

Off-Channel Fish Habitat Monitoring & Aquatic Habitat Assessments within Bella Coola River Watershed:

**Noosgulch Ponds,
Talchako 56.6 km Ponds,
Canoe Crossing Creeks**

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Prepared By
Kynoch Resources
Bella Coola Valley BC



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EXECUTIVE SUMMARY

Between February 23 and March 31, 2007, Kynoch Resources, on behalf of International Forest Products, completed Routine Effectiveness Evaluation and REE and Detailed Routine Effectiveness Evaluations (DREE) on two previously developed off-channel habitat complexes of the Bella Coola River watershed, including Noosgulch Ponds and Talchako 56.5 km Off-channel Complex. In addition to REE and DREE assessments, a location at Canoe Crossing in the Bella Coola Valley was assessed to determine preliminary feasibility/need for similar off-channel restoration. Works were completed as part of FIA evaluations.

Results of monitoring at Noosgulch Ponds and Talchako 56.5 km indicated very stable and productive habitat at both sites. Objectives at both sites were to increase off-channel over wintering habitat for coho and other salmonids.

Noosgulch Ponds was created in 2002 and consisted of three ponds comprising approximately 1,130 m² of off-channel pond habitat and approximately 75.7 m of stream channel. Applying REE standards off-channel Biological Performance of these works were considered 4.0 and Physical Performance 3.9, out of a maximum possible of 4.0. Fish were identified throughout the habitat unit and ecological assessment of invertebrates, riparian condition and water quality all indicated an ecologically functioning and moderately diverse habitat unit.

Talchako 56.5 km habitat was created during various projects from 2000 to 2006. Assessment and monitoring of Talchako 56.5 considered past development and compared that to recent (2006) development. Four established off-channel Ponds (Head, East, West and Channel Ponds) were evaluated for REE Biological and physical performance, as were four newly created (2006) Refugia Ponds. Previously established ponds received REE scores of 4.0 and 3.91 for Biological Performance and Physical Performance, respectively and the newly constructed ponds received REE scores of 4.0 and 3.89 for those same categories. The main impediment to the Talchako sites are related to riparian damage associated with livestock and minor channel erosion from those animals.

Comprehensive ecological evaluations of Noosgulch and Talchako sites were also undertaken, including sampling of: benthic invertebrate; basic water quality; and, fish distribution and population estimates. Findings and recommendations are reported in this document.

Beyond REE and DREE assessment an area at Canoe Crossing (approximately 5 km East of Noosgulch FSR, on Hwy 20) was assessed to determine feasibility of implementing similar off-channel habitat restoration. This report recommends proceeding to a more detailed assessment of this site as it seemed suited for off-channel or refugia pond development to enhance pool habitat and cover.

This report describes finding of 2007 assessments, provides data and summaries and makes recommendations as required. Photographs appear in Appendix 1, Fisheries Data in Appendix 2 and FIA REE forms and data in Appendix 3.

INTRODUCTION

On behalf of International Forest Products (InterFor), with funding from the Forest Investment Account (FIA), Kynoch Resources has prepared this report to describe findings of routine ecological monitoring (REM) of habitat compensation completed within the Bella Coola Valley between 2000 and 2006. This report assesses general aquatic habitat function of two previously established off-channel habitat rehabilitation projects within the Bella Coola River watershed, and provides pre-construction baseline data for one proposed site. Habitat Assessments were completed at:

- Noosgulch Ponds (Site 1);
- Talchako FSR Km 56.5 (Site 2); and
- Canoe Crossing creeks and side channels (Site 3).

Assessments were completed between February 23 and March 31, 2007 and consisted of monitoring habitat for function and stability (post construction), aquatic habitat value (benthos, water quality and fish) and preliminary fish population estimates through single mark-recapture methods. Monitoring methods and standards described by FIA (April 2006) were used as applicable to this project.

Methodology for field assessments, data interpretation and reporting are described below. This report is formatted to describe all monitoring components and results for each of the three (3) sites in individual report sections.

1.1 Proposed Aquatic Ecosystem Monitoring (Background)

As stated in the introduction, each of the three sites chosen for 2007 aquatic habitat monitoring were selected based on past habitat restoration/enhancement activities (Sites 1 and 2) or potential suitability for future habitat enhancement (Site 3). Figure 1 shows approximate location of these sites within the Bella Coola Valley. It was determined through review of project files, discussion with stakeholders involved in initial site development, and availability of fisheries data from comparable habitat areas of the Bella Coola Valley, that these sites would be suitable for routine effectiveness monitoring and assessment of ecological components. Originally, a fourth site was also considered at McCall Flats (Near Talchako Site), however; high snow pack resulted in restricted site access and assessment of McCall Flats was not completed as part of this study.

Aquatic ecosystem components to be assessed included:

- basic water quality;
- physical habitat;
- fish distribution;
- fish population estimates; and,
- qualitative benthic invertebrate community structure.

1.2 Methods

The Off-Channel monitoring program required assessment of two established off-channel restoration/enhancement sites (Sites 1 and 2) and baseline data collection of one potential enhancement site (Site 3).



Figure 1: Study Area of Bella Coola River Watershed showing Sites 1, 2 and 3. (NTS map 93D, original 1:250,000 scale)

1.2.1 Site Access

Owing to presence of snow during the sampling period (February 23 to March 31, 2007), access to each site required combined use of four wheel drive vehicles and snowshoes. ATVs and snowmobiles were considered but appeared logistically difficult to procure owing to budget and associated logistics. Access is normally feasible through use of high clearance vehicles suitable for FSR travel.

1.2.2 Habitat Assessment

Habitat assessment and description followed methods described for watershed restoration program (WRP) fish habitat assessment (Johnston and Slaney, 1996). Site assessment included measuring and assessing the following site characteristics:

- wetted and bank widths,
- water depth;
- substrate type
- channel gradient (where applicable);
- habitat cover type and composition; and,
- riparian vegetation composition.

Habitat data were collected in field notebooks. It should be noted standardized forms were not applicable to this type of assessment as many habitat features were created specifically during restoration activities, limiting applicability to standardized stream measurements (e.g., stream gradient within a pond is not applicable). Appendix 1 provides site photos and Appendix 2 provides data summary forms.

1.2.3 Water Quality

Water quality was assessed to determine basic parameters of each site, including:

- temperature;
- dissolved oxygen; and,
- pH.

Suitable field instruments were used for in-situ measurement of each of these water quality parameters. DO and Temperature were measured using an OxyGuard Gamma Instrument and pH was measured using a Hanna pocket meter.

1.2.4 Fish Collection

Fish collection was completed at each site using a combination of 4mm and 8mm mesh standard Gee-type minnow traps. Traps were baited with salmon roe and suspended in the water or placed under habitat cover, secured by twine to the shoreline. Traps were left 'fishing' from between 24 to 48 hrs, depending upon field logistics.

1.2.5 Fish Sampling

Salmonids collected in Gee traps were anaesthetized, identified as to species, measured to the nearest mm (fork length, FL), weighed, and released alive back into the site following the final

completion of sampling. Numbers of non-salmonid fish were recorded to Genus (e.g., *Cottus* sp.). with no other data collected from those specimens.

At Site 1, Noosgulch Ponds, a single-collection mark-recapture program was completed between March 7 and March 11, 2007. During initial fish collection and analysis all salmonids were marked with a caudal fin-clip for subsequent recapture assessment. Trap locations, bait type, and collection effort used in the initial (March 7) fish collection period were duplicated during the re-capture period (March 9-11).

Single event mark-recapture was completed at the Noosgulch Ponds sites using Peterson-Lincoln methods for proportional mark-recapture. Mark-recapture was intended primarily to assess approximate fish population composition and determine if fish migration occurred within certain areas.

The formula used was: $\check{N} = Mn/r$

Where:

- \check{N} = estimated total size of population;
- M = number of marks applied
- n = total animals collected in recapture; and,
- r = marked animals collected during recapture.

Confidence levels of 95% were also applied to recapture data.

1.2.6 Fisheries Data Assessments

Fisheries data were assessed differently for each site, owing to site specific monitoring objectives (described below). Data were typically assessed to determine three (3) primary components:

1. fish distribution and habitat use ;
2. mean size and condition factor;
3. approximate population (through mark and re-capture at Site 1 only).

Various other results were interpreted from these findings, as described in report sections specific to each site.

Fisheries data pertaining to habitat density, fish size and condition factor were assessed using MicroFish Fisheries Software (www.microfish.org). The Fulton condition factor (CF) was applied using MicroFish PC Software to analyse general size and weight comparisons of coho salmon and other salmonids collected in the Noosgulch Ponds. Condition factor is an index of fish well-being based on the following formula (Murphy and Willis, 1996):

$$CF = (W/L^3) * 100,000$$

where W= weight (g)
L= fish length (mm)

It was anticipated coho (*Oncorhynchus kisutch*), cutthroat trout (*O. clarki*), rainbow trout (*O. mykiss*) and Dolly Varden char (*Salvelinus malma*) would be encountered during this project. Condition factor allows comparison of fish health from one site to another; however based on

project scope and anticipated salmonid species to be collected; condition factor was only assessed for coho salmon during this project.

1.2.7 Benthic invertebrate Collection

Benthic invertebrates were collected using a 200 μ mesh kick net. In stream sections the net was placed downstream of the sample site and substrate was agitated and overturned to loosen invertebrates for collection in the net. In pond habitat the net was swept through submerged algae and other plant forms to collect invertebrate specimens.

An experienced invertebrate field and laboratory specialist completed invertebrate collection and invertebrate specimens were returned to the laboratory as live samples the same day as collection. A Kyowa SDZ-P zoom stereo microscope (7X – 45X) was used for sample identification to the highest taxonomic level feasible (e.g., typically genus) and photographs were taken of select species (Appendix 1).

1.3 Reporting

This report is laid out to provide site specific data for each of the three study areas. Owing to project scope completion of all required REE forms were not practical. Appendix 1 provides site photos, Appendix 2 fish data and Appendix 3 FIA and REE compendium reporting as available.

2.0 RESULTS

Kynoch Resources' observation and assessment of off-channel habitat at the three sites of the Bella Coola River were completed between February 23 and March 31, 2007. Figure 1 shows the approximate location of each site within the Bella Coola Valley, while Figures 2 through 4 provide site specific information for each sample area.

2.1 Site 1, Noosgulch Ponds

Noosgulch Ponds off-channel habitat consisted of three primary excavated ponds (Ponds 1-3) and three main connecting channels (Channels A, B and C; Figure 4). Channel A was noted as an ephemeral channel connecting the Ponds to the Noosgulch River in Reach 2, immediately upstream of the Noosgulch FSR bridge.

2.1.1 Site Summary (Noosgulch Ponds)

The Noosgulch Ponds were created in March 2002 as part of a joint Fisheries Renewal BC and InterFor Enhanced Forestry initiative. The project objective was to provide secure rearing and over-wintering habitat for salmonids, including coho and potentially remnant sockeye salmon of the Noosgulch / Bella Coola river watersheds. The site was selected based on presence of an observed shallow / swampy groundwater creek to the west of the active Noosgulch River stream channel. The area was logged circa. 1960 and it was assumed creation of the Noosgulch FSR altered the existing groundwater stream channel (Osborne, 2002).

Prior to completion an Archaeological Impact Assessment was completed (Dahm and Hobler, 1998) and results of a Sediment Source Survey (Summit, 1997) were consulted for the area. Neither report indicated reasons not to develop off-channel fish habitat in the selected site.

Proposed works included excavation of a pond approximately 75 m by 15 m with an approximate depth of 1.7 m. Initial Site Development costs were approximately \$29,138.00 (FSRBC, Project Budget).

2.1.2 Fish Habitat (Noosgulch Ponds 2007)

Figure 2 shows the approximate 'as-built' layout of the three Noosgulch Ponds as assessed by Kynoch Resources during field assessments. Where applicable, site habitat data were collected for application to standardized MOE site cards. Applicable Data for each site appear in Tables 1 and 2 below, and photographs of the site appear in Appendix 1.

Ponds 1, 2 & 3

Pond 1 was the largest pond, comprising approximately 780 m² of fish habitat. Water depth of Pond 1 was typically >1 m, with an estimated maximum depth of approximately 2.5 m. Habitat was complexed by abundant floating and submerged LWD, which was estimated to provide direct cover for approximately 55% of the pond habitat, an additional 5% cover was provided by boulders and 5% by over-stream vegetation. An island in the NW section of the pond also created channel/pond complexity and habitat variation. Pond substrate was observed to be predominantly fine silt and organic debris (e.g., leaf-litter), with occasional boulder presence, from construction and habitat creation. Aquatic vegetation was not noted as a dominant cover feature in Pond 1, however; green algae observed in littoral areas of the pond were noted o

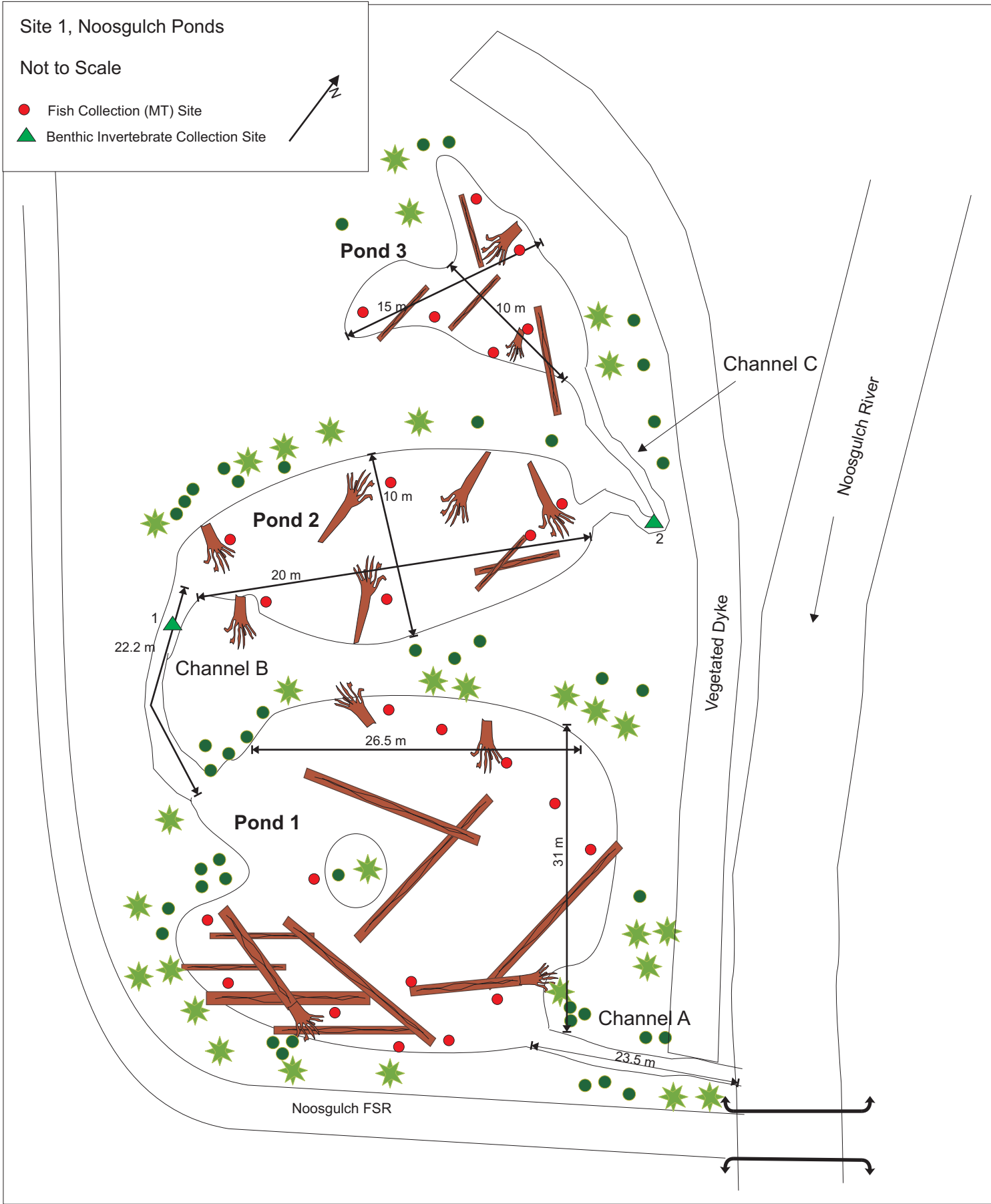


Figure 2: Site 1 Noosgulch Ponds.

provide grazing habitat for benthic invertebrates (e.g., caddis fly larvae). Pond 1 was drained by Channel A into Reach 2 of Noosgulch river. Channel B (Figure 2) flowed into the head of Pond 1.

Pond 2 was smaller than Pond 1, with an estimated area of approximately 200 m². Water depth was also slightly shallower on average with an estimated maximum depth of approximately 1.5m. Similar to Pond 1, approximately 30% to 40% of pond habitat was complexed by floating or submerged LWD. Substrate composition was similar in all ponds, with fine silt and organic material the predominant observed substrate types. Pond 2 was drained by Channel B and fed by Channel C, both channels provided apparent perennial migration for fish upstream and downstream and appeared to have continued year-round flow.

Pond 3 was the smallest pond at the Noosgulch Site, with an estimated surface area of approximately 150 m². Pond 3 was approximately 1.25 m maximum depth and was well complexed with LWD (50% estimated areal cover) and exhibited similar substrate composition as Ponds 1 and 2. Groundwater inflow to Pond 1 near the NW corner provided headwater inflow to the entire Pond network (although additional groundwater seepage may have occurred throughout the excavated area). Channel C connected Ponds 2 and 3 (Figure 2; Photos Appendix 1).

Table 1 provides water quality and basic habitat descriptions of Ponds 1 through 3.

Pond	Area (m ²)	Max Depth (m)	Habitat Cover %			Substrate %			DO (mg/l)	pH	Temp (°C)
			LWD	Boulder	Veg.	Silt/organics	Grvl	Bldr			
Pond 1	780	2.5	55	5	5	95	0	5	10.0	7.48	6.8
Pond 2	200	1.5	30	0	5	100	0	0	10.2	7.33	6.5
Pond 3	150	1.25	50	0	5	100	0	0	9.7	7.29	6.7

Channels A, B & C

Channels A, B and C were assessed for various habitat components and structure, including physical dimensions, substrate, gradient and basic stream morphology. Stream channels B and C were also selected for locations to collect benthic invertebrate samples (described below). Photos of the Noosgulch Channels are presented in Appendix 1. Table 2 summarizes habitat characteristics of Noosgulch Channels.

Channel A was assessed to measure length, width and stream gradient, as this channel provided migratory access to and from the Noosgulch Ponds, however; likely contributed little measurable ecological input to the ponds owing to its ephemeral nature and downstream location. Channel A was 23.5 m long and bordered by large angular rip rap on both banks, creating a confined, stable channel connecting the Noosgulch Ponds with the Noosgulch River (Photos, Appendix 1). Mean wetted width was approximately 1.25 m and bankfull width was 2.75 m. Fish or invertebrate samples were not collected from channel A.

Channel B was approximately 22.2 m long and provided a location for invertebrate collection in a small gravel riffle in its upper section (Figure 2 and Photos, Appendix 1). Substrate of Channel B was approximately 15% boulder-cobble, 40% gravel and 35% sand-silt. Wetted width was 1.25 m and gradient was 1.0% in this artificially created gravel-riffle stream channel (Photos, Appendix 1). Channel B was predominantly a straight stream section with vegetated banks. The right bank was tightly coupled to a stable, vegetated hillslope.

Channel C was a slightly meandering artificially designed stream channel approximately 30 m long connecting Ponds 2 and 3 (Figure 2, Photos in Appendix 1). Benthic invertebrates were sampled from riffle sections of Channel C (described below). Channel C varied in width with an average wetted width of approximately 1 m. Stream banks were well vegetated in grass, and forbs and appeared stable, with no bank erosion or instability noted. The 1% stream gradient in the meandering channel allowed apparently perennial fish migration and provided stream habitat for benthic invertebrates in areas of gravel-cobble substrate. Slower quiescent areas of this channel were exhibiting organic material accumulation, indicating a relatively stable stream flow, not likely subject to fluvial flushing.

Table 2 provides physical and habitat information for Channel A to C at Noosgulch Ponds.

Channel	Length (m)	Wet Width (m)	Bank Width (m)	Substrate (%)			Chan Depth (m)	Bank Depth (m)	Gradient (%)
				Boulder-Cobble	Gravel	Sand-Silt			
A	23.5	1.25	2.75	70	10	20	0.20	0.65	0.5
B	22.2	1.25	2.0	15	40	35	0.20	0.50	1.0
C	30	1.0	1.5	5	50	55	0.25	0.65	1.0

Riparian Areas

Riparian Habitat of the Noosgulch Ponds was difficult to assess owing to seasonal winter conditions, however; crew experience in the area during other seasons was considered during the assessment and site observations and past experience applied in completing a riparian assessment.

A brief riparian inventory of existing and established (i.e., natural or planted) conifer and deciduous trees was completed, indicating approximately 30 coniferous trees >1.5 m height (ranging up to >10 m height), and approximately 44 deciduous trees of the same approximate height classes immediately adjacent to pond and channel areas (Figure 2, Photos, Appendix 1). Riparian planting of nursery raised trees was not completed as part of the restoration program, however, numerous trees were salvaged from the site during construction and transplanted during site completion. Those trees observed appeared in reasonable to good growing condition and general health. Coniferous trees included Western red cedar, western hemlock and Sitka spruce. Deciduous trees were predominantly red alder and black cottonwood.

Under story shrubs were noted adjacent to cleared/disturbed areas of the site and consisted of typical pioneer species of the region, including: thimbleberry, Nootka Rose, gooseberry and elderberry. Devils club was also present in wet locations. It was not feasible to assess grass

and forb cover in the riparian area owing to snow and winter conditions, however, visits by field team members during previous summer months (i.e., 2002 to 2006) indicated these riparian plants were abundant.

2.1.3 Benthic Invertebrate Sampling (Noosgulch 2007)

Invertebrate sampling was completed in two stream sections (Channels B and C) as well as a sweep-net collection in Pond 1. Objectives of invertebrate sampling at Site 1 was to determine whether newly created (i.e., 2002 restoration) stream sections had effectively been colonized by benthic invertebrates to levels expected in naturally occurring stream channels.

Stream collection resulted in collection of mayflies, stoneflies, caddis flies, black flies and *chironomids*, presenting a moderately diverse group of organisms from relatively small channel sections. Features of each organism are described below:

Mayflies (Ephemeroptera)

- **Baetis spp.** - Very abundant in stream samples (Channels B and C). Possibly two species were encountered with one being *Baetis tricaudatus*. *Baetis bicaudatus* may also have been present in the early instar life stages but was difficult to identify to species at those sizes and developmental stage.
- **Baetis tricaudatus** was abundant and is known to be bivoltine (i.e. two “hatches” per season - early spring and fall) and is typically common to most streams in the area with good water quality and gravel substrate and can even persist in ephemeral stream habitat.
- **Cinygmula sp.** One specimen was collected and was considered an indicator of good water quality. Members of this Family (Heptagenidae) are very sensitive to poor water quality factors such as low dissolved oxygen, therefore; their presence indicated a stable relationship between stream habitat and good water quality.

Stoneflies (Plecoptera)

- **Capnidae family** (one specimen collected, not identified beyond family). The presence of *Capnids* (or any other Stonefly) is typically a sign of good water quality as these organisms are often most sensitive to low dissolved oxygen levels, or other water quality characteristics.

Caddisflies (Trichoptera)

- **Limnephilus sp.** Caddis flies occurred in stream and pond habitat, indicating aquatic diversity and providing prey at lower trophic levels.

Blackflies (Simuliidae)

- These organisms were abundant and identified to Family level only.

Chironomids (Chironomidae – non-biting midges)

- These organisms were abundant and identified to Family level only.

Pond Habitat

The pond areas were sampled only from a few net sweeps through a cold-water algae bloom in a section of Pond #1. Caddis larvae were prolific and visible grazing on this bloom:

***Limnephilus* spp.** Only Genus level identification was possible for the Caddis larvae collected, however; it is suspected that two species of this Genus were in the samples.

Benthic Invertebrate Summary – Noosgulch Off-Channel Complex

Although diversity appeared moderately low in samples collected at Noosgulch Ponds during February 23 field collection, it should be noted that this Off-Channel habitat has a ground water source at the upper end of Pond 3, which precludes recruitment of aquatic insects from an established upstream source (i.e., no downstream drift). Recruitment to this relatively new habitat (created in 2002) would, most probably, come from egg deposition from flying adult stages. Over time, such aquatic insects as the *Nemourids* (a “winter stonefly” Family) and free-swimming caddis larvae could establish themselves in the stream sections of the complex as they are found in similar, more established small stream habitats in the Bella Coola Valley.

The three primary aquatic insect Orders *Ephemeroptera*, *Plectoptera*, *Trichoptera* (May, Stone and Caddis flies) most often associated with fish habitat utilization were represented in samples taken from Noosgulch Ponds. Representatives from the *Dipteran* Order (i.e. *Simuliids*; Blackfly larvae and *Chironomids*; non-biting Midge larvae) were also recorded.

Baetis tricaudatus was the most prolific species of aquatic insect found in flowing stream samples and ranged from early to late instar stages of development.

Although not collected from pond samples, it is highly probable that *Chironomids* comprise the majority food supply for over-wintering juvenile salmonids as is typical for other equivalent habitats in the watershed (Wigle, 2007. pers. Com.).

2.1.4 Fish Sampling (Noosgulch 2007)

Fish Sampling was completed over a four day period from March 7 to 11, 2007 at Noosgulch Ponds. Fish collection included placing 25 Gee minnow traps baited with salmon roe in Ponds 1 through 3 for a 48 hrs (commencing March). Subsequently the traps were re-baited and placed for an additional 48 hours to complete a mark-recapture effort. Trap placement and recovery data appear in Table 4 (below).

Fish were enumerated and identified to species and subsequently sampled to measure fork length and weight. These data were used to assess general condition-factor of the fish. Fish were then marked with a caudal fin clip and released back into the pond from which they were initially collected. Recapture data were collected on March 11. Fish collection data and analysis appear in Tables 4 and 5 below with discussions regarding condition factor, relative migration or movement within the ponds and mark recapture data.

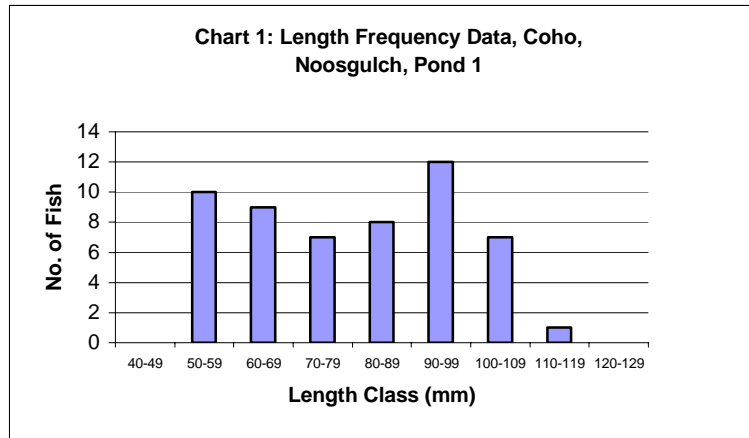
Mean Weight, Age Class & Condition Factor

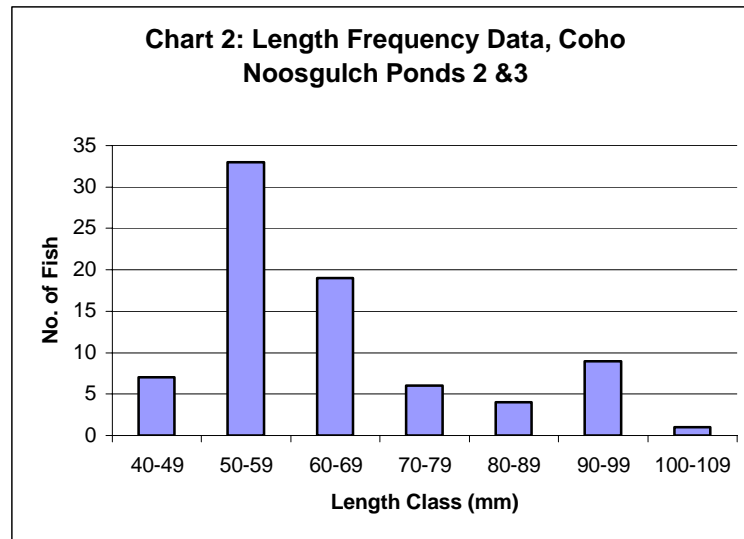
Table 3 shows mean weight, lengths and relative condition factor of fish collected at Noosgulch Ponds. Where the sample size was <5 fish condition factor was not calculated.

Table 3: Fish Collection Data ¹ , Noosgulch Ponds								
Species	Pond 1 13 traps 48 hrs				Ponds 2 & 3 (pooled) 6 traps in each pond, 48 hrs			
	No. of Fish	Mean weight (g)	Mean Length (mm)	Condition Factor	No. of Fish	Mean weight (g)	Mean Length (mm)	Condition Factor
CO	54	6.3	80.1	1.068	78	3.1	64.2	1.019
CT	1	18.8	122.0	NA	1	12.4	110.0	NA
DV	10	18.1	119.2	0.928	2	14.5	137.0	NA
RB	4	24.1	139.3	NA	2	11.5	111.5	NA

1- Data assessed through MicroFish 3.0 for Windows

Charts 1 and 2 show length frequency data of coho salmon collected in Ponds 1 and 2/3 (pooled). Juvenile coho were divided into two age classes based on lengths, with fish <70 mm considered 0+ and fish >70 mm >0+ (based on Braden, 2000).





Mark Recapture Estimates

Table 4 provides results of mark and recapture efforts complete at Noosgulch Ponds.

Pond	Area (m ²)	No. of Traps	Hours Set	Fish Collected				CO Marked	Recapture period (hrs)	Marks Collected (CO only)	Marks Migrating ²	Fish Estimates ¹		
				CO	CT	DV						Min.	Mean	Max
1	780	15	48	54	1	10	10	54	48	10	1	106	232	338
2 & 3 pooled	350	10	48	78	1	2	19	78	48	19	0	110	164	218

¹ based on 95% confidence limits

² Fish marked in one pond, migrating to another pond

Mark and recapture methods provided a general idea of fish population and structure and whether fish migration within the Noosgulch Ponds occurred, and if so whether there were preferred habitat areas for certain fish (e.g., habitat use by age class).

Based on mark and recapture data from Pond 1 it is estimated between approximately 106 and 338 juvenile coho were present in Pond 1 and between 110 and 218 in Ponds 2 and 3 (pooled based on a 95% confidence level. These numbers appeared to be relatively low compared to other studies in the region (e.g., Braden, 2000). This is likely attributed to several factors, including: relatively high water levels, allowing continued out migration throughout the winter months (reducing necessity of off-channel over-winter habitat); lower than optimal trap density in relatively large ponds; unconfined lower channel migration (e.g., stop nets were not placed in Channel A); potentially low coho recruitment during 2006 spawning periods (undetermined) and limited project time (owing to winter conditions) to allow for a 'rest' period to reduce 'trap avoidance' of fish targeted in the mark recapture.

Unique marks were used for Pond 1 fish (lower caudal clip) and Ponds 2-3 fish (upper caudal clip). Fish migration within the ponds was detected during the short (4 day) mark-recapture period, with a single coho from the upper ponds (Pods 2-3) migrating downstream to Pond 1.

This may have coincided with general outmigration of fish into mainstem habitat, or may have been a shift of habitat within the Ponds. Length frequency analysis indicated coho salmon in the upper ponds were of a younger age class than those in Pond 1.

Mark and recapture data presented in this report may not be representative of salmonid populations within the Noosgulch ponds owing to the items described above. However, this routine evaluation was not intended as a population density/productivity assessment as data are intended to show ecological function and diversity.

2.2 Site 2, Talchako Complex, 56.5 km

Assessment at the Talchako groundwater complex consisted of low intensity fish collection and moderate intensity investigation of fish habitat and ecological function. Previous assessments had established a relatively high level of fish use for ponds built in 2000 (e.g., Braden, 2000 and Annon. 2001). The object of this investigation was to assess continued productivity and fish distribution/use of newly created refugia (ponds) and modified migration channels.

2.2.1 Site 2 Summary

In April 2000 two initial ground water channels and ponds were created at 56.5 km along the Talchako FSR to offer over winter refugia for coho and other salmonids which had previously been frequently stranded during winter low-flow periods (Osborne, 2000a, 2002). Based on higher than anticipated levels of use by fish, and relatively high levels of fish health (as indicated by abundance and condition factor; Braden, 2000 and Osborne 2002) it was decided in 2002 to modify one existing pond constructed in 2000 and to add two additional ponds (East Pond and Channel Pond; Figure 3). Again, in 2006, additional ponds and channels were created or modified to further ensure fish did not become stranded during low winter or summer flow regimes. These ponds were smaller and established along the length of a migratory channel to add additional refugia habitat and avoid potential stranding of fish in those channel areas. Figure 3 (modified from Osborne, 2000a, 2002 and 2006) shows key restoration features and identifies the period in which they were constructed and/or modified.

For this project, sampling for fish, benthic invertebrates and measurements/observations of fish habitat and water quality were completed at the following locations, as identified in Figure 3:

- Head Pond and outlet channel (fish and benthos samples, constructed 2000);
- Refugia pond 1 and inlet/outlet (fish and benthos samples, constructed 2006);
- outlet at Refugia Pond 3 (benthos sample, constructed 2006); and,
- Refugia Pond 4 (fish sample, constructed 2006).

It is worth noting that a Crown Grazing Permit exists for the Talchako region and livestock are often in and around the off channel complex, causing stream and riparian disturbances. In 2006 trees were felled in a fence-like manner in some riparian areas to deter cattle from approaching or entering pond habitat and to protect planted and natural riparian vegetation of the area. Owing to winter conditions (e.g., >40 cm of snow cover) it was not feasible to assess impacts of livestock on riparian areas as part of this study (March 2007), however; indications of tree-top disturbances and damage were identified in areas frequented by cattle. In 2006 additional select planting was completed in riparian areas. During this planting, coniferous tree plugs were planted immediately adjacent to established deciduous trees to offer protection from livestock.

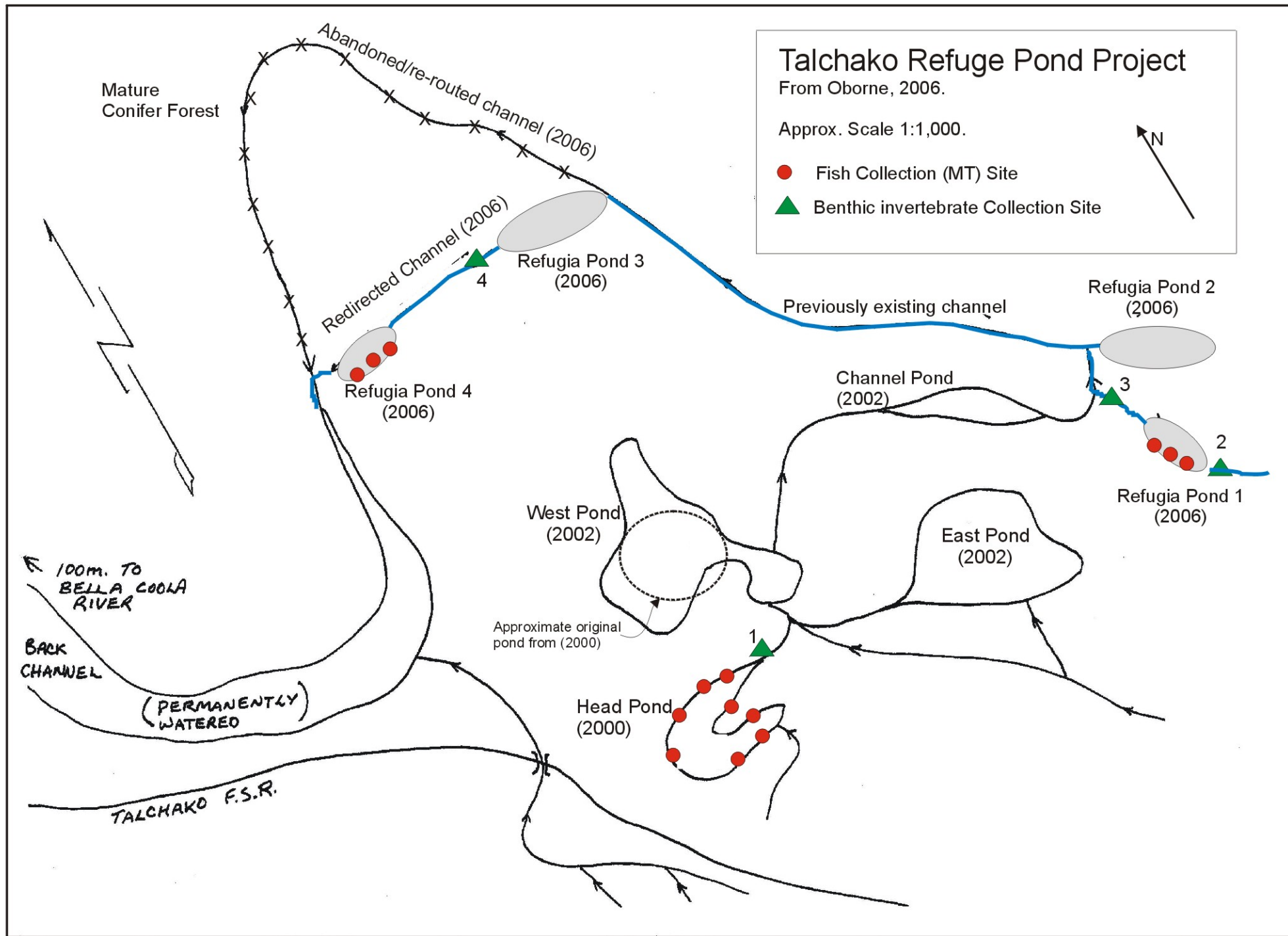


Figure 3: As-Built Diagram (2000 through 2006) of Talchako Off Channel Complex (Osborne, 2002a, 2006).

2.2.2 Fish Habitat (Talchako 56.5 km, 2007)

Owing to the large size, complexity and altered/restored nature of the Talchako off channel complex (Figure 3) it was not feasible to complete a standardized fish habitat assessment of all features. Comparison of the existing site (March 2007) to as-built reports (Osborne 2000, 2002a, 2006) indicated habitat features reported in those documents were built as described and from observations and literature review (e.g., Braden, 2000) appeared to be functioning.

Habitat measurements, ecological observations and water quality data were collected in conjunction with benthic invertebrate sampling from stream channel sections and are further described below.

General observations and literature review indicated approximately indicated approximately 4,853 m² of Pond Habitat and >300 m of lineal channel had been created during various restoration periods from 2000 to 2006. Field observations corroborated these approximate numbers, however, actual surface areas and channel lengths were not measured, as the focus of this assessment was ecological productivity.

For comparative values, assessment of original (i.e., 2000 and 2002 ponds) and recent (i.e., 2006 ponds) was completed, as described below.

2000 to 2002 Construction (Site 1)

The Head Pond and outlet channel were assessed in 2007 to collect fish and benthos data as well as stream channel and fish habitat data.

The head pond was estimated to be approximately 600 m² with an average depth of approximately 1.5 m. LWD was abundant in this pond and provided an estimated 60% habitat cover. Overstream vegetation provided approximately 10% to 15% additional habitat cover. Substrate of the pond was noted to be predominantly silt and fine material, remaining substrate appeared to be organic leaf-litter and detritus. The inlet culvert/pipe was originally installed as an intentional barrier to upstream fish migration (to avoid upstream stranding in marginal to poor ephemeral fish habitat) and appeared to be functioning well with water flowing freely into the head pond. Photos in Appendix 1 show pond and site details.

The outlet channel of the head pond was an 8 m stream section, which flowed into a larger channel connecting the East and West Ponds, ultimately draining towards the Channel Pond and Refugia Ponds 1 through 4 (Figure 3, Photos in Appendix 1). The channel was approximately 1 m wide with a gradient of 1%. Substrate was predominantly cobble with gravel and silt noted. Depth was 0.15 m and the channel was lined with a geotextile, as it was constructed channel built in 2000. Table 5 (below) provides habitat characteristics and water quality for each stream section assessed at the Talchako off channel complex.

2006 construction (Sites 2, 3 & 4).

Benthos Sites 2, 3 and 4 as well as fish collection in Refugia Pond 4 were in areas of newly constructed habitat established in 2006 (Figure 3). Sites 2 was a reference site established upstream of Refugia Pond 1, in an area of undisturbed natural stream channel that had not been influenced or affected by channel and pond restoration (Photos in Appendix 1). Sites 3 and 4 were areas of restored/relocated stream channel created in 2006 for fish migration.

Site 2 was a low gradient naturally occurring stream channel with a predominantly sediment and fine organic substrate. Emergent grass provided abundant habitat cover and benthic invertebrates were collected from this vegetation (described below). Wetted width was

approximately 2.75 m and gradient was <1%. The stream channel was predominantly glide habitat with a depth of 0.2 m. Table 5 (below) provides habitat characteristics and water quality for Site 2.

Site 3 was immediately downstream of Refugia Pond 1 and provided riffle habitat in a shallow stream channel (~0.1 m depth) approximately 1.25 m wide with a gradient of approximately 1%. This stream section was reconstructed in 2006 to provide a migration corridor for fish, with no intended residual pool habitat to further reduce fish stranding. The restoration theory was to encourage fish to migrate to larger Refugia Ponds, rather than reside in smaller stream-channel pools where stranding may occur (Oborne, 2007. Pers. Com.). The stream channel was not lined with geotextile, however, approximately 0.15 m to 0.25 m of gravel and cobble was placed in the channel bottom to provide a rocky substrate suitable for benthic invertebrate colonization and create riffle habitat. Table 5 (below) provides habitat characteristics and water quality for Site 3.

Site 4 of the Talchako off channel complex was located approximately 5 m downstream of Refugia Pond 3 (figure 3). Habitat was similar to that of Site 3, and the channel was also lined with gravel and exhibited habitat features similar to Site 3. Photos of each site are presented in Appendix 1 and Table 5 (below) provides habitat characteristics and water quality for Site 4. Site 4 appeared to exhibit an iron fixing bacteria, producing a red-orange 'iron' colour to periphyton and algal growth on the rocky substrate, however; this appeared to be a natural feature of the area.

Site	Length (m)	Wet Width (m)	Bank Width (m)	Substrate (%)			Chan Depth (m)	Bank Depth (m)	Slope (%)	Water Quality		
				Boulder-Cobble	Gravel	Sand-Silt				DO mg/L	Temp °C	pH
1	8	1.1	1.2	70	15	15	0.15	0.30	1.0	11.4	4.0	7.0
2	NA	2.7	4.5	0	0	100	0.2	0.4	0.5	12.1	3.2	6.9
3	16	1.25	3.5	10	80	10	0.10	0.50	1.0	12.0	3.1	6.9
4	27	2.3	5.0	15	80	5	0.15	0.75	1.0	12.1	3.7	7.04

Refugia Ponds

The four Refugia Ponds created in 2006 (Ponds 1 through 4, Figure 3) varied in size from approximately 400 m² to 700 m² providing a total of approximately 1,850 m² of rearing habitat. These ponds were excavated to approximately 1.5 m depth and appeared to provide abundant residual pool habitat based on maximum pool depth and minimal stream depths observed (e.g., stream channel depth was typically significantly less than pool depth). Pools were complexed with LWD and minimal disturbance to natural overstream vegetation during excavation was observed, further enhancing stream and habitat cover. Approximately 500 seedling western red cedars were planted in riparian areas adjacent to the ponds and connecting stream channels for long term habitat cover and LWD recruitment (Oborne, 2006). Although a thorough inventory or assessment of riparian conditions was not possible during the winter study period (March, 2007), numerous cedar seedlings were observed to have been planted adjacent to deciduous trees serving as nurse-wood, and those conifers inspected appeared to be in good health.

Fish Collection was completed in Refugia Ponds 2 and 4 and is further described below.

General Water Quality

Water quality of the Talchako off channel complex appeared good for fish habitat based on limited field data collection, (e.g., dissolved oxygen, temperature and pH). As indicated in Table 5 above, dissolved oxygen ranged from 11.4 to 12.1 mg/L which is well within ranges required for juvenile salmonid rearing and pH was noted as between 6.9 and 7.1, near circum neutral and within limits for aquatic life (Bjorn and Reiser, 1991). Stream temperature was between 3.1°C and 4°C, reflecting winter seasonal conditions.

2.2.3 Riparian Areas (Talchako 56.5 km)

A complete riparian assessment was not feasible as part of this monitoring project owing to winter conditions and snow levels. Site observations and discussion with N. Osborne (Pers.Com., supervisor during restoration activities) indicated that livestock grazing and browsing has been detrimental to deciduous trees previously planted in the riparian areas of the site. Evidence of damage to small conifers was noted and was apparently associated with livestock. Numerous stream channel banks and pond littoral areas were also noted to have been damaged as evident by numerous hoof prints noted at the site.

During 2000 and 2002 habitat restoration riparian planting of Douglas fir, and spruce seedlings was completed around the head Pond, and East and West Ponds. Willow was also planted near the head pond, however; in small amounts to deter beaver attraction. The area was not seeded with grasses to further deter cattle from encroaching on the area.

During 2006 Refugia Pond development approximately 500 western red cedar seedlings were planted in the region. During 2007 assessment numerous small cedar trees were seen in the area (although there was a considerable snow pack) and those plants observed appeared in good health. Most of these cedar trees were planted adjacent to a deciduous shelter tree, likely enhancing protection from cattle and over wintering conditions of the seedlings. Also in 2006 several large deciduous trees were felled in a fence-like pattern around riparian areas adjacent to the West Pond to deter cattle from entering the riparian zone. It appeared this tree-fence technique worked to some degree as it presented an imposing barrier, likely difficult for cattle to cross.

2.2.4 Benthic Invertebrates (Talchako 56.5 km)

Site 1 Talchako 56.5

Site 1 was a short riffle section connecting two excavated ponds. The substrate was cobble with some gravel (see photos in Appendix 3 for sampling area). A geo-fabric liner had been installed over the excavated channel with cobble and gravel laid overtop the fabric, limiting the depth of the sample.

The following organisms were collected at Site 1.

- **Mayflies (Ephemeroptera)** *Baetis tricaudatus* nymphs in early to late instar life stages were collected at Site 1.
- **Caddisflies (Trichoptera)** Family: Limnephilidae unknown Genus, possibly *Onocosmoecus*

Site 2 Talchako 56.5

Site 2 was selected as a reference site, as it was a stream section of the complex which was not excavated or otherwise disturbed during the building of the off-channel complex. This habitat was a low gradient glide and characterized by a fine silt substrate with instream grass vegetation (see photos in Appendix 1). The grasses were likely introduced by domestic cattle which free-range throughout the area. Many cow tracks were noted on the stream's bank.

- **Mayflies** Family: Siphonuridae *Ameletus sp.* – an early instar (immature) nymph.
- **Caddisflies** Family: Limnephilidae possibly *Onocosmoecus sp.*
- **Stoneflies (Plecoptera)**
Family: Nemouridae *Zapada oregonensis* mature
Family: Perlodidae: *Isoperla sp.* immature
- **Beetles (Coleoptera)**
Family: Dytiscidae Predaceous diving beetle adult

Sites 3 & 4 Talchako 56.5 km

These two collection sites were both created in 2006 (Figure 3) and exhibited similar width, depth, gradient and substrate and were found to have similar aquatic insect fauna, including:

- **Mayflies**
Family: Siphonuridae *Ameletus sp.* late instar nymphs
- **Stoneflies**
Family: Perlodidae *Megarcys sp.* late instar nymphs
- **Caddisflies**
Family: Limnephilidae possibly *Onocosmoecus sp.* larva
- **Dipteran Flies**
Family: Athericidae (Watersnipe Flies). One specimen collected in site 3 This ID is tentative as the specimen may be a *Tipulid* (Cranefly) larva.

Benthic Invertebrate Summary, Talchako 56.5 km

Although the quantity of aquatic insect fauna per sample appeared to be relatively low, qualitatively the diversity was relatively good with three stonefly species found in three of the four sampling areas:

Megarcys sp. and *Isoperla sp.* are predatory stonefly nymphs which would imply prey species sustenance in the habitat. The Nemourid stoneflies such as the *Zapada oregonensis* collected are generally herbivorous grazer/shredders on organic debris such as leaf litter. All stoneflies are very sensitive to environmental factors such as high water temperatures and the accompanying low dissolved oxygen levels which would ensue. To find three species within the few samples taken per site is an encouraging sign in such a relatively “new” habitat. Recruitment from upstream, undisturbed stream reaches (Site 2) appears to be proceeding well in the downstream Sites 3 and 4.

Large quantities of Chironomid (Midge) larvae casings were readily apparent in quieter, shallow sections of the complex. The larvae, which produce these casings, may represent the largest biomass component of this area and the dominant prey species to rearing salmonids and predatory aquatic insects such as the Dytiscid beetle and the *Megarcys sp.* and *Isoperla sp.* stoneflies found.

No stonefly nymphs were collected in the Site 1 sampling and the only mayfly species was *Baetis tricaudatus*. The source water for this particular stream habitat is probably ephemeral (*B. tricaudatus* has been known to be found in other ephemeral streams in the Bella Coola watershed ; M. Wigle, Pers,Com.). Over time, this relatively new habitat may experience recruitment from other mayfly or stonefly species.

2.2.5 Fish Sampling (Talchako Off Channel Complex)

Fish Sampling was completed over a 48 hr period from March 18 to 20, 2007 at Talchako Off-channel complex. Fish collection included placing 14 Gee minnow traps baited with salmon roe in the Head Pond and Refugia Ponds 1 and 4 (Figure 3). All trapping was completed over a 48 hour period between March 18 and 20, 2007. Fish were enumerated and identified to species and subsequently sampled to measure fork length and weight. These data were used to assess general condition-factor of the fish. Fish collection data and analysis appear in Table 6 below with discussions regarding condition factor, relative abundance and density data.

Mean Weight, Age Class & Condition Factor

Table 6 shows mean weight, lengths and relative condition factor of fish collected at Talchako 56.5 km. CF was not calculated for species where <5 fish were collected.

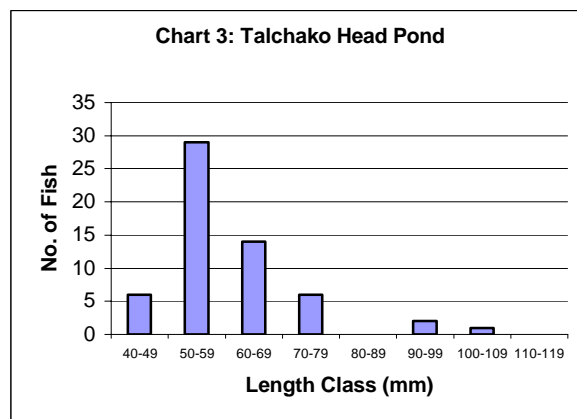
Table 6: Fish Collection Data ¹ , Talchako Off Channel Complex, 56.5 km												
Sp	Head Pond 8 traps 48 hrs				Refugia Pond 1 3 traps 48 hrs				Refugia Pond 4 3 traps 48 hrs			
	No. of Fish	Mean weight (g)	Mean Length (mm)	Condition Factor	No. of Fish ²	Mean weight (g)	Mean Length (mm)	Condition Factor	No. of Fish ³	Mean weight (g)	Mean Length (mm)	Condition Factor
CO	58	2.5	60.5	1.023	78	1.9	56.3	1.007	102	3.5	67.9	0.967
CT	1	19.8	129.0	NA	0	NA	NA	NA	0	NA	NA	NA
DV	11	8.4	91.8	0.914	11	3.7	72.0	0.868	21	7.5	87.8	0.897

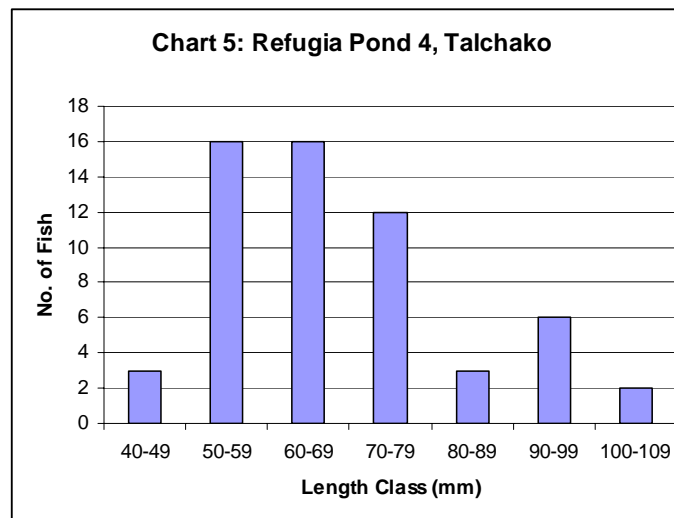
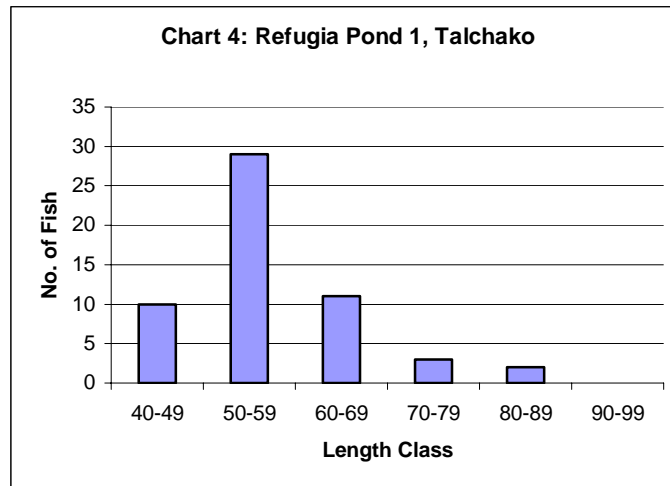
1- Data assessed through MicroFish 3.0 for Windows

2- 55 coho and 7 Dolly Varden were sampled for weight and length from Pond 1: 23 CO and 2 DV, not sampled

3- 58 coho and 11 Dolly Varden were sampled for weight and length from Pond 4: 44 CO and 10 DV, not sampled

Charts 3 to 5 show length frequency data of coho salmon collected at Talchako 56.5 km. Juvenile coho were divided into two age classes based on lengths, with fish <70 mm considered 0+ and fish >70 mm >0+ (based on Braden, 2000).





2.3 Site 3, Canoe Crossing

Site 3 was located at an area on the north side of the Bella Coola River locally referred to as Canoe Crossing, Figures 1 and 4. The site was located at approximately 126° 19' 41.8' W – 52° 26' 39.6" N. This location has not received prior fish habitat enhancement or restoration, however, provided potential opportunities for off-channel site development similar to that described for Sites 1 and 2. The area is a combination of relic channels of the Bella Coola River and small (ungazetted) stream channels and wetlands located between the Bella Coola River (to the south) and Provincial Highway 20 (to the North).

Approximately 700 m of stream channel were assessed to determine feasibility of creating off-channel pools or pond complexes in this region. Fish and invertebrate collection and sampling, habitat assessment, and water quality sampling were completed in this region.

2.3.1 Fish Habitat (Canoe Crossing)

Site 3 consisted of a homogenous small stream channel running approximately 700 m parallel to the Bella Coola River. (Figure 4). The stream was formed from two small tributaries draining upslope areas to the north of Highway 20. These channels flowed through culverts beneath

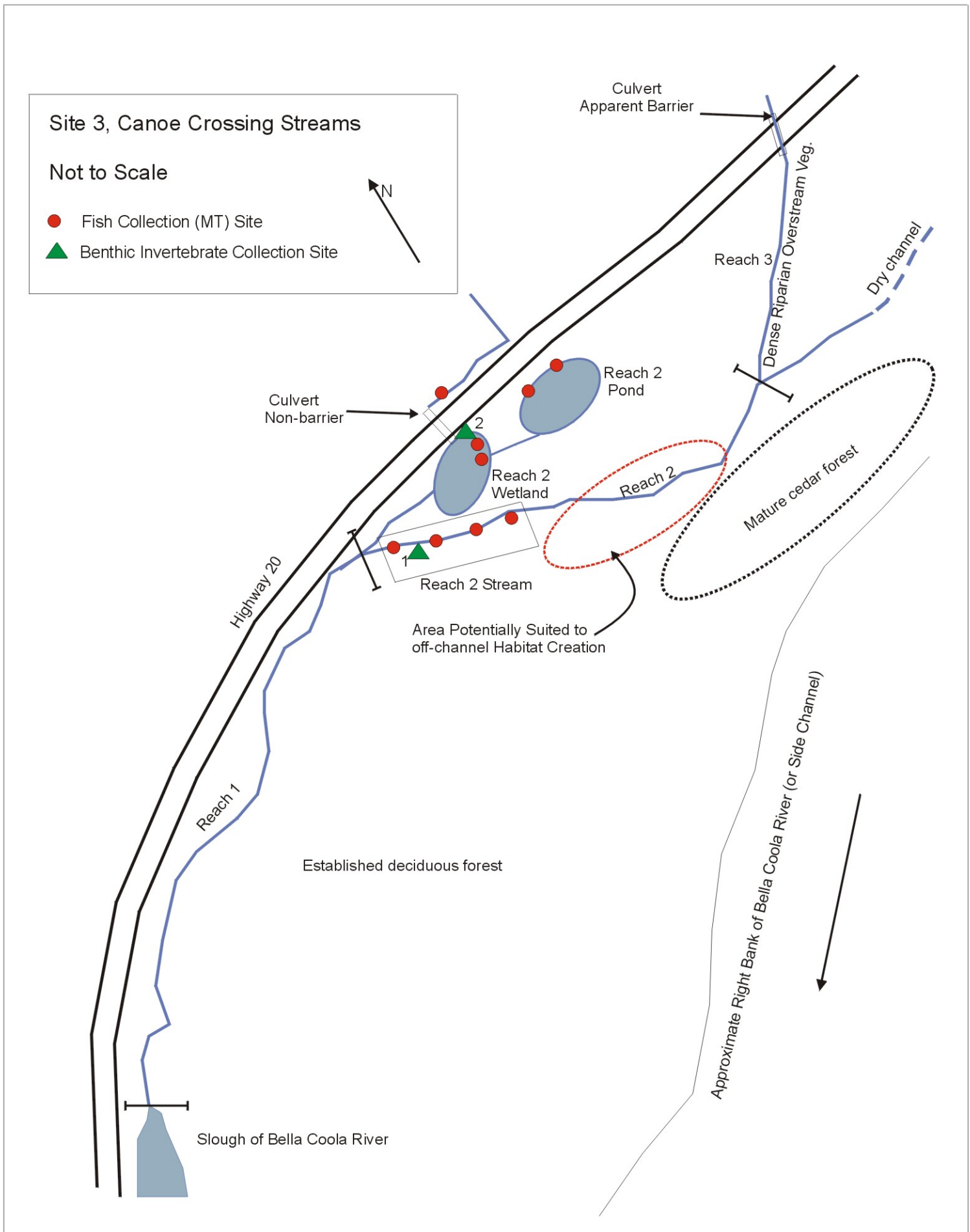


Figure 4: Site 3 Canoe Crossing Streams.

Highway 20, one of which created an apparent upstream barrier to fish migration (Figure 4, Photos in Appendix 1). The stream Channel was divided into three reaches for assessment and reporting purposes, as shown in Figure 4. Reach 2 and associated wetlands provided most apparent opportunities for habitat enhancement or restoration.

Reach 1

Reach 1 was approximately 165 m long and extended upstream from a slough of the Bella Coola River to a confluence with a wetland-channel (Figure 4). Reach 1 was approximately 4.5 m wide with a gradient of <1% and predominantly sand and silt substrate. Riparian vegetation was nearly exclusively mature deciduous trees, including black cottonwood and red alder (see photos in Appendix 1). Little or no LWD or other cover was evident in the homogenous, straight and shallow (e.g., <0.30 m channel depth) stream. No pools were noted in the 165 m section of Reach 1, with predominantly low gradient, slow moving glide/riffle/glide stream morphology flowing over an unstable sand/silt substrate. No other assessment of Reach 1 was completed.

Reach 2

Reach 2 extended from the confluence of the wetland-channel upstream approximately 235 m to the next stream confluence (Figure 4). Reach 2 had associated wetland and pond habitat adjacent to Highway 20 that was formed from a small stream flowing through a culvert from upslope areas. These wetland and pond areas were considered part of Reach 2 for assessment and reporting. Reach 2 was assessed at three locations, to sample fish, benthic invertebrates and basic water quality. Assessment at Site 3, Canoe Crossing, included (Figure 4):

- Reach 2 Stream Habitat;
- Reach 2 Wetland Habitat; and,
- Reach 2 Pond Habitat.

The stream channel of Reach 2 was similar to that of Reach 1, however sections of Reach 2 were adjacent to a stand of mature western red cedar trees, offering bank stability and more diverse riparian habitat (see photos in Appendix 1). Reach 2 had no pool habitat and substrate was similar sand/silt as noted in Reach 1. Benthic invertebrates, water quality and fish were sampled in Reach 2 stream sections (Figure 4).

Wetland and pond habitat associated with Reach 2 offered the only form of residual pool habitat in the Canoe Crossing assessment site (Site 3). The wetland area (Reach 2 Wetland; Figure 4) was relatively shallow with little or no LWD cover, however; in stream and over stream vegetation provided moderate habitat cover. Benthic invertebrates, fish and water quality were sampled in the wetland and pond habitats of Reach 2.

Reach 2 offered the most diverse habitat of the site, owing to inclusion of wetland areas and more diverse riparian habitat, however, fish habitat was generally considered poor, based on limited pool habitat, homogenous sand/silt substrate, limited stream cover and lack of stream morphological diversity (see photos in Appendix 1).

Reach 3

Reach 3 was not assessed owing to small channel size (e.g., approximately 1 m to 2 m width) and dense riparian shrub and over-stream vegetation, combined with snow during the assessment period (February 24, 2007). Reach 3 appeared to offer similar habitat as stream sections of Reaches 1 and 2, however; the upper reach boundary was formed at a culvert that

appeared to present a barrier to upstream fish migration (based on an estimated outfall height of approximately 0.5 m and limited plunge pool depth). The tributary channel to the south forming the Reach 2-3 break, was an ephemeral channel and may have occasional connectivity with the Bella Coola River, however; based on presence of rooted vascular plants and moss in the abandoned stream channel, flooding from the Bella Coola mainstem did not appear to be frequent.

2.3.2 Water Quality Results

Results of water quality assessment are presented in Table 7 Below.

Sample site/location	DO mg/L	Temp °C	pH
Reach 2 Stream Habitat	11.3	8.8	7.25
Reach 2 Wetland Habitat	9.1	8.2	7.6
Reach 2 Pond Habitat	9.2	9.4	7.16

Water quality appeared to be within acceptable standards for salmonids at all sites assessed (Bjorn and Reiser, 1991).

2.3.3 Benthic Invertebrates (Canoe Crossing)

Instream samples were taken from two general locations in reach 2, including Reach 2 Stream Site and Reach 2 Wetland Site (Figure 4).

Reach 2 Stream Habitat

Benthic invertebrate samples were collected from the stream channel of reach 2 on March 7, 2007 (Figure 4). The sample site exhibited a silt/organics/sand substrate. The sampling net was placed on the downstream side of instream woody debris/leaf litter and specimens sorted from this material. Select specimens were photographed and all specimens were identified to Genus level, which included:

- *Baetis tricaudatus* (Mayfly); and,
- *Onocosmoecus sp.* (Caddisfly)

Reach 2 Wetland Habitat

A small channel located at the outflow of a culvert passing beneath Highway 20, was assessed and sampled for benthic invertebrate presence. The substrate contained slightly more gravel than areas of the mainstem stream, owing to small riffle morphology caused by flow through the culvert. Photos in Appendix 1 show this stream section of the wetland. Organisms collected at this site included:

- *Baetis tricaudatus* (Mayfly);
- *Cinygma integrum* (Mayfly); and,
- Blackfly larvae – Family: Simuliidae.

Benthic invertebrate Summary, Canoe Crossing

Aquatic insect diversity appeared to be quite low and was most likely influenced by the instream substrate, which were predominantly organic detritus, silt and sand materials. This type of substrate provides an unstable environment for the clinging habits of many aquatic

insect life forms. Limited colonization by benthos was found in the ephemeral stability of instream small-woody-debris and/or leaf litter catchments, or where invertebrates attached to instream vegetation.

The presence of silt materials noted at Canoe Crossing indicated there was likely a past breakthrough flow-through condition related to historic floods from the adjacent Bella Coola River. Considering the low gradient of the adjacent Bella Coola River, breakthrough would most likely produce a depositional area. The area may also have been influenced in the past by a large back-eddy causing a depositional situation related to a high to very high water event in the adjacent Bella Coola River near the mouth of this stream channel.

From an invertebrate habitat perspective it was noted that there appeared to be sufficient gradient in this system (0.5% to 1.0%) to improve the substrate conditions for invertebrates (and/or fish) through placement of gravels and small cobble in existing glide and short riffle sections. This would likely require a more detailed assessment to ensure physical suitability of gravel placement.

2.3.4 Riparian Habitat, Canoe Crossing

Riparian areas of Canoe Crossing varied by stream reach. Reach 1 exhibited predominantly mature deciduous forests of red alder and black cottonwood, with few or no conifer trees noted. It was not feasible to assess understory owing to snow levels and winter conditions, however, cleared areas and opening within the riparian areas of Reach 1 exhibited understory shrubs (undetermined species).

Reaches 2 and 3 had mixed forests in the riparian areas. The right banks of these reaches were similar to Reach 1, with young to mature deciduous trees, while the left bank (south shore) was covered in young to mature stands of western red cedar (e.g., DBH ~40 cm). This left bank grove of cedar trees extended to the right bank of the Bella Coola River and offered conifer cover to both the mainstem river channel and areas of tributary streams of the Canoe Crossing assessment site (Figure 4).

2.3.5 Fish Sampling Canoe Crossing

Fish were collected in minnow traps set in stream, wetland and pond habitat of Canoe Crossing. Salmonids were collected at all sites with the exception of the two traps in the upstream Reach 2 Pond Habitat, where threespine sticklebacks (*Gasterosteus aculeatus*) were the only fish collected. Trapping was completed over a 48 hour period between March 7 and 9, 2007.

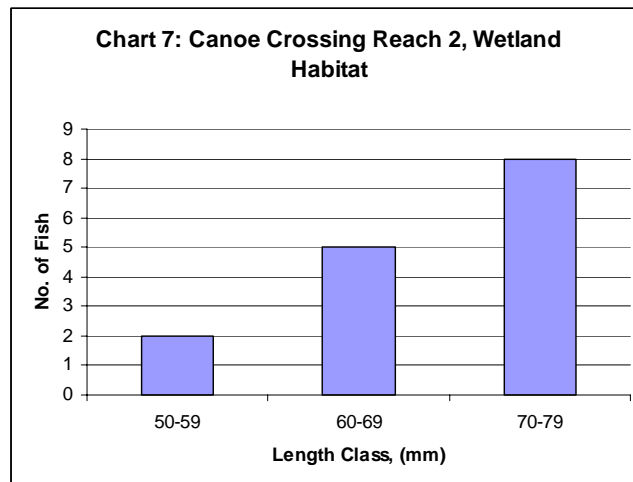
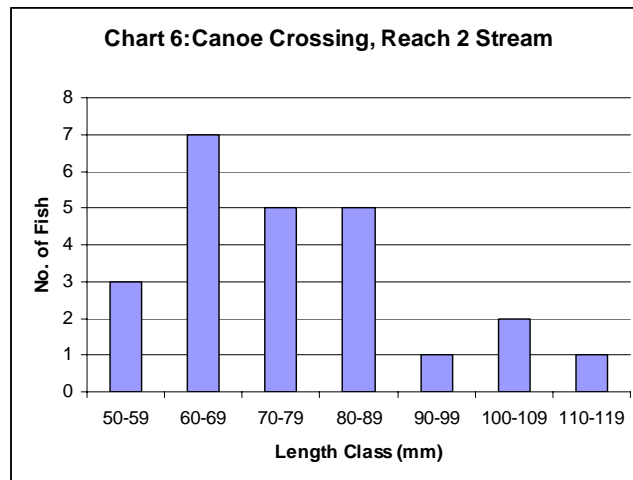
Coho and Dolly Varden were collected in a single trap placed upstream of the culvert below Highway 20, indicating this shallow ditch line is accessible to fish and provides fish habitat (see photos in Appendix 1).

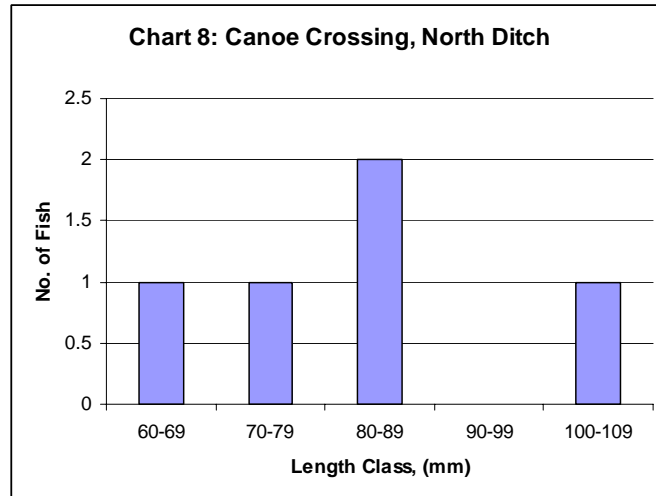
Table 8 shows mean weight, lengths and relative condition factor of fish collected at Canoe Crossing. CF was not calculated for fish species where <5 fish were collected.

Table 8: Fish Collection Data ¹ , Canoe Crossing Streams												
Sp	Reach 2 Stream Channel 4 traps for 48 hrs				Reach 2 Wetland 2 traps 48 hrs				Ditch line (North side Hwy 20) 2 traps 48 hrs			
	No. of Fish	Mean weight (g)	Mean Length (mm)	Condition Factor	No. of Fish	Mean weight (g)	Mean Length (mm)	Condition Factor	No. of Fish	Mean weight (g)	Mean Length (mm)	Condition Factor
CO	24	5.1	75.5	1.081	15	3.3	68.9	0.980	5	5.8	81.2	0.999
CT	1	19.7	126.0	NA	0	NA	NA	NA	0	NA	NA	NA
DV	1	4.3	79.0	NA	0	NA	NA	NA	1	7.8	120.0	NA
RB	1	17.1	130.0	NA	0	NA	NA	NA	0	NA	NA	NA

1- Data assessed through MicroFish 3.0 for Windows

Charts 6 to 8 show length frequency data of coho salmon collected at Canoe Crossing. Juvenile coho were divided into two age classes based on lengths, with fish <70 mm considered 0+ and fish >70 mm >0+ (based on Braden, 2000).





3.0 SUMMARY & DISCUSSION

This habitat evaluation and monitoring report was intended to determine if habitat restoration/creation completed at off-channel sites of the Bella Coola River between 2000 and 2006 were providing effective, stable and functioning fish habitat as originally intended. Components of this project were implemented based on site-specific criteria and conditions, including field logistics and available resources. Owing to unseasonably high continued snow pack, making access and assessment difficult, some assessment components were reduced or altered to most effectively collect data under those conditions (e.g., limited mark-recapture, limited riparian assessment, etc.).

Previous assessments and reports were reviewed during this project, including as-built reports (e.g., N. Osborne, 2000, 2002, 2006) and fish population reports (e.g., Braden, 2000). Through comparison of available literature and 2007 field assessments conclusions regarding each habitat components function and effectiveness has been drawn, as described below.

Photographs of each site are provided in Appendix 1 while Appendices 2 and 3 provide summary data and available FIA REE forms as required, respectively.

In Summary it appears Noosgulch Ponds and Talchako Off-channel Complexes at 56.5 km are functioning ecologically and provide valuable off-channel fish habitat. Each site is further described below with recommendations following. It should be noted Talchako River had lower than expected numbers of fish in 2007 (based on comparison to previous Braden data; Braden 2000) and fish in 2007 had a lower overall condition factor at Talchako 56.5 km. Noosgulch Ponds also exhibited a relatively low number of fish based on mark-recapture data, however, this may reflect limited effort rather than actual fish numbers. Both of these sites had good dissolved oxygen levels and benthic invertebrates appeared to be colonizing newly created/restored habitat at all sites.

It was further determined Canoe Crossing streams would likely benefit from habitat enhancement/restoration to create residual pools for refugia and riffle sections suited to invertebrate colonization and salmon spawning. These items are described below.

3.1 Site 1, Noosgulch Ponds Summary

Habitat

Noosgulch Ponds provided approximately 1,130 m² of off-channel pond habitat and approximately 75.7 m of stream channel. These habitat features were shown to provided off-channel rearing areas for juvenile salmonids as noted during fish collection. Assessment of physical habitat indicated the ponds, shorelines and associated stream channels were stable and functioning as off-channel habitat (Appendix 1).

LWD provided the most abundant habitat cover and appeared to be stable within the ponds providing surface and submerged cover. The relatively deep residual pool depth (i.e., >1.5 m) was sufficient to provide pool habitat in the lowest anticipated flows.

Riparian vegetation was difficult to assess owing to snow and winter conditions, however; an abundance of mixed deciduous and coniferous trees were obvious at the site and numerous relatively young western red cedar trees were noted, indicating a mixed age class of the forest. Deciduous shrubs and grass were also noted as abundant in riparian areas.

Invertebrates & Ecology

Water quality including dissolved oxygen and pH were within good ranges for salmonid and benthic invertebrate habitat within all three ponds and connecting channels, with little variation between ponds.

Owing to the relatively early seral stage of the Noosgulch Ponds (having been created to current condition in 2002) it appeared benthic invertebrate diversity was moderately low, however; this was not unanticipated based on the seral stage and lack of upstream recruitment methods (i.e., the ponds are groundwater fed). Habitat and water quality were well suited for benthic invertebrates and it is anticipated population size and diversity will increase over time.

Of importance to fish and fish habitat the three primary aquatic insect Orders *Ephemeroptera*, *Plecoptera*, *Trichoptera* (May, Stone and Caddis flies) most often associated with fish habitat utilization were represented in samples taken from Noosgulch Ponds.

Fish

Four species of salmonids were collected at Site 1, including coho, Dolly Varden, cutthroat and rainbow trout. While a mark re-capture component of this project was completed, it was not intended to determine total fish populations or densities. Rather it was intended to determine general habitat use and/or migration between habitat areas. Mark-recapture data indicated between approximately 216 to 556 coho were present during the assessment.

Fish migration within the ponds was detected during the short (4 day) mark-recapture period, with a single coho from the upper ponds (Pods 2-3) migrating downstream to Pond 1. This may have coincided with general outmigration of fish into mainstem habitat, or may have been a shift of habitat within the Ponds. Average length of coho in Pond 1 was 80.1 mm, while average length of Fish in Ponds 2-3 was 64.2 mm indicating coho salmon in the upper ponds were of a younger age class than those in Pond 1.

Condition factor (CF) of coho at Site 1 ranged from 1.019 (Ponds 2-3) to 1.068 (Pond 1). The higher condition factor of fish in Pond 1, coupled with larger size and relatively lower densities than Ponds 2 or 3 indicated these larger, older fish may be occupying better habitat areas of the off-channel complex. This hypothesis would be expected, as the larger, lower position of Pond 1 would be subject to more downstream drift and colonization by invertebrates and other aquatic organisms, providing a more diverse food source and therefore possibly higher quality habitat.

Comparison of CF of coho in the Noosgulch Ponds to other off-channel habitat assessments (Braden, 2000) indicated the observed CF was within the range of other off-channel restoration areas (e.g., Talchako 56.5 and 78 km, McCall Flats; Braden, 2000). When CF of Noosgulch Ponds was compared to CF of fish collected at Canoe Crossing (during this assessment), it appeared Noosgulch Ponds coho had a slightly higher CF over all than those of Canoe Crossing. CF for Dolly Varden (10 fish) were also calculated from Pond 1. Dolly Varden CF was lower than coho (0.928) however, was not be compared to other data.

3.2 Site 2, Talchako 56.5 km Off-Channel Complex Summary

Habitat

The Talchako off-channel complex at 56.5 km offered very abundant and diverse fish habitat. Approximately 4,853 m² of pond habitat and >300 m of lineal channel had been created during

various restoration periods from 2000 to 2006. Past fish productivity assessment (Braden, 2000) of this site indicated productivity could be as high as 7.21 coho/m² habitat (based on assessment of two ponds). While fish density or population size was not assessed salmonids were observed in all habitat units of the study area.

Primary objectives of the 2007 assessment were to determine if four newly constructed refugia ponds located on the outward migration channel, and realigned sections of this channel, provided function fish habitat and would reduce the potential for lethal fish stranding. Assessment sites were selected in stream channels to allow consistent benthic invertebrate collection (described below). Assessment of the previously established stream channel (Site 1) draining the Head Pond, which was created in 2000, was completed for comparative purposes, as was assessment of a reference area upstream of habitat restoration work (Site 2). The summary of invertebrates and ecology provided below further discusses these sites (below).

The three restoration sites sampled (Sites 1, 3 and 4) were similar in habitat attributes (e.g., slope, water quality, gravel substrate, etc.), providing apparently stable riffle habitat. The reference site (Site 2) differed slightly, providing glide or slough-like habitat, exhibiting a lower gradient and silt/sand substrate. The assessed restoration channels (Sites 1,3 and 4) all appeared to be stable and functioning as stream channels. The 282 m migration channel had been altered and redirected in lower sections (Figure 3) and channel sections between refugia ponds were deliberately left as relatively noncomplex riffles to deter fish from residing in these areas, where they would be most likely to become stranded in low flow events. These channels were lined with gravel, which was beneficial to benthic invertebrates and provided a certain level of habitat complexity.

The four refugia ponds (Figure 3) were assessed to determine suitability as over-wintering or summer low-flow refuge areas for coho and other salmonids. These Refugia Ponds were found to meet the requirements of fish for refugia and rearing purposes. Water quality was good at the inflow and outlet channels and ponds, providing adequate dissolved oxygen and a circum neutral pH. Habitat cover was stable and consisted of LWD, over stream and riparian vegetation and deep pool cover. In stream vegetation was also noted to be established in Refugia Pond 1, providing additional habitat complexity. Residual pool depth exceeded 1 m in each Refugia Pond, and pond size ranged from approximately 400 m² to 700 m² providing a total of approximately 1,850 m² of rearing habitat which would likely provide sufficient refuge in times of low water. This habitat was noted to be functioning as rearing habitat, similar to Ponds established in 2000 and 2002 (Head, East and West Ponds), making it more valuable than simple refugia.

Riparian habitat was mixed along the length of the migration channel and adjacent to the four Refugia Ponds. This area had also received riparian planting of 500 cedar trees in 2006 and appeared stable providing good riparian cover. Riparian habitat adjacent to the West Pond (Figure 3) appeared to provide the least cover would likely benefit from additional conifer planting, however; it was expressed that livestock grazing in the area substantially damages young trees (Osborne, Pers. Com.), reducing planting effectiveness.

Invertebrates & Ecology

Benthic invertebrate sampling and water quality analysis indicated ecology of the Talchako Off-channel Complex was relatively diverse and provided good quality components associated with fish habitat (e.g., appropriate composition of aquatic invertebrates, good DO levels, etc.). Stream sections of the restored migration channel (Sites 3 and 4) exhibited a greater diversity

of benthic invertebrate organisms than the outlet channel of the Head Pond (Site 1) and very comparable to the reference site (Site 2), indicating this channel was functioning to local ecological levels, even in its relatively early seral stage. The slightly lower diversity of organisms collected at the Head Pond outlet channel may have been attributed to limited gravel and cobble habitat in the stream bed owing to the geo-textile liner placed in the channel for erosion control.

Of importance to fish and fish habitat the three primary aquatic insect Orders *Ephemeroptera*, *Plecoptera*, *Trichoptera* (May, Stone and Caddis flies) most often associated with fish habitat utilization were represented in samples taken from the Talchako Off-channel Complex.

Fish

Fish collection at Talchako 56.5 km was completed to determine distribution of fish throughout the off-channel complex and determine relative health of salmonids based on condition factor. Fish were collected in relatively low density from the Head Pond (58 coho, 1 cutthroat and 11 Dolly Varden) in eight baited minnow traps over a 48 hour period (3.63 coho per trap-day). It was undetermined why these numbers were comparatively lower than other previous assessments (e.g., Braden, 2000, reported much higher density, although not expressed in the same CPUE, in September and October assessment). It may be that out migration of coho had occurred prior to the March 18-20 sample period of this assessment (2007).

Outmigration may be supported by comparison of CPUE of Refugia Ponds 1 and 4, for which coho collection in each pond was 102 and 78 fish, respectively in three traps over a 48 hr period. These numbers suggest a CPUE of approximately 17 coho per trap-day in Pond 1 and 12 coho per trap-day in Pond 4. Outmigration is further supported by analysis of the length frequency data from each pond, which suggests those upstream areas (Head Pond and Refugia Pond 1) had very few coho fry (smolts) over 70 mm (e.g., Pond 1 had 5 fish or ~9% >70 mm), while downstream areas (Refugia Pond 4) had 23 fish or approximately 40% coho >70 mm length.

Relatively high abundance of fish in the Refugia Ponds suggested that these areas were serving as rearing and a migration corridor as intended.

Condition factor of coho collected at the Talchako 56.5 km site ranged from 0.967 to 1.023, with a mean of 0.999 which was slightly lower than the CF reported by Braden (2000), which had a mean of 1.145. It was suggested in the 2002 *As Built Report* for Talchako 56.5 km (Osborne, 2002) that the CF reported in 2000 (Braden) was lower than desired, and this may have been a result of over crowding in the ponds during a highly productive season. The CF reported in this project (0.999) during a period of relatively low observed density in the pond habitat, suggests there may not have been a correlation between 2000 population and CF. There may be other issues affecting the CF of coho that have not been assessed as part of this study or the 2000 assessment by Braden.

3.3 Site 3, Canoe Crossing Summary

Habitat

Canoe Crossing stream and wetland/ponds had not received habitat restoration in the past. This site was assessed to determine feasibility of creating or enhancing off-channel and stream habitat suitable for winter and summer rearing for juveniles and potentially suited to adult coho salmon spawning. This project would require excavation of deep residual pools similar to those

at Site 2 (Talchako Refugia Ponds) and stream channel alteration to enhance localised riffles and scour. Gravel placement for spawning habitat would likely be required.

Existing habitat was found to be of marginal to poor quality for salmonid rearing as there were few or no residual pools, very little LWD, homogenous sand/silt substrate and a predominantly deciduous over story riparian canopy. Pond and wetland habitat was adjacent to Highway to with little or no riparian buffer remaining on the north side (photos, Appendix 1). Wetland and pond habitat was relatively shallow limiting its value as refugia. One of the two culverts assessed at the site appeared to be a barrier to upstream fish migration, while the upstream habitat of the passable culvert was a marginal ditch line providing little valuable habitat in its current condition.

Opportunities for enhancement were noted during field visits and are further discussed in the Recommendations section below.

Invertebrates & Ecology

Aquatic insect diversity appeared to be quite low and was most likely influenced by the instream substrate, which were predominantly organic detritus, silt and sand materials. This type of substrate provides an unstable environment for the clinging habits of many aquatic insect life forms. Limited colonization by benthos was found in the ephemeral stability of instream small-woody-debris and/or leaf litter catchments, or where invertebrates attached to instream vegetation. Dissolved Oxygen was within levels required for salmonids (i.e., >9 mg/L) was recorded at all sites, however, DO was lower in the pond and wetland habitat (~9.1 mg/L), while the stream channel had relatively high DO (11.3 mg/L) and pH was circum neutral.

Fish

Distribution of Salmonids was relatively even at Canoe Crossing, with juvenile coho and Dolly Varden having been collected in stream and wetland habitat, including a road ditch on the north side of Highway 20 (Figure 4). Wetland habitat of Reach 2 yielded the highest CPUE of juvenile coho, with 3.75 fish per trap-day, the stream channel of Reach 2 yielded 3.0 fish per trap day. were the most abundant fish at the site. These numbers are relatively low, however, reflect the limited diversity in habitat and lack of cover noted during the assessment. The higher numbers of fish (based on CPUE) in the wetland areas suggest, that although they have lower DO levels the wetlands provide valuable habitat which is likely favoured by salmonids because of the pool and in-stream cover provided. However, fish coho collected in the stream channel had a slightly higher condition factor than those from the wetland. Coho collected in the ditch line stream had the lowest condition factor (0.999). As shown by length frequency data the stream channel of Reach 2 supported larger fish from (0+) to (>0+) age classes, while fish from the wetland were all <70 mm, suggesting they were (0+) fry.

3.4 Recommendations

Based on assessment findings and data analysis certain recommendations can be made.

Site 1 Noosgulch Ponds

Noosgulch Ponds appeared stable and productive and no obvious recommendations for site enhancement have been made. Certain optional aspects of site enhancement, including:

- Planting sedges or other emergent aquatic vegetation to diversify littoral areas and provide habitat cover.

- Remove or replace some deciduous trees with additional conifers to limit or reduce leaf litter accumulations.

No other recommendations have been made for Site 1.

Site 2 Talchako 56.5 km.

Site 2 is a very large-scale and complex restoration project spanning several years of construction and various phases of implementation. It is understood certain aspects of the site have been modified since original placement and the site as a whole appeared to be functioning well. The restoration system seemed stable and no remediation or repairs were required to in-stream structures. Annual inspections of upslope groundwater source systems are recommended to ensure a continued supply of water to the Head Pond, and east and West Ponds.

It is also recommended additional measures be taken to limit cattle access to the site as notable stream-site and riparian impacts and damage associated with grazing and cattle presence was noted (e.g., localized bank erosion, pant trampling and browse, etc.).

In the future if the use of geotextile can be avoided during construction of channels that would be recommended. It was noted that presence of geo-textile at sample Site 1 of the Talchako complex may have limited invertebrate habitat of the stream. Where feasible an additional one or two layers of cobble is recommended instead of geotextile.

No other recommendations have been made for Site 2.

Site 3 Canoe Crossing Streams

The area adjacent to Reach 2 of the Canoe Crossing creek system (an ungazetted channel flowing formed from two streams north of Highway 20; Figure 4) appeared suitable for pond or pool creation or enhancement. This area appeared to be on Crown Land.

A lack of residual pools was identified as a limiting factor for fish habitat. Of approximately 700 m of stream channel assessed the only pool habitat was associated with wetlands and pond habitat adjacent to highway 20 (Figure 4).

Creating residual pools (similar to the Refugia Pools of Talchako) would likely diversify fish habitat and reduce potential for fish stranding in the relatively shallow and homogenous existing stream channel. There may also be an opportunity for gravel placement and low gradient riffle creation suited to adult coho spawning. These riffle complexes would also diversify the habitat and would be more suitable to a variety of benthic invertebrates. Stream and channel complexing with LWD and riparian panting of conifer trees would also be recommended for habitat cover and long-term site stability.

While this assessment identified biological components of the area that could benefit from stream or pond restoration, it is recommended resources be committed to a more thorough investigation of the area to assess practicality and logistics of creating off-channel habitat at Site 3.

This assessment should include:

- Assessment of property status to ensure the site is on Crown Land;
- Archaeological overview;
- Detailed site map and elevation profiles;
- Creation of a work plan and budget; and,
- Consultation, meetings and submissions for government approvals.

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