LONGITUDINAL DISTRIBUTION OF FISH COMMUNITIES IN THE CLAYOQUOT RIVER SYSTEM

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SUMMARY

This report describes the collection of data in the Clayoquot River system on Vancouver Island, using methodology designed to measure longitudinal changes of fish species found in Pacific Northwest river systems. Four minnow traps were used at each of 19 sample sites at 500 m intervals along the mainstem of the river. This technique provided baseline data for future studies in the Clayoquot River and could be useful throughout the Pacific Northwest. The objectives were to assess fish communities, establish the upper limit accessible to anadromous salmonids, and conduct baseline habitat measurements.

Four minnow traps were used to capture fish at each sampling site, a total of eight species were found. Of these, the 4 most common were coho salmon, rainbow trout, cutthroat trout and Dolly Varden char. Coho and rainbow dominated the lower Clayoquot River and the upper Clayoquot River to the 3.4 km barrier. Dolly Varden were found exclusively in the upper Clayoquot River, with the highest numbers above the barrier. Numbers of cutthroat were the lowest of the 4 main species, with most above the barrier. The 3.4 km barrier restricts access to anadromous salmonid migration at most flow levels, resident species were the main component above the barrier.

Recommendations for future use of this method include monitoring the Clayoquot River in subsequent years, surveying Clayoquot River tributaries, studying other watersheds, and comparing logged and unlogged systems. Little is known about resident fish species above the barrier, studies into their life histories and function in the ecosystem are recommended. Longitudinal distribution of aquatic insects would complement the fish distribution research.

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The Clayoquot Valley Witness Trail, built by Tla-o-qui-aht First Nations and Western Canada Wilderness Committee, was gratefully utilized during the field work. Shayne MacLellan, Department of Fisheries and Oceans, and staff analyzed the scale samples. Bill Pollard, MacMillan Bloedel, Ltd., supplied 1:20,000 maps for use on the project.

1. INTRODUCTION

This report describes fisheries research that is part of the long-term ecosystem research being conducted in the Clayoquot River valley by the Clayoquot Biosphere Project. The objectives of the present study were:

1) To assess longitudinal distribution of fish communities in the Clayoquot River mainstem from the mouth to the headwaters at 500 m intervals.
2) To establish the upper limit that is accessible to anadromous salmonids on the Clayoquot River mainstem.
3) To conduct baseline habitat measurements at 500 m intervals on the Clayoquot River mainstem.

Few researchers have attempted to assess fish communities over the long profile of river systems in the Pacific Northwest. Instead the emphasis in research has been on single species and representative reaches. However, studies that concentrate on salmon and trout may not be good indicators of the health of a given system, as resident fish species may be more sensitive to habitat change and thus more useful as indicator species. It would seem, therefore, that longitudinal patterns of distribution in fish communities may provide highly useful data on Pacific Northwest ecosystems and long-term effects of environmental change (Bisson et al., 1992; Reeves et al., 1993).

The River Continuum Concept (Vannote et al., 1980) and related research into this theory (Minshall et al., 1985) provide the basis for evaluating fish community structure as part of understanding stream ecosystems. Downstream processes in a river are longitudinally linked to its upstream processes, and fish communities adapt to these processes within a system. The purpose of applying this concept in the Clayoquot River watershed was to analyze any changes in fish communities and abundance over the mainstem length of the system and in so doing to develop the baseline data needed for future studies. The results suggest that longitudinal distribution of fish communities could be used as a monitoring tool to detect any changes in species composition resulting from timber harvest.

Changes in climate, geology, tributary influence, gradient and geomorphology and long-term changes imposed by man all contribute to the character and continuum of a given river system (Minshall et al., 1985). The fish communities that we studied appeared to have adapted to some or all of these changes. If timber harvest is to proceed in the Clayoquot River system it will become increasingly important to utilize longitudinal distribution of fish species as a monitoring tool. The Clayoquot Scientific Panel (1995) recommends fish community structure as a monitoring tool, initially once every five years and more often in areas of suspected degradation.

2. STUDY AREA

Clayoquot River is located 30 km east of Tofino on the west coast of Vancouver Island. The watershed is 84 km^2 and the river system flows southeast into Clayoquot Arm, the northern tip of Kennedy Lake. Clayoquot River is a fourth-order stream with a total mainstem distance of 16.2 km (Fish Habitat Inventory and Information Program, 1991). The river is separated into two parts by Clayoquot Lake. This study included the mainstem length of the lower and upper Clayoquot River (Figure 1).

The system is fed by 20 tributaries (Fish Habitat Inventory and Information Program, 1991). There are 2 major lakes on the mainstem: Clayoquot Lake, at 20 m elevation, is in the lower part of the system; Norgar Lake, at about 370 m elevation, is near the headwaters. The elevation of the river ranges from 4 m above sea level at Clayoquot Arm to 1000 m at the headwaters. The watershed terrain is steep and rugged, with a maximum elevation of 1395 m. A 1 km wide and 3.4 km long floodplain just above Clayoquot Lake provides extensive off channel rearing habitat for salmonids.

The Clayoquot River watershed is located in the Coastal Western Hemlock Biogeoclimatic Zone. The dominant tree species in the valley are western hemlock, western redcedar, Sitka spruce, and red alder, with dense shrubs in the riparian zone. The Clayoquot River is subject to rapid fluctuations in water level and current velocity due to high annual levels of rainfall. In 1995, 650 cm of rain was reported at Clayoquot Lake (J. Cleland, pers. comm.).

Four anadromous salmonid species have been reported in the Clayoquot River: sockeye salmon (Oncorhynchus nerka), coho salmon (Oncorhynchus kisutch), steelhead trout (Oncorhynchus mykiss) (Fish Habitat Inventory and Information Program, 1991; Triton Environmental Consultants, 1993 ; Morrell and Kotilla, 1993; Kotilla, 1995), and chinook salmon (Oncorhynchus tshawytscha) (Triton Environmental Consultants, 1993).

Other fish species reported in the system are: Dolly Varden char (Salvelinus malma), cutthroat trout (Salmo clarki), prickly sculpin (Cottus asper), peamouth chub (Mylocheilus caurinus), threespine stickleback (Gasterosteus aculeatus), and river lamprey (Lampetra ayresi) (Fish Habitat Inventory and Information Program, 1991; Triton Environmental Consultants, 1993; Morrell and Kotilla, 1993; Kotilla, 1995).

3. METHODS

We did the field work for this project September 5-15, 1995. Four base camps were used during the data collection: Clayoquot Biosphere Project research station at Clayoquot Lake, two tent sites at 4100 m and 5000 m on the upper Clayoquot River, and one tent site in the upper Kennedy River watershed.

We accessed the sample sites by canoe and on foot. Canoe access is limited to Clayoquot Lake and up to about 800 m on the upper Clayoquot River. We approached Norgar Lake and the area above via the upper Kennedy River watershed, and used the Clayoquot Valley Witness Trail to access the upper portions of the Clayoquot River.

Copies of all field notes and raw data are on file at the office of the Clayoquot Biosphere Project in Tofino, B.C., and the office of the author in Courtenay, B.C. Albums of captioned photographs documenting this and other fish studies in the Clayoquot River system are available for viewing at Clayoquot Biosphere Project, Tofino, B.C.; through Mike Morrell, Denman Island, B.C.; and through Wendy Kotilla, Courtenay, B.C.

3.1 FISH INVENTORY

The Clayoquot River mainstem was sampled at approximately 500 m intervals, using a hip chain to measure the distances. The lower Clayoquot River was measured from a 0 m point at Clayoquot Arm of Kennedy Lake to the outflow of Clayoquot Lake. The upper Clayoquot River was measured from a 0 m point at Clayoquot Lake to the base of the falls below Norgar Lake (Figure 1).

At each sample site four minnow traps were used as capturing devices and baited with salted salmon roe. All fish sampling sites were established in pool habitat with the exception of Site 2, which had two traps in riffle habitat and two traps in pool habitat. The minnow traps were evenly distributed at each sample site, tied to logs or overhanging vegetation, and left for a 24 hour period.

All fish collected were anaesthetized with Alka Seltzer and their fork length was measured to the nearest millimetre. A maximum of 3 scale samples were taken for every even numbered length > 65 mm for coho salmon, rainbow trout and unidentified trout. One peamouth chub was captured in the lower Clayoquot River and a scale sample was taken. No scale samples were taken from Dolly Varden char as assessment of otoliths is the preferred method for estimating the age of this species. All scale samples were sent to Department of Fisheries and Oceans, Pacific Biological Station in Nanaimo, B.C. for analysis. Ageing was conducted by Shayne MacLellan and staff at the ageing lab. Some scale samples were not readable. Estimates of ages and age-length relationships were based on data from the scales that were readable.

3.2 HABITAT INVENTORY

Habitat inventory features were recorded at all fish sampling sites on the lower and upper Clayoquot River (Figure 1). The area at and above Norgar Lake was walked, but surveying was limited to one sample site. Reach breaks and elevation information were established from a 1:20,000 topographical map and observations made during the field work. Reaches were defined according to changes in tributary and geological influence.

Hip chain was used to measure distances from the mouth of the lower Clayoquot River to Clayoquot Lake and the mouth of the upper Clayoquot River to the base of the falls below Norgar Lake. Clayoquot Biosphere Project measured every 100 m on the upper Clayoquot River to 3000 m, with a Sonin electronic distance measurer, on December 15, 1994 and January 6, 1995. Permanent markers were established at 100 m intervals from these measurements. When the two measurements were compared, they were found to have a 2% margin of error to the 3000 m marker. We found our hip chain measurements to be accurate to the established 2000 m marker on the upper Clayoquot River, but there was a difference of 9% when the 3000 m marker was reached. The hip chain measurements had a 17% margin of error to the base of the falls below Norgar Lake when compared to distances on a 1:20,000 map. The measurements from the 1:20,000 map were used to establish distances and sample site locations in this report.

Using a metric ruler to measure the distances on the 1:20,000 map, the lower Clayoquot River was 1400 m and the upper Clayoquot River was 12,600 m. These measurements were checked using a Pamap, Geographic Information System (GIS). The stream was digitized by running a utility to calculate the stream length, the information was then exported to a database and the GIS measurements were: lower Clayoquot River 1337 m, and the upper Clayoquot River 12,338 m (P. Beltgens, pers. comm.). The following margins of error were observed: lower Clayoquot River 5%, and upper Clayoquot River 2%.

We found some differences between maps. The 1:20,000 map produced by MacMillan Bloedel Ltd. (1988) shows 2 small lakes above Norgar Lake, while the 1:50,000 map produced by the Canadian centre for mapping, Department of Energy, Mines and Resources (1989) shows 3 small lakes. Field observations proved that there are 2 small lakes above Norgar Lake in the Clayoquot River watershed, the third lake is in the upper Kennedy River watershed. Different lengths are also reported for the Clayoquot River mainstem: Department of Fisheries and Oceans, Stream Summary Catalogue (1991) reports 16.2 km; Triton Environmental Consultants (1993) give a distance of 15.9 km; and the distance in this report is 14.0 km. The reasons for the discrepancy are generally unknown, but if measurements were taken using the information that 3 small lakes are above Norgar Lake it would account for some of the differences.

At each sampling site, at approximately 500 m intervals, the following habitat features were recorded: channel morphology; gradient; crown closure (streamside vegetation that projects over the stream channel and that is > 1 m above the water surface); substrate composition; D90 (the average diameter of the individual streambed material which is larger than 90% of the remaining streambed material); stream channel width (the distance between roots of perennial vegetation on both banks); wetted width of the channel; maximum and average water depth; channel aspects (the general downstream direction of the stream flow); cover type and per cent coverage.

Proportions of pool, riffle, cascade and complex habitat were measured using hip chain. These measured proportions were: over the total length of the lower Clayoquot River, and over the upper Clayoquot River from Clayoquot Lake to the base of the falls below Norgar Lake. Additional gradient measurements were taken in areas other than sample sites where obvious inclines in streambed occurred. Weather conditions, water temperature and flow conditions were also recorded at all sample sites.

The terminology and methodology developed by Ministry of Environment and Department of Fisheries and Oceans were used throughout the study (Fish Habitat Inventory and Information Program, Stream Survey Guide, 1989). Methods were also adapted from Basinwide Estimation of Habitat and Fish Populations in Streams, a model developed by the Forest Service, United States Department of Agriculture (Dolloff et al., 1993).

4. RESULTS AND DISCUSSION

The study results are organized into 2 sections describing fish distribution and habitat inventory. The fish distribution results are listed for each species captured during the field work. Habitat description provides details for 2 reaches of the lower Clayoquot River and 8 reaches of the upper Clayoquot River. The Appendices include fish statistics, habitat and environmental condition data.

Weather conditions during the 11 days of the field study were generally very good. Conditions were overcast on September 5, 1995, but cleared by the afternoon of September 6, 1995. The weather remained clear, with the exception of some fog on the morning of September 8 and cloud mixed with very light rain on September 11. Water temperatures varied between 10.5 and 16.8 °C. The highest readings were taken in the lower Clayoquot River and in the upper Clayoquot River, above Norgar Lake. Flow levels in the river were moderate to low.

4.1 FISH DISTRIBUTION

Longitudinal distribution of fish communities was assessed over the mainstem length of the Clayoquot River. Coho salmon, rainbow trout, cutthroat trout, Dolly Varden char, prickly sculpin, coast range sculpin and peamouth chub were found in the system. As the elevation and the distance from the mouth of the river increased, aquatic habitat and fish communities changed (Table 1, Figures 2-4). Moderate numbers of fish were found in the lower Clayoquot River, higher numbers in the upper Clayoquot River to the 3.4 km falls, lower numbers were captured from 3.4 km to the base of the falls below Norgar Lake, and no fish were found above Norgar Lake. Fish age data for coho salmon, rainbow trout, cutthroat trout, unidentified trout and peamouth chub is located in Table 2. Average, range and standard deviation for fish lengths and the number of fish captured per minnow trap at each sampling site are given in the Appendices.

The use of 4 minnow traps at each sample site resulted in variability in the numbers captured per trap per site (standard deviation ranged from 0.5 to 21.1). The entrances to the minnow traps (22 cm) limited the capture of large fish, while the mesh size (8 mm) limited the capture of smaller individuals.

4.1.1 Coho Salmon

Coho were found in the lower and upper Clayoquot River at Sites 1-10, with the exception of Site 3 (Reach 2 of the lower Clayoquot River). No coho were captured at Site 3, probably because of the larger substrate size and steeper gradient at the outflow of Clayoquot Lake, which is not preferred coho habitat. Moderate numbers of coho were found in Reach 1 of the lower Clayoquot River (Sites 1 and 2). The highest numbers were located in Reaches 1, 2 and 3 of the upper Clayoquot River (Sites 4 to 10) (Figure 2, Table 1). No coho were captured above the 3.4 km falls on the upper Clayoquot River.

The falls creates a barrier to fish. The barrier may be passable at high flows as 3 juvenile coho salmon were found above it in 1992 (Triton Environmental Consultants, 1993).

The majority of captured coho were aged 0+ (Table 2). The largest 0+ coho sampled was 83 mm in Reach 1 of the lower Clayoquot River. The largest 0+ coho length varied in the upper Clayoquot River: 81 mm in Reach 1, 76 mm in Reach 2, and 82 mm in Reach 3 (Table 2). These lengths were slightly higher than those found in 1994 fisheries research in Clayoquot River tributaries (Kotilla, 1995). Coho growth rates are the highest in their first year and most of the mortality for juvenile coho takes place in their first summer. They move to winter habitat, either upstream or downstream, with the onset of fall freshets. River systems with good winter habitat of side channels and tributaries have higher over-winter survival rates (Groot, C. and L. Margolis, 1991). The floodplain and tributaries in Reaches 1, 2 and 3 of the upper Clayoquot River provide excellent winter rearing habitat.

4.1.2 Rainbow Trout

Samples from Site 1 in the lower Clayoquot River contained no rainbow trout, whereas those from Site 2 contained low numbers, and from Site 3 moderate numbers. Site 3 had the most suitable rainbow trout habitat of the lower Clayoquot River, which is faster flowing water and larger substrate . Rainbow trout catch per trap was highest in Reaches 1, 2 and 3 of the upper Clayoquot River (Sites 4-10). Above Reach 3 capture rate declined noticeably: Sites 11-17 produced low numbers, Sites 18 and 19 produced none (Figure 3, Table 1). The 3.4 km falls in the upper Clayoquot River restricts upstream access for rainbow trout. There are a number of possibilities to explain existence of rainbow trout above the barrier: either they are able to negotiate the falls at high flows, or resident populations were isolated above the barrier following the last glacial retreat. Triton Environmental Consultants (1993) found 9 rainbow trout above the barrier in 1992.

The rainbow trout captured were mainly aged 1+ at all sites where they were found. The smallest rainbow trout at this time of year have a fork length of approximately 40 mm, allowing most of them to swim through the mesh size (8 mm) of the minnow traps. One rainbow trout, aged 3+, was found in Reach 2 of the upper Clayoquot River (Table 2). The entrance of the minnow traps (22 cm) limits the entry of larger rainbow trout.

4.1.3 Cutthroat Trout

Two cutthroat trout were captured at Site 1 in the lower Clayoquot River. Sites 2-12 produced no cutthroat. Low numbers of cutthroat were found at Site 13, and Sites 14-17. The highest numbers were at Site 17 (Figure 3, Table 1). Most of the cutthroat were found above the series of falls and pools located at the bottom of Reach 5. Cutthroat trout prefer smaller streams with lower gradients, they do not typically inhabit the mainstem of river systems. Higher numbers of this species were found in the 1994

fisheries study of upper Clayoquot River tributaries (Kotilla, 1995). Because the sample numbers for this species were low, we were unable to positively conclude the age-length relationship. However, most of the cutthroat captured were aged 2+.

4.1.4 Unidentified Trout

Nine individual trout were not conclusively identified as rainbow or cutthroat trout. Two trout captured in Reach 3 and two in Reach 5 were too small to positively identify (range 48-70 mm). Five others (range 113-124 mm) were also classified as unidentified trout in Reaches 4, 5 and 6 of the upper Clayoquot River (Tables 1 and 2, Figure 3). The difficulty in identification of trout occurred mainly above the barrier at the bottom of Reach 4. It is possible that some hybridization of trout species occurs in the upper reaches of the upper Clayoquot River. Resident headwater populations of rainbow trout have been found to have cutthroat trout influence in other systems on the west coast of Vancouver Island (Parkinson et al., 1984).

4.1.5 Dolly Varden char

Dolly Varden char were absent in samples from the lower Clayoquot River, but were captured in Reaches 1-6 in the upper Clayoquot River (Sites 4, 7 and 8-18). They were the most common and abundant species above Reach 3 (Table 1, Figure 2). Above the 3.4 km barrier Dolly Varden were captured in habitat that coho utilize below the barrier. A definite shift in species composition of the fish communities occurs at the 3.4 km barrier. Dolly Varden have also been found in tributaries of the upper Clayoquot River below the barrier and in Clayoquot Lake (Kotilla, 1995: Triton Environmental Consultants, 1993). They were especially abundant in low gradient tributaries B and C (Kotilla, 1995).

There are anadromous and nonanadromous populations of Dolly Varden char in coastal British Columbia. Further investigation into this species is required to determine the status of the Clayoquot River populations. Upstream resident populations may be genetically distinct from their downstream counterparts. No ageing analysis was conducted on Dolly Varden char because the preferred method requires taking otoliths and we decided that no individuals should be sacrificed.

4.1.6 Sculpins

Most of the prickly sculpins captured were from the lower Clayoquot River (Sites 1 and 3), with the majority located at Site 1, which was closest to Kennedy Lake. The numbers at Site 1 were substantially higher than any other site where they were captured. Four individuals were captured in the upper Clayoquot River (Sites 4, 5 and 9) (Table 1, Figure 4). Triton Environmental Consultants (1993) identified prickly sculpins in Clayoquot Lake. They also found sculpins in the lower Clayoquot River (.5 km above Kennedy Lake), the upper Clayoquot River (.8 km and 2.5 km above Clayoquot Lake)

and Tributary 500 (.5 km upstream of the confluence with the Clayoquot River), but did not identify them as to species.

Two coast range sculpins were captured in the system, both from Reach 3 in the upper Clayoquot River (Table 1, Figure 4). The two were both captured at Site 10, which is immediately below the 3.4 km barrier. A shift in species of sculpins occurred below the 3.4 km barrier on the upper Clayoquot River and none were captured above the barrier. In Carnation Creek (located in Barkley Sound) prickly sculpins are known to inhabit the upper reaches of the estuary, the lower reaches of the stream up to approximately 1500 m, and a few larger individuals were found as far up as 2000 m. Coast range sculpins are found throughout the stream up to 3070 m (Ringstad, 1982).

4.1.7 Peamouth Chub

One peamouth chub was found in the lower Clayoquot River, a scale sample indicated an age of 3+ (Tables 1 and 2, Figure 4). This individual was captured at Site 1 which is located just above Kennedy Lake. Peamouth chub are known to inhabit Kennedy Lake (Scott and Crossman, 1973), so we decided that it had strayed from the lake environment.

4.2 HABITAT DESCRIPTION

Habitat descriptions were recorded for 2 reaches in the lower Clayoquot River and 8 reaches in the upper Clayoquot River (Figure 1).

4.2.1 Lower Clayoquot River: Reach 1 - Sample Sites 1 and 2 (1-1000 m)

Reach 1 of the lower Clayoquot River was a single channel approximately 1 km in length, with 3 tributaries entering the mainstem. The gradient in this portion of the river was low and there was no significant crown closure. At the lower sample site, fish cover was limited but diverse, consisting of pools, large woody debris (LWD) and streamside vegetation; at the upper sample site, fish cover remained low and the habitat changed to boulders. Habitat in Reach 1 was equal amounts of pool and riffle. Channel widths at Sites 1 and 2 were 38.5 and 39.2 respectively. Sample Site 1 was in a pool and Site 2 in riffle and pool habitat. Substrate composition was mainly large cobble and boulders at both sample sites, with more boulders at Site 2.

4.2.2 Lower Clayoquot River: Reach 2 - Sample Site 3 (1000-1400 m)

Reach 2 was a single channel 400 m long, with a gradient of 3% and no crown closure. This increase in gradient over Reach 1 results in a section of cascade riffle. Substrate size increased as well, providing mostly boulders and some pools for fish cover. The channel width at Site 3 was 27.8 m.

4.2.3 Upper Clayoquot River: Reach 1 - Sample Sites 4 and 5 (1-800 m)

Reach 1 of the Upper Clayoquot River was a single channel and had 3 tributaries entering the mainstem. Gradient and crown closure remained low. At approximately 350 m there was a deep pool created by bedrock on the left bank. Channel widths were 41.3 to 23.8 at Sites 4 and 5, respectively. Substrate at Site 4 consisted of mainly large gravel and small cobble, whereas at Site 5 it was predominantly small and large gravel. Fish cover was low to moderate, and consisted of LWD and vegetation. The stream character was evenly divided between pool and riffle habitat.

4.2.4 Upper Clayoquot River: Reach 2 - Sample Sites 6 and 7 (800-1900 m)

Reach 2 of the upper Clayoquot River was a single channel at both sample sites, but much of this section is complex with log jams, side channels and large gravel bars. Three tributaries entered the mainstem in Reach 2. Gradient remains low and crown closure increases from 0% to 5%. Channel width was 26.8 m at Site 6 and 29.0 m at Site 7. Substrate at Site 6 was mostly gravels and small cobble, whereas at Site 7 it was gravels. Fish cover was moderate at both sites and consisted mainly of LWD. Although much of this reach is complex, stream structure was categorized as pool and riffle due to the pools created by the log jams.

4.2.5 Upper Clayoquot River: Reach 3 - Sample Sites 8, 9 and 10 (1900-3000 m)

The Clayoquot River was noticeably smaller in size above the confluence with Tributary 500. The channel was single at Sites 8 and 10, but Site 9 was braided with several log jams. Gradient continued to be low and crown closure increased from 10% to 20% within the reach. Channel width at the 3 sample sites varied from 19.2 to 35.7 m. Substrate size increased from gravels at Site 8 to cobble and boulder at Sites 9 and 10. Fish cover was moderate at all three sites, changing from LWD and overhanging vegetation at Sites 8 and 9 to boulders at Site 10. A greater proportion of stream structure in Reach 3 was riffle, compared with Reach 1 and 2.

4.2.6 Upper Clayoquot River: Reach 4 - Sample Sites 11, 12 and 13 (3000-4600m)

Reach 4 was a single channel for its entire length, with a gradient of 2-3%. In the lowest portion there is bedrock forming a short series of plunge pools with an overall gradient of 5 %. The plunge pools and gradient increase create a barrier for anadromous salmonid species at most flow levels. This barrier may be passable at high flows as 1 juvenile coho salmon and juvenile rainbow trout have been identified above the barrier (Triton Environmental Consultants, 1993). The 3 tributaries in this section of the river were very steep, especially Tributary G, which had a falls of about 6 m at the confluence with the Clayoquot River. Crown cover was consistently 20% throughout the reach. Channel width at the 3 sample sites in Reach 4 ranged from 11.9 m to 18.0 m. The predominate substrate was boulders, with bedrock included at the two upper sites. Fish

cover was boulders at Sites 11 and 12, whereas Site 13 was a deep pool with boulders. Cascade and riffle make up most of the steam structure in Reach 4.

4.2.7 Upper Clayoquot River: Reach 5 - Sample Sites 14, 15 and 16 (4600-6700 m)

The lower 263 m of Reach 5 was a complex section with a series of 5 pools and falls, formed by bedrock, with an average gradient of 11%. There was also a 139 m side channel on the left bank, which was dry at the time of the study but clearly diverts water at high flows. This area of falls presented another barrier to fish migration. The remainder of the channel in this reach was single, with an average gradient of 1%, except immediately above Site 16, where the gradient was about 8%. Three tributaries were in this reach: an unnamed tributary on the right bank (not indicated on Figure 1), which had a 230 m long side channel associated with it; Tributary H on the left bank, which is low lying and which contained coho in 1992 (Triton Environmental Consultants, 1993); and Tributary I on the left bank, which had no flow, but had 3 outlets containing large substrate and woody debris, indicating extreme runoff at high flows. Channel width varied from 16.3 to 19.2 m. Substrate was mainly large cobble and boulder throughout the reach, with some bedrock at Site 14. Crown closure was 20-30% and fish cover was boulders throughout the reach. Riffle was the main stream structure component.

4.2.8 Upper Clayoquot River: Reach 6 - Sample Sites 17 and 18 (6700-7300m)

In Reach 6, above the confluence with Tributary J, the upper Clayoquot River narrows to half its size. Channel width was decreased and LWD was increased resulting in stream complexity increased, and several braided sections. Channel width was 9.8 m at both sites. Gradient was 1-3% and crown cover varied between 40 and50 %. Substrate at both sites was large cobble and boulder size. Fish cover was boulders at Site 17 and at Site 18 was both boulders and vegetation. Stream structure was predominantly riffle and complex habitat.

4.2.9 Upper Clayoquot River: Reach 7 - Sample Site 19 (7300-12600m)

Reach 7 extends from approximately 500 m above Norgar Lake to the base of the falls at the outflow. This steep falls, which is immediately above Site 18, continues for 500 m and ascends 200 m in elevation. It is an impassable barrier to fish. We were unable to find the outflow of the lake marked on the topographical map: after searching for it for 2 hours, we concluded that the river runs below the surface from about 500 m above the lake to approximately 100 m below the lake. At extremely high flows, the outflow probably spills over in the area marked on the map. Norgar Lake itself is formed by limestone and is a striking aquablue. A large alluvial fan, consisting of gravel material, was deposited at the inflow of Norgar Lake.

Site 19 was located about 500 m above the lake, where the crown cover was 50%. Channel width was 10.9 m. and the pool sampled was at the base of a 15 m falls. Water became subsurface about 20 m below the pool. Substrate composition was mostly cobble,

with some boulder and bedrock. Fish cover was moderate, consisting of boulders and a pool.

Above Site 19 was not surveyed, but parts of it were observed from locations along the Clayoquot Valley Witness Trail. This portion of the river has both surface and subsurface flows. Bed material is composed mostly of large substrate and there is evidence of high velocity during storm events. Two small lakes exist near the headwaters, where the terrain becomes subalpine. In this 3400 m section, elevation increases from about 380 m to 1000 m.

5. CONCLUSIONS

In this study on the Clayoquot River mainstem 8 fish species were found. Of these, the 4 most common species were coho salmon, rainbow trout, cutthroat trout and Dolly Varden char. The most striking changes in fish community structure along the length of the river involved coho salmon and Dolly Varden char. Coho were common and abundant below the 3.4 km barrier. No coho were found above the barrier, where Dolly Varden was the most abundant species captured. Rainbow trout, cutthroat trout and unidentified trout also showed changes in species composition at the falls. Numbers of rainbow declined above the barrier, and numbers of cutthroat and unidentified trout increased (Table 1, Figures 2-4).

The 3.4 km barrier on the Clayoquot River blocks upstream migration of fish species under most flow conditions. A past study found 3 coho salmon and 9 rainbow trout above the barrier (Triton Environmental Consultants, 1993), concluding that it is passable under some conditions. Above the barrier there are populations of Dolly Varden char, cutthroat trout, and rainbow trout, as well as unidentified trout that may represent hybridization of rainbow and cutthroat trout. These may be resident populations that are genetically isolated from fish populations below the barrier. Resident populations inhabit relatively short reaches of stream channel and are particularly vulnerable to degradation of aquatic habitat. Preservation and protection of resident fish stocks is recommended by Parkinson et al. (1984) and the Clayoquot Scientific Panel (1995).

Analysis of longitudinal distribution of fish communities in the Clayoquot River system has provided data that can be used as a baseline for future studies. This method offers comprehensive, relatively inexpensive and statistically valid information. It looks beyond specific species and representative reaches, to consider the system as a whole. Reeves et al. (1993) found that juvenile salmonid assemblages decreased in diversity after timber harvest due to decreased habitat complexity. Longitudinal distribution of fish communities can be used to monitor postlogging effects, as well as long-term effects of environmental change. Bisson et al. (1992) suggest that past forest practices have probably contributed to substantial changes in fish communities. In some instances we will never know what we have lost. Assessment of fish community structure could be used as a potentially powerful tool to better understand Pacific Northwest ecosystems and improve future forest practices.

6. RECOMMENDATIONS FOR FURTHER WORK

The 1995 research provides information from a fish community perspective. This perspective could be a valuable way of increasing our understanding of different fish species within a system and their interactions with each other. If logging is to proceed in the Clayoquot River system the longitudinal distribution of fish communities method could be used to monitor any changes in these communities.

1. Use the longitudinal distribution of fish communities as a monitoring tool.
   - to monitor the Clayoquot River in subsequent years, especially if timber harvest proceeds.
   - to study other watersheds in Clayoquot Sound.
   - to compare a logged and an unlogged river system.
   - to survey other tributaries in the Clayoquot River system, especially Tributary 500 and Tributary J.

2. Study resident fish in the upper Clayoquot River to gain a better understanding of their life histories and function in the ecosystem.

3. Assess longitudinal distribution studies of aquatic insects at 500 m intervals as a complement to the fish distribution research.

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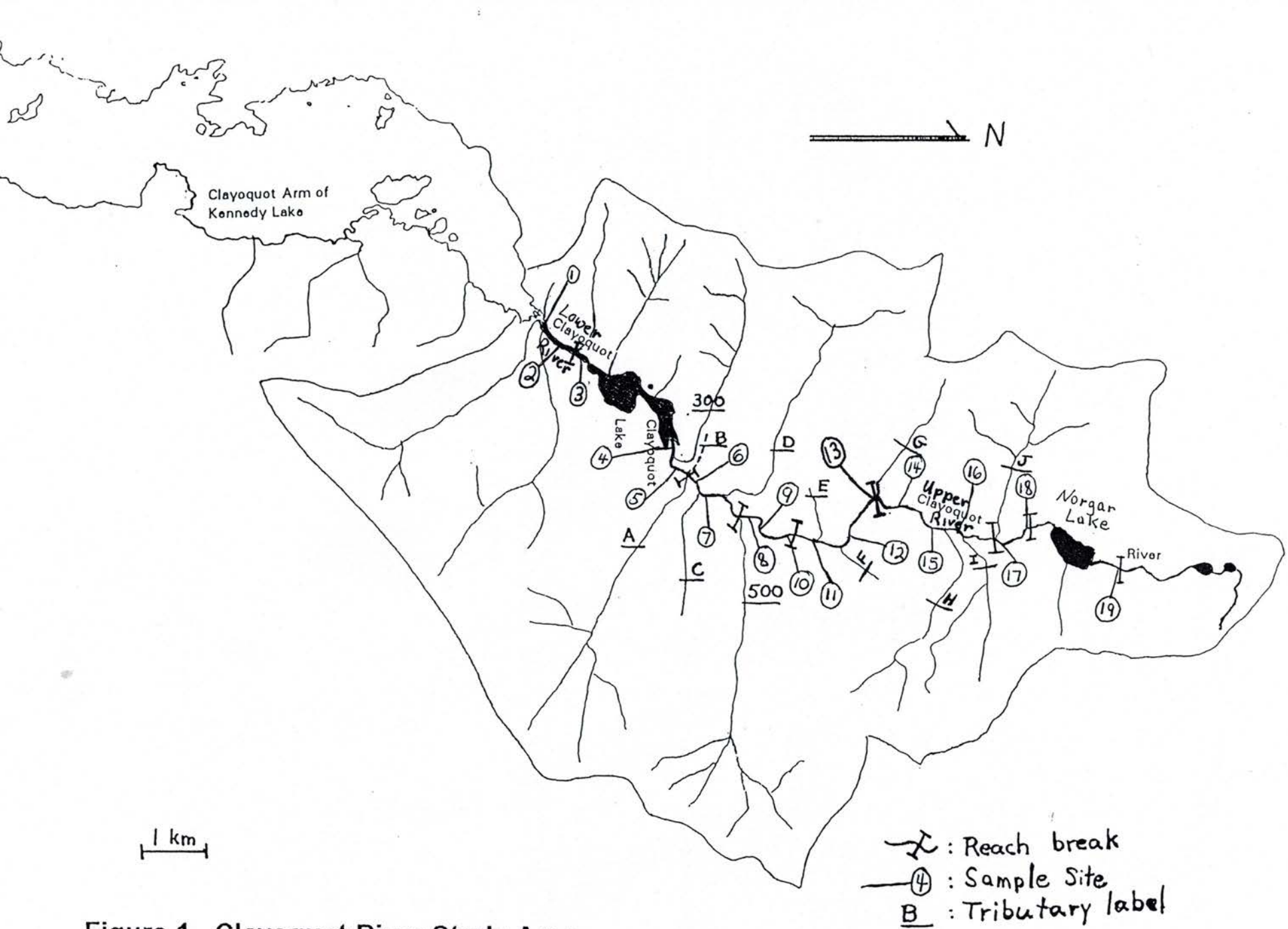

Figure 1. Clayoquot River Study Area

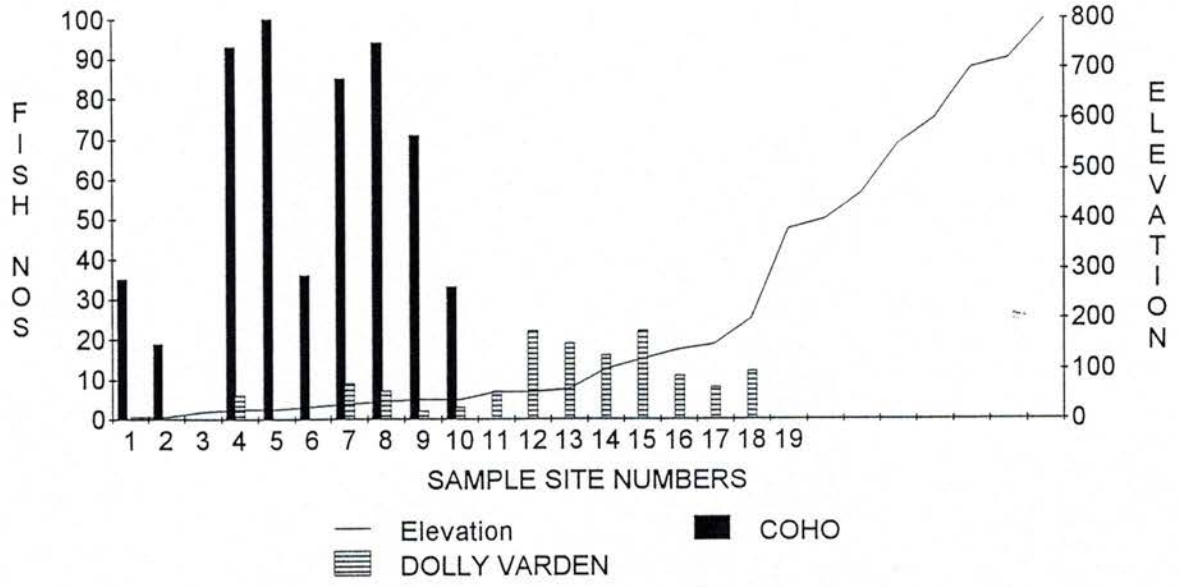

Figure 2: Numbers of coho salmon and Dolly Varden char captured at 19 sample sites on the mainstem length of the Clayoquot River.
Sampled September 5-15, 1995.

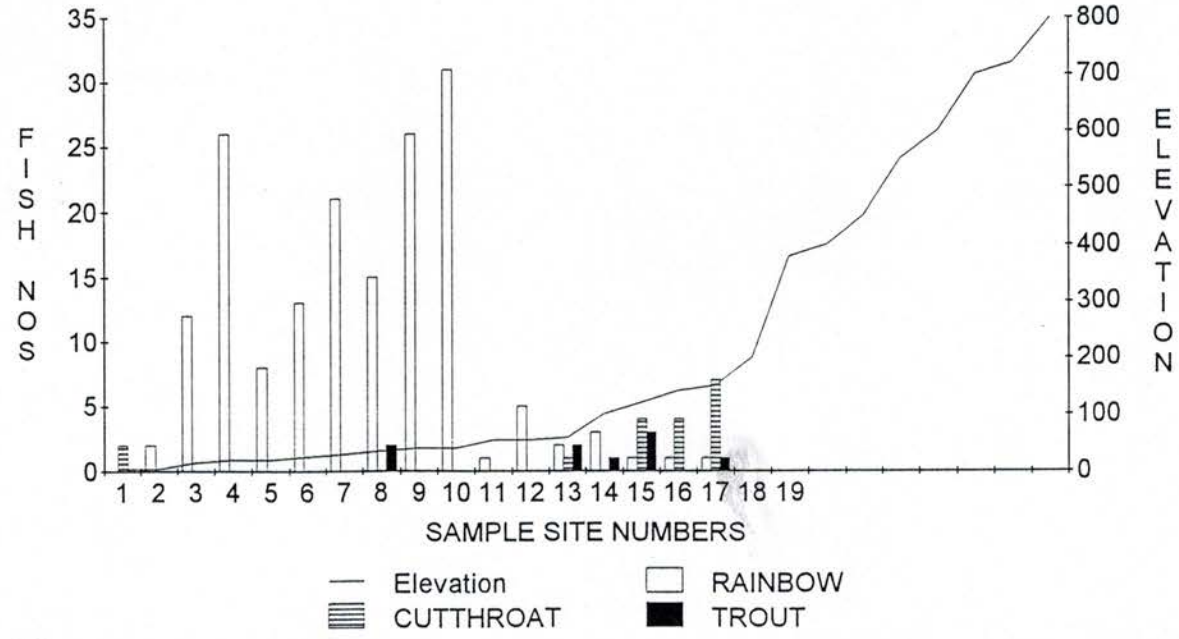

Figure 3: Numbers of rainbow trout, cutthroat trout and unidentified trout captured at 19 sample sites on the mainstem length of the Clayoquot River.
Sampled September 5-15, 1995.

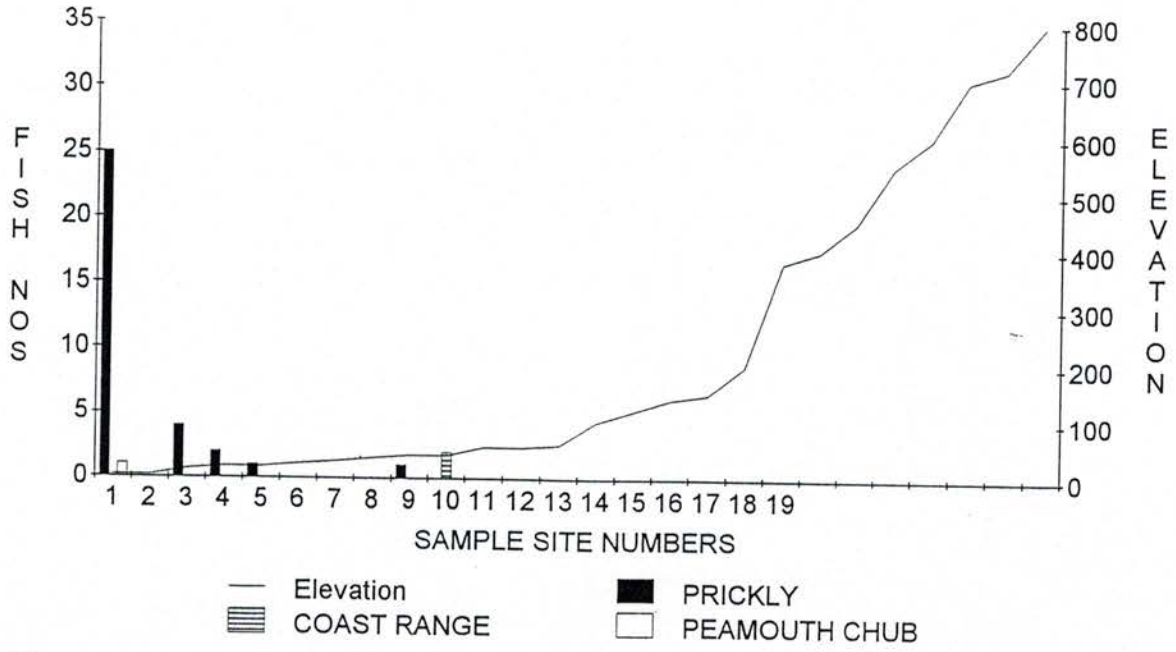

Figure 4: Numbers of prickly sculpin, coast range sculpin and peamouth chub captured at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Table 1: Numbers of fish at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Reach, Location (m from 0 point) and Sample Site	ELEV (m)	CO	RB	CT	TR	DV	CAS	CAL	PCC
Lower Clayoquot River									
R 1 - 0050m - Site 1	4	35	0	2	0	0	25	0	1
R 1 - 0800m - Site 2	4	19	2	0	0	0	0	0	0
R 2 - 1100m - Site 3	15	0	12	0	0	0	4	0	0
FISH TOTALS		54	14	2	0	0	29	0	1
Upper Clayoquot River									
R 1 - 0150m - Site 4	20	93	26	0	0	6	2	0	0
R 1 - 0450m - Site 5	20	100	8	0	0	0	1	0	0
R 2 - 1100m - Site 6	25	36	13	0	0	0	0	0	0
R 2 - 1600m - Site 7	30	85	21	0	0	9	0	0	0
R 3 - 2100m - Site 8	35	94	15	0	2	7	0	0	0
R 3 - 2500m - Site 9	40	71	26	0	0	2	1	0	0
R 3 - 3000m - Site 10	40	33	31	0	0	3	0	2	0
FISH TOTALS		512	140	0	2	27	4	2	0
3.4 km falls									
R 4 - 3500m - Site 11	55	0	1	0	0	7	0	0	0
R 4 - 4100m - Site 12	55	0	5	0	0	22	0	0	0
R 4 - 4500m - Site 13	60	0	2	1	2	19	0	0	0
R 5 - 5000m - Site 14	100	0	3	0	1	16	0	0	0
R 5 - 5800m - Site 15	120	0	1	4	3	22	0	0	0
R 5 - 6200m - Site 16	140	0	1	4	0	11	0	0	0
R 6 - 6800m - Site 17	150	0	1	7	1	8	0	0	0
R 6 - 7200m - Site 18	200	0	0	0	0	12	0	0	0
R 7 - >Norgar L. - Site 19	380	0	0	0	0	0	0	0	0
FISH TOTALS			14	16	7	117	0	0	0

Footnote: Column Heading Abbreviations.
ELEV = elevation, CO = coho salmon, RB = rainbow trout, CT = cutthroat trout, TR = unidentified trout, DV = Dolly Varden char, CAS = prickly sculpin, CAL = coast range sculpin, PCC = peamouth chub.

Table 2: Numbers of fish aged 0+ to 3+ years per reach on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Species	Age (years)					Readable Samples	Fish Sampled per reach	Total Fish per reach
	0+	1+	2+	3+	Cut-off(mm)			
LOWER CLAYOQUOT RIVER								
REACHES 1 AND 2 (Sites 1, 2 and 3)								
Coho Salmon	16	1			<83=0+	17	18	54
Rainbow Trout		5	1		<126=1+	6	14	14
Cutthroat Trout			1		<108=1+	1	2	2
Peamouth Chub				1	N/A	1	1	1
UPPER CLAYOQUOT RIVER								
REACH 1 (Sites 4 and 5)								
Coho Salmon	10	8			<81=0+	18	29	193
Rainbow Trout		12	7		<121=1+	19	34	34
REACH 2 (Sites 6 and 7)								
Coho Salmon	11	8			<76=0+	19	30	121
Rainbow Trout		12	5	1	<115=1+	18	34	34
REACH 3 (Sites 8, 9 and 10)								
Coho Salmon	33	1			<82=0+	34	46	198
Rainbow Trout		36	7		<117=1+	43	70	72
Unidentified Trout	2					0	0	2
REACH 4 (Sites 11, 12 and 13)								
Rainbow Trout	1	5			<136=1+	6	8	8
Cutthroat Trout					N/A	0	1	1
UnidentifiedTrout		2			<122=1+	2	2	2
REACH 5 (Sites 14, 15 and 16)								
Rainbow Trout		4	1		N/A	5	5	5
Cutthroat Trout	1	1	4		<118=1+	6	8	8
Unidentified Trout	1	2			<115=1+	3	4	4
REACH 6 (Sites 17 and 18)								
Rainbow Trout		1			N/A	1	1	1
Cutthroat Trout		3	3		<127=1+	6	7	7
UnidentifiedTrout		1			<113=1+	1	1	1
REACH 7 (Site 19) No Fish								

Footnote: Cut-off is the approximate fork length measurement that scale analysis determined year classes to be below.

APPENDICES

Appendix Table 1: Fish numbers and lengths at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Appendix Table 2: Channel width, channel depth and substrate composition at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Appendix Table 3: Channel character, gradient and habitat notes at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Appendix Table 4: Water temperature, weather and flow conditions at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Appendix Table 1: Fish numbers and lengths at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Reach	Species	Total Fish	Number Captured per Trap			Fish Length (mm)		
			Ave	Range	SD	Ave	Range	SD
LOWER CLAYOQUOT RIVER								
Reach 1	**0050m/Site 1**							
	Coho Salmon	35	8.8	4-13	3.7	67	49-90	6.9
	Cutthroat Trout	2	0.5	0-1	0.6	120	108-132	17.0
	Prickly Sculpin	25	6.3	3-8	2.2	92	68-121	14.1
	Peamouth Chub	1	0.3	0-1	0.5	99	0	0
	0800m/Site 2							
	Coho Salmon	19	4.8	0-9	4.9	66	54-92	10.6
	Rainbow Trout	2	0.5	0-2	1.0	116	107-124	12.0
Reach 2	**1100m/Site 3**							
	Rainbow Trout	12	3.0	0-5	2.2	127	103-155	16.8
	Prickly Sculpin	4	1.0	0-2	1.2	98	65-114	22.7
UPPER CLAYOQUOT RIVER								
Reach 1	**0150m/Site 4**							
	Coho Salmon	93	23.3	15-40	11.4	63	49-89	10.5
	Rainbow Trout	26	6.5	6-7	0.6	109	80-141	18.2
	Dolly Varden Char	6	1.5	0-5	2.4	115	96-137	15.2
	Prickly Sculpin	2	0.5	0-2	1.0	116	110-121	7.8
	0450m/Site 5							
	Coho Salmon	100	25.0	5-39	14.9	60	47-88	6.7
	Rainbow Trout	8	2.0	0-6	2.8	102	78-123	18.1
	Prickly Sculpin	1	0.3	0-1	0.5	111	0	0
Reach 2	**1100m/Site 6**							
	Coho Salmon	36	9.0	4-21	8.0	68	55-90	9.4
	Rainbow Trout	13	3.3	0-7	3.8	103	75-143	18.3
	1600m/Site 7							
	Coho Salmon	85	21.3	17-30	6.0	63	44-109	13.8
	Rainbow Trout	21	5.3	1-7	2.9	107	73-131	18.0
	Dolly Varden Char	9	2.3	1-4	1.5	104	86-133	14.0
Reach 3	**2100m/Site 8**							
	Coho Salmon	94	23.5	2-50	21.1	62	45-84	7.8
	Rainbow Trout	15	3.8	0-9	4.1	93	76-120	12.9
	UnidentifiedTrout	2	1.8	0-1	2.1	50	48-52	2.8
	Dolly Varden Char	7	0.5	0-4	0.6	113	101-132	10.8
	2500m/Site 9							
	Coho Salmon	71	17.8	0-32	14.6	66	50-80	7.6
	Rainbow Trout	26	6.5	5-10	2.4	103	85-135	13.3
	Dolly Varden Char	2	0.5	0-1	0.6	110	99-120	14.8
	Prickly Sculpin	1	0.3	0-1	0.5	103	0	0

App.Table 1 (cont): Fish numbers and lengths at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Reach	Species	Total Fish	Number Captured per Trap			Fish Length (mm)		
			Ave	Range	SD	Ave	Range	SD
Reach 3 (cont.)	**3000m/Site 10**							
	Coho Salmon	33	8.3	4-18	6.7	65	48-79	7.4
	Rainbow Trout	31	7.8	3-12	3.7	108	83-132	12.5
	Dolly Varden Char	3	0.8	0-2	1.0	109	98-115	9.3
	Coast Range Sculpin	2	0.5	0-1	0.6	104	94-113	13.4
Reach 4	**3500m/Site 11**							
	Rainbow Trout	1	0.3	0-1	0.5	116	0	0
	Dolly Varden Char	7	1.8	0-3	1.5	128	109-137	9.0
	4100m/Site 12							
	Rainbow Trout	5	1.3	0-4	1.9	126	114-136	8.2
	Dolly Varden Char	22	5.5	2-11	4.0	121	101-133	8.5
	4500m/Site 13							
	Rainbow Trout	2	0.5	0-2	1.0	94	73-115	29.7
	Cutthroat Trout	1	0.3	0-1	0.5	151	0	0
	UnidentifiedTrout	2	0.5	0-2	1.0	123	122-124	1.4
	Dolly Varden Char	19	4.8	1-10	4.1	117	96-141	14.7
Reach 5	**5000m/Site 14**							
	Rainbow Trout	3	0.8	0-3	1.5	118	94-151	29.4
	UnidentifiedTrout	1	0.3	0-1	0.5	115	0	0
	Dolly Varden Char	16	4.0	0-14	6.7	118	103-126	7.0
	5800m/Site 15							
	Rainbow Trout	1	0.3	0-1	0.5	100	0	0
	Cutthroat Trout	4	1.0	0-2	1.2	109	80-129	21.0
	UnidentifiedTrout	3	0.8	0-3	1.5	81	58-116	30.6
	Dolly Varden Char	22	5.5	1-12	4.8	104	69-128	11.8
	6200m/Site 16							
	Rainbow Trout	1	0.3	0-1	0.5	119	0	0
	Cutthroat Trout	4	1.0	0-2	0.8	106	96-119	9.7
	Dolly Varden Char	11	2.8	2-5	1.5	109	104-115	3.4
Reach 6	**6800m/Site 17**							
	Rainbow Trout	1	0.3	0-1	0.5	96	0	0
	Cutthroat Trout	7	1.8	0-4	1.7	122	101-138	12.8
	UnidentifiedTrout	1	0.3	0-1	0.5	113	0	0
	Dolly Varden Char	8	2.0	0-4	1.8	101	65-116	16.7
	7200m/Site 18							
	Dolly Varden Char	12	3.0	1-4	1.4	106	63-126	20.4
Reach 7	**9200m/Site 19**							
	No fish							

Appendix Table 2: Channel width (m), channel depth (m) and substrate composition (%) at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Location	Width (m)		Depth (cm)		Substrate Size (mm)							
(m)	Chann	Wet	Avg	Max	Fine	Gravel		Cobble		Bould.	Bedrk.	D90
						Sm.	Lg.	Sm.	Lg.			
Lower Clayoquot River												
Reach 1 - Sites 1 and 2												
0050	38.5	25.2	50	140	0	5	5	20	50	20	0	300
0800	39.2	27.0	25	50	0	0	20	20	30	30	0	700
Reach 2 - Site 3												
1100	27.8	20.8	40	80	0	0	5	10	60	25	0	1400
Upper Clayoquot River												
Reach 1 - Sites 4 and 5												
0150	41.3	23.6	100	150	0	15	30	50	5	0	0	1000
0450	23.8	21.3	100	250	10	30	30	20	10	0	0	1200
Reach 2 - Sites 6 and 7												
1100	26.8	15.4	100	180	10	25	30	30	5	0	0	1000
1600	29.0	25.3	75	150	10	40	40	10	0	0	0	1000
Reach 3 - Sites 8,9 and 10												
2100	19.2	15.7	50	80	10	30	30	20	10	0	0	200
2500	35.7	19.8	50	120	5	5	10	25	30	25	0	500
3000	27.8	21.9	75	100	0	10	10	30	20	30	0	1500
Reach 4 - Sites 11,12 and 13												
3500	16.2	11.1	50	75	0	0	10	10	20	60	0	600
4100	11.9	11.0	50	N/A	0	10	10	20	20	30	10	800
4500	18.0	12.0	150	200	0	0	10	10	10	60	10	1000
Reach 5 - Sites 14,15 and16												
5000	16.3	12.7	75	120	0	0	10	15	30	40	5	750
5800	17.1	11.8	50	75	0	5	15	30	30	20	0	600
6200	19.2	11.2	50	75	0	0	5	15	20	60	0	1000
Reach 6 - Sites 17 and 18												
6800	9.8	9.8	50	100	0	5	5	15	25	50	0	700
7200	7.8	7.8	40	100	0	0	5	10	25	60	0	500
Reach 7 - Site 19												
9200	10.9	6.0	100	250	0	5	15	20	40	10	10	N/A

Footnotes: Substrate size classes (average diameter)
Fine: clay, silt and sand (<2mm), Small gravel: 2-16mm, Large gravel: 16-64 mm, Small cobble: 64-128 mm, Large cobble:128-256 mm, Boulder: >256 mmm,
D90: Average diameter of the individual streambed material which is larger than 90% of the remaining streambed material.

Appendix Table 3: Channel character, gradient and habitat notes at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Location (m)	Site	Channel Aspect	Gradient 0%	Cover (%) Pool	LWD	Bould	Veg	Crown Closure	Habitat Type (%) Pool	Riffle	Cascade	Complex	Channel Form
Lower Clayoquot River													single
Reach 1 (0-1000 m)									46	54			
0050	1	127	0%	5	5		5	0%					Trib 1
0800	2	157	1%			20		0%					Trib 2
Reach 2 (1000-1400m)										24	76		single
1100	3	N/A	3%	5		75		0%					Trib 3
Upper Clayoquot River													single
Reach 1 (0-800 m)									46	54			
0150	4	202	0%		10		10	0%					Trib 300
0450	5	167	0%		5.		20	0%					Trib A + B
Reach 2 (800-1900m)									42	58			complex/single
1100	6	157	0%	5	25			0%					side channel
1600	7	157	0%		20			5%					Trib C + 500
Reach 3 (1900-3000m)									21	74		5	complex/single
2100	8	142	1%		15		5	10%					single
2500	9	127	1%		15		5	20%					LWD/braided
3000	10	169	>=5%			40		20%					single
Reach 4 (3000-4600m)									12	43	45		single
3500	11	125	0%			40		20%					single
4100	12	71	0-2%			30		20%					Trib E + F
4500	13	75	3%	25		25		20%					Trib G

Footnotes: Channel Aspect = the general downstream direction of stream flow, Gradient = all measurements were taken at sample sites except where indicated as > or < (measurements taken above or below sample sites), LWD = large woody debris, Veg = vegetation.

Appendix Table 3 (cont): Channel character, gradient and habitat notes at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Location (m)	Site	Channel Aspect	Gradient 0%	Cover (%)				Crown Closure	Habitat Type (%)				Channel Form
				Pool	LWD	Bould	Veg		Pool	Riffle	Cascade	Complex	
Reach 5 (4600-6700m)									8	75	5	12	complex/single
5000	14	117	<=11%			30		30%					side channel/falls
5800	15	193	1%			30		30%					single
6200	16	179	>=8%			50		20%					Trib H + I
Reach 6 (6700-7300m)									19	42	9	30	single
6800	17	161	1%			40		40%					Trib J
7200	18	47	>=15%	10		20	20	50%					complex/braided
Reach 7 (7300-12600m)													single/subsurface
9200	19	189	>=5%	18	2	20		50%					single

Footnotes: Channel Aspect = the general downstream direction of stream flow, Gradient = all measurements were taken at sample sites except where indicated as > or < (measurements taken above or below sample sites, LWD = large woody debris, Veg = vegetation.

Appendix Table 4: Water temperature, weather and flow conditions at 19 sample sites on the mainstem length of the Clayoquot River. Sampled September 5-15, 1995.

Location (m from 0 point) and Sample Site	Date	Time	Water Temperature	Weather Conditions	Flow Conditions
Lower Clayoquot River					
Reach 1					moderate
0050m/Site 1	Sept 5/95	15:30	16.8	overcast	
0050m/Site 1	Sept 6/95	10:17	15.0	80% cloud	
0800m/Site 2	Sept 5/95	17:00	14.0	overcast	
0800m/Site 2	Sept 6/95	12:21	15.0	80% cloud	
Reach 1					moderate
1100m/Site 3	Sept 5/95	18:10	15.5	overcast	
1100m/Site 3	Sept 6/95	13:16	15.5	80% cloud	
Upper Clayoquot River					
Reach 1					moderate
0150m/Site 4	Sept 6/95	15:03	11.5	mainly clear	
0150m/Site 4	Sept 7/95	9:17	10.5	clear	
0450m/Site 5	Sept 6/95	15:45	12.0	mainly clear	
0450m/Site 5	Sept 7/95	12:00	11.0	clear	
Reach 2					moderate
1100m/Site 6	Sept 6/95	16:35	12.0	mainly clear	
1100m/Site 6	Sept 7/95	13:15	12.0	clear	
1600m/Site 7	Sept 6/95	17:45	12.0	mainly clear	
1600m/Site 7	Sept 7/95	15:00	N/A	clear	
Reach 3					low
2100m/Site 8	Sept 8/95	10:00	12.0	fog	
2500m/Site 9	Sept 8/95	12:25	13.0	clear	
3000m/Site 10	Sept 8/95	14:30	13.0	clear	
3000m/Site 10	Sept 9/95	9:15	11.5	clear	
Reach 4					low
3500m/Site 11	Sept 8/95	16:00	12.5	clear	
3500m/Site 11	Sept 9/95	10:50	11.5	clear	
4100m/Site 12	Sept 8/95	18:20	12.8	clear	
4100m/Site 12	Sept 9/95	11:40	12.0	clear	
4500m/Site 13	Sept 9/95	15:04	12.0	clear	
4500m/Site 13	Sept 10/95	12:00	11.8	clear	
Reach 5					low
5000m/Site 14	Sept 9/95	16:58	12.5	clear	
5000m/Site 14	Sept 10/95	14:30	12.0	clear	
5800m/Site 15	Sept 10/95	16:25	13.0	clear	
5800m/Site 15	Sept 11/95	9:45	12.0	10% cloud	
6200m/Site 16	Sept 10/95	17:25	12.5	clear	
6200m/Site 16	Sept 11/95	10:48	12.0	95% cloud	
Reach 6					low
6800m/Site 17	Sept 10/95	18:30	12.5	clear	
6800m/Site 17	Sept 11/95	12:00	12.0	95% cloud	
7200m/Site 18	Sept 11/95	15:15	12.8	95% cloud	
7200m/Site 18	Sept 12/95	11:30	12.2	clear	
Reach 7					low
9300m/Site 19	Sept 14/95	18:00	15.0	clear	
9300m/Site 19	Sept 15/95	10:30	14.5	clear	