Watershed Restoration Program

Overview and Level 1 Fish Habitat Assessment

of

Unnamed Tributary of Mohun Creek (locally known as Coho Creek)

prepared for the

Campbell River
Fish and Wildlife Association

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Summary

A Watershed Restoration Program Overview and Level 1 Fish Habitat Assessment was conducted for an unnamed tributary of Mohun Creek (locally known as Coho Creek) from August 26 - September 1, 2000. The main objectives of this project were to determine the distribution of fish and fish habitat in the system, to identify and assess areas of impacted habitats and make recommendations for restoration activities. Another objective was to determine the correct drainage pattern for the mainstem and tributaries, as existing maps are not accurate. This project was initiated and funded by the Campbell River Fish and Wildlife Association.

The Coho Creek mainstem and tributaries drain an area of approximately 9 km^2. Total stream length in the drainage is approximately 13.6 km, all of which is accessible to anadromous fish. Part of the drainage falls within Weyerhaeuser Ltd. and Merill and Ring Canadian Properties Inc. forest development areas. The remainder of the drainage is owned by private property owners and the John Howard Society.

Fish species present in Coho Creek and its tributaries include coho salmon, cutthroat trout, rainbow trout, coastrange sculpins, threespine stickleback and lamprey. The distribution of all fish species is assumed to include the entire Coho Creek mainstem and all tributaries as no barriers to fish migration exist in the drainage. Low water flow levels may restrict fish movements into Tributary 1, Reaches 4 and 5 of Tributary 2, Reach 2 of Tributary 4, Reaches 13, 14 and 15 of Coho Creek and Tributaries 5-8 at some times of the year.

Fish habitat present in Coho Creek includes summer / winter rearing habitat, overwinter habitat and spawning habitat. Summer / winter rearing and overwinter habitat were the most abundant types present, accounting for 96% of the habitat combined. A minimal amount of the system is spawning habitat.

Level 1 Habitat Assessments were conducted at three railway trestle crossings (Reach 2 of Coho Creek, Reach 3 of Tributary 2 and Reach 1 of Tributary 4) and two reaches that contained critical spawning habitat (Reach 8 and 9 of Coho Creek). In the railway trestle sites, the dismantling and re-distribution of the trestle debris and/or standing trestle structure is recommended to improve the abundance and distribution of

large woody debris in the channel. The amount of large woody debris present in the spawning habitat in Reach 8 of Coho Creek was also found to be less than desired for optimal fish habitat. Large woody debris placement is recommended for this reach. The best overall habitat was found in Reach 9 of Coho Creek, but again large woody debris was slightly less abundant than recommended. This reach could also be considered for large woody debris placement if it is successful in other areas.

Further study is required to complete the assessment and make final conclusions on the status of Reach 1 in Tributary 4. Part of this stream could not be surveyed during this study and historical information is not available. Based on the results of the survey upstream and downstream of the unsurveyed section, it is suspected that an alteration may have occurred in the natural flow pattern for this stream. If this proves to be correct, restoring natural flow levels is important as the lower portion of Tributary 4 contains potential spawning habitat and is actually a larger channel than the Coho Creek mainstem upstream of their confluence.

Existing maps of the Coho Creek drainage are often incomplete or incorrect. An accurate representation of the drainage has been constructed from the existing maps, aerial photographs and the field survey. A GIS survey is required to construct a completely accurate map of the drainage.

Acknowledgements

Mainstream Biological Consulting

Many people deserve acknowledgement for their contributions to this project. First, many thanks to the Campbell River Fish and Wildlife Association for providing funding and their support for this project. Our sincere appreciation goes to Karen Furber for her assistance in gathering background information and applying for permits. Also, thanks to Bill Hardy (Ministry of Forests, Campbell River) for allowing us access to all of his information and aerial photographs, and for his time answering questions. The staff at the Quinsam Fish Hatchery (Department of Fisheries and Oceans) were helpful in supplying information on coho fry stocking.

We would also like to acknowledge the many property owners who graciously allowed us access to their properties so that we could complete the field portion of this project. They include: Weyerhaeuser Ltd., Merril & Ring, Jeremey Devlin, Duncan Devlin and the John Howard Society.

Finally, field assistance by Lance Stewardson was very much appreciated. Many thanks are also extended to Derek Tripp for his contribution to the field survey and his recommendations provided for the completion of this report.

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1.0 Introduction

This is a Watershed Restoration Program (WRP) Overview and Level 1 Fish Habitat Assessment of an unnamed tributary of Mohun Creek. The lack of information on the fish and habitat distribution for this system lead the Campbell River Fish and Wildlife Association to initiate this project. Through the completion of this Overview and Level 1 Assessments, they hope to provide information for the responsible management and improvement of this stream and its tributaries for all property owners within its drainage area.

This project has three main objectives. First, the fish species distribution in the stream and its tributaries were to be determined. Second, fish habitat such as spawning and rearing areas were to be located and then assessed when they were deemed to be critical to the production of fish. Finally, degraded habitats were located and assessments conducted so that recommendations could be made for potential restoration projects. A secondary objective of this project was to determine the correct drainage pattern for this system, as there are no existing maps that show the entire stream accurately.

The procedures for this type of survey are outlined in Fish Habitat Assessment Procedures, WRP Technical Circular No. 8 (Johnston, N.T. and Slaney, P.A., 1996). Other WRP manuals that were consulted during the course of this project include Guidelines for Planning Watershed Restoration Projects, WRP Technical Circular No. 1 (Johnston, N.T. and Moore, G.D., 1995), and Fish Habitat Rehabilitation Procedures, WRP Technical Circular No. 9 (Slaney, P.A. and Zaldokas, D, 1997). Also used were the Resource Inventory Committee Reconnaissance (1:20000) Fish and Fish Habitat Inventory: Standards and Procedures (Anonymous, 1998a) and Fish Collection Methods and Standards (Anonymous, 1997)

This report has three main sections. The first (2.0 Study Area) includes a description of the drainage and the information that existed prior to this project. An updated map of the drainage is located in Section 2.0. Section 3.0 contains an overview of the methods used in the office and field to gather the data required. Any deviations from the recommended procedures in the manuals mentioned above are described in this section. A discussion of the results of the Overview Assessment and Level 1

Assessments, and a description of potential restoration activities is in Section 4.0 (Results and Discussion). This section also includes maps of the fish and fish habitat distribution. Four appendices are found at the end of the report. Appendices I and II contain data collected during the Overview phase of the project. Data collected during the Level 1 Habitat Assessments is found in Appendix III. Attachment 1 contains a catalogue of photographs taken during the project.

2.0 Study Area

The stream surveyed for this project is a second order, unnamed tributary of Mohun Creek. Locally, this stream has been called "Coho" Creek, "Miller" Creek and "East Snowden" Creek. The Campbell River Fish and Wildlife Association began referring to this stream as Coho Creek after one member (Jack Smith) noticed a sign nailed to a tree next to the stream with "Coho Creek" written on it. For this report, it will be referred to as Coho Creek.

The confluence of Coho Creek with Mohun Creek occurs approximately 1.8 km upstream of the ocean. Mohun Creek flows into Discovery Passage via Menzies Bay, approximately 12 km northeast past the Campbell River bridge crossing on Highway 19.

Figure 1 contains a map of the stream and its tributaries constructed from existing maps, aerial photographs and information collected during the field survey. Existing maps of this stream are generally inaccurate. The 1:50000 NTS map (92K/3) shows Coho Creek as part of the Snowden Creek drainage, which is the next tributary upstream on Mohun Creek. While the connection to Mohun Creek is correctly mapped on the 1:20000 TRIM maps, the actual drainage of the upper half of the stream is mis-mapped. The complete drainage pattern of Tributary 4 is still unclear, as permission was not obtained to access the property (a private farm) this portion runs through. The drainage pattern above the private farm and for the headwaters was taken from the 1:5000 forest service map (92K.004.3.2) and confirmed during the field survey and using aerial photographs.

The incorrect mapping of Coho Creek on the 1:50000 NTS map has resulted in an error when the watershed codes were determined for this area. The watershed code atlas map lists the watershed code of Coho Creek as 930-643100-09200. Snowden Creek, the next tributary upstream on Mohun Creek, has been given 930-643100-09200-23610 as a watershed code, which suggests that Snowden Creek is a tributary of Coho Creek. This is incorrect, and the two streams should have independent watershed codes as tributaries of Mohun Creek.

The Coho Creek mainstem and tributaries drain a combination of privately owned properties and Crown land. Timber companies that currently hold harvesting rights in

the drainage area include Weyerhaeuser Ltd. and Merril & Ring. Several privately owned residential properties are located in the upper portion of the drainage. The John Howard Society operates a rehabilitation camp for juvenile offenders within the drainage area.

The Coho Creek system drains an area of approximately 9 km^2 (Fig. 1). Total stream length is at least 13 km, plus the section of channel that was not surveyed for this project. The Coho Creek mainstem is approximately 7.6 km long. The two major tributaries (Tribs 2 and 4) account for at least 2.4 km of stream length, while the six small tributaries (Tribs 1, 3, 5-8) make up the remaining 3.0 km.

Historical information about the fish species and habitat present in Coho Creek is limited. In the mid-1980's, this stream caught the attention of the Campbell River Fish and Wildlife Association (CRFWA). At that time, a culvert at the lower Iron River Main crossing was considered insufficient for fish passage, as it was too high above the stream bed. The CRFWA worked to improve fish passage by building up the stream bed below the culvert in 1989.

The Quinsam Fish Hatchery (DFO) started stocking coho fry in the stream just above the Iron River Main in 1989, and released fish eight more times over the next 11 years (1989-93, 1995, 1997-98 and 2000). The success of the fry release has not been determined as formal counts of returning adult coho have not been conducted. Informal inspections by CRFWA members have not been successful in observing returning coho.

Other fish species reported in the drainage include cutthroat trout (M. Lough Environmental Consultants Ltd., 1998), rainbow trout, stickleback, sculpins (Jack Smith, CRFWA) and lamprey (Bill Hardy, Ministry of Forests).

Figure 1. The Coho Creek drainage

3.0 Methods

The methods used to complete the WRP Overview and Level 1 Fish Habitat Assessment are described in detail in Fish Habitat Assessment Procedures, or FHAP (Johnston, N.T. and Slaney, P.A., 1996). The following sections describe those methods briefly and note any deviations made from the recommended procedures.

3.1 Overview Fish Habitat Assessment

The goal of the overview assessment is to assemble existing information on the drainage of interest and to identify specific reaches that are candidates for Level 1 Fish Habitat Assessment. This assessment is intended to be an office exercise, with existing information and aerial photograph analysis providing the information required to proceed with Level 1 Assessments. For this project, a field survey component was added to the overview assessment.

A field component was added to this phase of the project for several reasons. The small channel size made the habitat assessment from aerial photograph analysis nearly impossible, as most features were to small to observe or the forest canopy obscured any view of them. Four series of aerial photographs (Table 1) were viewed, ranging from scales of approximately 1:8850 to 1:40000. It was not possible to identify areas of concern, such as critical fish habitats or areas with habitat degradation, from the aerial photograph analysis.

Table 1. The aerial photographs used to assess the habitat and drainage pattern of the Coho Creek drainage.

Flightline	Photo numbers	Scale
BCC 444	66-67	Approx. 1:8850
30BC C90019	104-105, 110-112, 173-175	Approx. 1:8850
30BCB91031	47-48, 84-85	1:15 000
15BCB96068	254-256	1:40 000

The standards outlined in the FHAP recommend aerial videotaping or more extensive Level 1 field surveys if aerial photograph analysis does not provide suitable information. These options were considered to be less cost effective than doing an overview field survey, as this is a small stream that could feasibly be walked over the period of a few days.

Existing fish and habitat information for Coho Creek is limited. Information sources included personal interviews, existing consultant reports, personal CRFWA diary entries and the FISS database. Table 2 contains a description of each source and the information provided. This information was mapped on a clean 1:20000 TRIM map for use by the field crew.

Table 2. A summary of the information collected prior to the field survey during the Overview Assessment of Coho Creek.

Type	Contact	Information Supplied
Maps, aerial photographs, personal information.	Bill Hardy, Ministry of Forests, Campbell River, BC.	Location of railway grade crossings that may be affecting fish access, maps of drainage with corrected channel locations, information on species (lamprey, CT, CO) presence in the drainage.
Personal diary	Jack Smith, CRFWA member	Information collected since 1985 about Coho Creek. Describes efforts to improve fish passage at lower Iron River Main culvert, reports of coho stocking, and efforts to observe returning coho adults.
FISS database	www.env.gov.bc.ca:8100/fiss_pub/owa/fiss_login.display	Presence of pink salmon and Aleutian sculpins in Mohun Creek.
Stocking report	Dave Ewart, Quinsam Fish Hatchery, Campbell River, BC.	Summary of coho fry stocking at lower Iron River Main crossing by hatchery staff (1989 - present).
Consultant letter	Fishfor Contracting, Port McNeill, BC.	Consultant letter (Sept. 9, 1999) regarding fish sampling at culvert at upper Iron River Main crossing. 32 Coho fry and 17 cutthroat captured.
Reconnaissance (1:20000) Fish and Fish Habitat Inventory Interpretive map (draft, 1998)	M. Lough Environmental Consultants, Lantzville, BC. (via Karen Furber, CRFWA member)	Shows location of sample site on Coho Creek Tributary (Trib 2) and capture of cutthroat trout.

Information to complete the fish distribution for the drainage could be collected during the overview field survey. Since Level 1 assessments are usually focused on specific reaches, not all areas of the drainage would be surveyed during that process. If

fish sampling were left to be conducted during that phase, it may not be possible to determine the complete distributions of all species present.

No barriers had previously been reported in the drainage. However, several old railway grade crossings had been identified as areas of potential fish obstruction or habitat degradation (Bill Hardy, Ministry of Forests, personal communication, August 2000). These crossings occur on the Coho Creek mainstem and Tributaries 1, 2, 3 and 4.

Reach breaks on the Coho Creek mainstem and tributaries were added during the course of the field survey. A stream reach is defined as "a length of watercourse having similar channel morphology, channel dimension and gradient" (Anonymous. 1998b). Generally, reaches are required to have a minimum length of 100 m, to prevent "the division of streams into unmanageably small portions that may be little more than individual habitat units such as riffles, pools and glides" (Anonymous. 1998b). The placement of reach breaks marked a significant change in riparian vegetation, channel confinement, gradient and substrate composition based on observations during the field survey and aerial photograph analysis.

Information on the fish species distribution collected during the field overview would help direct the selection of reaches for Level 1 assessments. An important component of the Overview Assessment is to identify "target" species for the drainage of interest. Target species are "economically or culturally important salmonids whose abundance has declined following past timber harvest or which are known to be sensitive to the effects of logging" (Johnston, N.T. and Slaney, P.A., 1996). Anadromous species such as coho salmon, chinook salmon, pink salmon, sockeye salmon, chum salmon and steelhead trout, along with resident species such as cutthroat trout, rainbow trout and Dolly Varden char are common target species in coastal streams on Vancouver Island. Once one or more target species has been identified for a system, areas of critical habitat for the species can be identified and considered for future Level 1 Assessment.

Finally, it was considered important at this stage to attempt to construct an accurate map of the drainage prior to completing the more detailed assessments. Being able to accurately locate the stream reaches for Level 1 Assessments would be

important if any future work was recommended. Information on the drainage pattern may also be needed when making recommendations for restoration work, as the areas upstream of the section being worked on must also be considered.

During the overview field survey, fish sampling was conducted and some habitat data (gradient, bankfull width, substrate composition, cover types) recorded. Fish sampling took place using a Smith-Root backpack electroshocker (Model 12A) and baited Gee minnow traps. The electroshocker was set at 400 volts, with a frequency of 80 Hz and amplitude of 4 ms. Electroshocking effort was recorded as the length of stream shocked (meters) and the time spent shocking (seconds). Gee minnow traps were set in ponded areas that were not suitable for electroshocking and baited with preserved salmon roe. The number of traps set in a site ranged from 2 to 4 traps. Traps were always left overnight, and soak times ranged from 17 to 22 hours.

The fish sampling that occurred was not intended to produce a population estimate, but to locate all species of fish and their life stages present. Once it was felt this had been accomplished for a reach, fish sampling was halted until a new reach was located.

The fish captured were identified to species and measured to the nearest millimeter (fork length for salmonids, total length for sculpins and sticklebacks). Lamprey were not usually measured as they were difficult to capture without risking injury to other species present by increasing electroshocker settings. When it was not possible to identify fry as either cutthroat or rainbow trout, they were recorded as trout only. Information collected during fish sampling has been recorded on a modified FHAP Form 1 (Overview Assessment - Fish Distribution Summary Form) that is found in Appendix I.

Minimal habitat data was recorded during the Overview Assessment. Bankfull channel widths (W_b) and channel gradients were measured for most reaches (66% and 79% respectively). Observations about the substrate composition, cover types, channel morphology, potential habitat degradation, water flow levels, riparian vegetation and potential fish use were recorded as field notes. This information has been transferred to a modified version of the FHAP Form 2 (Overview Assessment - Habitat Condition Summary Form) that can be found in Appendix II. Color photographs were taken to

show examples of typical habitat types encountered, potential restoration areas and fish species captured. These photographs are contained in Attachment 1.

At the conclusion of the overview field survey, four reaches were chosen for more intensive Level 1 Fish Habitat Assessments. Two reaches (Reaches 2 and 8) on the Coho Creek mainstem were selected, while two other reaches on the two main tributaries (Tribs 2 and 4) were also selected. The rationale behind their selection is described in Table 3. FHAP Form 3 (Overview Assessment - Preliminary Habitat Assessment Form) was not used during the selection of Level 1 Assessments reaches.

Table 3. The four reaches selected for Level 1 Fish Habitat Assessments after the Overview Assessment of the Coho Creek drainage.

Stream	Reach	Reach length (km)	Reason for selection
Coho Creek	2		Railway trestle runs through 18 m of the channel. Much of the structure is still standing, but could become an obstacle or barrier to fish migration as it falls into the channel.
Coho Creek	8		Identified as potential anadromous and resident spawning area, therefore considered critical habitat for this stream.
Tributary 2	3		Railway trestle has collapsed into the channel of this tributary. May be impacting the channel morphology by causing aggradation upstream and downstream of the debris jam. The debris may be acting as an obstacle or barrier to the potential overwintering habitat in the wetland habitat at the upper end of this tributary.
Tributary 4	1		Railway trestle has collapsed into the channel of this tributary. May be causing habitat degradation due to aggradation. Also, the flow of this tributary may be being affected by activities taking place in the section upstream which runs through a private farm.

3.2 Level 1 Fish Habitat Assessment

The main objective of a Level 1 Fish Habitat Assessment is to collect data from the reaches identified in the Overview Assessment as being of "special concern". These reaches generally contain critical fish habitat (i.e. spawning habitat) or areas that have been impacted and are used by the target species as habitat. This data is then used to determine specific habitat limitations (i.e. insufficient cover for returning adult fish,

potential obstructions to fish migration) and to make recommendations for future restoration and enhancement activities.

As fish sampling had been conducted as part of the overview assessment, no further fish sampling was required for this part of the project. Therefore, the Level 1 Fish Habitat Assessment required only habitat measurements be taken for the selected reaches and FHAP Form 5 (Level 1 - Fish Distribution Data Form) was not used.

Sampling for the Level 1 Habitat Assessments requires stratifying the habitat in each reach into distinct habitat units. There are five habitat types considered for this level of survey; pools, glides, riffles, cascades and other (includes wetlands without an identifiable channel, lakes, areas of sub-surface flow or areas where the channel cannot be observed due to large debris jams). Habitat measurements taken in a sub-sample of the habitat units found in each reach is used to characterize the average habitat conditions of the reach.

For this project, it was decided to sample every second habitat unit encountered for each habitat type. This would result in a sample of approximately 50% of the reach, and provide sufficient data to describe the habitat in the reach accurately. Predetermining the sampling ratio (1/2) reduced the risk of being biased in the selection of habitat units for sampling, and would result in an unbiased representation of the habitat in the reach.

As the Level 1 assessments were being conducted, it was decided to add an additional reach for assessment. This was Reach 9 of Coho Creek, which was also considered to be potential spawning area for anadromous and resident salmonids. The five sample reaches were labeled as Sites 1, 2, 2A, 3 and 4 as listed below, starting at the downstream-most site and working upstream.

Site no.	Location
1	Coho Creek - Reach 1
2	Coho Creek - Reach 8
2A	Coho Creek - Reach 9
4	Tributary 2 - Reach 3
5	Tributary 4 - Reach 1

A detailed description of the habitat data recorded can be found in FHAP (Johnston, N.T. and Slaney, P.A., 1996). All the habitat units sampled are considered primary habitat units, as they occurred in the main stream channels and occupied more than 50% of the wetted widths. Lateral scour pools present in Site 1 could be

considered tertiary habitat units (contained within primary habitat units, but meet minimum size requirements), but did not meet the minimum size criteria (area=2.0m^2)for a stream of this size (W_b = 2.5 - 5.0 m).

Habitat unit length was measured using a hipchain. Water and bankfull depths were measured using a wooden staff marked in 1 cm increments. A hand-held metal tape was used to measure bankfull and wetted widths. The total amount of large woody debris (LWD) within the bankfull channel was counted, and then counts of functional LWD (which influence channel geomorphology) were divided into three size classes. Visual assessments of the substrate composition, spawning gravel, cover types and amounts, disturbance indicators, riparian vegetation and canopy cover were done by both field crew members. The resulting data recorded was a consensus taken from both members' assessments. Habitat data was recorded as presented in the FHAP Form 4 (Level 1 - Habitat Survey Data Form) within the field notes.

Water samples for the purpose of determining nutrient concentrations in the stream were not taken for this project. The cost of processing the water samples made these measurements impossible within the budget proposed for this project.

Generally, water nutrient levels are measured for the purpose of determining if stream fertilization is a viable restoration activity. Ashley and Slaney (1997) report that the recycling of nutrients from decomposing fish carcasses is important in maintaining healthy nutrient levels in coastal streams. For this to occur, adult fish must be returning to spawn in the stream. Therefore, ensuring fish passage into the stream and suitable spawning areas is an effective way to ensure healthy nutrient levels without undertaking stream fertilization.

4.0 Results

4.1 Overview Fish Habitat Assessment

The data collected during the overview assessment was used to construct maps of the fish species distribution and habitat distribution in the Coho Creek drainage. These maps are found in Sections 4.1.2 and 4.1.3 respectively. Also, a map with the corrected drainage pattern was constructed from the information gathered during the field survey, from existing maps and aerial photograph analysis (Section 4.1.1).

4.1.1 Mapping

Figure 1 contains a map of the corrected channel locations on a TRIM base map and the reach breaks added during the course of the field survey.

While the lower 4 km of the Coho Creek mainstem (to Reach 11) is mapped correctly on the 1:20000 TRIM map, the upper 3.6 km are either not shown as connected to the Coho Creek drainage, or missing from the map entirely. Tributary 1, Tributary 3, the lower section of Tributary 4 (downstream of the private farm) and Tributary 6 are not currently mapped on the TRIM map. The confluence of Tributary 2 has been adjusted approximately 100 m upstream of where it was mapped on the TRIM map. The channel portions added to the TRIM map are mapped as accurately as the methods used to locate them allowed. In order to get a completely accurate representation of the stream and its tributaries, a GIS mapping system should be used.

It is important that the drainage pattern of this system be completed when permission is granted to access the portion of the stream not surveyed during this project, or if information on that area is made available. Any alterations to the flow pattern may be affecting water levels downstream of that point. The channel in Tributary 4 (W_b = 5.57 m) is actually larger than the Coho Creek channel (W_b = 3.30 m) upstream of their confluence, and may have carried the bulk of the flow at one time. The lowering of water levels may have affected fish movements upstream as one would expect returning adult coho to select the larger channel to return to. The most suitable gravel for coho spawning is located in the lower portion of Tributary 4, but the current intermittent water flow and aggraded substrate would discourage adult coho from entering this stream to spawn.

4.1.2 Fish Species Composition and Distribution

Prior to this survey, species reported in this drainage included cutthroat trout, rainbow trout, coho salmon, sculpins, sticklebacks and lamprey. While no new species were located during this survey, fish sampling provided the information needed to complete the known fish species distribution for the Coho Creek mainstem and its tributaries (Figure 2). Sculpins (coastrange) and sticklebacks (threespine) were identified to species, which had not been done in the past. The lamprey present in the drainage have not been classified to species. The small size of the specimens captured made it difficult to see the structures (tooth bars, teeth, tongue) that are used to key out the species. River lamprey have been reported in Mohun Creek, so it is possible that they are the same species.

Juvenile coho salmon were captured up to Reach 12 of the Coho Creek mainstem and Reach 2 of Tributary 2. It is suspected that these fish are a combination of fish stocked in June 2000 and the offspring of returning adults. The length-frequency data presented in Figure 3 suggests that two age classes are present, with a one peak for the 50 - 59 mm size class representing 0+ fish, and a second smaller peak in the 90 - 99 mm size class, representing 1+ fish. The two age classes indicate that there are adult coho returning to spawn. Because there was no stocking in 1999, the 1+ fish would be the offspring of adults who spawned in 1999. Further study to confirm adults are spawning in this stream could include:

- Visual inspections for adult spawners
- Mark hatchery fry to distinguish them from "wild" fry, then sample to look for wild fry
- Sample for juvenile fry in spring, prior to any further stocking to look for young of the year coho

Efforts to locate coho upstream of Reach 12 were unsuccessful, but Fishfor Contracting reports collecting 32 coho fry at the Iron River main culvert in Reach 14 in September 1999. The absence of any barriers in the mainstem suggests that the distribution of coho could extend to the upper portions of the headwaters of the drainage. The gradient measured in Reach 10 (9%) may pose somewhat of an obstacle for migration upstream, but comprises only a short section of channel (less than 250 m) as the gradient decreases again to approximately 5% by Reach 11. At higher flow levels,

this section would be passable, as evidenced by the presence of coho upstream of this reach.

Figure 2. The distribution of fish species present in the Coho Creek drainage.

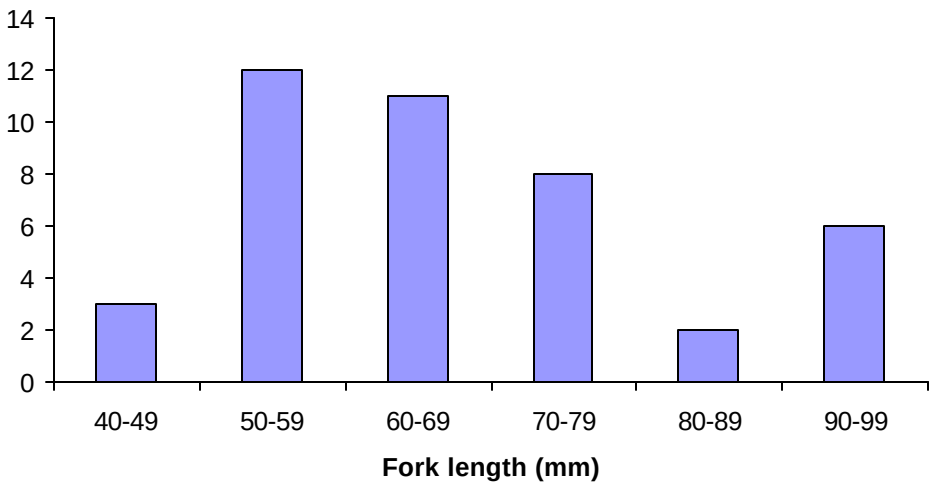

Figure 3. Age-length frequency of the coho salmon captured during the field survey of the Coho Creek drainage, August 26 - September 1, 2000.

Upstream of Reach 12, the majority of the habitat in the mainstem and tributaries is comprised of small, low gradient, muck bottomed channel with poor cover and an absence of spawning gravels. Much of the channel runs through wetland areas with barely defined banks. It is possible that the area upstream of Reach 12 is used by the coho as refuge habitat for overwintering when water levels are high.

The distribution of coho in the tributaries was limited. Habitat in Tributary 1 is of poor quality and there are several beaver dams blocking fish passage. This area may provide limited amounts of overwinter habitat. Coho were captured in Reach 2 of Tributary 2. Water flow upstream of Reach 2 was inconsistent, and the channel was completely dry in Reach 5 at the time of the survey. Provided that the trestle debris does not pose too significant an obstacle, the stream habitat in Reach 3 and 4 and wetland habitat in Reach 5 are potential overwinter refuge areas for rearing coho. The steep gradient (13%) in Tributary 3 would prevent coho fry from accessing this small stream. The total absence of coho in Tributary 4 is not easily explained due to the incomplete information on the upstream portion of this stream. Water in the section downstream of the railway trestle crossing was limited to small pools connected by very little flow. Upstream of the trestle crossing, the flow becomes discontinuous leaving isolated pools. At this time, coho may not be utilizing habitat in this stream due to the low water levels, but this stream is accessible to coho, and is considered to be part of their distribution.

Tributaries 5-8 join Coho Creek upstream of Reach 12, and therefore are also considered overwintering habitat.

Cutthroat trout were abundant in the Coho Creek drainage and their distribution was widespread throughout the entire system. Individuals captured during electroshocking and minnow trapping ranged in fork length from 39 - 195 mm. The length-frequency data (Figure 4) for the cutthroat measured during this survey show that at least four age classes are present. The FISS database reports a sport fishery for anadromous cutthroat trout in the Mohun Creek estuary. Some of those fish may return to spawn in Coho Creek and their offspring may comprise a portion of the individuals present. Although cutthroat were not captured in the Coho Creek headwaters (Reach 15 and Tributaries 5-8) during this survey, there are no barriers preventing them from utilizing these areas at other times of the year. Therefore, it is assumed that the distribution of cutthroat trout extends to the very upper portions of the drainage.

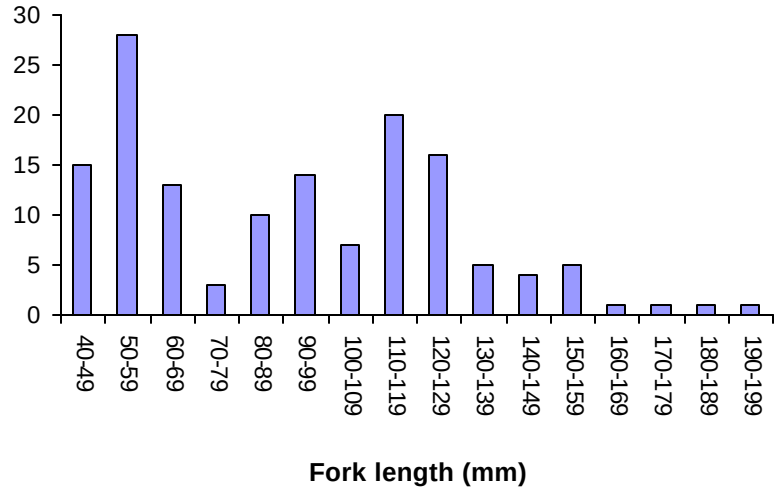

Figure 4. Age-length frequency of the cutthroat trout captured during the field survey of the Coho Creek drainage, August 26 - September 1, 2000.

Rainbow trout were not abundant. Only two trout were positively identified as rainbow trout during this survey (one each in Reaches 4 and 7 of Coho Creek). One 40mm trout captured in Reach 1 of Coho Creek was suspected to be a rainbow trout, but the small size made positive identification difficult. A total of 23 other unidentifiable trout (ranging in size from 42 - 64 mm) were captured in Coho Creek (Reaches 4, 7 and 11), which could be either rainbow or cutthroat fry. Minnow trapping by J. Smith (CRFWA) in

Reach 1 of Coho Creek resulted in the capture of one rainbow trout (approx. 100 mm long) as well. Steelhead trout have been reported in Mohun Creek (FISS). Since there is no barrier blocking fish migration from Mohun Creek into Coho Creek, it is possible that there are rearing juveniles from that population that move into Coho Creek instead of staying in the mainstem. The overall low abundance of this species suggests that there is not a distinct population of resident rainbow trout or steelhead in the Coho Creek drainage.

Threespine stickleback were abundant in the lower portion of the Coho Creek mainstem (downstream of Reach 8) and in Tributary 1. This species is common in the lowland waters of Vancouver Island (MacPhail and Craveth, 1993), such as those found in this drainage. The individuals captured could be a combination of resident and anadromous populations.

Coastrange sculpins were also captured in the mainstem of Coho Creek. Although sculpins were not captured upstream of Reach 9 during this survey, it is assumed that their distribution extends throughout the entire drainage.

Lamprey were captured to the very upper end of Tributary 6, and throughout the Coho Creek mainstem. They are also assumed to be able to access all areas of the drainage.

4.1.3 Fish Habitat Distribution

In general, habitat in the Coho Creek drainage is ideally suited for juvenile fish rearing. The slow-flowing water and low gradient throughout much of the system is especially suitable for rearing coho fry.

Figure 4 shows the locations and approximate amounts of fish habitat present in the Coho Creek drainage. The habitat is broken into three categories, and includes summer / winter rearing habitat (plentiful cover, water present at low flow levels), overwinter habitat (quiet water areas that provide refuge from high water flows) and spawning habitat (appropriate amounts of gravels suitable for spawning). There can be overlap in these habitat types. For example, good spawning habitat also must have rearing areas for the emerging fry. The most dominant habitat type in each location is shown.

Summer / winter rearing is the most abundant habitat type in this system, and accounts for approximately 57% (7.45 km) of the stream. Overwinter habitat comprises approximately 39% (5.05 km), and the remaining 4% (0.37 km) was determined to be the best spawning habitat in the system. Within the habitat designated as summer / winter rearing habitat, some reaches had patches of suitable gravels for anadromous and resident spawning. These included Reaches 10,11 and 12 of Coho Creek (2.06 km), Reaches 2 and 3 of Tributary 2 (0.62 km) and Reach 1 of Tributary 4 (0.12).

4.1.4 Wildlife and other Aquatic Species

A diverse range of organisms was encountered during the field sampling for this project. Freshwater mussels (most likely *Anodonta kennerlyi*) were common in the first 2.5 km of the Coho Creek mainstem, particularly where the substrate was predominantly sand. Crayfish were captured in the minnow traps set in Reach 14 of Coho Creek.

Species of birds observed included Stellar's jays, winter wrens and kingfishers. Evidence of Roosevelt elk use of the habitat surrounding the stream was abundant, including trails, scat, wallows and beds, especially in the wetland habitat in Reaches 2 and 13 of Coho Creek. Deer (Columbian black-tailed) use of the area was also evident through tracks and scat. Black bear tracks were observed in Reach 1 of Coho Creek, and scat was observed in the wetland habitat in Reach 13 of Coho Creek.

Figure 5. The distribution of fish habitat in the Coho Creek drainage.

4.2 Level 1 Fish Habitat Assessment

The data collected during the Level 1 assessments is contained in Appendix III. A summary of the reach averages and totals for some of the habitat attributes measured is found in Table 4. These numbers were calculated using the weighted averages of the values measured for each habitat type within the reach, as described in FHAP. Locations of the Level 1 assessment sites can be found in Figure 6.

Table 4. A summary of the habitat attributes for the five reaches assessed during the Level 1 Habitat Assessment.

Site	1	2	2A	3	4
Total site length (m)	319	175	186	258	120
Total no. of habitat units	14	17	14	14	10
avg. gradient (%)	0.8	0.6	0.5	3.6	1.5
avg. W_b depth (m)	0.74	0.85	0.79	0.57	1.26
avg. water depth (m)	0.34	0.39	0.31	0.11	0.21
avg. W_b width (m)	4.50	4.34	5.72	3.72	5.57
avg. wetted width (m)	2.94	3.59	3.70	2.10	2.81
avg. max pool depth (m)	0.80	0.80	0.63	0.41	0.48
avg. residual pool depth (m)	0.60	0.70	0.55	0.39	0.46
% pools (by area)	13.0	73.0	41.0	3.0	18.5
Pool frequency (no. of W_b between pools)	9.5	4.5	5.3	at least 29.3[1]	4.5
Total LWD/ W_b	0.54*	0.82	2.05	1.45*	6.70 [2]
Large (>50 cm) fxnl LWD/ W_b	0.16	0.00	0.57	0.07	0.6
Medium (20-50 cm) fxnl LWD/ W_b	0.17*	0.28	0.57	0.55*	3.12 [2]
Small (10-20 cm) fxnl LWD/ W_b	0.16	0.54	0.6	0.46	2.05
Boulder cover in riffles (avg. %)	none	None	none	none	none
Overhead (LWD/B/C/OV) cover (avg. %)	13.3	36.9	28.3	40	38.4
Substrate (dominant/subdominant)	sand	Gravel/sand	gravel/sand	cobble/gravel	sand/gravel
Off-channel habitat	1 slough	1 pond	none	none	none
Adult holding pools (>1 m depth)	1	None	none	none	none

*calculations do not include trestle debris counts as the debris was concentrated in one habitat reach.
1 - Only one pool in this site, therefore the next pool is found in the next reach.
2 - calculations include trestle debris counts, as the debris was disbursed throughout the reach.

In order to assess the status (poor, fair or good quality) of the habitat present in the reaches sampled, the values found in Table 4 were compared with standardized values presented in Table 5 in FHAP. The results of this comparison for each site are presented in the following five sections (4.2.1 - 4.2.5). This information, combined with

other observations during the Overview Assessment, has been used to make recommendations for future restoration activities in the Coho Creek drainage.

Three of the diagnostic habitat attributes listed in FHAP (Johnston, N.T. and Slaney, P.A., 1996) are not included in the habitat status tables. These attributes include the total number of adult holding pools (depth > 1m), the presence of redd scour and inorganic nutrient levels.

The small drainage area, channel size and low gradient of this drainage do not preclude the formation of pools that would exceed 1 m in depth. It is likely that the natural maximum depth of pools in this system is less than 1 m. Therefore, the absence of pools with depths greater than 1 m is not a reliable indicator of poor adult migration access for this stream.

Field crews did not do detailed searches for evidence of redd scour. The lack of data for this category does not allow for conclusions on the spawning and incubation quality of these sites.

As water samples were not collected, no data was collected on the present nutrient levels in this stream. Conclusions on the water quality and its impact on summer rearing habitat cannot be made.

4.2.1 Site 1

Site 1 was completed in Reach 2 of Coho Creek. The downstream end of the reach is marked by the double culvert crossing on the Iron River main. Immediately upstream of that crossing the channel has ponded for approximately 15m. Upstream of the pond, the low gradient, 4.5 m wide channel flows through a grassy wetland bordered by a mixed (coniferous and deciduous) young forest. (Photo 1). Approximately 240 m upstream of the double culvert, an old railway grade trestle runs through the channel for 18 m. At least 114 pieces of trestle are present in that section and many of them still standing (Photo 2). At this time, the trestle is not a barrier to the upstream migration of fish.

Photo 1. A downstream view taken in Site 1, from 200 m downstream of the upper reach break.

Photo 2. A downstream view of the railway trestle, most of which is still standing in the channel in Site 1.

Table 5 contains a summary of the assessed habitat values for this reach. With the exception of the trestle debris, large woody debris is scarce in this reach. It appears there is little or no natural recruitment of large woody debris into the channel. This is

likely due to the age of the surrounding forest (61 - 80 years old). Second growth forest, such as that bordering this section, provides a higher proportion of smaller diameter coniferous and deciduous trees than old growth forest. This type of debris degrades more quickly than old growth debris, and therefore has less value as large woody debris (Cederholm et al, in Slaney, P.A. and Zaldokas, D., 1997).

Table 5. The quality (poor/fair/good) of the assessed habitat attributes in Site 1.

Habitat attribute	Importance as fish habitat	Quality
Percent pool (by area)	Summer / winter rearing habitat	Poor
Pool frequency	Summer / winter rearing habitat	Poor
Total LWD / W_b	Summer / winter rearing habitat	Poor
% wood cover in pools	Summer / winter rearing habitat	Fair
Boulder cover in riffles	Summer / winter rearing habitat	Poor
Overhead cover	Summer / winter rearing habitat	Fair
Substrate	Winter rearing habitat	Poor
Off-channel habitat	Winter rearing habitat	Poor
Access to upstream spawning areas	Adult migration	Good
Gravel quantity	Spawning and incubation	Poor
Gravel quality	Spawning and incubation	poor

The lack of large woody debris may help explain the scarcity of deep pools. Most of the pools that are present are lateral scour pools located in the bends in this meandering channel, and are not associated with large woody debris.

The habitat in the pond upstream of the culvert crossing was not assessed during this survey. As it is pond habitat, it falls into the "other" habitat unit category, along with the section obscured by trestle debris. This reach was surveyed working downstream from the upper reach break, and the pond was the second "other" habitat unit encountered. Following the sampling strategy of sampling every second habitat unit for each category, this meant that the pond did not qualify for sampling. Also, the large "channel" size, deep water and very soft substrate made habitat measurements very difficult. However, this pond is providing an area of deep pools that are suitable for use as summer and winter rearing habitat for juvenile fish and holding areas for adult salmon. The presence of the pond would increase the overall habitat quality of this reach.

4.2.2 Site 2

Site 2 is located in Reach 8 of Coho Creek (Figure 6). During the Overview Assessment, this reach was identified as a potential spawning area. Past beaver activity

in this stream has resulted in a series of meadow areas that formed in old beaver pond areas that have re-channelized. Reach 8 flows through one of the grassy shrub meadows sections.

Photo 3. A downstream view into the spawning habitat present in Site 2, taken from the break between Reaches 8 and 9.

In general, overhead cover was good due to the large amount of vegetation overhanging the channel (Table 6). The amount of large woody debris and boulder cover was low in this reach. The abundant pools in this reach were long, deep lateral scour pools associated with the channel bends.

Table 6. The quality (poor/fair/good) of the assessed habitat attributes in Site 2.

Habitat attribute	Importance as fish habitat	Quality
Percent pool (by area)	Summer / winter rearing habitat	Good
Pool frequency	Summer / winter rearing habitat	Poor
Total LWD / W_b	Summer / winter rearing habitat	Poor
% wood cover in pools	Summer / winter rearing habitat	Poor
Boulder cover in riffles	Summer / winter rearing habitat	Poor
Overhead cover	Summer / winter rearing habitat	Good
Substrate	Winter rearing habitat	Fair
Off-channel habitat	Winter rearing habitat	Poor
Access to upstream spawning areas	Adult migration	Good
Gravel quantity	Spawning and incubation	Good
Gravel quality	Spawning and incubation	Fair

Gravel in this reach was of sufficient size and quantity to be considered suitable for anadromous (patches 1 - 2 m^2 in area, with particles ranging from 10 - 150 mm) and

resident (patches at least 0.1 m^2 in area, with particles ranging from 10 - 75 mm) spawning. The subdominant substrate type was determined to be sands, which lowers the gravel quality rating from good to fair. Overall, the spawning habitat in this reach could be used by anadromous species (such as coho salmon), but was more suitable for cutthroat trout as the more of the gravels present were within the smaller size range (10 - 75 mm).

4.2.3 Site 2A

Site 2A was located in Reach 9 of Coho Creek. It was determined that this reach contained spawning habitat during the Overview Assessment. The main difference between this reach and Reach 8 is in the riparian vegetation. In Reach 8, the riparian vegetation is grass and shrubs, while in Reach 9 it is mainly young (21 - 40 years old), deciduous forest.

Table 7. The quality (poor/fair/good) of the assessed habitat attributes in Site 2A.

Habitat attribute	Importance as fish habitat	Quality
Percent pool (by area)	Summer / winter rearing habitat	Fair
Pool frequency	Summer / winter rearing habitat	Poor
Total LWD / W_b	Summer / winter rearing habitat	Good
% wood cover in pools	Summer / winter rearing habitat	Fair
Boulder cover in riffles	Summer / winter rearing habitat	Poor
Overhead cover	Summer / winter rearing habitat	Good
Substrate	Winter rearing habitat	Fair
Off-channel habitat	Winter rearing habitat	Poor
Access to upstream spawning areas	Adult migration	Good
Gravel quantity	Spawning and incubation	Good
Gravel quality	Spawning and incubation	Fair

This site was the only reach assessed on Coho Creek where the amount of total large woody debris present was considered good for summer and winter rearing (Table 7). Overhead cover was also good. Pools were not as common in this reach, but still accounted for 41% of the total area of the reach. As in Reach 8, gravels suitable for anadromous and resident spawning were present, but the presence of fines reduced their quality rating to fair. Overall, this reach contained the best combination of rearing and spawning areas of the three Coho Creek reaches that were assessed.

4.2.4 Site 3

Site 3 is located in Reach 3 of Tributary 2. Tributary 2 drains into Reach 8 of Coho Creek, and is accessible to all species of fish present in the mainstem. A collapsed railway trestle in Reach 3 led to the selection of this reach for further assessment.

Downstream of this reach, the stream contains rearing habitat for juvenile fish, and occasional sections of spawning gravels. A large wetland forms the headwaters of this tributary. When surveyed for this project (August 2000), the wetland was dry. At times of high flow levels, this wetland could be providing overwinter habitat for juvenile fish from the lower reaches and possibly Coho Creek.

Table 8. The quality (poor/fair/good) of the assessed habitat attributes in Site 3.

Habitat attribute	Importance as fish habitat	Quality
Percent pool (by area)	Summer / winter rearing habitat	Poor
Pool frequency	Summer / winter rearing habitat	Poor
Total LWD / W_b	Summer / winter rearing habitat	Fair
% wood cover in pools	Summer / winter rearing habitat	Fair
Boulder cover in riffles	Summer / winter rearing habitat	Poor
Overhead cover	Summer / winter rearing habitat	Good
Substrate	Winter rearing habitat	Fair
Off-channel habitat	Winter rearing habitat	Poor
Access to upstream spawning areas	Adult migration	Fair
Gravel quantity	Spawning and incubation	Fair
Gravel quality	Spawning and incubation	Fair

The habitat in this reach lacked the complexity that is desired for good fish habitat (Table 8). Although this reach has a cascade-pool morphology, pools accounted for only 3% of the total area. This is far below what is considered good (>40%) for a stream of this size and gradient (W_b = 3.72, 3.6 % avg. gradient). The substrate at the upstream end of the reach was coarser than the substrate at the downstream end of the reach, but patches of fines were present throughout the reach. Cover was primarily provided by overhanging vegetation, with smaller amounts from cutbanks, boulders and large woody debris.

Trestle debris is concentrated in a 16 m section of this reach. The "fair" rating for large woody debris presence for this reach is due to trees falling into the channel from the adjacent deciduous forest (41 - 80 years old) on the v-shaped side slopes. Again, the quality of the natural large woody debris present is low because it consists of smaller and more quickly degraded trees.

The trestle debris itself does not appear to be blocking fish passage at this time, as the channel flows underneath the debris jam. However, sediment deposits upstream of the jam are causing the flow to be intermittent above the debris, and may be affecting fish access to the wetland area in Reach 5 of this stream.

Photo 4. An upstream view from the downstream end of Site 3. Note the lack of pool areas and low water flow.

Photo 5. An upstream view at the downstream end of the collapsed trestle. The channel flows underneath the debris.

4.2.5 Site 4

Site 4 was located in Reach 1 of Tributary 4. Only the lower 580 m of this stream was surveyed. Permission to access the upstream portion of this stream was not

obtained for this project. A collapsed railway trestle is located in the first reach, and led to further assessment of this reach.

Table 9. The quality (poor/fair/good) of the assessed habitat attributes in Site 4.

Habitat attribute	Importance as fish habitat	Quality
Percent pool (by area)	Summer / winter rearing habitat	Poor
Pool frequency	Summer / winter rearing habitat	Poor
Total LWD / W_b	Summer / winter rearing habitat	Good
% wood cover in pools	Summer / winter rearing habitat	Fair
Boulder cover in riffles	Summer / winter rearing habitat	Poor
Overhead cover	Summer / winter rearing habitat	Good
Substrate	Winter rearing habitat	Poor
Off-channel habitat	Winter rearing habitat	Poor
Access to upstream spawning areas	Adult migration	Fair
Gravel quantity	Spawning and incubation	Fair
Gravel quality	Spawning and incubation	Poor

Habitat disturbance in this site was evident by the lack of habitat complexity, similar to that found in Site 3. Other disturbance indicators observed included eroded banks, elevated mid-channel bars and the orientation of much of the large woody debris parallel to the banks. Sediment deposition is responsible for the infilling of possible pool areas in much of the site.

Trestle debris was distributed throughout this reach, downstream of where it had collapsed into the channel (Photo 7). The dispersal of the debris results in an overall ranking of good for the large woody debris presence. As in Site 3, the riparian vegetation consists of a young deciduous forest (41 - 60 years old) on steep side slopes. This suggests that the natural large woody debris amount would be similar to that found in Site 3. Large woody debris is the dominant overhead cover type, with some overhanging vegetation and very little boulder cover.

Access to upstream areas is not blocked by the trestle debris. The low surface flow would have more impact on upstream migration and the survival of rearing juveniles.

Photo 6. An upstream view of a cascade in Site 4, taken 35 m upstream of the confluence with Coho Creek. There is little water flow at this point.

Photo 7. An upstream view of the channel where the railway trestle has collapsed.

Figure 6. The location of the Level 1 Habitat Assessment sites and recommended restoration activities.

4.3 Future Restoration and Enhancement Recommendations

The sections below discuss specific recommendations for future restoration and enhancement projects. The reaches surveyed during the Level 1 Habitat Assessments are discussed in Sections 4.3.2 - 4.3.6. The map in Figure 6 shows the locations of the suggested restoration activities. The final section (4.3.8 Suggested Timeline for Restoration Activities) presents a suggested timeline (in the form of a five-year plan) for the implementation of these activities.

4.3.1 Status of the coho salmon population

The target species identified for this drainage is coho salmon. The widespread distribution and presence of several age classes of cutthroat trout suggests that this species has established itself within the drainage. Restoration activities should be focused on improving habitat conditions for coho salmon to maximize the output of juvenile coho from this system. However, the activities suggested will positively effect all species present.

Overall, the habitat in this drainage was of moderate quality. Past disturbances, such as railway trestle crossings, road crossings, logging and beaver activity have impacted the channel in areas. It appears that, left alone, the stream has restored itself adequately to support a healthy population of cutthroat trout and provide rearing habitat for stocked coho salmon. There is still room for improvement, especially with respect to the coho salmon population in the stream.

At this time, it has not been confirmed that adult coho are returning to spawn in Coho Creek. It is critical that this be studied further so that the full impact of any restoration activities can be assessed. There are three ways that it can be determined that adult coho are returning to Coho Creek.

The most obvious method of determining adult fish presence is to observe adult fish in the stream when they return to spawn. Fish may be spotted while migrating to spawning areas, in the act of spawning or as carcasses once they have completed spawning. Observations for any of these stages may be difficult if the number of returning fish is very low, as is possible for a stream the size of Coho Creek. Therefore, the results of this method may not be entirely conclusive if no adults are observed. The

FISS database reports that adult coho return to Mohun Creek in the last two weeks of October. This timeframe could be used to time stream walks on Coho Creek.

An assessment of the juvenile population could help confirm that adults are returning. At this time, it is not possible to distinguish stocked coho fry from "wild" coho fry. The hatchery fry could be "marked" (by clipping the adipose fin or injected pigments) prior to their release in Coho Creek. Then, capturing juvenile coho and tallying up the number of "marked" fry and unmarked fry would provide a rough estimate of the ratio of stocked to "wild" fry. If no unmarked fry are present, this suggests that there is no coho spawning directly in Coho Creek. The main problem with this type of survey is the possibility of not catching unmarked fry if their relative abundance is low. Intensive sampling, targeting multiple sample areas would be required. Using two sample methods (electrofishing and minnow trapping) may also be desirable.

The final method for assessing if coho are returning to Coho Creek would require sampling for young-of-the-year coho in June or July, prior to stocking. If young-of-the-year are present when sampling in early summer, this indicates that spawning has occurred within the drainage. This is the least costly and least labor intensive method. Again, intensive sampling would be required to confirm that young-of-the-year were not present, not just low in abundance.

4.3.2 Site 1

The railway trestle crossing in this section of Coho Creek is a major concern at this time. The large amount of debris present in the 18 m section of stream impacted by the crossing could potentially become a barrier to the upstream migration of fish as it continues to collapse into the channel. This is particularly critical as all the potential spawning areas in this system are located upstream of this crossing. If coho salmon are returning to spawn in Coho Creek, blocking access to the spawning areas would be extremely detrimental. It is recommended that the trestle be dismantled and removed from the channel. This would be a fairly simple exercise, and would involve cutting the debris into suitable size pieces using a chainsaw and removing them by hand from the stream. Care would have to be taken to ensure a minimum disruption to the channel as the work was conducted.

The frequency of large woody debris (LWD) in this reach is below what is considered ideal for fish habitat. Large woody debris is important is small streams for trapping sediments, providing cover for adult and juvenile salmonids, trapping other debris as it travels downstream and causing channel bed scour to form pools. Many studies have shown that the yield of coho smolts from a stream increases significantly after large woody debris enhancement (Cedarholm et al, in Slaney, P.A. and Zaldokas, D., 1997).

A large amount of debris will be available during the trestle removal. This material could be placed back into the channel throughout the reach to improve the frequency of large woody debris in this reach. If this approach is to be used, the size of the debris pieces should be considered prior to the dismantling of the trestle. Other materials that could be used would include natural blow-downs from the adjacent area and small root wads. While some single pieces of debris can be used (will encourage pool scour, provide cover and dissipate water velocity), more complex structures using several pieces (will provide cover, promote pool scour, dissipate water velocity and capture debris coming downstream) should also be constructed. Using debris already in the area would reduce the potential costs of materials for this type of project. However, small root wads would probably have to be flown in by helicopter.

The removal of the trestle debris is a high priority for this stream. Large woody debris placement is a moderate priority activity.

4.3.3 Site 2

This reach contained the first occurrence of spawning gravels in Coho Creek. The quality of the habitat in this reach is reduced by the presence of fines in the substrate and the reduced frequency of pools. Therefore, habitat in this reach could also be improved by the placement of large woody debris. Increasing the frequency of large woody debris structures would increase the number of pools. Also, as the large woody debris reduces the velocity of the water in that area, it would result in a separation of the substrate types present. This should improve the quality of the gravel present in the reach by separating some of it from the fines.

Large woody debris placement in this reach is a moderate priority activity for this drainage.

4.3.4 Site 2A

Overall, the quality of the habitat in this reach was satisfactory. At this time, no recommendations are made for improvements. If large woody debris placement is found to be beneficial in Site 2, it could be considered in the future for this reach as well to increase the frequency of pools and improve the gravel quality.

4.3.5 Site 3

The presence of railway trestle debris in this reach is impacting the stream channel. Removal of this debris and re-distributing it within the channel would be beneficial. Regular flow needs to be restored, so that access to the upstream areas, which provide overwinter habitat, is not impeded. The placement of large woody debris as discussed above (4.3.1) at spaced intervals would retain the cover value of the debris, promote a natural distribution of sediments, promote pool formation and increase the average stream depth. Again, using the debris present would keep projects costs to a minimum.

The re-distribution of the trestle debris to improve fish passage and improve large woody debris frequency is a moderate priority activity in this drainage.

4.3.6 Site 4

Recommendations for improving habitat in Reach 1 of Tributary 4 includes restoring natural flow patterns and removing and redistributing the railway trestle debris in the channel. Obviously, the trestle debris in the channel is impacting the habitat present, and the recommendations made for Site 3 could apply to this reach as well. A large amount of important information is missing for this stream for the upper section that was not surveyed and for which historical data does not exist. It is suspected that natural flow levels have been altered in this tributary, and possibly the Coho Creek drainage as a whole. Depending on the severity of this action, it could be influencing fish migration patterns and affecting habitat quality in the tributary and Coho Creek mainstem downstream of this point. Therefore, prior to doing any work on this tributary, the current status of the unsurveyed section of this tributary needs to be determined. Once this information is made available, better recommendations can be made regarding potential restoration opportunities.

At this time, this tributary is considered a moderate priority for restoration activities due to the incomplete information available. Obtaining the missing information on this stream is however, considered very important for assessing the overall health of the Coho Creek drainage and being able to make further recommendations.

4.3.7 Lower Iron River Main culverts

In 1989, the double culvert crossing on the lower Iron River main was improved by the Campbell River Fish and Wildlife Association. Fish passage past this crossing had previously been restricted. A minor improvement to these culverts would result in the best possible fish access. Currently, the bottom of the culverts is above the level of the water. The water that is being funneled through the culvert has to drop to the surface of the pool. At high flow levels, the force of the water shooting out of the culvert would effectively create an obstacle for fish. Raising the level of the water surface to drown out the lip of the culvert can be accomplished by adding rip-rap to the top of the riffle immediately downstream. Doing this would ensure that the level of the water entering the culvert is the same as the level as it leaves the culvert, thereby eliminating the potential velocity barrier. Raising up the level of the top of the riffle that restrains the pool may cause too much increase in the gradient at that point. Therefore, it may be necessary to lengthen the cascade section downstream to reduce the overall gradient.

4.3.8 Suggested Timeline for Restoration Activities

The timeframe for completing the recommended restoration activities will depend on the availability of funding, manpower (paid and volunteer) and interest in completing the work by all the parties (property owners, forest companies and government agencies) involved. As well, instream work can only be completed with permission and within the accepted work windows. The following timeline is therefore presented as an example of how to proceed with the restoration work, and need not be considered the only option.

Year 1

1. Request that hatchery stocking not occur until after sampling for coho young-of-the-year can be conducted. Do sampling in late June or July to confirm presence or absence of young-of-the-year to confirm that adult coho are returning to spawn.
2. Conduct smolt counts in Reach 1 of Coho Creek (would require a smolt fence) to assess the number of juvenile fish leaving Coho Creek

drainage in spring and early summer. This information will be useful for determining the success of any restoration activities.

3. Remove railway trestle debris in Reach 2 of Coho Creek, and redistribute with other large woody debris materials throughout reach to improve large woody debris abundance and distribution in this reach. (requires further project planning)
4. Complete improvements to the Iron River Main culvert crossing.
5. Attempt to obtain the missing information for Tributary 4. Further planning for restoration in this stream can be completed, if necessary once this information is available.

Year 2

1. Conduct smolt counts in Reach 1 of Coho Creek (would require a smolt fence) to assess the number of juvenile fish leaving Coho Creek drainage in spring and early summer. This information will be useful for determining the success of any restoration activities.
2. Remove and re-distribute railway trestle debris in Reach 3 of Tributary 2 to improve large woody debris abundance and distribution in this reach. (requires further project planning)
3. Do large woody debris placements in Reach 8 of Coho Creek to improve large woody debris abundance and distribution in this reach. (requires project planning and implementation) It may be possible to use left-over debris from the dismantled trestle in Reach 2 of Coho Creek or Reach 3 of Tributary 2.
4. Attempt to obtain the missing information for Tributary 4. Further planning for restoration in this stream can be completed, if necessary once this information is available.

Year 3

1. Conduct smolt counts in Reach 1 of Coho Creek (would require a smolt fence) to assess the number of juvenile fish leaving Coho Creek drainage in spring and early summer. This information will be useful for determining the success of any restoration activities.
2. If possible, plan and complete restoration activities for Tributary 4.
3. Assess the success of the completed large woody debris placement in Reach 8 of Coho Creek (i.e. confirm that structures are stable and functioning as intended). Use this information to determine if large woody debris placement would be beneficial in Reach 9 of Coho Creek.

Years 4 and 5

1. Continue to conduct smolt counts in Reach 1 to monitor the productivity of the system.
2. Assess the stability and effectiveness of the large woody debris placement in Reaches 2, 8 and 9 of Coho Creek, Reach 3 of Tributary 2 and Reach 1 of Tributary 4 (if completed). Make improvements if required.

5.0 Conclusions

Based on the results of the fish sampling and existing information, it can be concluded that the target species for this drainage is coho salmon. The population of cutthroat trout in the system appears to be healthy and self-supporting, as evidenced by their widespread distribution and presence of at least four age classes. Other species present in the drainage include a small population of rainbow trout, threespine stickleback, coastrange sculpins and lamprey.

No barriers to fish migration are present in the Coho Creek mainstem or tributaries. Fish distribution is mainly limited by water flow levels at different times of the year. Coho salmon were present to Reach 12 of Coho Creek during this survey and were reported in Reach 14 in 1999. Cutthroat trout were captured to Reach 14 of Coho Creek. The distribution of all species present is assumed to include the entire length of Coho Creek and all tributaries due to the lack of barriers.

Three types of fish habitat were identified in the Coho Creek drainage. The most abundant habitat is summer / winter rearing habitat which accounts for approximately 57% of the habitat present. Overwinter habitat that would provide refuge for rearing fish at high water levels accounts for approximately 39% of the habitat available. A small portion of the drainage (4%) contains moderate quality spawning habitat. This spawning habitat is most suited for cutthroat trout at this time, but could also be used by coho salmon.

The results of the Level 1 Habitat Assessments indicated that overall, the amount of large woody debris present in the Coho Creek mainstem and two main tributaries is lower than desired for fish habitat. This has resulted in a reduced amount of pool areas and the substrate composition being relatively homogenous within a reach. Increasing the amount of large woody debris within the channel will promote pool scour, increase overall average stream depth, increase cover for rearing juvenile fish and migrating adults and encourage the separation of substrate types to improve the quality of gravel for spawning.

Habitat damage has occurred where railway trestle crossings have collapsed into the channel in Reach 3 of Tributary 2 and Reach 1 of Tributary 4. Debris jams have

formed and sediment deposition upstream of the jams is causing some sub-surface flow. This debris could be re-distributed throughout the channel during the large woody debris placement to reduce the amount of material that has to be brought in and reduce the overall costs of these projects.

A railway trestle crossing is mostly still standing in Reach 2 of Coho Creek. At this time the structure is having little impact on the fish habitat. If the structure were to collapse into the channel, it could form a debris jam that will block fish migration and/or effect the flow of the channel. Removing this structure and using the debris for large woody debris placement is highly recommended.

Enhancement in the form of coho fry stocking is already taking place in Coho Creek. It is important to ensure that suitable habitat exists for this species to reproduce and rear in, and that passage to those areas is not impeded by obstacles or insufficient holding areas. The ultimate goal of any further restoration or enhancement activities in this drainage should be to promote the establishment of a self-supported population of coho salmon so that further stocking becomes unnecessary. If it is not possible to establish adult coho spawning in this system, the drainage could still be restored and maintained as a natural "nursery" system for stocked hatchery fry.

6.0 References

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Appendix I

WRP Form 1 (modified)
Overview Assessment - Fish Distribution Summary

					Size (mm) range (N) or sample result						
Stream	**Reach**	**Data Source**	**Method**	**Effort**	**CO**	**RB**	**CT**	**TR**	**TSB**	**CAL**	**L**
Coho	1	field survey	EF	34m for 150 s	45-75 (12)			40 (1)		55-75 (2)	
Coho	1	J.Smith diary	MT	1 trap for 1 hr	8 fry caught	1 caught	1 caught		1 caught	1 caught	
Coho	2	J.Smith diary	MT	1 trap for 1 hr	5 fry caught				6-8 caught		
Coho	2	J.Smith diary	MT	4 traps	2 fry caught				35+ caught		
Coho	3	field survey	VO					present			
Coho	4	field survey	EF	38m for 219 s	66-73 (2)	60 (1)	53-155 (7)	43-59 (13)	46-63 (6)	94-120 (2)	5 caught
Coho	7	field survey	EF	41m for 149 s	60-65 (4)	64 (1)	57-117 (5)	43-64 (5)	46-49 (2)		1 caught
Coho	8	field survey	EF	13m for 20 s	52 (1)		180 (1)				
Coho	9	field survey	EF	5m for 31 s	52-70 (6)		120 (1)			90 (1)	
Coho	10	field survey	VO					present			
Coho	11	field survey	EF	30m for 153s	90-91 (3)		47-135 (15)	42-61(5)			
Coho	11	field survey	EF	80m for 78s	62-80 (4)		39-170 (15)				
Coho	12	field survey	EF	630m for 293s	84-95 (5)		50-165 (10)				
Coho	13	field survey	EF	63m for 282 s			48-113(3)				120-150 (2)
Coho	14	field survey	EF	15m for 180s			35-122 (6)				
Coho	14	field survey	MT	8 traps for 22 hrs			60-147 (15)				
Coho	14	Fishfor report	EF		32 fry caught		17 caught				
Trib 1	1	field survey	EF	11m for 41s					22-39 (4)		
Trib 1	1	field survey	MT	4 traps for 17 hrs					35-50 (127)		
Trib 2	1	field survey	EF	9m for 48s	55 (1)		45-88(3)				
Trib 2	2	field survey	EF	8m for 134s	65-76 (3)		47-195 (9)				
Trib 2	2	M. Lough map					captured (number unknown)				
Trib 2	3	field survey	EF	31m for 75s			44-128 (14)				

WRP Form 1 (modified) - concluded

					Size (mm) range (N) or sample result						
Stream	**Reach**	**Data Source**	**Method**	**Effort**	**CO**	**RB**	**CT**	**TR**	**TSB**	**CAL**	**L**
Trib 2	3	field survey	EF	18m for 36s			42-95 (6)				
Trib 2	3	field survey	EF	37m			47-125 (5)				
Trib 2	4	field survey	EF	4m			48-75 (5)				
Trib 3	1	field survey	EF	84m for 94 s			64-90(3)				
Trib 4	1	field survey	EF	10m for 62s			105-125 (2)	45-65 (27)			
Trib 4	2	field survey	EF	40m for 192s			40-127 (33)				1 caught
Trib 6	1	field survey	EF								4 caught

Note: Trout species, sticklebacks, lamprey and sculpins were not identified as juveniles or adults as it is often difficult to determine during a brief visual inspection. All coho captured are juveniles and no adults were observed.

EF = backpack electrofisher CO = coho salmon TSB = threespine stickleback L = lamprey

MT = Gee minnow traps RB = rainbow trout CAL = coastrange sculpin

Appendix II

WRP Form 2 (modified)
Overview Assessment - Habitat Condition Summary Form

Stream	Reach	Length (km)	Field Gradient (%)	W_b (m)	Channel type	Substrate (dom/sub dom)	Dominant cover types	Impacts	Comments
Coho	1	0.30	1.0	6.67	RP	S/G	LWD/OV/C	culvert at upstream end	
Coho	2	0.32	0.8	4.50	RP	S	LWD/OV	railway trestle crossing	
Coho	3	0.81	0.5	7.70	RP	G/S	C/OV		
Coho	4	0.22	0.5	3.00	RP	S/G	DP/OV/C		
Coho	5	0.24	2.0	6.90	RP	S/G	OV/LWD		
Coho	6	0.28			pond			beaver dams	
Coho	7	0.10	0.5		RP	G/S	LWD/C/OV		
Coho	8	0.18	0.6	4.34	RP	G/S	OV/C/DP		spawning area
Coho	9	0.19	0.5	5.72	RP	G/S	OV/LWD		spawning area
Coho	10	0.26	9.0		CP	C/B			
Coho	11	1.14	5.3		CP	C/G	OV/C/B	old man-made dam	dam at swimming hole, not blocking flow now
Coho	12	0.66	2.7	3.30	CP	C/F	OV		
Coho	13	0.54	0.5	2.50	wetland	S	IV		barely defined channel through swamp
Coho	14	1.08			RP	S	OV	2 culvert crossings	
Coho	15	1.28	0.5	14.50	RP	S	IV/OV		
Trib 1	1	0.44	0.5	1.00	ponds	S		beaver dams / railway trestle crossing	
Trib 2	1	0.44	2.0	4.20	RP	G/S	C/OV		
Trib 2	2	0.36	2.5	2.90	CP	C/G	LWD/OV		
Trib 2	3	0.26	3.5	3.98	CP	C/S	LWD/OV	railway trestle crossing	
Trib 2	4	0.15	1.0	2.70	RP	G/C			water intermittent
Trib 2	5	1.06			wetland				
Trib 3	1	0.32	13.0	2.20	CP	C/G	OV		

WRP Form 2 (modified) - concluded

Stream	Reach	Length (km)	Field Gradient (%)	W_b (m)	Channel type	Substrate (dom/sub dom)	Dominant cover types	Impacts	Comments
Trib 3	2	0.10	27.0	1.40	SP	C/G	OV		very low water
Trib 4	1	0.12	1.5	5.57	CP	G/S	OV/LWD	railway trestle crossing	potential spawning area
Trib 4	2	UN	1.5		RP				water intermittent
Trib 5	1	0.76							barely defined channel at upper road crossing
Trib 6	1	0.44	6.5	0.54	RP	S	OV/IV	man-made dam at road crossing	
Trib 7	1	0.44							
Trib 8	1	0.48							

Appendix III

WRP Form 4 (modified)
Level 1 - Habitat Survey Data Forms

Date: August 31, 2000 Crew:MS/LS Weather: slight cloud
Subsampling fractions: 1/2 for all habitat strata Discharge: 0.14 m/s
Site # 1 (Reach 2 of Coho Creek mainstem)

Distance (m) from start	0	18	50	61	79	120	140	190
Habitat unit - type	G	R	P	G	O	G	P	G
Length (m)	18.0	18.0	11.0	18.0	17.0	20.0	10.0	85.0
Gradient (%)	0.5	1.0	0.5	1.0	3.5	0.5	0.5	0.5
mean Bankfull depth (m)	0.72	0.70	1.01	0.78	0.73	0.74	1.08	0.52
mean Water depth (m)	0.17	0.09	0.47	0.23	0.20	0.50	0.74	0.24
mean Bankfull width (m)	7.86	4.78	4.53	4.14	3.80	3.70	4.41	2.24
mean Wetted width (m)	4.22	2.94	3.49	2.48	2.00	3.34	4.06	1.98
Maximum depth (m)	-	-	0.59	-	-	-	1.01	-
Crest depth (m)	-	-	0.18	-	-	-	0.28	-
Residual depth (m)	-	-	0.41	-	-	-	0.73	-
Pool type (scour/dammed)	-	-	S	-	-	-	S	-
Dominant	S	S	S	S	S	S	S	S
Sub-dominant	-	-	-	-	-	-	-	-
Spawning gravel type	-	-	-	-	-	-	-	-
Spawning gravel amount	N	N	N	N	N	N	N	N
Total LWD tally	2	3	3	8	144	1	0	4
10-20 cm	-	2	-	-	2	1	-	1
20-50 cm	2	-	-	2	92	-	-	3
>50 cm	-	1	2	3	-	-	-	-
Cover type (%)	LWD (5)	OV (1)	LWD (20)	LWD (20)	LWD (50)	OV (5)	DP (20)	OV (10)
Cover type (%)	-	-	OV (5)	OV (30)	OV (25)	C (1)	0V (5)	-
Type	-	-	-	-	-	-	-	SL
access	-	-	-	-	-	-	-	P
Length (m)	-	-	-	-	-	-	-	4
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-
Type	M	M	D	D	D	S	S	M
Structure	YF	YF	YF	YF	YF	S	S	YF
Canopy Closure (code)	2	2	1	1	1	1	1	1
Comments					This section runs under the railway trestle, most of which is still standing but is beginning to collapse.	Riparian vegetation is wetland type plants.	Riparian vegetation is wetland type plants.	

Date: August 30, 2000 Crew:MS/LS Weather: overcast
Subsampling fractions: 1/2 for all habitat strata Discharge: 0.3 m/s
Site # 2 (Reach 8 of Coho Creek mainstem)

	Distance (m) from start	0	15	33	55	83	94	129	135	162
	Habitat unit - type	P	R	P	R	P	R	G	P	R
	Length (m)	15.0	3.5	22.0	7.0	11.0	21.0	6.0	5.0	13.0
	Gradient (%)	0.5	0.0	0.0	1.5	0.5	1.0	0.5	0.5	1.0
	mean Bankfull depth (m)	1.08	0.48	1.10	0.66	1.21	0.43	0.83	1.12	0.61
	mean Water depth (m)	0.69	0.10	0.70	0.15	0.61	0.14	0.22	0.60	0.15
	mean Bankfull width (m)	6.33	3.59	3.94	3.33	4.86	2.35	4.53	5.75	3.88
	mean Wetted width (m)	5.92	3.59	3.60	2.31	3.81	2.05	2.11	5.05	3.45
Pools only	Maximum depth (m)	0.99	-	0.88	-	0.71	-	-	0.70	-
Pools only	Crest depth (m)	0.09	-	0.09	-	0.18	-	-	0.13	-
Pools only	Residual depth (m)	0.90	-	0.79	-	0.53	-	-	0.57	-
Pools only	Pool type (scour/dammed)	S	-	S	-	S	-	-	S	-
Bed materia	Dominant	S	G	G	G	S	G	G	S	G
Bed materia	Sub-dominant	G	S	S	S	G	S	S	G	S
Bed materia	Spawning gravel type	AR	AR	AR	AR	AR	AR	AR	AR	AR
Bed materia	Spawning gravel amount	IP	H	IP	H	IP	H	H	IP	H
	Total LWD tally	2	0	0	2	3	0	2	0	9
functional LWD tally	10-20 cm	-	-	-	2	1	-	1	-	7
functional LWD tally	20-50 cm	2	-	-	-	-	-	1	-	2
functional LWD tally	>50 cm	-	-	-	-	-	-	-	-	-
	Cover type (%)	OV (20)	OV (30)	OV (25)	OV (60)	OV (35)	OV (50)	OV (20)	OV (30)	OV (15
	Cover type (%)	C (10)	-	C (5)	-	DP (20)	-	C (5)	C (15)	C (15)
off channel habitat	Type	-	-	PD	-	-	-	-	-	-
off channel habitat	access	-	-	P	-	-	-	-	-	-
off channel habitat	Length (m)	-	-	4	-	-	-	-	-	-
Dist Ind Present	1	-	-	-	-	-	-	-	-	-
Dist Ind Present	2	-	-	-	-	-	-	-	-	-
Dist Ind Present	3	-	-	-	-	-	-	-	-	-
Riparian Veg.	Type	S	S	S	S	S	S	S	S	D
Riparian Veg.	Structure	S	S	S	S	S	S	S	S	YF
Riparian Veg.	Canopy Closure (code)	1	1	1	1	1	1	1	1	1
	Comments	left bank is wetland vegetation		1m riffle section within this unit.					Tributary 1 joins Coho Creek in this habitat unit.	

Date: August 30, 2000 Crew:MS/LS Weather: overcast
Subsampling fractions: 1/2 for all habitat strata Discharge: 0.3 m/s
Site # 2A (Reach 9 of Coho Creek mainstem)

	Distance (m) from start	27	59	68	105	131	139
	Habitat unit - type	P	G	R	P	R	G
	Length (m)	5.0	9.0	4.0	23.0	3.0	11.0
	Gradient (%)	0.5	0.0	1.0	0.5	1.5	0.5
	mean Bankfull depth (m)	0.66	0.97	0.69	1.06	0.71	0.64
	mean Water depth (m)	0.34	0.24	0.11	0.70	0.18	0.21
	mean Bankfull width (m)	5.94	4.50	5.40	7.26	6.96	3.61
	mean Wetted width (m)	5.83	2.10	4.67	5.23	1.41	2.39
Pools only	Maximum depth (m)	0.46	-	-	0.79	-	-
	Crest depth (m)	0.08	-	-	0.08	-	-
	Residual depth (m)	0.38	-	-	0.71	-	-
	Pool type (scour/dammed)	S	-	-	S	-	-
Bed materia	Dominant	G	G	G	S	G	S
	Sub-dominant	S	S	S	-	S	G
	Spawning gravel type	AR	AR	AR	-	AR	AR
	Spawning gravel amount	H	H	H	N	H	IP
	Total LWD tally	7	0	3	9	2	7
functional LWD tally	10-20 cm	3	-	3	1	-	1
	20-50 cm	3	-	-	1	1	3
	>50 cm	1	-	-	3	1	3
	Cover type (%)	OV (5)	OV (60)	OV (1)	LWD (50)	OV (2)	OV (5)
	Cover type (%)	LWD (2)	C (30)	LWD (1)	OV (20)	-	C (2)
channel habitat	Type	-	-	-	-	-	-
	access	-	-	-	-	-	-
	Length (m)	-	-	-	-	-	-
Dist Ind Present	1	-	-	-	-	EB	-
	2	-	-	-	-	-	-
	3	-	-	-	-	-	-
Riparian Veg.	Type	D	D	D	D	D	D
	Structure	PS	YF	YF	YF	YF	YF
	Canopy Closure (code)	1	1	1	2	2	2
	Comments		substrate is coarser, more suitable for anadromous fish.	good anadromous spawning gravel	LWD jam over pool, not a barrier. This habitat unit is a combination of 3 pools with one 70 cm riffle.		

Subsampling fractions: 1/2 for all habitat strata Discharge: 0.16 m/s
Site # 3 (Reach 3 of Tributary 2)

	Distance (m) from start	0	39	45	60	83	105	162	169
	Habitat unit - type	C	G	R	P	C	O	G	C
	Length (m)	39.0	6.0	15.0	5.0	22.0	16.0	7.0	45.0
	Gradient (%)	5.5	3.5	4.5	0.5	4.0	5.5	0.5	4.0
	mean Bankfull depth (m)	0.41	0.68	0.70	0.86	0.50	0.62	0.73	0.20
	mean Water depth (m)	0.02	0.14	0.05	0.30	0.08	0.16	0.20	0.07
	mean Bankfull width (m)	3.11	3.84	3.51	5.86	3.77	5.64	3.13	2.94
	mean Wetted width (m)	2.87	2.66	1.11	4.26	1.62	1.18	1.84	1.90
Pools only	Maximum depth (m)	-	-	-	0.41	-	-	-	-
	Crest depth (m)	-	-	-	0.02	-	-	-	-
	Residual depth (m)	-	-	-	0.39	-	-	-	-
	Pool type (scour/dammed)	-	-	-	S	-	-	-	-
Bed material	Dominant	C	S	G	S	C	G	C	C
	Sub-dominant	G	C	S	C	G	S	S	B
	Spawning gravel type	AR	-	AR	-	AR	R	-	-
	Spawning gravel amount	IP	N	IP	N	IP	IP	N	N
	Total LWD tally	5	3	4	7	11	51	0	24
functional LWD tally	10-20 cm	-	1	3	5	2	3	-	6
	20-50 cm	2	-	1	2	3	32	-	12
	>50 cm	-	-	-	-	1	1	-	1
	Cover type (%)	OV (25)	OV (40)	OV (30)	LWD (20	OV (75)	LWD (50)	OV (25)	OV (15)
	Cover type (%)	B (1)	C (10)	LWD (5)	OV (10)	C (5)	OV (10)	B (2)	B (2)
off channel habitat	Type	-	-	-	-	-	-	-	-
	access	-	-	-	-	-	-	-	-
	Length (m)	-	-	-	-	-	-	-	-
Dist Ind Present	1	FP	-	PD	JM	DW	JM	-	FP
	2	PD	-	FP	-	-	FP	-	-
	3	-	-	-	-	-	-	-	-
Riparian Veg.	Type	D	D	D	D	D	D	M	M
	Structure	YF	YF	YF	YF	YF	YF	YF	YF
	Canopy Closure (code)	2	1	1	1	2	2	1	1
	Comments	Very low flow, pockets of water connected by interstitial flow.	Rafted SWD at top of unit.	Rafted SWD in LWD jam.			The channel flows under the railway trestle debris. SWD rafting at the upstream end and		

Date: August 30, 2000 Crew:MS/LS Weather: overcast
Subsampling fractions: 1/2 for all habitat strata Discharge: <1m/sec
Site # 4 (Reach 1 of Tributary 4)

	Distance (m) from start	0	35	79	87	93
	Habitat unit - type	C	P	R	C	P
	Length (m)	35.0	2.7	7.0	6.0	5.0
	Gradient (%)	5.5	0.0	0.5	1.5	0.0
	mean Bankfull depth (m)	0.60	1.35	1.80	1.19	2.25
	mean Water depth (m)	0.02	0.30	0.15	0.03	0.60
	mean Bankfull width (m)	3.60	8.75	5.73	5.30	7.30
	mean Wetted width (m)	1.70	5.80	1.35	0.67	5.20
Pools only	Maximum depth (m)	-	0.33	-	-	0.63
	Crest depth (m)	-	0.02	-	-	0.03
	Residual depth (m)	-	0.31	-	-	0.60
	Pool type (scour/dammed)	-	S	-	-	S
Bed material	Dominant	C	S	G	G	S
	Sub-dominant	G	G	S	S	G
	Spawning gravel type	AR	-	R	R	-
	Spawning gravel amount	IP	N	IP	IP	N
	Total LWD tally	14	10	18	11	28
Functional LWD tally	10-20 cm	5	-	6	4	10
	20-50 cm	9	2	11	5	12
	>50 cm	-	3	1	-	3
	Cover type (%)	OV (50)	LWD (20)	LWD (30)	OV (10)	LWD (70)
	Cover type (%)	LWD (10)	B (5)	OV (10)	LWD (2)	OV (5)
Off channel habitat	Type	-	-	-	-	-
	access	-	-	-	-	-
	Length (m)	-	-	-	-	-
Dist Ind Present	1	MB	EB	EB	MB	EB
	2	FP	-	PD	-	-
	3	EB	-	-	-	-
Riparian Veg.	Type	D	D	D	D	D
	Structure	YF	YF	YF	YF	YF
	Canopy Closure (code)	2	2	1	1	1
	Comments	recent LWD jams present	pool formed at base of LWD jam	The majority of LWD is railway trestle debris	The majority of LWD is railway trestle debris	Pool has formed as a result of the collapsed trestle debris.