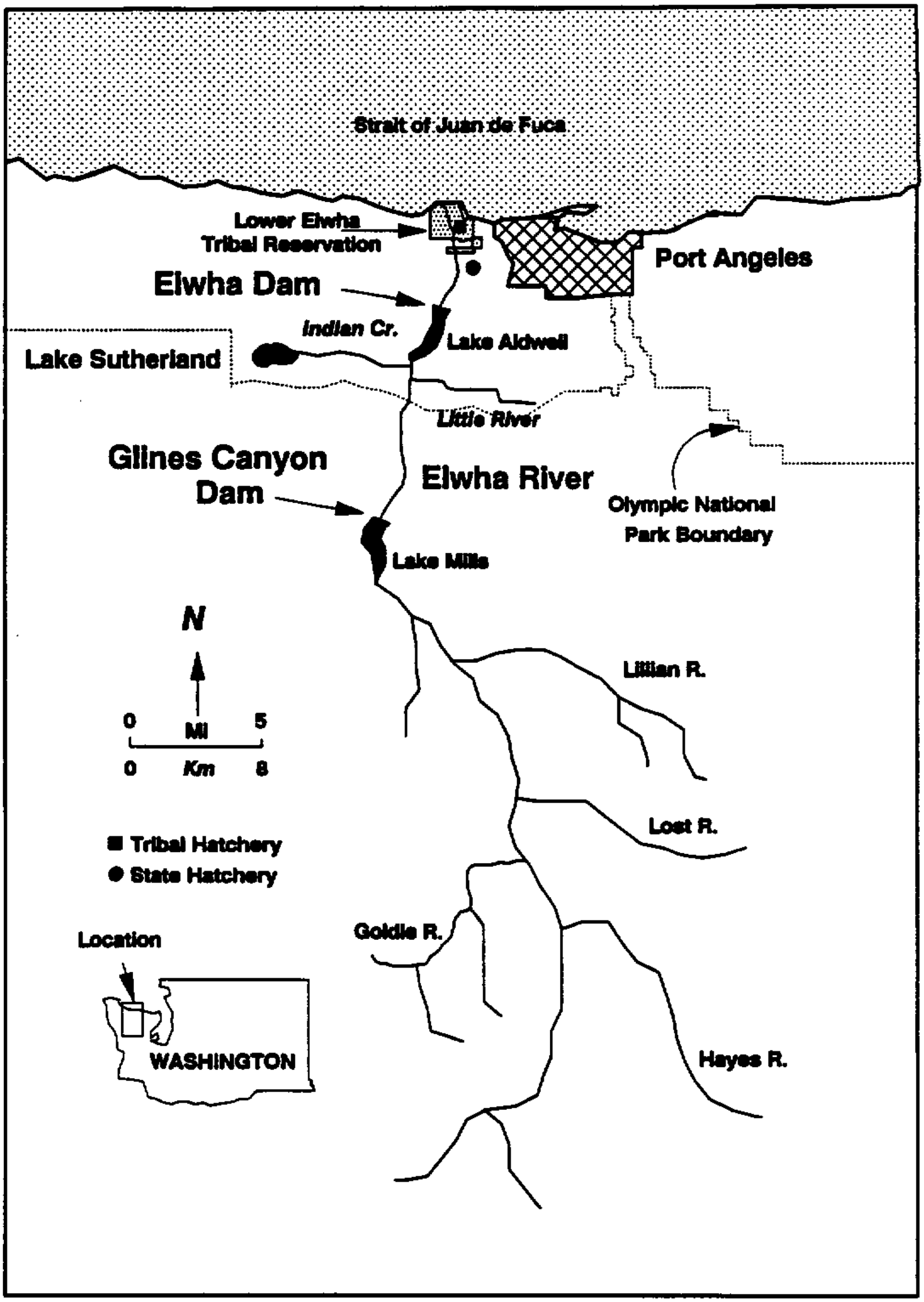

Figure 1. Elwha River Basin showing WWFRO's 1994 sampling locations.

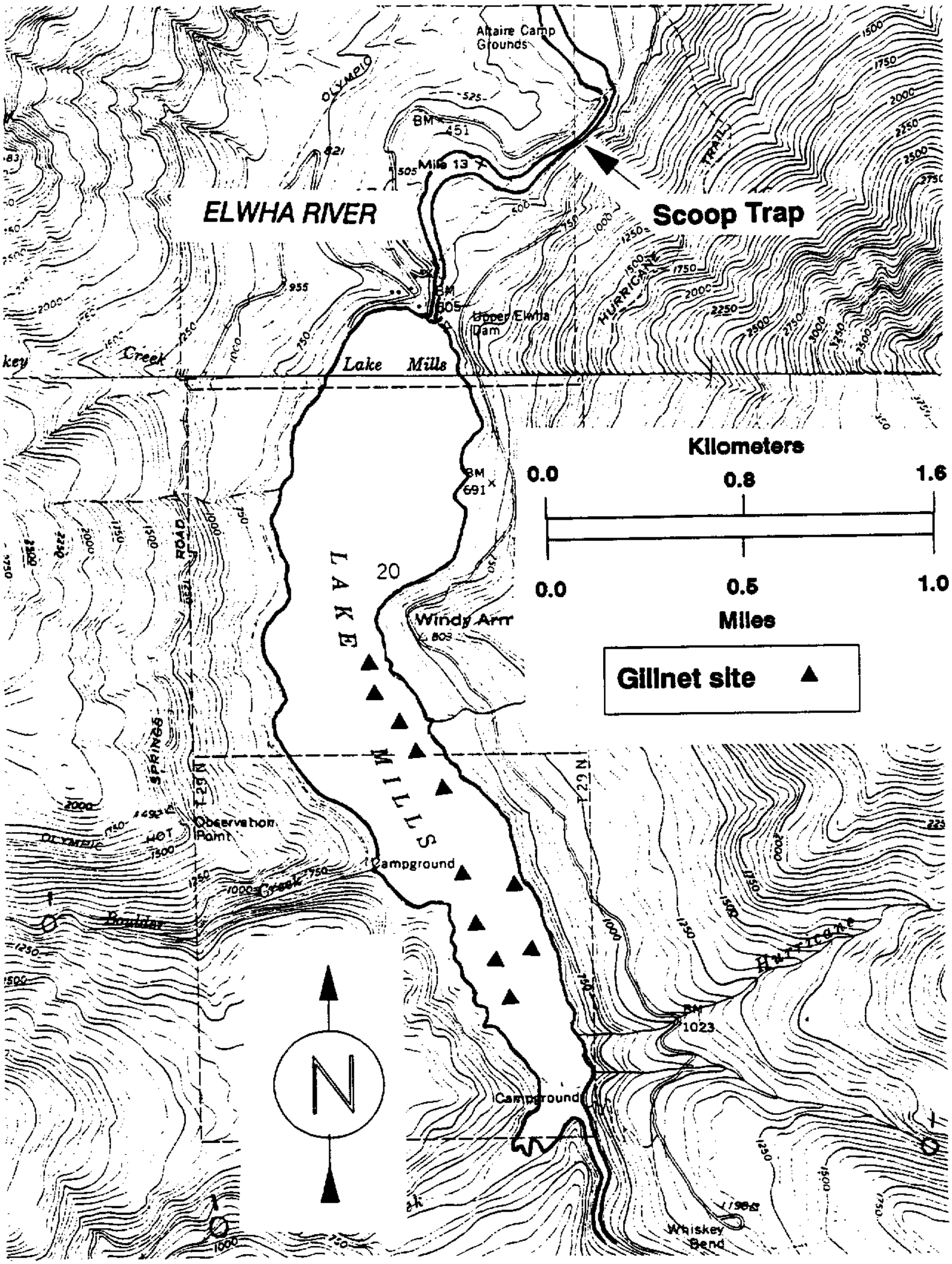

Figure 2. Middle Elwha River from Glines Canyon to Lake Mills, showing scoop trap and gillnetting sites.

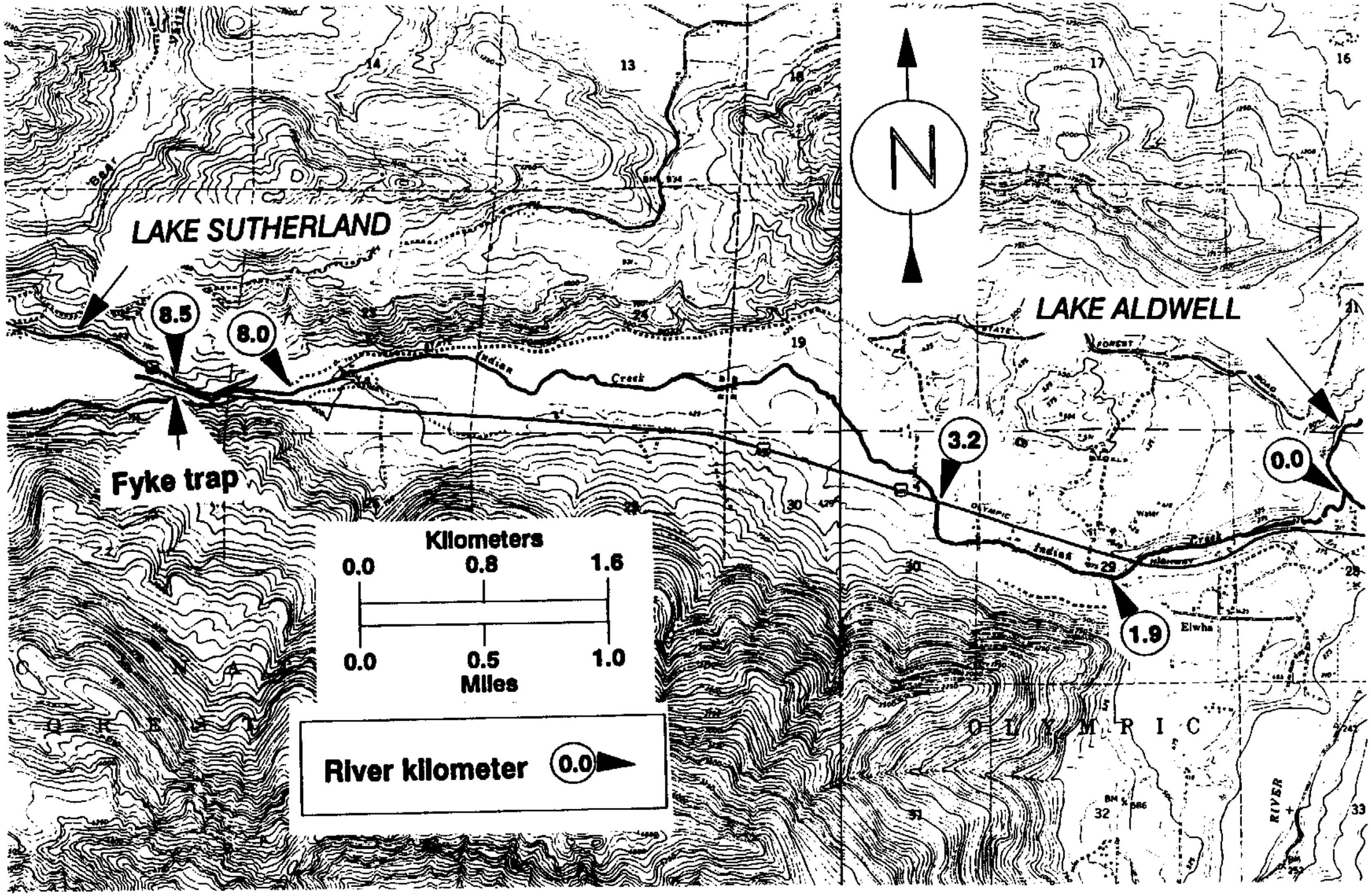

Figure 3. Lake Sutherland outlet and Indian Creek, showing fyke trap and electroshocking sites. RKm 1.9 = RM 1.2; RKm 3.2 = RM 2.0; RKm 8.0 = RM 5.0; and RKm 8.5 = RM 5.3.

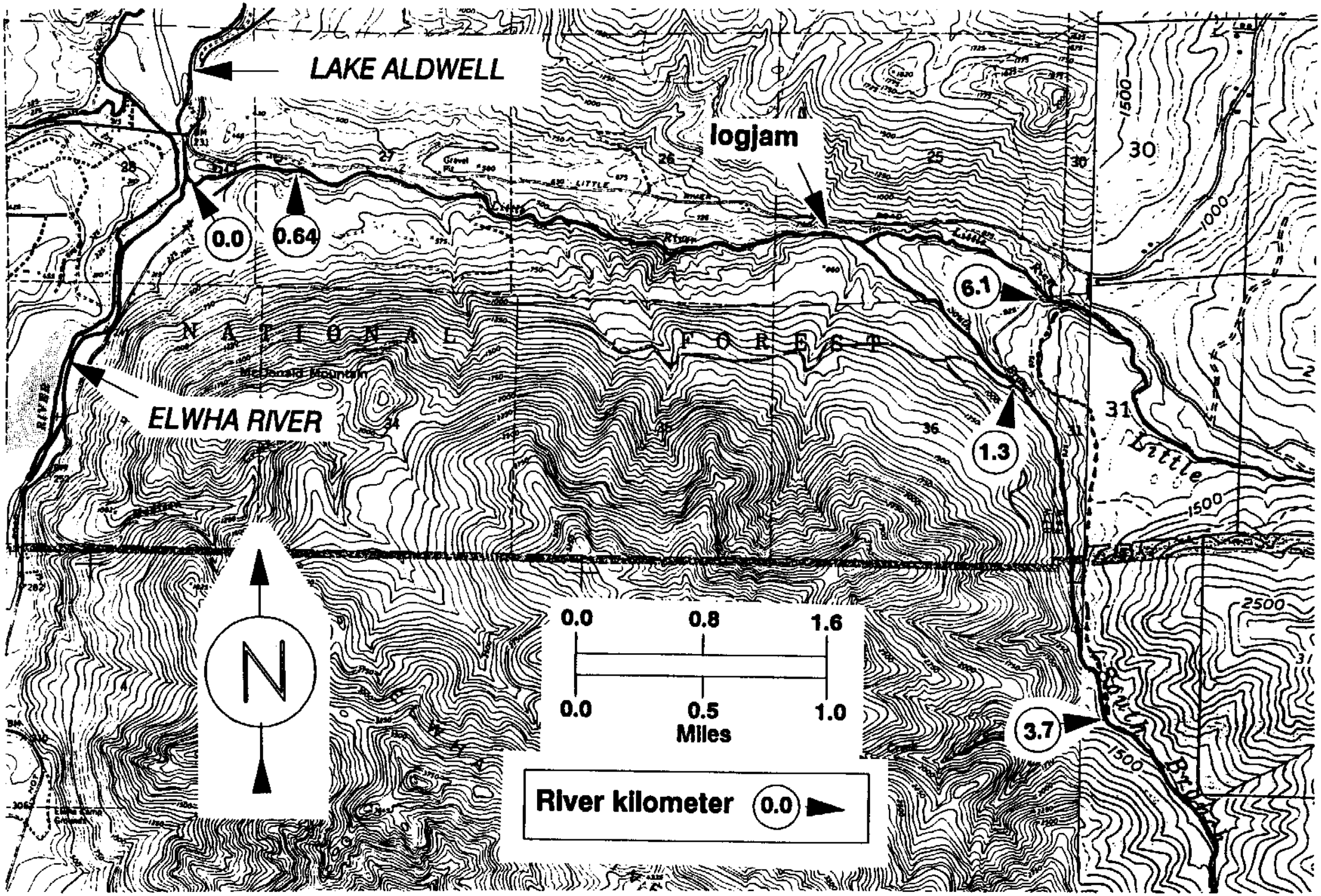

Figure 4. Little River, showing electroshocking sites. RKm 0.64 = RM 0.4; RKm 1.3 = RM 0.8; RKm 3.7 = RM 2.3; and RKm 6.1 = RM 3.8.

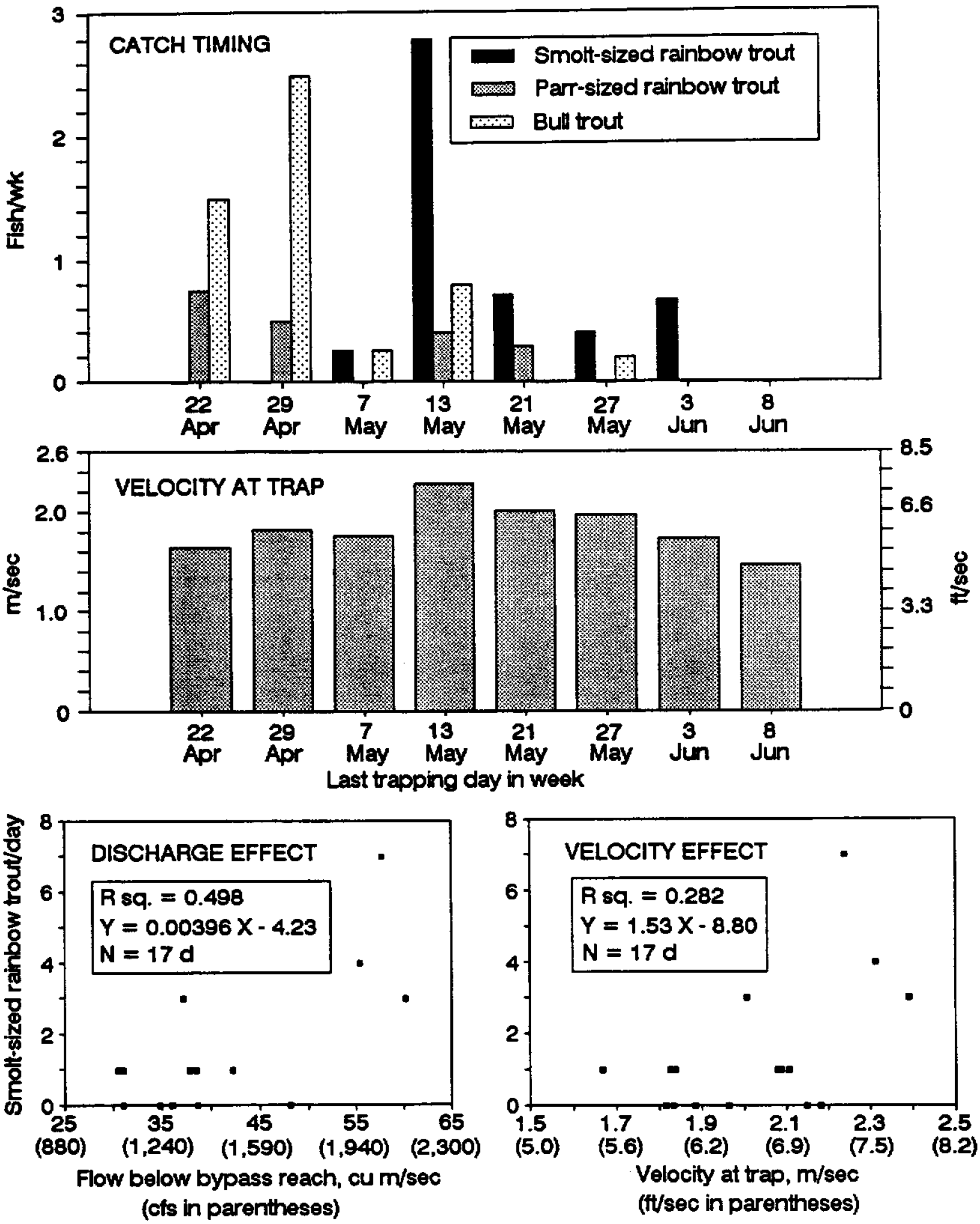

Figure 5. Salmonid migration timing at mainstem Elwha scoop trap. Data from Appendix A.

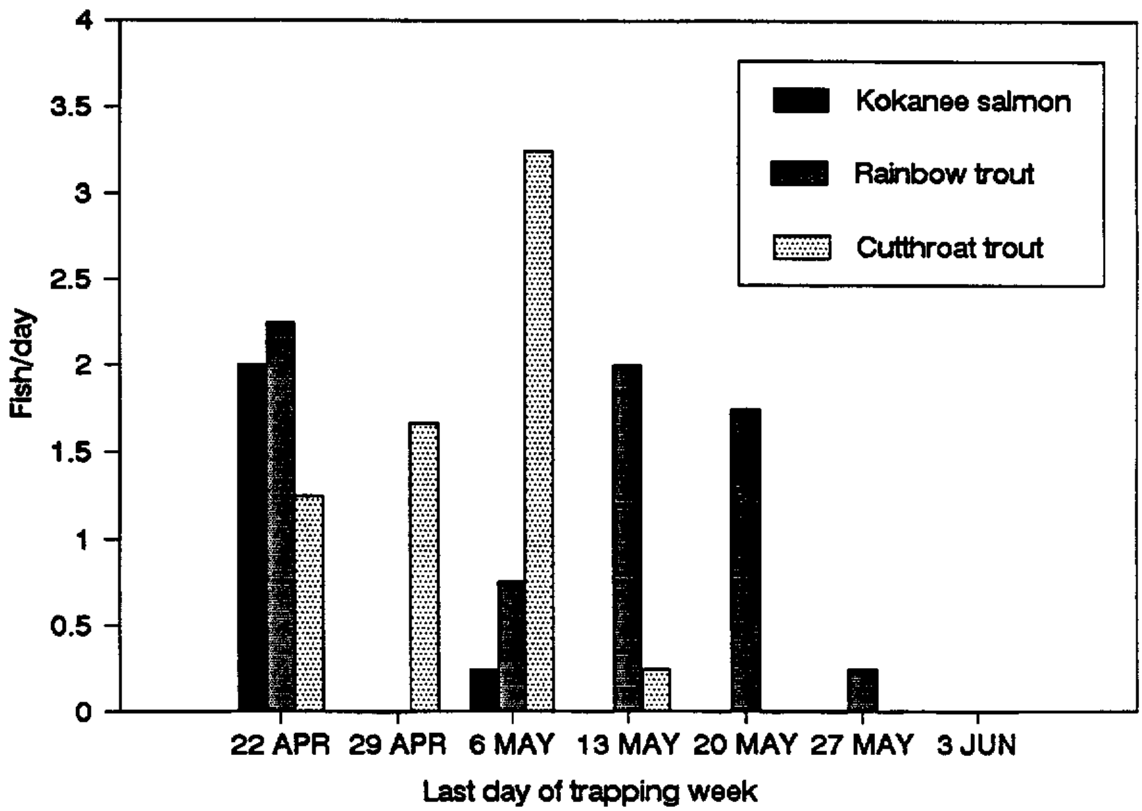

Figure 6. Salmonid migration timing at fyke trap at Lake Sutherland outlet. Data from Appendix B.

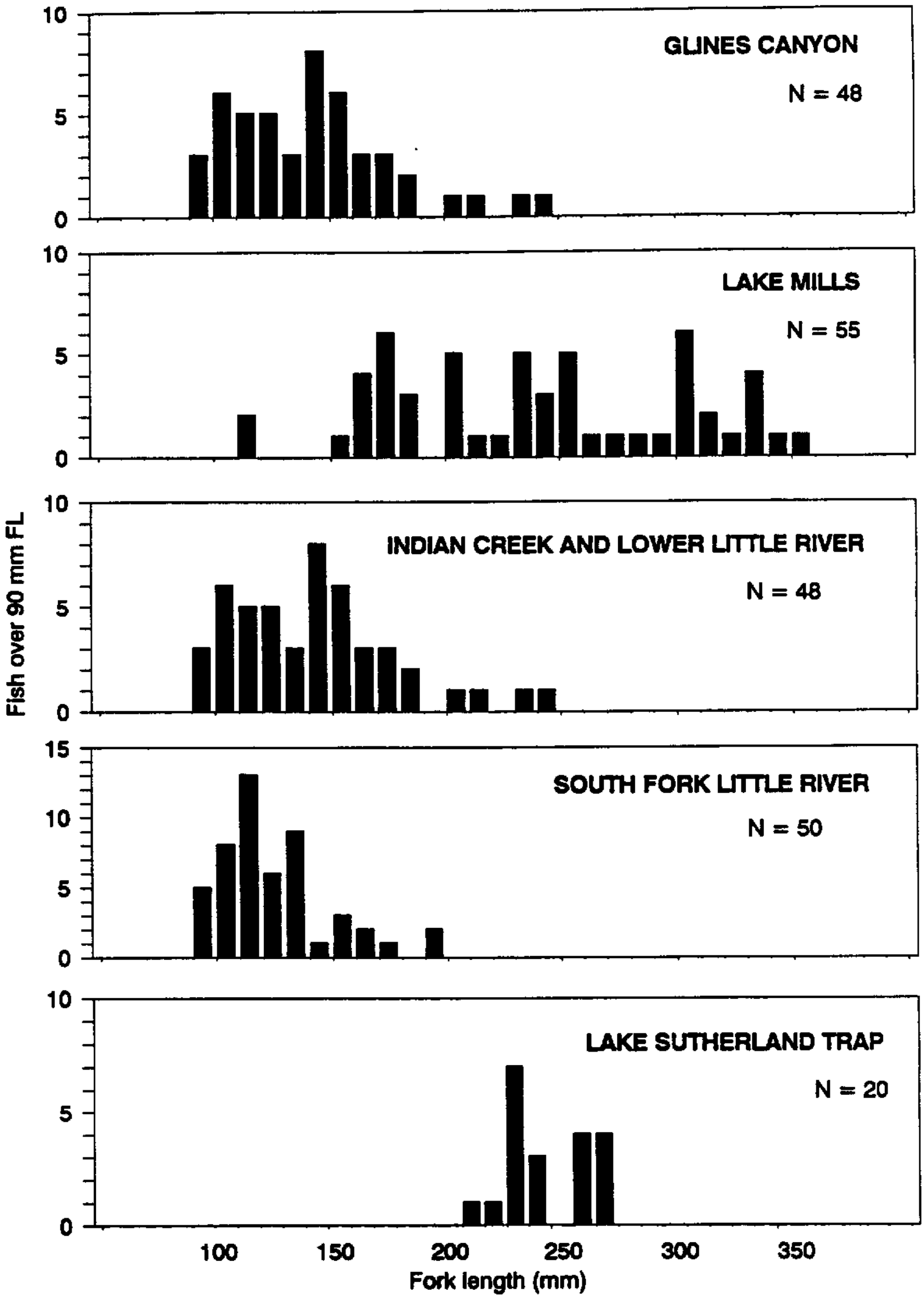

Figure 7. Rainbow trout length frequency from all Middle Elwha sites. Data from Appendix C.

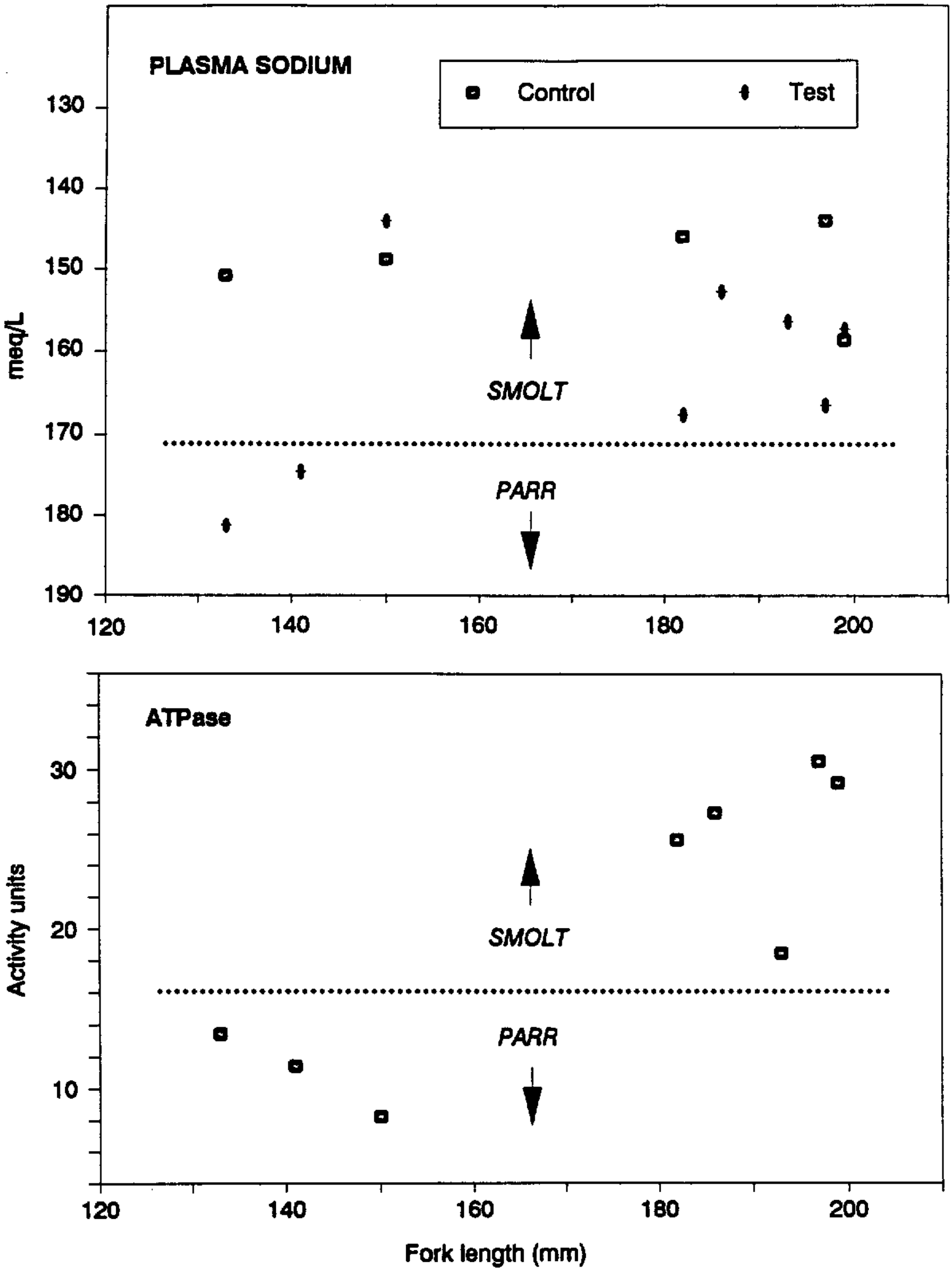

Figure 8. Smolt readiness of rainbow trout over 130 mm FL from middle Elwha River below Glines Canyon. Analysis provided by Nancy Elder, Marrowstone Island Lab, National Biological Survey; and Dr. Wally Zaugg, consultant, Cook, Washington.

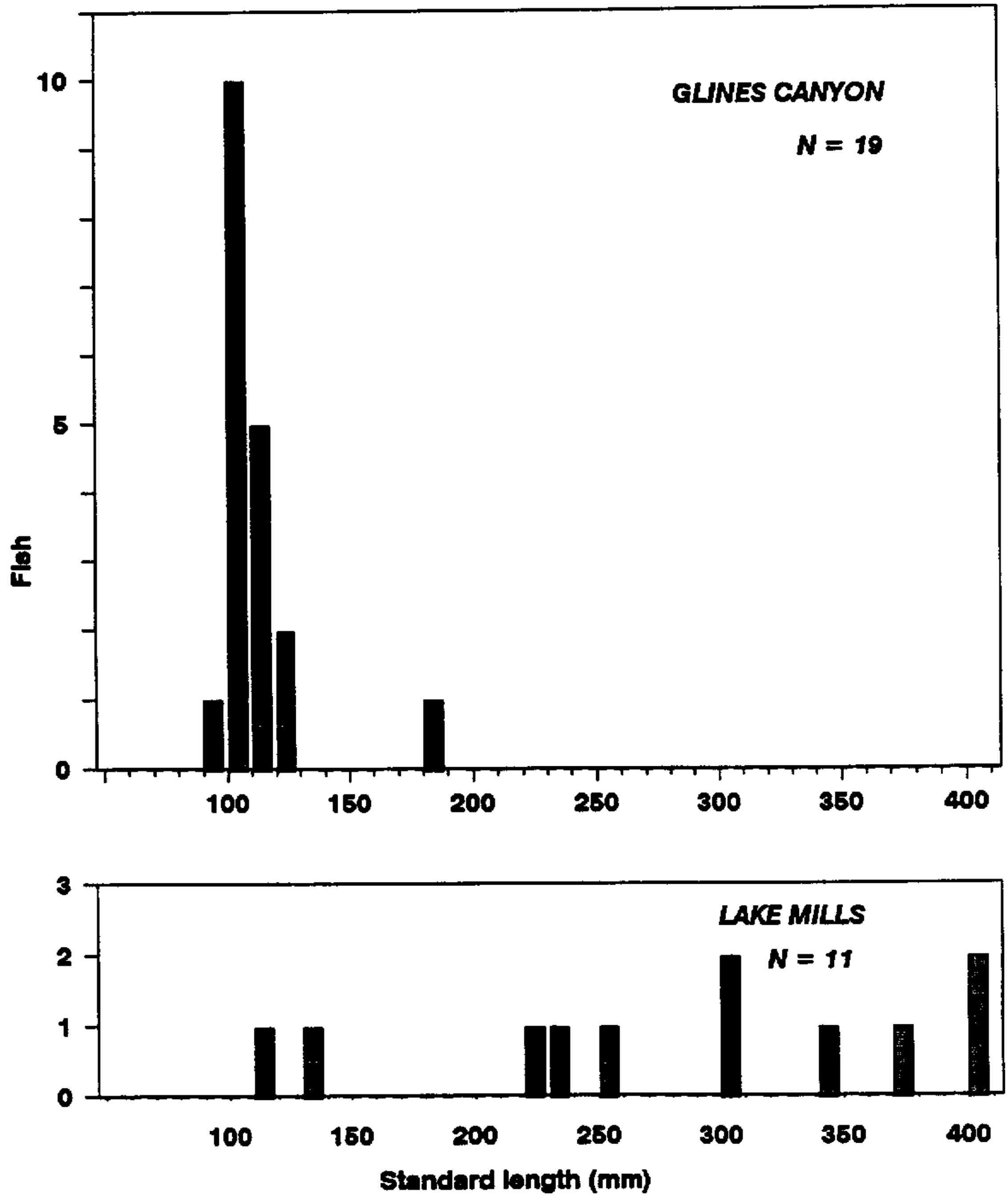

Figure 9. Bull trout length frequency. Data from Appendix D.

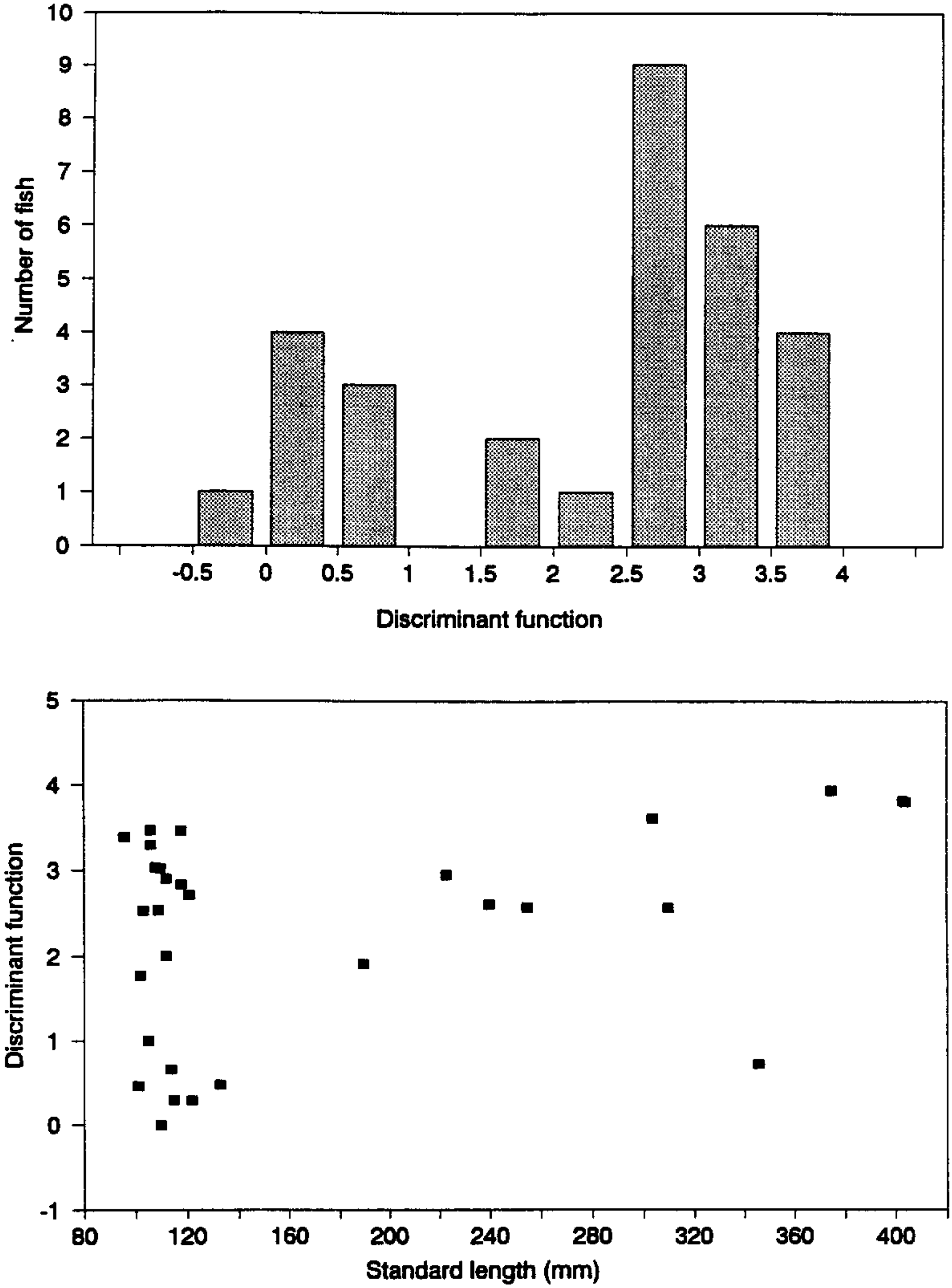

Figure 10. Evaluation of discriminant function (Haas 1988, with modification reported by Johnson 1990) in identifying bull trout (*Salvelinus confluentus*) and Dolly Varden char (*S. malma*) from the Middle Elwha basin.

APPENDIXES

Appendix A. Scoop trap catch from mainstem Elwha below Glines Canyon, 1994.

Date	Discharge m^3/sec	Discharge cfs	Velocity m/sec	Velocity ft/sec	Dolly Varden	Rainbow trout <130mmFL	Rainbow trout >130mmFL	Bull trout	Sculpin
0419	--	--	1.7	5.6	0	0	0	1	0
0420	--	--	1.6	5.3	0	1	0	0	0
0421	--	--	1.6	5.2	0	2	0	--	0
0422	--	--	1.7	5.6	0	0	0	6	0
Mean			1.7	5.4	0.0	0.8	0.0	1.8	0.0
0426	--	--	1.9	6.3	0	1	0	1	0
0427	--	--	2.0	6.4	0	0	0	4	0
0428	--	--	1.8	5.8	0	0	0	5	0
0429	--	--	1.6	5.4	0	1	0	0	0
Mean			1.8	6.0	0.0	0.5	0.0	2.5	0.0
0503	31.2	1100	1.7	5.4	0	0	0	1	0
0504	28.6	1010	1.8	5.9	0	0	0	0	1
0505	31.2	1100	1.8	6.0	0	0	0	0	0
0506	31.2	1100	1.8	6.0	0	0	1	0	0
Mean			1.8	5.8	0.0	0.0	0.3	0.3	0.3
0510	55.5	1958	2.3	7.6	0	1	4	1	0
0511	60.2	2127	2.4	7.9	0	0	3	0	0
0512	57.8	2040	2.2	7.4	0	1	7	1	0
0513	48.3	1704	2.2	7.2	0	0	0	0	0
Mean			2.3	7.5	0.0	0.5	3.5	0.5	0.0
0515	--	--	2.1	7.1	0	0	0	2	0
0516	37.3	1318	2.0	6.6	0	0	3	0	0
0517	37.9	1340	2.1	6.9	0	0	1	0	0
0518	31.2	1100	1.8	6.0	0	0	0	0	0
0519	38.7	1366	2.1	6.9	0	1	1	0	0
0520	38.7	1368	2.1	7.1	0	1	0	0	1
0521	--	--	1.9	6.1	0	0	0	0	0
Mean			2.0	6.6	0.0	0.3	0.7	0.3	0.1
0522	--	--	2.0	6.6	0	0	0	0	0
0523	36.3	1281	2.0	6.4	0	0	0	0	0
0524	36.1	1276	1.9	6.2	0	0	0	0	0
0525	38.6	1363	2.1	6.8	0	0	1	0	0
0526	42.3	1495	2.1	6.8	0	0	1	0	0
0527	34.9	1232	1.8	6.0	0	0	0	1	0
Mean			2.0	6.5	0.0	0.0	0.3	0.2	0.0
0601	31.2	1100	1.8	6.0	0	0	1	0	0
0602	30.6	1082	1.7	5.5	1	0	1	0	0
0603	31.2	1100	1.7	5.4	0	0	0	0	0
Mean			1.7	5.7	0.3	0.0	0.7	0.0	0.0
0607	--	--	1.5	5.0	0	0	0	0	0
0608	--	--	1.4	4.7	0	0	0	0	0
Mean			1.5	4.8	0.0	0.0	0.0	0.0	0.0
Total (34 days)					1	9	25	23	2

Appendix B. Fyke net catch on Indian Creek at Lake Sutherland outlet, upstream of fish screen, 1994.

Date	Kokanee salmon	Sculpin	Rainbow trout	Cutthroat trout	Minnow
0419	8	154	0	0	0
0420	0	168	7	2	0
0421	0	119	2	3	0
0422	0	--	0	0	2
Subtotal	8	441	9	5	2
Mean/wk	2.0	147.0	2.3	1.3	0.5
0427	0	257	0	0	0
0428	0	338	0	5	0
0429	0	258	0	0	0
Subtotal	0	853	0	5	0
Mean/wk	0.0	284.3	0.0	1.7	0.0
0503	1	79	0	0	0
0504	0	149	0	1	0
0505	0	96	0	3	0
0506	0	110	3	9	0
Subtotal	1	434	3	13	0
Mean/wk	0.3	108.5	0.8	3.3	0.0
0510	0	57	2	1	0
0511	0	70	1	0	0
0512	0	36	1	0	0
0513	0	27	4	0	0
Subtotal	0	190	8	1	0
Mean/wk	0.0	47.5	2.0	0.3	0.0
0517	0	14	0	0	0
0518	0	15	2	0	0
0519	0	16	2	0	0
0520	0	3	3	0	0
Subtotal	0	48	7	0	0
Mean/wk	0.0	12.0	1.8	0.0	0.0
0524	0	13	0	0	0
0525	0	4	1	0	0
0526	0	4	0	0	0
0527	0	12	0	0	0
Subtotal	0	33	1	0	0
Mean/wk	0.0	8.3	0.3	0.0	0.0
0601	0	11	0	0	0
0602	0	14	0	0	0
0603	0	4	0	0	0
Subtotal	0	29	0	0	0
Mean/wk	0.0	9.7	0.0	0.0	0.0
Total catch	9	2,028	28	24	2
Days	36				

Appendix C. Middle Elwha basin rainbow trout measurements, 1994.

Location	Date	Fork length (mm)	Weight (g)	Sex[A]	Life stage[B]	Specimen no.
Mainstem Elwha	0508	194	65.6	F	P	19
		156	28.1	F	I	20
		133	22.2	M	P	11
		148	26.2	M	P	18
		202	81.2	U	I	1
		190	64.9	U	S	2
		147	35.5	U	P	3
		193	72.2	U	S	4
		186	52.1	U	S	5
		141	22.1	U	P	6
		150	27.8	U	P	7
		182	48.9	U	I	8
		199	60.7	U	S	9
		197	63.5	U	S	10
		218	81.1	U	S	12
		175	44.3	U	S	13
		205	66.7	U	S	14
		180	52.0	U	S	15
		180	43.3	U	S	16
		187	48.5	U	S	17
	0608	140	30.9	U	U	21
		174	43.1	U	U	22
Indian Creek	0628	190		U	P	27
		115		F	P	28
		171		M	P	29
		147		F	P	30
		124		M	P	31
		117		F	P	32
		98		M	P	33
		163		F	P	34
	0629	160		F	R	39
		117		M	R	40
		136		M	R	41
		112		F	R	42
		145		M	R	43
		96		M	R	44
		174		F	R	45
	0719	163		F	R	60
		141		M	R	61
		152		M	R	62
		209		F	R	63
		157		F	R	64
		185		M	R	65
		245		M	R	66

Appendix C, continued.

Location	Date	Fork length (mm)	Weight (g)	Sex[A]	Life stage[B]	Specimen no.
Indian Creek	0719	105		M	R	67
		105		I	R	68
		107		I	R	69
		97		I	R	70
	0720	150		F	R	87
		150		M	R	88
		232		F	R	89
		154		M	R	90
		215		M	R	91
		155		F	R	92
		132		M	R	93
		105		I	R	94
Lake Mills	0623	258		M	R	23
		233		M	R	24
		168		M	R	25
		337		M	R	110
		334		M	R	111
	0624	238		F	R	26
	0628	282		F	R	35
		315		F	R	36
		279		F	R	37
		253		F	R	38
	0718	174		M	R	46
		163		F	R	47
	0719	331		M	R	48
		186		F	R	49
		215		M	R	50
		305		F	R	51
		240		F	R	52
		176		M	R	53
		320		F	R	54
		170		F	R	55
		228		F	R	56
		178		M	R	57
		260		M	R	58
		350		F	R	59
	0720	247		M	R	71
		165		F	R	72
		208		M	R	73
		307		F	R	74
		210		F	R	75
		184		F	R	76
		301		M	R	77

Appendix C, continued.

Location	Date	Fork length (mm)	Weight (g)	Sex[A]	Life stage[B]	Specimen no.
Lake Mills	0720	189		F	R	78
		235		F	R	79
		248		F	R	80
		305		M	R	81
		231		F	R	82
		160		F	R	83
		175		F	R	84
		175		F	R	85
		204		M	R	86
	0721	245		F	R	95
		253		F	R	96
		360		F	R	97
		305		F	R	98
		306		F	R	99
		258		M	R	100
		333		F	R	101
		267		F	R	102
		296		F	R	103
		203		F	R	104
		208		M	R	105
		324		F	R	106
		171		M	R	107
		118		I	R	108
		120		I	R	109
Lower Little R.	0810	141		U	R	121
		104		U	R	122
		125		U	R	123
		131		U	R	124
		125		U	R	125
		143		U	R	126
		120		U	R	127
		148		U	R	128
		106		U	R	129
		U		U	R	130
		127		U	R	131
		176		U	R	132
		130		U	R	133
		152		U	R	134
		161		U	R	135
Upper Little R.& S.Br.	0811	138		F	R	136
		154		F	R	137
		155		F	R	139
		121		F	R	145
		131		F	R	148
		140		F	R	149

Appendix C, continued.

Location	Date	Fork length (mm)	Weight (g)	Sex[A]	Life stage[B]	Specimen no.
Upper Little R.& S.Br.	0811	162		F	R	151
		137		F	R	153
		117		F	R	159
		165		F	R	160
		96		F	R	163
		115		F	R	166
		134		F	R	167
		139		F	R	168
		102		F	R	172
		132		F	R	179
		101		F	R	181
		105		F	R	184
		100		I	R	141
		123		I	R	143
		112		I	R	146
		123		I	R	152
		99		I	R	162
		105		I	R	165
		135		I	R	173
		111		I	R	176
		111		I	R	177
		98		I	R	183
		97		I	R	185
		196		M	R	138
		117		M	R	140
		132		M	R	142
		125		M	R	144
		128		M	R	147
		194		M	R	150
		151		M	R	154
		107		M	R	155
		171		M	R	156
		120		M	R	157
		116		M	R	158
		115		M	R	161
		109		M	R	164
		115		M	R	169
		120		M	R	170
		141		M	R	171
		115		M	R	174
		125		M	R	178
		115		M	R	180
		110		M	R	182
		102		U	R	175

[A] M = male, F = female, U = undetermined, I = immature.
[B] P = parr, S = smolt, I = intermediate, R = resident.

Appendix D. Dolly Varden/bull trout discriminant function data, Middle Elwha basin, 1994.

Location	Date	Branchi-ostegal rays	Anal rays	Maxillary length (mm)	Standard length (mm)	Discriminant function[A]
Mainstem Elwha	0428	28	9	14	103	2.53
		25	8	16	122	0.28
		30	9	13	106	3.30
		27	8	14	102	1.77
		25	10	14	115	0.29
		26	8	12	101	0.45
		30	8	13	108	3.03
		25	10	15	114	0.66
		30	9	12	96	3.38
		30	9	15	118	3.46
	0429	29	9	15	121	2.72
	0502	29	9	13	109	2.54
	0510	29	8	15	112	2.91
	0512	26	10	13	105	1.00
	0513	27	10	25	190	1.92
	0515	30	8	14	106	3.47
		29	10	14	110	3.02
	0527	27	10	15	112	2.01
	0602	28	8	8	110	-0.01
Lake Mills	0628	28	8	44	310	2.58
	0719	26	9	42	346	0.73
		28	10	32	240	2.61
		27	9	13	133	0.48
	0720	29	10	28	223	2.95
		29	10	60	403	3.82
		29	9	45	304	3.61
	0721	28	9	35	255	2.58
		28	9	17	118	2.84
		29	10	57	375	3.94
		29	10	60	404	3.81

[A] Formula presented in "Methods" section of report text.

Appendix E. Inspection of plunge basin.

MEMORANDUM

June 14, 1994

To: Bob Wunderlich

From: Joe Hiss

Subject: Fish passage in Glines Canyon plunge basin area, spring of 1994

File: FR 90-60

Condition of the falls

- Under 150 cfs of spill. On 2 June 1994 I made the first of two visits to the plunge basin below glines Canyon Dam. I determined that the gravel bar immediately below the plunge basin was not blocking fish passage, even after spill was turned off. Rather, a falls existed some 61 m (200 ft) downstream of the dam, that may have impinged fish. The falls are formed by several house-sized boulders that lie between the rock walls of the canyon. Water exits primarily through a crevice between the westernmost boulder and the left canyon wall. The bottom of the crevice is filed with rocky debris, and the top is filled with driftwood. This leaves a hole about 0.9 m (3 ft) wide. At 4.2 m^3/sec (150 cfs) this hole is below the water surface, so the water exits at pressure. It falls about 4.6 m (15 ft) onto a bed of boulders before cascading into the pool below.

- Under 450 cfs of spill. On 8 June 1994 I made the second visit to the plunge basin to ascertain whether spill of 12.7 m^3/sec (450 cfs) was better for fish passage than the 150 cfs I observed the previous week. The answer was yes, for the higher flow resulted in a layer of turbulent water over the boulders at the foot of the falls. This may have cushioned the fall. However, conditions were still not ideal. Some flow exited the pool over the top of the lip, but impinged on the sides of the boulders on the way down, or on a log near the base of the falls.

Relation of spill to scoop trap catch

Virtually no trout were captured whenever spill did not exceed the minimum promised by dam operators -- that is, 4.2 m^3/sec (150 cfs) for 7 hr. This was usually given from 10:00 PM to 5:00 AM each night of trapping. Trout entered the scoop trap primarily on those infrequent days when instream flow exceeded 31.1 m^3/sec (1,100 cfs), for then the dam operator could spill more the agreed-upon minimum for our trapping. Remember that throughout the days of minimum spill, the spill water does not represent release of stored water, but rather, a reallocation of water from the turbine to the spillway, at no net gain in instream flow at the powerhouse tailrace or at the scoop trap.

On three occasions over the two days before my final inspection of the plunge basin area, spill was compressed into 12.7 m^3/sec (450 cfs) for three 3 hr periods. These spills were released 36 hr before my inspection, 24 hr before, and during the inspection itself. None of these three spills resulted in any fish catch at the scoop trap.