SPECIES COMPOSITION, UTILIZATION, AND OVERWINTERING SURVIVAL OF FISHES IN OFF-CHANNEL HABITATS OF THE FRASER RIVER, HOPE BC

A REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DIPLOMA OF TECHNOLOGY

Christie Morrison
Heather Hutchinson
Stephanie Ells

May 2011

Prepared For
The Rivers Institute at BCIT
Matt Foy, Senior Fisheries Biologist and Habitat Specialist, DFO
Dr. Marvin Rosenau, Instructor, Fish Wildlife and Recreation
Ken Lukawesky AscT, Regional Gravel Resource Manager, MoTI

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We accept this report as conforming to the required standard

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Supervisor

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Program Head

BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

May 2011

Executive Summary

Fish surveys were conducted between September 2010 and March 2011 in two seasonally-flooded off-channel habitats in the Heart of the Fraser—the reach between Hope and Mission--south of Hope BC, including Tom Berry Gravel Pit (TBGP) and Delair Pond. Mark-recapture surveys were conducted in Delair Pond and TBGP using a seine net and all fish were identified to species, counted, weighed and measured. Using the Lincoln-Petersen mark-recapture method, fish were marked using upper and lower caudal fin clips. Upon recapture, population estimates of an isolated section of TBGP, as well as Delair Pond, were conducted. Minnow traps were also used in TBGP as a comparison-tool in areas where a mark recapture was not possible. Seine net sampling was also conducted in the Fraser River to compare species composition and condition factor between fishes in the mainstem to those residing in off-channel habitats. Species composition, overwintering survival, health, and growth of fishes were compared between sites and previous studies over previous years including 2008/2009 and 2009/2010.

For 2011, all three study sites including TBGP, Delair and the Fraser River mainstem comprised varying habitat qualities and quantities and had differing species compositions. Fishes captured during sampling included salmonids, cyprinids, cottids, and catostomids. TBGP contained two juvenile salmonid species, including Chinook (*Oncorhynchus tshawytscha*) and coho (*Oncorhynchus kisutch*) as well as five non-salmonid species. Delair Pond contained five salmonid species, including Chinook, coho, sockeye (*Oncorhynchus nerka*), rainbow trout (*Oncorhynchus mykiss*), and cutthroat trout (*Oncorhynchus clarkii*), and four non-salmonid. Fraser River sampling captured three salmonid species, including juvenile Chinook, young-of-the-year chum (*Oncorhynchus keta*), mountain whitefish (*Prosopium williamsonii*), and seven non-salmonid species.

It was determined that all Chinook and sockeye found in off-channel habitats were in their second year class (1+), where as Chinook captured in the Fraser River were in their

first year class (0+). This could be due to the fact that low freshet levels isolated fish in off-channel habitats for another year, allowing them to grow older, whereas the same age class of Chinook in the Fraser migrated. When compared to previous years, all juvenile coho (0+) were larger during this study, and could be attributed to the lower freshet levels restricting fish from entering or leaving, and therefore decreased the competition among fish. All salmonid species found in each of the sites had low condition factors. This could be due in part to a low flood regime, where adequate amounts of nutrients cannot enter off-channel habitats during lower freshet levels.

The restoration potential of TBGP borrow-pit area was also considered in this study. Through personal communications and observations it was determined that restoration efforts, such as increasing the depth and connectivity of basins in TBGP and restoring constant water flow, would improve the quality of salmonid habitat within the site.

Keywords

Salmon, salmonid, coho, Chinook, sockeye, redside shiner, prickly sculpin, largescale sucker, common carp, Fraser River, Heart of the Fraser, off-channel habitat, overwintering survival, Delair Pond, gravel reach, Tom Berry Gravel Pit, fish study.

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Acknowledgements

We would like to thank instructor Dr. Marvin Rosenau of the British Columbia Institute of Technology (BCIT) Fish, Wildlife and Recreation (FWR) Program for his input and guidance on this project. We would also like to thank Sam Gidora and Matt Foy of the Department of Fisheries and Oceans Canada (DFO) for their support of our study. Thanks goes to Scott Misumi from the District of Hope who provided us with important information regarding the Tom Berry Gravel Pit. Additionally we would like to extend appreciation to Dr. Mark Angelo and the Rivers Institute at BCIT for covering our costs incurred. Glenn Callander of the Ministry of Transportation and Infrastructure is also thanked for granting us access to the sampling site.

In order to do our work, a number of Hope locals were generous in their time and information. We are grateful to Dan and Sara Jane Connal, and Jack and Betty Delair, for providing historical background information and for granting us access to the sampling sites. We are also very thankful for the hospitality provided by the Connals during our visits.

We would also like to extend thanks to everyone who volunteered their time on this project including the dedicated students who assisted in fieldwork, as well as the BCIT-FWR instructors including Robert Gunn, Tom Saare, Wayne Horvath, Laura Billing, Doug Ransome, and Laurie Stott.

1.0 Introduction

1.1 The Fraser River

The Fraser River is the largest river system wholly contained within British Columbia and the fifth-largest watershed in Canada. With its headwaters in the Rocky Mountains, this stream spans a distance of 1,375 km and encompasses a watershed area of 233,100 km^2, which drains approximately one fourth of the province of British Columbia (Gray and Tuominen, 1998). The Fraser River crosses 11 biogeoclimatic zones en route to the Pacific Ocean and is supported by 13 main sub-basin tributaries (Calbick *et al*., 2004). The Fraser watershed is comprised of 50% of BC's arable land and contains inputs from forestry operations, pulp and paper mills, mining, agriculture, sewage, and gravel extraction (Gray and Tuominen, 1998; Calbick *et al*., 2004; Chittenden *et al.,* 2010). Two-thirds of BC's human population inhabits the Fraser Basin, with the vast majority living in the Lower Fraser Region (Gray and Tuominen, 1998).

The Fraser River is recognized worldwide as its most productive salmon river (TCHRS, 2011) supporting five species of Pacific salmon. It is also the most productive fish-bearing stream in British Columbia, supporting 59 fish species (Gray and Tuominen, 1998). The Fraser River has an average yearly flow of 3540m3/s (Chittenden *et al*., 2010) with a uni-modal flood cycle, peaking in June due to large interior spring/summer snowmelt. This leads to a significant increase in wetted-channel width and depths for up to four months (Rempel, 1997). The Fraser Canyon separates the Fraser River into upper and lower reaches and the high velocities therein act as a velocity barrier to many fishes (Chittenden *et al*., 2010). The lower portion of the Fraser downstream of the Fraser Canyon, particularly the stretch from Hope to Mission, is recognized as the most biologically productive stretch of this stream and is also often referred to as the "Heart of the Fraser" (Rosenau and Angelo, 2007). It is also known as the gravel reach of the Fraser River.

1.2 The Fraser River Gravel Reach

The gravel reach, or Heart of the Fraser, as coined by Mark Angelo (Angelo, 2006) is the remaining extant undyked and free-flowing alluvial floodplain of the Fraser River that stretches from Hope to Mission (Fig. 1; Rosenau and Angelo, 2007). The floodplain is characterized by a broad U-shaped valley bottom carved out by past glacial activity (Rosenau and Angelo, 2007). Emerging from its narrow confines within the Fraser Canyon, the increasingly-lessening gradient of this reach allows the Fraser River to deposit the gravel component of its sediment load throughout the upper Fraser Valley (Rice *et al.*, 2009). This section of river is unique because it contains multi-threaded wandering gravel bed channels that are separated by established vegetated islands and unstable gravel bars (Li *et al*., 2008; Rice *et al.* 2009). While being constrained by flood-prevention defenses (e.g., diking bank hardening, training), the active channel is 1-2km wide with an average of 10m deep at the thalweg (Rice *et al.* 2009). The gravel reach ends at Mission where a sharp reduction in gradient and a widening of the floodplain creates a gravel-sand transition and the river turns into a single-thread sand-bed channel (Ellis and Church, 2005; Li *et al*., 2008).

Figure 1. The gravel reach of Fraser River stretching from Hope to Mission.

The gravel reach section of the Fraser River has the highest diversity of fish species when compared with any other freshwater ecosystem in BC. Approximately 30 species of fish use the reach for at least one stage, and often more, of their lifecycles (Table 1; Rosenau and Angelo, 2007). The reach directly supports five Pacific salmon species including BC's largest runs of pink salmon (*Oncorhynchus gorbuscha*), the largest chum (*O. keta*) spawning habitats in southwest BC, juvenile Chinook (*O. tshawytcha*) rearing areas, as well as migration pathways for runs of coho (*O. kisutch*), and some of the largest spawning runs of sockeye (*O. nerka*) in the world (Northcote and Larkin, 1989). Other salmonid species that are found in the Heart of the Fraser include steelhead trout (*O. mykiss*), cutthroat trout (*O. clarkii*), bull char (*Salvelinus confluentus*), and mountain whitefish (*Prosopium williamsonii*). The reach is also home to BC's largest white sturgeon (*Acipenser transmontanus*) populations as well as many other species of fish including species from families Gasterosteidae, Cottidae, Petromyzontidae, Clupeidae, Ictaluridae, Cyprinidae, Catostomidae, Acipenseridae, Centrarchidae, and Osmeridae (Rosenau and Angelo, 2007). This great diversity of fishes is due, in some extent, to the wide range of physical and hydrological variability contained within the reach, and characterized by the multitude of secondary channels and off-channel habitat (OCH).

Secondary channel networks and seasonally-flooded off-channel habitats provide many fish species with a variety of habitat requirements that are often lacking in single-uniform channels. These secondary channel-habitats are often rich in nutrients, support a variety of invertebrate species, and provide the foundation for high biological productivity (Rosenau and Angelo, 2007). OCH also provides species refuge from high water discharge velocities that are found in mainstem channels and can increase overwintering survival rates of juvenile salmonids (Blackwell *et al*., 1999). Juvenile coho utilize OCH as post-emergent fry, in advance of mainstem spring and summer freshet events, and as overwintering habitats (Lister and Finnigan, 1997). While coho and chum are the salmonid species most often associated with OCH, including the Fraser River gravel reach, Chinook, sockeye, steelhead, and cutthroat trout, among others, are known to use OCH during part of their life stages (Lister and Finnigan, 1997).

In the case of the Fraser River gravel reach, water levels increase in spring/summer when mountain snow melts and floods across much the remaining flooplain (Rosenau and Angelo, 2007). This inundated OCH along the Fraser River is then connected to the main channel, thus allowing fish to enter these areas. When the Fraser River freshet-water levels drop, fish are often trapped within these habitats due to a lack of connection with the main channels and are, thusly, forced to overwinter. OCH within the Fraser River gravel-reach geographic area constitutes key rearing and feeding grounds, as well as spawning habitat for many fish species (Rosenau and Angelo, 2007). However, many of these habitats have declined in abundance and productivity due to changes in the physical landscape of the floodplain as a result of landscape development and isolation from the active channel of the Fraser River gravel reach (Rosenau and Angelo, 2001).

The Heart of the Fraser is under stress from local-urbanization, resource extraction, agriculture, and industrial development (Rosenau and Angelo, 2007). Since human colonization of the Fraser Valley began in the 1880's, the Fraser River has been exploited and its biological and physical diversity has decreased (Rosenau and Angelo, 2007). With the loss of this diversity comes a decline in the plant and animal species and the habitats they support (Rosenau and Angelo, 2007). Many riparian and floodplain areas on the Fraser River have been isolated from spring and summer freshets due to land development, dyking, and draining (Rosenau and Angelo, 2007). The construction of roads and dykes alters stream channels, simplifies the stream course and cuts off side channel habitats (Harvey, 2008). When freshwater habitats are compromised fish populations can become reduced, restricted in range, or extirpated (Harvey, 2008). The declining number of fishes and salmonids, in particular, in the Fraser River and the gravel reach reinforces the need for conservation and protection not only of the different species, but also their habitats. Preserving and restoring habitat used for spawning and rearing is critical to ensure survival of salmonid species (Bailey *et al*., 2010).

Table 1. Fishes found in the Heart of the Fraser. * signifies a non-native species; R signifies a species of rare occurrence; L signifies a species at risk listed by federal and/or provincial agencies. (Source: Rosenau and Angelo, 2007).

Salmon, trout, char and whitefish (Families Salmonidae, Coregonidae)	Minnows (Family Cyprinidae)
sockeye salmon *Oncorhynchus nerka*	northern pikeminnow *Ptychochielus oregonensis*
Chinook salmon *Oncorhynchus tshawytscha*	peamouth chub *Mylocheilus caurinus*
chum salmon *Oncorhynchus keta*	leopard dace *Rhinichthys falcatus*
coho salmon *Oncorhynchus kisutch*	longnose dace *Rhinichthys catarctae*
pink salmon *Oncorhynchus gorbuscha*	redside shiner *Richardsonius balteatus*
steelhead trout *Oncorhynchus mykiss*	brassy minnow *Hybognathus hankinsoni* L
cutthroat trout *Oncorhynchus clarkii* L	common carp *Cyprinius carpio* *
bull char *Salvelinus confluentus* L	
mountain whitefish *Prosopium williamsoni*	Suckers (Family Catostomidae)
	mountain sucker *Catostomus platyrhynchus* L
Sticklebacks (Family Gasterosteidae)	largescale sucker *Catostomus macrocheilus*
threespine stickleback *Gasterosteus aculeatus*	bridgelip sucker *Catostomus columbianus* R
Sculpins (Family Cottidae)	Sturgeon (Family Acipenseridae)
prickly sculpin *Cottus asper*	white sturgeon *Acipenser transmontanus* L
coastrange sculpin *Cottus aleuticus*	green sturgeon *Acipenser medirostris* R L
Lampreys (Family Petromyzontidae)	Sunfish (Family Centrarchidae)
pacific lamprey *Lampetra tridentata*	black crappie *Pomoxis nigromaculatus** R
river lamprey *Lampetra ayresii*	
	Smelts (Family Osmeridae)
Herrings (Family Clupeidae)	eulachon *Thaleichthys pacificus* L
american shad *Alosa sapidissima**	longfin smelt *Spirinchus thaleichtys* R
Catfish (Family Ictaluridae)	
brown bullhead *Amieurus nebulous**	

1.3 Previous Studies

Previous studies by the British Columbia Institute of Technology's (BCIT) Fish, Wildlife and Recreation Program (FWR) were conducted in the Heart of the Fraser at Hope, BC, during 2008/2009 (Fig. 2; Frake *et al.*, 2009) and again in 2009/2010 (Fig. 2; Bailey *et al.*, 2010). These projects were aimed at understanding fish ecology and utilization of off-channel habitats through fall and winter. The 2008/2009 study assessed Delair Pond and the 2009/2010 project studied both Delair and Connal ponds. The off-channel habitats that these ponds comprise are flooded seasonally during the spring/summer freshet of the Fraser River, but are largely isolated once the mainstream declines in discharge in late summer or fall. The freshet connectivity to these off-channel areas allows for the movement of fishes between the active channel and these floodplain habitats these at certain times of the year.

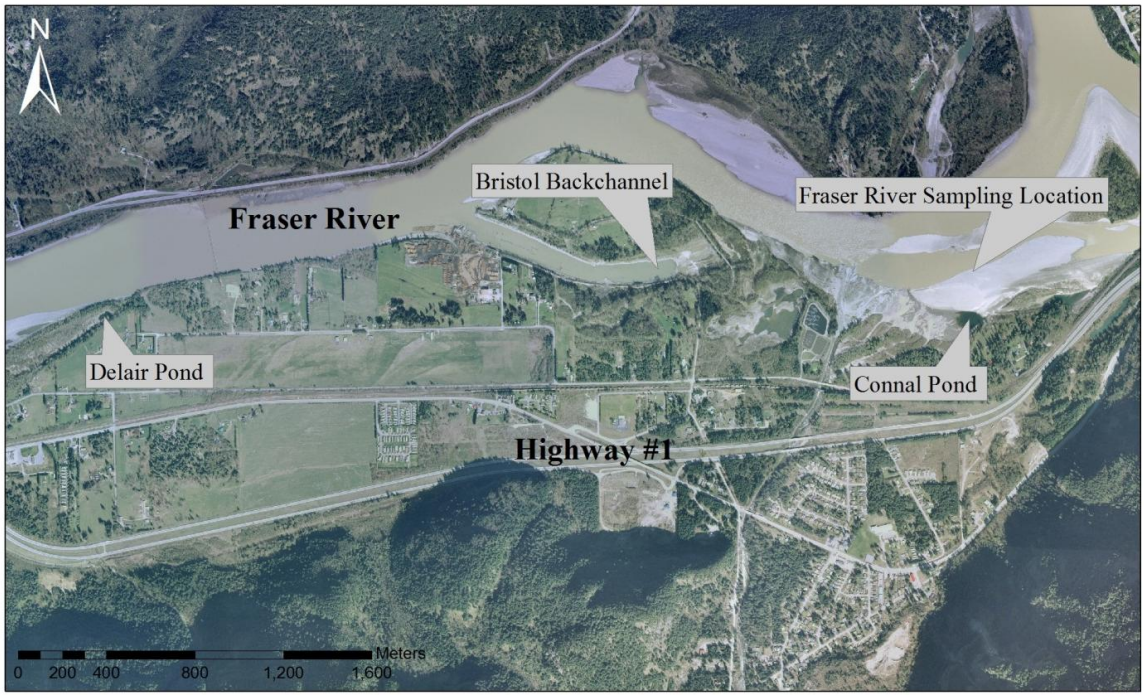

Figure 2. Previous study sites assessed by the British Columbia Institute of Technology's (BCIT) Fish, Wildlife and Recreation Program, which were conducted in the Heart of the Fraser, Hope BC. Studies include 2008/2009 (Frake *et al.* 2009) and 2009/2010 (Bailey *et al.* 2010). 2008-2009 sites included Delair Pond and the Fraser River Sampling Site. 2009-2010 sites included Dealer Pond, Connell Pond, Bristol Backchannel, and the Fraser River Sampling Site. (Source: Bailey *et al*. 2010).

The purpose of the 2008/2009 FWR study of Delair Pond was to assess fish survival and productivity of an enhanced side channel during the fall and winter period, when it was isolated from the mainstem Fraser River after spring/summer freshet (Frake *et al*., 2009). The study determined fish composition and tracked overwintering survival and growth. Five species of non-salmonids and seven species of salmonids were captured during the study (Table 2; Frake *et al.* 2009). Numbers of salmonids decreased over the course of the project with juvenile Chinook faring the worst starting with a population of 2,217 (95% CI 1992-2520) in the fall, dropping to 197 (95% CI 185-210) in early winter and then down to15 individuals in the spring. The Fraser River mainstem was also sampled to compare average size and condition factor between Chinook in the Fraser River and Delair Pond. Frake *et al.* 2009 found Chinook in the Fraser River in both fall and spring to be significantly larger then Chinook caught in Delair Pond.

The 2009/2010 FWR study looked at composition and overwintering survival rates of various species of fish Delair and Connal Ponds. The findings were aimed to assist in the decisions surrounding rehabilitation and conservation of salmonid habitat (Bailey *et al.*, 2010). Bailey *et al*. (2010) found that seven species of non-salmonids, and three species of salmonids utilized Connal Pond (Table 3). In 2009/2010 five species of non-salmonids and five species of salmonids were found in Delair Pond (Table 3; Bailey *et al.*, 2010). The results of the assessments of the ponds were compared to samples of Chinook taken on the Fraser River mainstem for 2009/2010. They found Chinook on the Fraser River, caught in the fall, had a higher condition factor than Chinook caught in Delair or Connal Pond, with Connal Pond Chinook having a higher condition factor than Chinook caught in Delair Pond.

Sampling of Bristol Backchannel, a near-by habitat, which is always connected to the active channel, was also conducted as an initial evaluation of fish utilization in this type of habitat (Bailey *et al.,* 2010). This occurred in order to make a comparison to the off-channel study sites that were normally disconnected to the Fraser mainstem throughout the lower-discharge parts of the year.

Results of fish's growth and survival from the 2009/2010 study were compared to the work conducted by Frake *et al*. (2009). The results of Bailey *et al.* (2010) for Delair Pond were similar to findings of Frake *et al*. (2009), although Chinook fared much better in 2009/2010 than they had in the previous year, having a population decline of 85% as compared to 99 % the previous year (Bailey *et al.*, 2010). Of note, other salmonid species were much less abundant at the start of fall in 2008 than they were in the same season in 2009. This may have been due to the lower freshet in 2009 and less access to perimeter floodplain habitats in this year.

Table 2. Delair Pond salmonid population estimates September 2008 to April 2009. Source: Frake *et al*. 2009.

Species	Early Fall		Early Winter		Early Spring	
	Population Estimate	95% Confidence Interval	Population Estimate	95% Confidence Interval	Population Estimate	95% Confidence Interval
Chinook	2217	1992 - 2520	197	185 - 210	15	n/a***
coho	671	597 - 774	631	561 - 730	429	415 - 444
sockeye	964	662 - 2469	560	513 - 621	400	385 - 416
mountain whitefish	6	4 - 11	4	4 - 4	8	5 - 38
steelhead trout	2*	2 - 2	1*	n/a*	3	1 - 16
Dolly Varden	1*	1 - 1	n/a**	n/a**	n/a**	n/a**
cutthroat trout	5	2 - 18	1*	n/a*	n/a**	n/a**

*minimum estimate
**none caught during session
***extreme and unreliable values result because too few individuals were caught

Table 3. Delair Pond salmonid population estimates September 2009 to April 2010. Source: Bailey *et al*. 2010.

Species	Early Fall		Early Winter		Early Spring	
	Population Estimate	95% Confidence Interval	Population Estimate	95% Confidence Interval	Population Estimate	95% Confidence Interval
Chinook	1504	1168 - 2275	308	303 - 314	222	220 - 224
coho	646	529 - 860	268	257 - 280	183	180 - 187
sockeye	108*	n/a*	6*	n/a*	6*	n/a*
steelhead trout	1	n/a	1	n/a	n/a**	n/a**
cutthroat trout	1	n/a	2*	n/a*	2*	n/a*
mountain whitefish	n/a**	n/a**	1	n/a	1	n/a

*minimum estimate **none caught during session

While the BCIT FWR studies were conducted over the last few years, Fisheries and Oceans Canada (DFO) also conducted a mark-recapture minnow trap study in February and March of 2000. The results of this earlier assessment indicated a coho pre-smelt population of 2,083 fish (Gidora, 2010); this contrasts greatly to the relative lack of coho juveniles in the more current FWR studies. Unfortunately, no size measurements of the fish were recorded or confidence intervals of the population estimates were calculated in the 2000 DFO investigation. Similar to some of the more current work, the DFO assessment had an incidental catch of 135 sockeye juveniles, five suckers (*Catostomus spp.*), two rainbow trout (*O. mykiss*), and one sculpin (*Cottus spp.*) on the first capture and 48 sockeye on the second capture (Frake *et al.,* 2010; sourced from Gidora, 2009).

2.0 Purpose and Objectives

The objective of our 2010/2011 study was to assess the species composition, utilization, growth, and overwintering survival rate of fishes in an old aggregate-extraction site located nearby to these earlier British Columbia Institute of Technology study sites and along the Fraser River; this new location is known as Tom Berry Gravel Pit (TBGP). For

comparison purposes and continuity, Delair Pond was also studied again, by us, in 2010/2011. Our project continued on the research themes undertaken on the earlier BCIT FWR Heart of the Fraser studies by Frake *et al.* (2009) and Bailey *et al.* (2010). Studying aquatic attributes in off-channel locations was undertaken in order to have a better understanding of fish utilization and species composition in these off-channel habitats. We, again, sampled the Fraser River mainstem and the goal of this sampling was to look at species composition, sizes of fish and see how they differed from the off-channel habitats that were sampled.

TBGP was selected as a new site for off-channel pond investigations for 2010/2011 because it provided an opportunity for assessing a completely man-made water body. TBGP was an historic gravel-extraction site for the Coquihalla Highway Construction. Gravel removal in the 1980's left behind as an area that contains a variety of differing landscape elevation and basins that become inundated during spring/summer freshet but are subsequently isolated from each other and the mainstem during lower water flows. Fish that enter this habitat during spring freshet become trapped during the subsidence of the flood and can potentially die if the isolated pond they enter dries up. Predation by fish-eating birds may also be considerable. A secondary purpose of our project was to look at the possibility for restoration of TBGP in order to prevent the potential overwintering fish mortality when ponds get isolated and/or dry up. No studies had ever been conducted on the TBGP site prior to our investigation (Misumi, 2010). In order to comprehensively provide an understanding of the habitat capability, we developed bathymetric profiles of the water bodies in the TBGP and mapped their probable spring/summer freshet connectivity to the Fraser River mainstem.

3.0 Study Area

Our study area for 2010/2011 was located in Hope, British Columbia, in the upper reaches of the Heart of the Fraser (Fig. 1). Three sites were studied including Tom Berry Gravel Pit (TBGP), Delair Pond, and the Fraser River mainstem (Fig. 3). TBGP and Delair Pond are normally both inundated during spring/summer freshet when mountain snow melts increasing discharge levels (Fig. 4) and primary stream levels (Fig. 5) and floods much of the remaining Fraser River floodplain. The Fraser River discharge, at this time of year, reaches an average of 6970m^3/s, but can often be well above 10,000m^3/s at peak freshet. At the Hope hydrometric station, freshet water levels, reach an average of 7.48m, as compared to low winter/early spring flows at a base average of 835m^3/s and 3.48m (Environment Canada, 2010). Again, during large freshets the water-surface elevation can be several meters greater than the long-term average. By late summer/early fall the Fraser River discharge and water levels drop and the floodplain study sites become isolated.

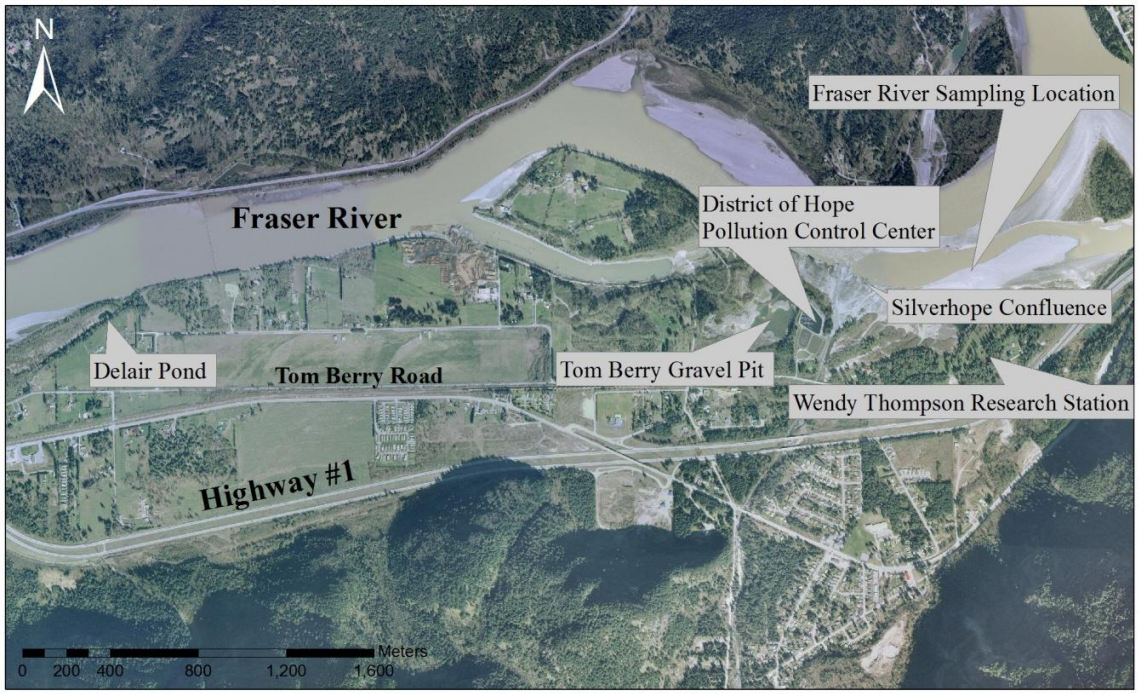

Figure 3. The 2010/2011 BCIT Fish, Wildlife and Recreation Hope Project study sites. This included: Tom Berry Gravel Pit, Delair Pond, the Fraser River Mainstem sampling location. The Pollution Control Centre, Silverhope Creek, and the Wendy Thompson Research Station are also shown.

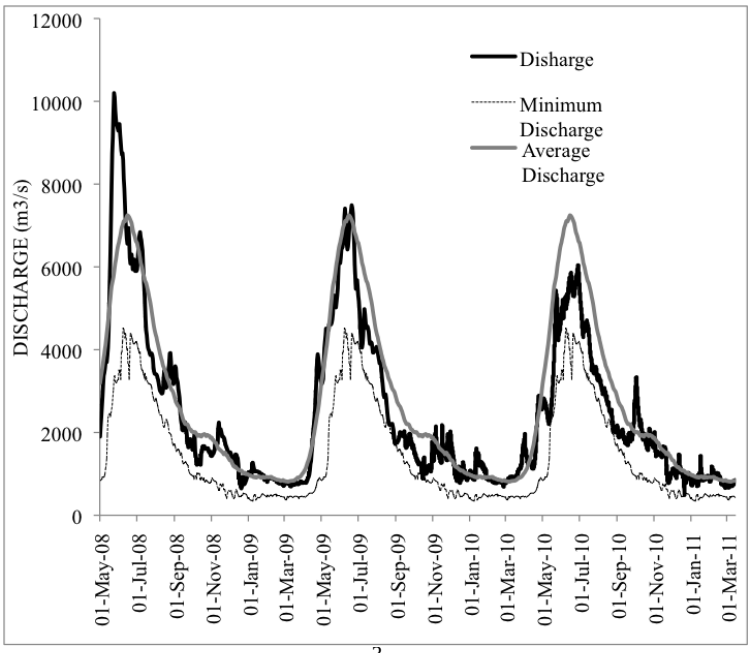

Figure 4. Water discharge (m^3/s) of the Fraser River near Hope BC (Water Survey of Canada Gauging Station 08MF005) from May 2008 to March 2011. The mean and minimum data was sourced from data collected from 1912 to 2009 (Environment Canada, November 2010). Freshet occurs at peak flows, approximately between May and July each year.

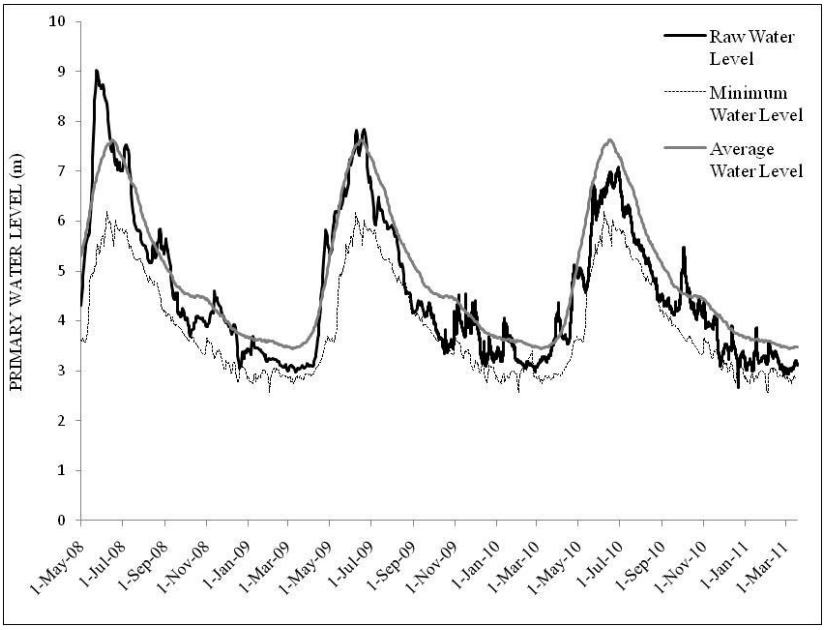

Figure 5. Primary water level (m) of the Fraser River near Hope BC (Water Survey of Canada Gauging Station 08MF005) from May 2008 to March 2011. The mean and minimum data were sourced from data collected from 1912 to 2009 (Environment Canada, November 2010). Freshet occurs at peak flows, approximately between May and July each year.

3.1 Tom Berry Gravel Pit (TBGP)

Tom Berry Gravel Pit (TBGP) (Fig. 6) is located in the District of Hope, just west of the District of Hope Pollution Control Center. The gravel pit was created in 1986 when aggregate was extracted from the site for use in building the Coquihalla Highway. For the purpose of this study, we separated the gravel site into two study sites, TBGP-1 and TBGP-2.

TBGP becomes inundated during spring/summer freshet, and then isolated from the Fraser River mainstem as the spring/summer flood levels recede (Misumi, 2010). Fish that enter the pond during freshet levels must remain in the pond over winter if they do not leave before the connectivity to the main river is cut off and isolating the pond; thus, for anadromous fish, they cannot migrate downstream to the estuary and the ocean if they wait too long to emigrate.

Vegetation surrounding TBGP is typical of the Coastal Western Hemlock zone (Meidinger and Pojar, 1991). Deciduous vegetation includes, black cottonwood (*Populous balsimifera*), paper birch (*Betula papyrifera*), red alder (*Alnus rubra*), snowberry (*Symphoricarpos albus*), willows (*Salix* sp.), bigleaf maple (*Acer macrophyllum*.), red-osier dogwood (*Cornus sericea*), and salmonberry (*Rubus spectabilis*). Coniferous species include Douglas-fir (*Psuedotsuga menziesii*), grand fir (*Abies grandis*) and western red-cedar (*Thuja plicata*).

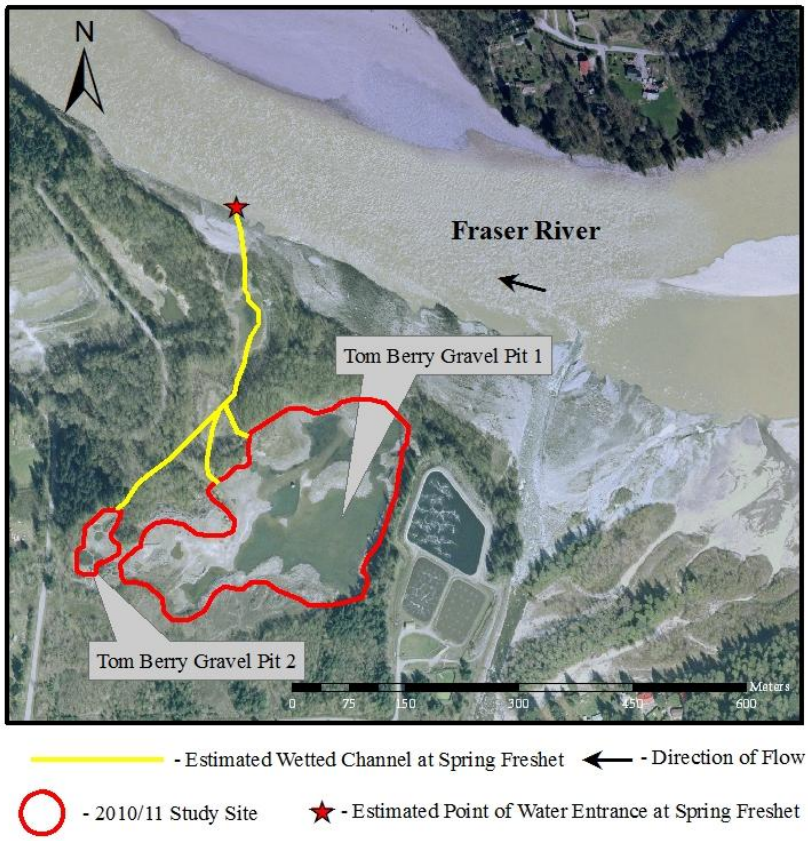

Figure 6. Tom Berry Gravel Pit (TBGP) site, encompassing 8.1 ha, is just west of the District of Hope Pollution Control Centre and Silverhope Creek. The area was split into two sampling sites for the 2010/2011 BCIT FWR Hope study; TBGP-1 and TBGP-2. Also shown is the estimated wetted channel at spring freshet and the likely point of water entrance.

3.1.1 Tom Berry Gravel Pit 1 (TBGP-1)

The largest water body in the Tom Berry Gravel Pit site was referred to as TBGP-1 (Figs. 7 and 8); this was an isolated pond within the greater TBGP aggregate extraction site (Fig. 6). The depth of the pond's benthic surface was variable, containing four basins that were separated by underwater gravel and mud bars. These basins become isolated from each other when water levels drop, exposing areas of gravel and stretches of mud. We separated TBGP-1 into two sections (A and B) and four basins (a,b,c,d) (Fig. 8). At low pond water levels, the various sections were separated because of the difference in elevation of the pond benthic topography. Section-B was slightly higher in elevation then

Section-A. During lower water levels in March 2011, water was observed flowing from Section-B into Section-A, temporarily raising the water level of Section-A while lowering the level in Section-B. TBGP-1 had a maximum depth of 2.09m (Basin-b) during early spring, on March 20, 2011 and with the Fraser River having a discharge of 802 m^3/s.

Figure 7. Tom Berry Gravel Pit 1 on October 9, 2010, looking east towards the Pollution Control Centre. Photo by: Stephanie Ells, 2010

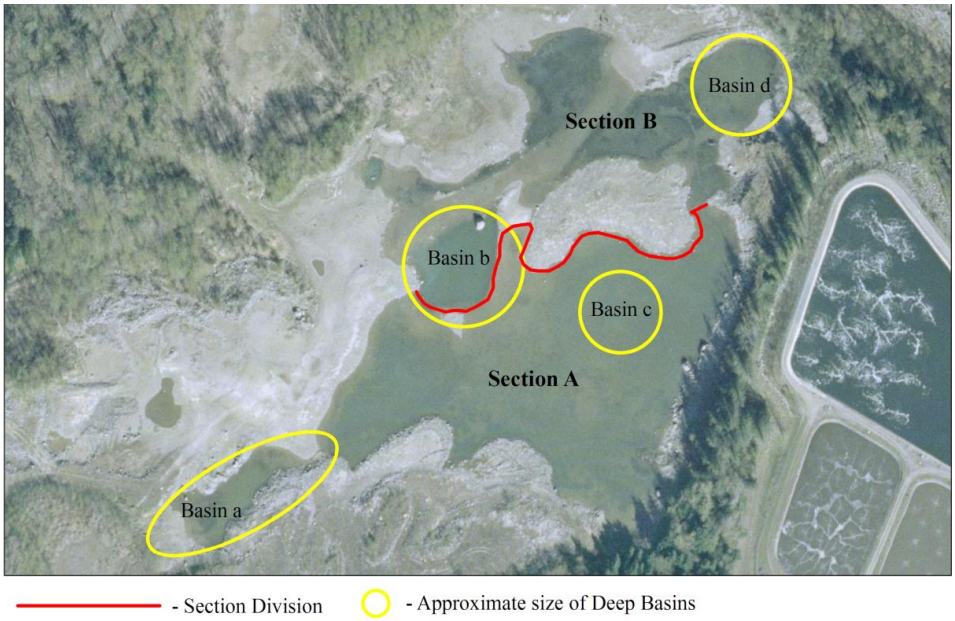

Figure 8. Tom Berry Gravel Pit -1 (TBGP-1) divided into Sections-A and -B, and Basins a,b,c,d for the purpose of the 2010/2011 BCIT FWR Hope study. Section-B is higher in bottom elevation than Section A. Basins a,b,c,d are areas of TBGP-1 where depth was notably deeper than Sections A and B. Basin a and b were the locations of fall and spring seine sampling.

3.1.2 Tom Berry Gravel Pit 2 (TBGP-2)

TBGP-2 was a small pond located in the eastern portion of the TBGP site (Fig. 6) During low water levels, TBGP-2 was separated into a series of four small basins divided by gravel bars. When the basins are connected during higher water levels, fishes intermingle among the basins. The basins within TBGP-2 were referred to as a, b, c, and d (Fig. 9).

Figure 9. Tom Berry Gravel Pit 2 separated into four basins labeled a, b, c, d for the purpose of the 2010/2011 BCIT FWR Hope study.

3.2 Delair Pond

Delair Pond (Figs. 10 and 11) is located within a man-made side-channel known as Delair Side Channel, in the District of Hope, BC. The site is best accessed via the Delair farm at 62180 Delair Road. The Delair Pond is hydraulically connected to the Fraser River mainstem in a downstream direction, via the Delair Side Channel, at two points

along the river during spring/summer freshet (Fig. 11). As water levels drop, Delair Pond is isolated from the Fraser River and the Delair Side Channel dries up, and fishes trapped in the pond are forced to overwinter until it reconnects to the Fraser River during the next spring freshet.

Figure 10. Delair Pond looking west. This photo was taken October 10, 2010 after a heavy rainfall event. Water levels on this day were the highest recorded during the 2010/2011 study period. Photo by Stephanie Ells, 2010.

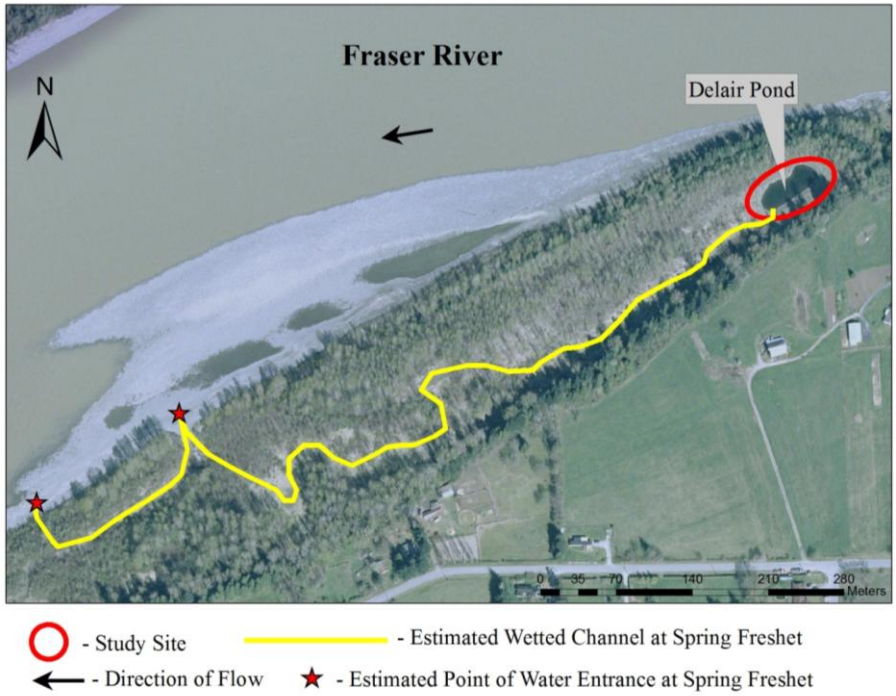

Figure 11. Delair Pond located in the Delair side-channel on the south bank of the Fraser River at 62180 Delair Road, Hope BC. The yellow line indicates the wetted channel known as Delair Side Channel and the red stars indicate the site of water entrance from the Fraser River.

The Delair Side Channel was originally constructed by RivTow Straits Ltd. for log-boom storage in 1959 (Frake *et al*., 2009; sourced from Delair, 2009). After the mid-1960's, a rock and gravel dyke was further constructed at the upstream end of the channel cutting off Fraser River inflow; subsequent sediment deposition and vegetation growth began to fill in the channel (Frake *et al*., 2009; sourced from Delair, 2009). Several decades ago and over several years, the property owners, the Delairs, observed that fishes were becoming stranded when the channel dried up during the winter. Jack Delair contacted the Department of Fisheries and Oceans (DFO) and initiated a site visit to determine if a permanent solution to prevent fish mortality could be undertaken (Frake *et al*., 2009; sourced from Delair, 2009). In 1995, enhancement of the site began. It involved digging out the east end of the channel, using an excavator, to create a permanently wetted pond. The enhancement also included placing in a fish shelter in the pond to create cover habitat. The shelter was constructed out of foot long plastic tubes enclosed in netting, and which was sunk at the east end of the newly created pond and secured in place by a concrete block (Bailey *at al.,* 2010; sourced from Foy, 2010). The pond has been known as Delair Pond ever since (Frake *at al*., 2009; sourced from Foy, 2008).

Delair Pond site is located in the Coastal Western Hemlock biogeoclimatic zone (Meidinger and Pojar, 1991) and the vegetation is typical of this zone. Deciduous vegetation includes black cottonwood, paper birch, red alder, snowberry, willows, broadleaf maple, red-osier dogwood, and salmonberry. Coniferous species include Douglas-fir, grand fir, and western red-cedar. Reed canary grass extends from the water edge's to the tree line.

3.3 Fraser River Seine Site

Assessment of the fishes utilizing the mainstem of the Fraser River (Fig. 12) was conducted on a gravel bar adjacent to the Wendy Thompson Research Station at 64043 Tom Berry Road, Hope BC (Fig. 3). The site was located approximately 0.5 km upstream

from the Silverhope Creek confluence into the Fraser River (Fig 3). This site was also sampled during the previous 2008/2009 and 2009/2010 FWR studies.

Figure 12. Fraser River main-stem seine location, on November 6, 2010, looking upstream towards the District of Hope. Photo by Stephanie Ells, 2010.

4.0 Sampling Methodology

4.1 Sampling Session Dates

Sampling of fishes at TBGP in 2010/2011 was conducted in two sessions, fall and early spring (Table 4). Two seine samples, using a 30 m seine net, (in TBGP-1 Basins a and b) and one day of minnow trapping were conducted on TGBP-1 in both fall and spring to determine fish-species composition and condition factor. For TBGP-2, during the fall sampling, fishes were captured with a 30 m seine net, marked, and recaptured one week later. Minnow trapping was conducted in one session on TBGP-2a in the spring.

Fishes in Delair Pond were sampled once each during the fall and the winter/spring. Fishes were captured using a 30 m seine net, sweeping the full length of the pond, with

one day of sampling utilized for marking the fishes and a second sampling day to collect recapture data. Recapture occurred three weeks after the mark phase in the fall and one week after the mark phase in the spring. Sampling of fish, using seining, was conducted on the Fraser River mainstem, during both day and night, during both fall and spring. Day seines were conducted around 9:00 hours in the fall and 16:00 hours in the spring, while night seines were conducted just before midnight in both fall and spring.

Bathymetric mapping and collection of random depth data were also collected on TBGP-1 on March 19 and 20, 2011 (Table 4). Additional water quality information on TBGP-1 and TBGP-2 was also collected on days when no fish were sampled (Table 4).

Table 4. Fish capture, site mapping, and additional water quality sampling dates for our four study sites. Fish marking dates are indicated by fin clip data (UC= upper caudal, LC=lower caudal) and R indicates recapture dates. Site-mapping dates were for bathymetric measurements. Additional water quality sampling dates took place on days when no fish were sampled.

Sampling Period	Fish Sampling Dates			
	Tom Berry Pit #1	Tom Berry Pit #2	Delair Pond	Fraser River
Fall	Oct 2, 2010 Nov 7, 2010 Nov 12, 2010	Oct 3, 2010 (UC) Oct 9, 2010 (R)	Oct 10, 2010 (UC) Nov 6, 2010 (R)	Nov 6 (Day) Nov 6 (Night)
Early Spring	Mar 19, 2011 Mar 20, 2011	Mar 19, 2010	Mar 18, 2011(LC) Mar 23, 2011 (R)	Mar 18 (Night) Mar 18 (Day)
Sampling Period	Site Mapping Dates			
	Tom Berry Pit #1	Tom Berry Pit #2	Delair Pond	Fraser River
Fall	n/a	Nov 20, 2010	n/a	n/a
Early Spring	Mar 19, 2011 Mar 20, 2011	n/a	n/a	n/a
Sampling Period	Additional Water Quality Sampling Dates			
	Tom Berry Pit #1	Tom Berry Pit #2	Delair Pond	Fraser River
Fall	Oct 3, 2010 Oct 9, 2010 Nov 11, 2010	Oct 2, 2010 Nov 7, 2010 Nov 11, 2010 Nov 20, 2010	n/a	n/a
Early Spring	Mar 23, 2011	Mar 20, 2011 Mar 23, 2011	n/a	n/a

4.2 Fish Capture and Mark-Recapture

Fish were captured using seines and minnow traps from TBGP-1 during fall and early spring. These samples were used to determine species composition and to compare condition factor of fishes between these seasons. Species composition and condition factor were also compared to assessments undertake in our other study sites in 2010/2011 as well as sampling undertaken in previous years.

Two seine-sampling sessions were conducted in fall and spring in TBGP-1. A 30-m seine (Fig. 13) was manually dragged across Basin a, and the ends were brought together along the shore. Captured fish were held in a holding pen created by placing the net on garden stakes hammered into the ground (Fig. 14), until transferred to the processing area in 20L buckets. The second seine, on Basin b was undertaken by boat in fall and by wading in spring. The seine net was deployed from the boat, which was paddled across Basin b in a semi-circle. Minnow trapping was also conducted to sample fishes. Forty minnow traps (Fig. 15) were baited with salmon roe in the afternoon and placed along the shoreline of TBGP-1. In all sessions, the traps were left over night, and the fish were collected in 20L buckets and processed the next morning.

A 30-m seine net (Fig. 13) was used to sample TBGP-2 in the fall a 30m seine net. The net was pulled manually across the middle of the pond and the ends were drawn together in a circle along the shore. This was done once at either side of the pond during the recapture phase due to a dividing gravel bar that the seine net could not be deployed over. Captured fish were held in a holding pen created by placing the net on garden stakes hammered into the ground (Fig. 14), until transferred to the processing area in 20L buckets. In the spring, ten minnow traps (Fig. 15) were baited with salmon roe in the morning and placed in TBGP-2a. The traps were left for the day and checked in the afternoon of the same day. Fish were collected in 20L buckets and processed.

Figure 13. Three-panel, 30m seine net with weighted led line (bottom) and float line (top) used to capture fish in the 2010/2011 BCIT FWR Hope study. (Source: Bailey *et al*., 2010; photo by: Hajar Courteau)


Figure 14. Holding pen for captured fish. Two garden stakes were hammered into the ground to hold up the 30m seine net so fishes could not escape. Photo by: Stephanie Ells.

Figure 15. Forty minnow traps were baited on the afternoon Nov. 11, 2010 with salmon roe before being placed into Tom Berry Gravel Pit to be left overnight. Photo by: Stephanie Ells.

Fish-sampling methodology at Delair Pond (Fig. 16) utilized methods described in Frake *et al*. (2009) and Bailey *et al*. (2010). A 30m seine net (Fig. 13) was pulled manually across the middle of the pond and the ends were drawn together in a circle along the shore. Captured fish were held in a holding pen created by placing the net on garden stakes hammered into the ground (Fig. 14). In the fall, during the mark phase, pole seining was also conducted on a small section of shallow water connecting to the west end of the pond. The pole seine was manually dragged through the water and looped together. Captured fish were placed in a 20L bucket for processing.

Figure 16. Seining of Delair Pond on Nov. 10, 2010. A 30m seine net was dragged across the pond to capture fish for sampling. Photo by: Heather Hutchinson.

Seining in the Fraser River mainstem (Fig. 17) consisted of having one end of a 30m seine net (Fig. 13) attached to an inflatable boat, while the other end was tied to a rope that was being held on shore. The boat was paddled towards the center of the channel at a ferry angle and then paddled downstream parallel to shore while the net was manually deployed from the stern of the boat. The boat was then paddled back to shore, and both ends of the net were brought together. Fish were collected from in 20L buckets for processing. Both fall and spring day and night seining-sampling sessions in the Fraser River were conducted three times, moving further downstream for each subsequent seine haul. Fishes caught from the Fraser River were placed in 20L buckets full of water and immediately processed.

Figure 17. Nov. 6, 2010 day seine on the Fraser River. Net was deployed from an inflatable kayak, which was paddled upstream. Once the net was deployed the boat was then moved downstream with the current and paddled back to shore. Two people remained on shore to act as anchors. Photo by: Stephanie Ells.

For the seine samples, fishes immediately ready to be processed were placed in 20L buckets full of water. This comprised of a subset of the catch of any given seine haul as only a small number of fish were taken at a time in the bucket while the rest remained in the holding pen in order to ensure maximum survival. Water was refreshed in the buckets if fishes were showing signs of stress.

For the minnow trappings, one trap was processed at a time. Fish caught in the trap were placed in 20L buckets full of water and the same processing steps were taken as those captured by seining in order to ensure maximum survival. For all sampling sessions, fish were placed in plastic viewing containers to help with identification (Fig. 18); a dichotomous key (McPhail, 2007) was used to confirm species ID.

Figure 18. A Chinook being placed in the clear plastic viewing container for identification during the initial capture phase on Delair Pond.

Voucher specimens were collected and retained if specimens could not be identified in the field. Specimens were stored in 10% formalin and later identified to species by Dr. M. Rosenau and Dr. J.D. McPhail. All salmonids, and the first 30 of all non-salmonid species, were weighed (grams) with an electronic scale and measured (millimeters) to fork length (total length for sculpin species). All fish-parameter data were recorded on pre-made field cards. These data were used to calculate body condition factor at each site for comparative purposes.

Population estimates were calculated using the Lincoln-Peterson Mark-Recapture Method. The estimates, along with 95% confidence intervals for population size, were determined by entering collected data into the online Lincoln-Peterson Mark-Recapture Applet at: http://people.hws.edu/ryan/Ryan/Pages/Petersen2.html.

The Lincoln-Peterson method assumes the following:

- The population is sampled only twice; once initially to mark a subset and again, later, to count the number of recaptures.
- The population is closed during the sampling period.
- Each individual in the population has an equal probability of being captured.
- The mark used to identify the individual does not harm the animal or reduce the

chances of it being captures again in the second session.

It is our opinion that none of these key assumptions were significantly violated during our study.

Data required for the analysis are:
n_1 = total number of marked and released individuals during the initial mark phase
n_2 = total number captured in the recapture phase
m_2 = total number found marked in the recapture phase

Total population size (N) was calculated using:

$$N = [\frac{(n_1 + 1)(n_2 + 1)}{m_2 + 1}] - 1$$

95% confidence intervals for population were calculated. The following equation was used to calculate plus and minus values (W1 and W2):

$$W1, W2 = p \pm \left[1.96 \sqrt{\frac{p(1-p)(1-\frac{m_2}{n_1})}{(n-1)+\frac{1}{2n_2}}} \right]$$

$p = m_2 \div n_2$

To obtain the 95% confidence values for N, W1 and W2 were divided into n.

This method of population estimation was conducted in the fall and spring for both Delair Pond and in the fall on TBGP-2. During the marking phase, all fishes (except sculpin species; mark-recapture on sculpins was not conducted) had their upper caudal fins clipped in the fall, and lower caudal fins clipped in the spring. For the recapture phase, sampling was conducted no later than two weeks for fish in TBGP-2 and Delair Pond in spring, and four weeks in the fall on Delair Pond (two weeks later due to unforeseen circumstances). Once fish were captured the second session, caudal fins were checked to

determine if the fish was marked, and fishes were tallied and recorded by species as clipped or not clipped.

Condition factor (K) was calculated for Chinook, and coho salmon, to provide an understanding of their overall health. A K factor of less than one indicates poor health while a K factor of greater than one suggests good health (Williams, 2000). Condition factor was calculated with the following equation:

$$K = \frac{W\ x\ 100{,}000}{L^3}$$

W = weight (g)
L = length (mm)
100 000 = scaling factor

4.3 Physical Parameters

Water temperatures were recorded using three Tidbit v2 Temp data loggers. These were placed in the Fraser River mainstem, as well as TBGP-1 and TBGP-2, for the duration of the project. The data loggers were secured in the hollows of concrete blocks and roped to another concrete block on shore for security, and then sunk into the water. Data loggers were placed in the Fraser River and in TBGP-1 October 2, 2010 and in TBGP 2, October 9, 2010. The data loggers recorded water temperature (in degree Celsius) at 15-minute intervals during the study period and this information was downloaded to a computer for analysis at the end of the field-sampling period.

Using a handheld, Hach SensIon 156 meter, pH, conductivity, dissolved oxygen, and air and water temperatures (degrees Celsius), were recorded at surface levels on TBGP-1, TBGP-2, and Delair Pond, for each site visit. Turbidity was also recorded using the Hach

2100P Turbidimeter. Water-elevation staff gauges were placed into TBGP-1 and TBGP-2 for the duration of the study and changing water levels were recorded at each site visit.

4.4 Site Mapping

A topographical map from BC Water Surveys Unit and Canada-BC Floodplain Mapping Program was analyzed to assess the elevations of TBGP and Delair Pond. The topographical information, with elevations accurate to 1 m, was used to estimate the path of water into TBGP during spring freshet. The map was also used to determine if both study sites were inundated at the same time.

Bathymetric measurements were undertaken on TBGP-2a in the fall and sections of TBGP-1 in the spring. A 3x5m-interval (basin-a) and a 5x5m interval (basin-b) grid pattern were placed over TBGP-1 and a 3x3m-interval grid pattern was placed over TBGP-2a. Water depths were measured at each designated point from a kayak (or by wading in TBGP-1 basin-a) and by using a weighted Eslon tape. Measurements at each grid point were recorded and inputted into Excel. Random depth measurements were also taken throughout TBGP-1 to determine average depths as well depths of small basins within the water body; these data were used to determine depth characteristics of Sections A and B as well as Basins c and d.

5.0 Results

5.1 Tom Berry Gravel Pit-1

5.1.1 Physical Parameters

The water levels in TBGP-1 fluctuated throughout the sampling dates. During sampling in early October 2010, TBGP-1 was observed to be much more connected throughout the pond than later in November 2010. During spring sampling in March 2011, when bathymetric measurements were made, the water level was lower still and discontinuities were seen. Basin-a (Fig. 19) was separate from Section-A in September 2010 but the two parts were rejoined during the above-average Fraser River discharge levels in October 2010, presumably due to increased water pressure though sub-surface connection between the pond and the main stream. These separate water bodies became isolated from each other, again, when sampling reconvened in March 2011. Basin-b (Fig. 20) also became isolated from Sections A and B in March 2011.

The average depth of TBGP-1 on March 20, 2011 during the Fraser River discharge of $800m^3/s$ was 0.51m in Section-A and 0.45m in Section-B. Basin-a, b, c, and d's deepest points at this time were recorded at 1.80m, 0.67m, 0.78m, and 0.55m, respectively. When studies commenced in March 2011, the water level in TBGP-1 had dropped 0.30m since the last record in November 2010 after having already dropped considerably between October and November 2010 (Table 5). However no accurate estimation could be made for overall depth of TBGP-1 during this time due to the needed replacement of the meter stick placed in TBGP-1. Surface area for TBGP-1 was never calculated owing to the irregular shape and large size of the pond.

Recorded surface water temperatures in TBGP-1 showed a steady decline through fall to winter, from 17°C on October 2, 2010 down to 7°C on November 12, 2010. When spring sampling commenced on March 18, spot temperatures were recorded at 7°C. Data from a Tidbit placed in TBGP-1 (Fig. 21) showed the same decline in water temperatures from October to November, but indicates lower temperatures of between 1 and 2 °C throughout December 2010, with yet another decline in January, reaching slightly below -3°C on January 10, 2010. From this point temperature varied, increasing from 2°C in early winter to 7°C in early spring.

Table 5. Physical data collected at Tom Berry Gravel Pit 1 during the 2010/2011 study Water temperature were spot temperatures taken at random locations throughout the pond and averaged. Depth was taken in Basin-b and were recorded as relative water surface elevation changes.

Date	Air Temperature (°C)	Water Temperature (at surface) (°C)	Depth	Discharge at Hope (m^3/s)
Oct. 2, 2010	22	17	n/a	3267
Oct. 3, 2010	15	17	n/a	3234
Oct. 9, 2010	15	14	gauge reads 46.7cm	2193
Nov. 7, 2010	12	10	-113cm	1529
Nov. 11, 2010	7	7	n/a, reset gauge 60.8cm	1487
Nov. 12, 2010	8	7	-0.4cm	148
Mar. 19, 2011	11	7	-30.3cm	807
Mar. 20, 2011	11	7	+1.5cm	800
Mar. 23, 2011	13	n/a	-2.3cm	793

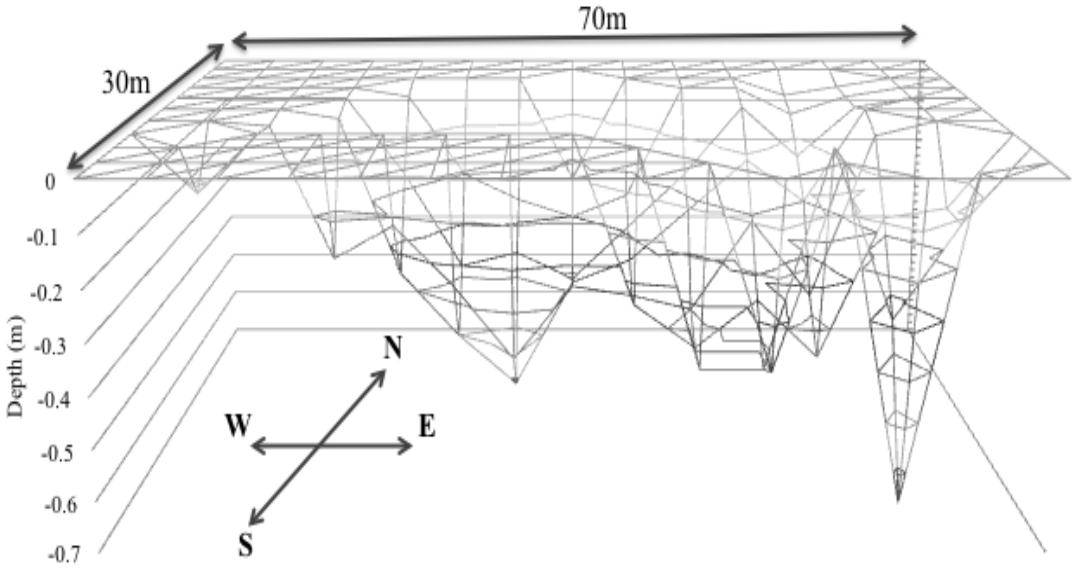

Figure 19. Bathymetric profile of Tom Berry Gravel Pit-1 basin-a. Data collected on March 19, 2011.

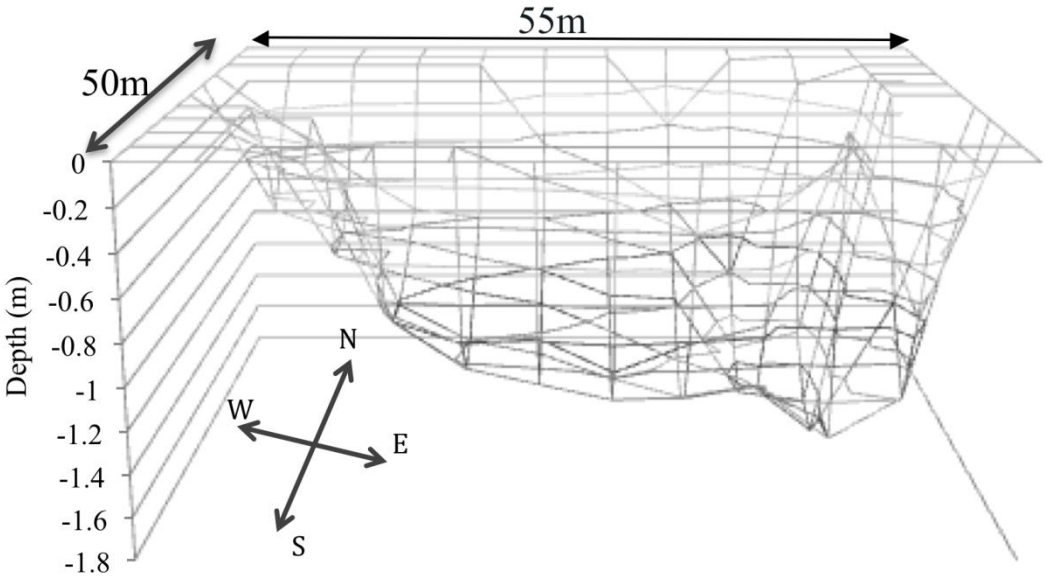

Figure 20. Bathymetric Profile of Tom Berry Gravel Pit-1 basin b. Data collected on March 20, 2011.

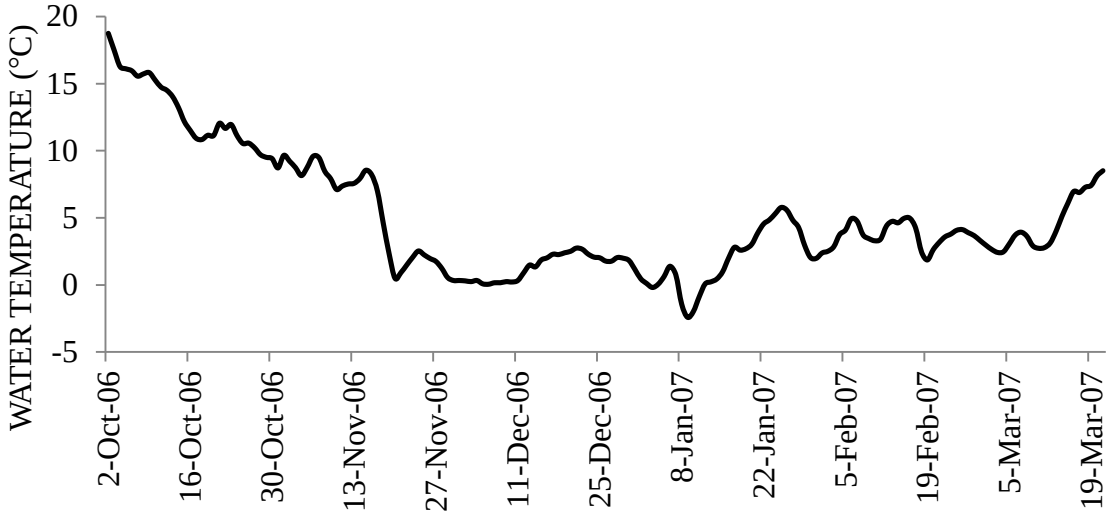

Figure 21. Tom Berry Gravel Pit-1 Tidbit v2 datalogger water temperatures from October 3, 2010 to March 22, 2011.

5.1.2 Fish Parameters

5.1.2.1 Non-Salmonid Species

Six species of fish from three families (Catostomidae, Cottidae, and Cyprinidae) were captured from TBGP-1 during our study (Table 6). During the October 2 seine session, high mortalities began to occur due to stress while the fish were being held in the net pen; thus we quickly released the fish (total catch estimated >1000) before they could be completely inventoried and counted. Redside shiner and peamouth chub juveniles were counted as one species for the October 2 seine session due to difficulties in identification. All species caught in the fall seine sessions (Oct. 2 and Nov. 7) were juveniles based on length (McPhail, 2007; Table 7). Based on fish lengths and body colouration (McPhail, 2007; Table 8), catches during the November 12 minnow-trapping comprised juveniles from all of the non-salmonid species previously captured as well as likely-sexually-mature redside shiners and prickly sculpins. Catch per unit effort (CPUE) (Table 9) of non-salmonids, from the November 12 minnow-trap session, ranged from 0.18 common carp per trap to 0.78 peamouth chub per trap, with redside shiners and prickly sculpin having similar CPUE's as peamouth chub at 0.75 and 0.73 fish/trap respectively.

Catches by the November 12 minnow-trapping included juveniles from all non-salmonid species as well as potentially sexually mature redside shiners and prickly sculpins (McPhail, 2007; Table 8). Seines in the spring session caught one mature largescale sucker, and ten large mature common carp (Table 7). The two spring seines also caught juvenile prickly sculpin, peamouth chub, and redside shiners and these were mature specimens based on fish-body lengths (McPhail, 2007). CPUE (Table 9) of non-salmonids, from the March 20 minnow-trap session, ranged from 0.03 largescale sucker per trap to 1.48 prickly sculpin per trap. Unlike fall, no common carp were caught in traps.

Table 6. Species and numbers of fishes caught from Tom Berry Gravel Pit-1 by seine during two fall (Oct. 2 and Nov. 7, 2010) and two spring (March 19, 2011; data for seines were combined) sampling sessions, and in fall (Nov. 12, 2010) and spring (March 20, 2011) by minnow-traps.

Species	Oct. 2, 2010 seine catch *	Nov. 7, 2010 seine catch	Nov. 12, 2010 minnow trap catch	March 19, 2011 seine catches	March 20, 2011 minnow trap catch
largescale sucker	0	0	0	1	1
prickly sculpin	1	4	29	438	59
common carp	0	0	7	10	0
minnow spp.*	203	-	-	-	-
peamouth chub	-	25	31	90	49
redside shiner	-	25	30	46	44

* estimated >1000 fish released before tallied; juvenile peamouth chub and redside shiner not differentiated between species for this sampling session.

Table 7. Average lengths and weights of non-salmonids caught by seining from Tom Berry Gravel Pit-1 during Fall (Oct 2. and Nov. 7, 2010) and Spring (March 19, 2011) seines. With 95% confidence intervals.

Species	Early Fall				
	Sample Size (n)	Mean Length (mm)	95% Confidence Intervals	Mean Weight (g)	95% Confidence Intervals
prickly sculpin	5	40.2	32.6 - 47.8	0.50	n/a
peamouth chub	25	60.1	58.3 - 61.9	1.08	0.98 - 1.18
redside shiner	24	42.3	40.6 – 43.9	0.52	0.48 – 0.56
Species	Early Spring				
	Sample Size (n)	Mean Length (mm)	95% Confidence Intervals	Mean Weight (g)	95% Confidence Intervals
largescale sucker	1	357	n/a	243.5	n/a
prickly sculpin	30	38.3	36.3 – 40.3	0.50	0.50 – 0.50
common carp	10*	546.6	520 – 573	1811.75	1602.5 – 2021.0 **
peamouth chub	30	60.4	58.8 – 62.1	0.92	0.85 – 0.99
redside shiner	30	40.7	38.6 – 42.9	0.50	0.50 – 0.50

* sample size of 2 was used for mean weight
** range is given

Table 8. Average lengths and weights of non-salmonids caught in Tom Berry Gravel Pit-1 during fall (Nov. 12, 2010) and early spring (March 20, 2011) minnow-traps. With 95% confidence intervals. For species with a sample size less than 10, range is given instead of confidence. Redside shiners are separated into juveniles (1) and potentially sexually mature (2).

Species	Early Fall				
	Sample Size (n)	Mean Length (mm)	95% Confidence Intervals	Mean Weight (g)	95% Confidence Intervals
prickly sculpin	29	84.2	75.3 – 93.2	4.38	3.19 – 5.57
common carp	7	63.7	49 - 80	3.21	1.5 – 6.0
peamouth chub	31	60.7	59.5 - 62.0	1.03	0.95 - 1.11
redside shiner (1)	14	48.9	44.3 – 47.4	0.61	0.48 – 0.73
redside shiner (2)	16	97.1	91.9 – 102.2	5.78	4.85 – 6.71
Species	Early Spring				
	Sample Size (n)	Mean Length (mm)	95% Confidence Intervals	Mean Weight (g)	95% Confidence Intervals
largescale sucker	1	80	n/a	2.0	n/a
prickly sculpin	30	95.9	87.9 – 104.0	3.51	4.69 – 7.31
peamouth chub	30	62.4	61.1 – 63.7	1.02	0.96 – 1.08
redside shiner (1)	11	43.2	40.4 – 46.0	0.50	0.50 – 0.50
redside shiner (2)	19	92.7	88.2 – 97,2	4.95	4.22 – 5.67

Table 9. Catch per unit effort (fish per trap) of non-salmonids caught in minnow-traps in Tom Berry Gravel Pit-1 on Nov. 12, 2010 and March 20, 2011. Forty traps were placed around TBGP-1 in the afternoon of Nov. 11 and March 20, and processed the following morning.

Species	November 12, 2010		March 20, 2011	
	Minnow-trap catch	Catch per Unit Effort (fish/trap)	Minnow-trap catch	Catch per Unit Effort (fish/trap)
largescale sucker	0	0.00	1	0.03
prickly sculpin	29	0.73	59	1.48
common carp	7	0.18	0	0.00
peamouth chub	31	0.78	49	1.23
redside shiner	30	0.75	44	1.10

Two specimens of common carp caught in March 19, 2011 seines were taken back to the lab for sampling. Due to their large size, the carp were not weighed in the field, thus weights were recorded only for the laboratory specimens. One of the carp that was taken was found to have considerable numbers of eggs in its body cavity and would have spawned the next spring. Upon examining their stomach contents, the carp were both found to contain plant matter in their stomachs, while one of the carp was also found to have mollusk shells in its stomach. Scale analysis revealed the carp to be around six or seven years of age.

Of the six species of non-salmonids caught in TBGP-1, only three were caught consistently in both fall and spring in both seine nets and minnow-traps. Juvenile peamouth chub, redside shiner, and prickly sculpin caught in seine nets did not show a significant increase in average length from fall to early spring (t-test; t=0.27, p=0.791; t=1.10, p=0.278; t=0.33, p=0.745 respectively). The same three species were also caught in minnow traps in both fall and spring; however, the traps also caught likely-mature reside shiners and prickly sculpin along with juveniles. Consistent with seine catches, all fish caught in minnow traps did not show a significant increase in length from fall to early spring (t-test; peamouth chub t=1.85, p-0.070; juvenile redside shiner t=1.95, p=0.063; juvenile prickly sculpin t=0.71, p=0.485; potentially mature redside shiner t=1.34, p=0.190; potentially mature prickly sculpin t=0.63, p=0.532).

5.1.2.2 Salmonid Species

Five Chinook salmon juveniles were caught in TBGP-1 during the seine sampling session on October 2, 2010 and one coho was caught during the minnow-trapping session on November 12, 2010 (Table 10). No salmonids were caught during the November 7 seine. No salmonids were caught in the spring sampling sessions in either seine nets or minnow traps. While high-heat stress led to mortalities of non-salmonids for the October 2 seine haul, all Chinook were identified, measured, and quickly released early in the sampling

session. Lengths of Chinook (Table 10) ranged from 90-150mm which, based on McPhail (2007), would put them into the second year-class. The one coho that was caught was 92mm in length (Table 10). Coho fry reach 80-90mm on average in their first year (McPhail, 2007).

Condition factor (K) was calculated for both Chinook and coho from TBGP-1 and ranged from 0.46 to 0.62, with the average condition factor for Chinook being 0.58 and the single coho juvenile having a condition factor of 0.58. No salmonids were captured in the spring sampling sessions.

Table 10. Lengths, weights, and 95% confidence intervals of salmonids caught in Tom Berry Gravel Pit-1 during sample sessions (Oct. 2 seine and Nov. 12, 2010 minnow-trapping).

Species	Sample Size (n)	Mean Length (mm)	Range (mm)	95% Confidence Intervals	Mean Weight (g)	Range (g)	95% Confidence Intervals
Chinook	5	113.8	90 - 150	84.1 - 143.5	9.30	4.5 – 20.0	1.59 - 17.01
coho	1	92.0	n/a	n/a	4.50	n/a	n/a

5.2 Tom Berry Gravel Pit-2

5.2.1 Physical Parameters

A bathymetric profile was completed for TBGP-2a (Fig. 22). This pond was approximately circular in surface shape with the deepest area to be in the west end of the pond.

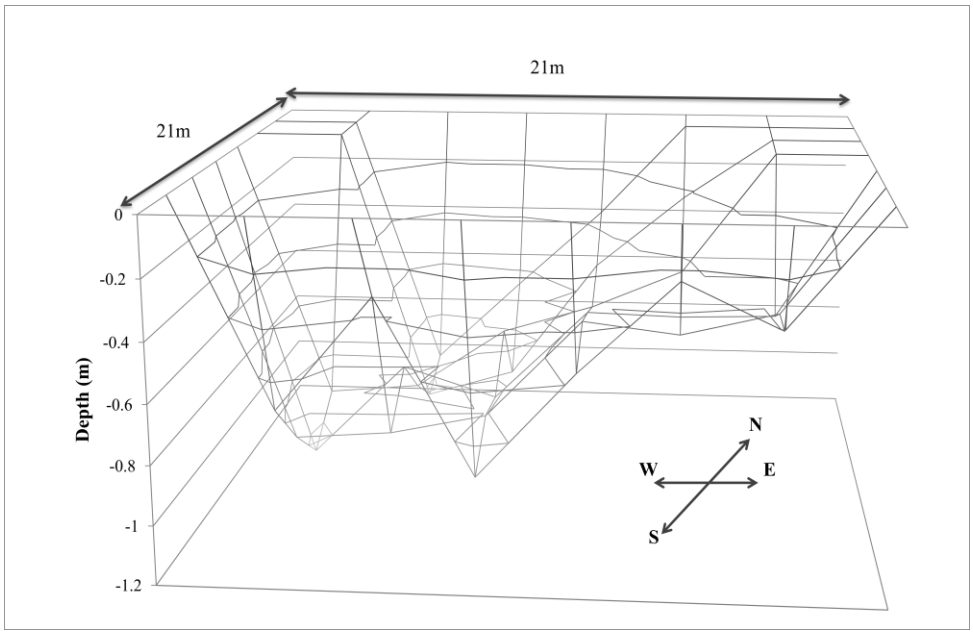

Figure 22. Bathymetric profile of Tom Berry Gravel Pit-2a. Measurements taken Nov. 20, 2010.

The water levels in TBGP-2 fluctuated throughout the sampling dates (Table 11). The four distinct basins (a,b,c,d) were separated from each other in September but became one continuous water body when sampled in October during above-average Fraser River discharge levels for that time of the year. The surface area of TBGP-2 was 2235m^2 on October 3, 2010. Over the next several weeks water levels then dropped substantially and TBGP-2 was separated into four distinct basins by November 7, 2010. During this time, the combined surface area for the four basins was 699m^2 on November 7, 2010. Water levels continued to drop over the winter and when sampling reconvened in March, TBGP-2a was the only one of the basins to contain water, having a surface area of 215m^2; this was a 142m^2 decrease from the last record on November 7, 2010. The deepest-recorded depth of TBGP-2 was in TBGP-2a and was 2.1m on October 3, 2010. The depth gauge, which had been placed in TBGP-2c was relocated into TBGP-2-a in March since TBGP-2c had dried up. Water level in TBGP-2a was recorded at 0.51m (not the deepest point) on March 20, 2011 and then further fell by 0.1m by March 23, 2011 when the study concluded.

Recorded surface water temperature in TBGP-2 was at its highest during fall at 18°C on October 2 2010, and from fall to early winter it declined from 7.25°C to -0.5°C, and increased again by early spring to 6.6°C (Table 11). This temperature trend was also apparent from data retrieved from a Tidbit placed in TBGP-2 (Fig. 23). From its highest point in the fall, the temperature steadily declined as the winter progressed. Reaching its lowest temperature of -3°C in January 2011, it increased into late winter before climbing again by March 2011.

Table 11. Physical data recorded for Tom Berry Gravel Pit-2 during the 2010/2011 study. Water temperatures were obtained by spot temperatures. Depth measurements were recorded as relative water surface elevation changes.

Date	Air Temp. (°C)	Water Temp. (at surface) (°C)	Depth	Surface Area (m^2)	Discharge at Hope (m^3/s)
Oct. 2, 2010	22	18	n/a	n/a	3267
Oct. 3, 2010	15	18	gauge reads 71.2cm	2235	3234
Oct. 9, 2010	15.3	16	-8.4cm	n/a	2193
Nov. 7, 2010	12	n/a	-109cm, reset gauge 44.3cm	698.97*	1528
Nov. 11, 2010	7	7.25	-2.1cm	n/a	1487
Nov. 20, 2010	-3	-0.5	+16cm	n/a	1506
Mar. 19, 2011	10.6	6.2	n/a	n/a	806
Mar. 20, 2011	11.3	6.6	Reset at 51.0cm**	215***	800
Mar. 23, 2011	13	n/a	-10.5cm	n/a	793

* surface areas combined (a=356.5m^2 b=98.92m^2, c=112.12m^2, d=131.45m^2)
** Not current with previous depth measurements.
*** TBGP-2a only

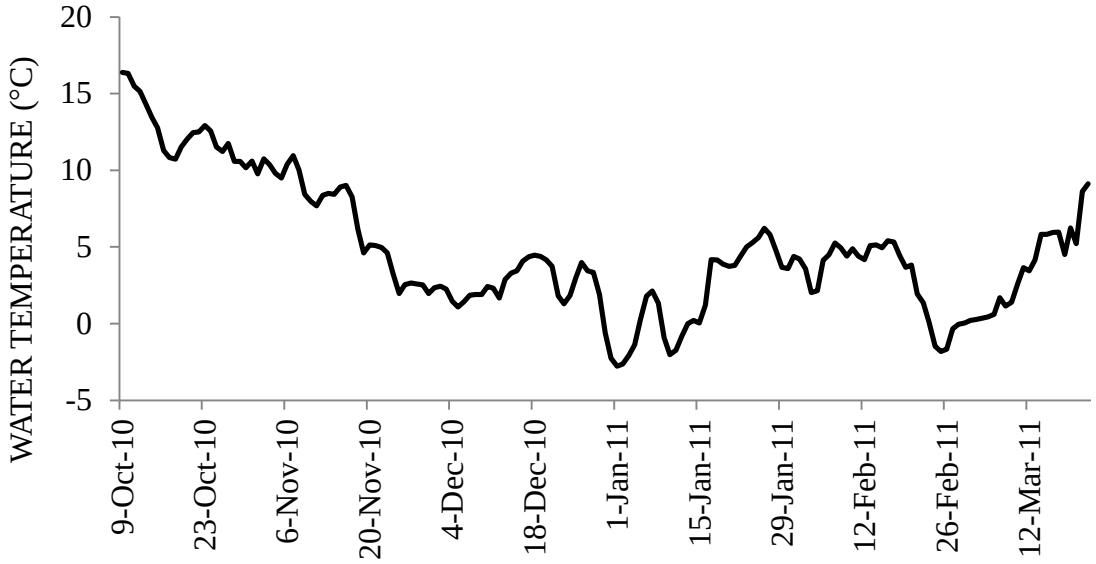

Figure 23. Water temperatures in Tom Berry Gravel Pit-2 from data recorded on a Tidbit v2 Temperature Logger, from October 9, 2010 to March 22, 2011.

5.2.2 Fish Parameters

In the fall, five species of fishes from three families (Cyprinidae, Cottidae, and Catostomidae) were captured by seine in TBGP-2 during the study (Table 12). No salmonids were captured. During the mark phase, juvenile redside shiner and peamouth chub were not distinguished from each other due to difficulties in identification relating to their small sizes. This issue was subsequently resolved and during the recapture phase, and there were approximately eight redside shiners caught for every one peamouth chub. Prickly sculpin, peamouth chub, and redside shiners were all likely young juveniles based on length (McPhail, 2007, Table 13). Common carp had lengths ranging from 33-158mm and were likely one and two year juveniles (McPhail, 2007; Table 13). All largescale suckers caught were likely second year juveniles (McPhail, 2007; Table 13).

In the spring, the water bodies comprising TBGP-2b, c, and d had completely dried up, with only TBGP-2a containing water. Only one prickly sculpin was caught during a minnow-trap session from TBGP-2a, which resulted in a catch per unit effort of 0.1 fish/trap. The prickly sculpin had a length of 46mm and weighed 0.5g. There was also a

single prickly sculpin observed swimming outside the traps when they were removed from the water but it was not captured.

Table 12. Mark-recapture population estimates for fishes caught by seine in Tom Berry Gravel Pit-2 during the Fall (Oct. 3 and 9, 2010) with 95% confidence intervals.

Species	Population Estimates	95% confidence intervals
prickly sculpin	147*	n/a
largescale sucker	21	n/a**
common carp	454	n/a**
juvenile peamouth chub and redside shiner ***	4413	3786 - 5390

* minimum estimate, no mark-recapture
** sample size to small
*** not differentiated between during mark phase

Table 13. Lengths and weights of non-salmonids caught by seine in Tom Berry Gravel Pit-2 during sample sessions (Oct 3 and 9, 2010), with 95% confidence intervals. Peamouth chub and redside shiner data were obtained from the recapture session when species were distinguished between.

Species	Sample Size (n)	Mean Length (mm)	95% Confidence Intervals	Mean Weight	95% Confidence Intervals
prickly sculpin	30	43.6	39.8 - 47.3	0.70	0.56 – 0.84
largescale sucker	21	83.7	81.3 - 86.0	3.55	3.29 - 3.81
common carp	30	60.7	51.0 - 70.5	4.60	1.58 - 7.62
peamouth chub	30	69.1	65.4 - 72.2	3.70	3.14 - 4.26
redside shiner	30	36.7	34.9 - 38.6	0.80	0.63 - 0.97

5.3 Delair Pond

5.3.1 Physical Parameters

Depth measurements for Delair Pond were not taken during this project, but the deepest section of the Pond, which was determined by Frake *et al*. (2009) during their bathymetric mapping of Delair Pond in November 2008, was in the eastern section of the pond (Fig. 24).

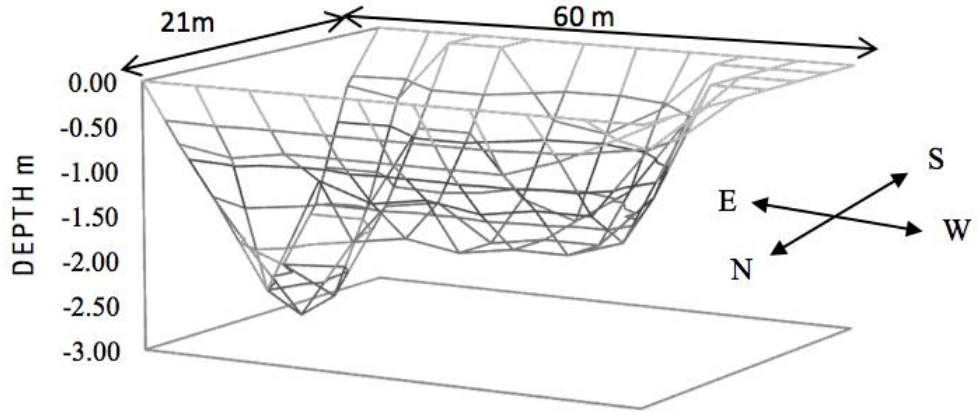

Figure 24. Bathymetric profile of Delair Pond. Source: Frake *et al*. 2009.

Surface area of Delair Pond (Table 14) during fall 2010 was measured at 1760m² on October 10, 2010. The pond then dropped in surface area to 898m² by November 6, 2010. During early spring, the surface area had decreased to 867m² on March 18, 2010, and then continued to decline to 849m^2 at the conclusion of the study on March 23, 2011. Based on observations during sampling sessions, continuous drop in surface area fluctuated along with the decreasing water levels of Delair Pond.

Recorded spot surface-water temperatures remained relatively consistent during October 10, and November 6, 2010 at 14°C and 12°C respectively. The temperature was recorded at its coldest on March 18, 2011 at 8°C (Table 14); however, the temperature would have dropped close to zero as the winter progressed. A Tidbit v2 Temp data logger was not placed in Delair Pond for the duration of this year's sampling, therefore temperature data were only be recorded at the surface and only during sampling days.

Table 14. Physical data recorded for Delair Pond during the 2010/2011 study.

Date	Air Temperature (°C)	Water Temperature (at surface) (°C)	Surface Area (m^3)	Discharge at Hope (m^3/s)
Oct. 10, 2010	14	14	1760	2291
Nov. 6, 2010	14	12	898	1484
Mar. 18, 2011	10	8	867	806
Mar. 23, 2011	13	9	849	792

5.3.2 Fish Parameters

5.3.2.1 Non-Salmonid Species

Four species of non-salmonids fishes from two families (Catostomidae, Cottidae, and Cyprinidae) were found in Delair Pond during the study (Table 15). In the fall only two species were captured; prickly sculpin and redside shiner. No mark recapture study was undertaken for the sculpins. Due to low numbers of prickly sculpin caught during the fall mark-recapture, only a minimal estimate can be determined by adding the fish captured on both mark and recapture days. The mean population estimate of redside shiner was 1357. Most non-salmonids were juveniles, based on length (McPhail, 2007; Table 16), except for one large prickly sculpin, which that had a length of 169mm and weighed 32.5 and which had likely reached maturity, and some mature redside shiners (McPhail, 2007).

In the spring, during the mark-phase, the only non-salmonids found in Delair Pond included prickly sculpin and redside shiner. During the recapture phase, additional species included largescale sucker and pikeminnow (Table 15). Therefore, only minimum estimates can be made for largescale sucker (20 individuals) and northern pikeminnow (two individuals).

The mean population estimate of redside shiners dropped from 1357 in the fall to 758 in the spring. Most non-salmonids caught from Delair Pond were probably juveniles based on their lengths, except for all specimens of largescale suckers, which were sexually mature based on length). The redside shiners also included some potentially mature specimens as well (Table 16). Average lengths of prickly sculpin and juvenile redside shiner did not show a significant increase from fall to early spring (t-test; $t=0.17$, $p=0.860$; $t=1.21$, $p=0.235$ respectively).

Table 15. Mark-recapture population estimates for non-salmonids caught in Delair during fall (Oct. 10 and Nov. 6, 2010) and early spring (March 18 and 23, 2011) sample sessions, with 95% confidence intervals.

Species	Fall		Early spring	
	Population Estimates	95% Confidence Intervals	Population Estimates	95% Confidence Intervals
largescale sucker	0	n/a	20**	n/a
prickly sculpin	14*	n/a	29*	n/a
northern pikeminnow	0	n/a	2**	n/a
redside shiner	1357	990 - 2537	758	704 - 823

* minimum estimate, no mark-recapture
** none caught during mark phase

Table 16. Mean lengths and weights of non-salmonids caught during fall (Oct. 10 and Nov. 6, 2010) and early spring (March 18 and 23, 2011) sample sessions with 95% confidence intervals. For species with sample size below 15, range is given instead of confidence intervals. Redside shiners were separated juveniles (1) and potential sexually mature fish (2) based on length and weight data; they were not separated in overall population estimates and field counts.

Species	Fall				
	Sample Size (n)	Mean Length (mm)	95% Confidence Intervals	Mean Weight	95% Confidence Intervals
prickly sculpin	14	52.6	30 - 169	3.00	0.5 – 32.5
redside shiner (1)	29	48.9	47.5 – 50.3	0.80	0.66 – 0.86
redside shiner (2)	2	109.5	109 - 110	8.0	7.5 – 8.5
Species	Early Spring				
	Sample Size (n)	Mean Length (mm)	95% Confidence Intervals	Mean Weight	95% Confidence Intervals
largescale sucker	20	295.8	284.5 – 307.1	255.13	214.13 – 296.12
prickly sculpin	23	37.8	33.3 – 42.3	0.61	0.50 – 0.72
northern pikeminnow	2	143.0	91 - 195	21.75	3.5 – 40.0
redside shiner (1)	27	49.3	47.9 – 50.9	0.52	0.48 – 0.56
redside shiner (1)	3	99.0	89 - 105	6.0	4.5 – 7.0

5.3.2.2 Salmonid Species

Five salmonid species were captured from Delair Pond during this study including Chinook, coho, sockeye, cutthroat trout, and steelhead (Table 17). No population estimates could be determined for salmonids due to low capture and recapture numbers. Difficulty in identification of smolting salmonids (Chinook, coho, and sockeye) may have introduced errors in some of our results. Voucher samples from March 23, 2011 sampling, in addition to field identification and interpretation of salmonid frequency graphs, determined species identification for the purpose of this report.

In the fall, two Chinook were caught during the mark phase and seven during the recapture phase. None of the Chinook in the recapture phase were marked. The lengths of Chinook caught by seine net ranged from 105-115mm (Table 18). These were likely in their second year of life based on size (McPhail, 2007). Sockeye were not identified in the field. However, it was later determined that they were likely caught during the seine sampling and were likely in their second year based on scale analysis of salmonids caught in spring. The lengths of sockeye caught in fall ranged from 122-165mm (Table 18). Based on scale analysis of spring salmonids, two age classes of coho were caught in the fall; year class 1 (0+) and year class 2 (1+). Length of 0+ coho ranged from 93 to 130mm whereas length of 1+ ranged from 190 to 220mm (Table 18). Average condition factor (K) for all salmonids in Delair was low (Fig. 25), indicating poor health. K for Chinook, sockeye, juvenile coho, and year-two coho was 0.60, 0.53, 0.60, and 0.49 respectively. No confidence intervals can be determined for second year coho due to the small sample size of two. Low sample sizes for sockeye and Chinook also resulted in large confidence intervals.

In the spring, sockeye, coho, steelhead, and cutthroat trout were caught in Delair Pond (Table 17). No sockeye were identified during the mark-phase, however it was later determined that they were likely caught during sampling but mis-identified; they were in their second year of life (1+). Sockeye caught in the recapture phase were identified in

lab by counting gill rakers and pyloric caeca. Their scales were also analyzed for age, and they were determined to be in their second year. Length of sockeye ranged from 134 to 170mm (Table 18). There were no recaptures of marked sockeye during the recapture phase. Average condition factor for sockeye was low at 0.47 (Fig. 25). Juvenile 0+ coho were identified in the mark phase, and 1+ coho were later determined to be caught during the mark phase. Coho caught in the recapture phase were identified and confirmed in the lab by counting gill rakers, pyloric caeca, and branchiostegal rays. Scales were also analyzed, and two age classes of coho were caught from Delair Pond. Lengths of first-year (0+) juvenile coho, in the spring, ranged from 101 to 128mm (Table 18) with second year coho length ranging from 172 to 210mm (Table 18). Average condition factor for 0+ juvenile and second year 1+ coho was low at 0.517 and 0.509 respectively (Fig. 25). There was no significant difference in average condition factor between the two age classes in the spring (t-test; $t=0.32$, $p=0.751$). The single steelhead caught from Delair Pond was captured in both mark and recapture sessions. It had also been captured in previous years due to the presence of a regenerated caudal fin clip mark. It had a length of 275mm, a weight of 107.5g and a K factor of 0.517 (Table 18 and Fig. 25). A single adult cutthroat trout was also caught during the recapture session. It had also been captured in a previous year due to the presence of a regenerated caudal fin clip mark. The body cavity of this trout contained eggs and she had a length of 395mm, a weight of 303.0g and a K factor of 0.49 (Table 18 and Fig. 25).

Sockeye juveniles were caught in both fall and spring. Average length of sockeye increased significantly over the winter from an average of 146.7 to 154.8mm (Fig. 26; t-test, $t=2.85$, $p=0.007$). However, while already in poor health, average condition factor of sockeye decreased over the winter dropping from 0.527 to 0.470 (t-test; $t=3.96$, $p<0.001$). Average length of juvenile 0+ coho increased over the winter from an average of 110.5 to 116.2mm (Fig. 26; t-test, $t=2.16$, $p=0.034$). However, while already in poor health, average condition factor of juvenile 0+ coho continued to decrease over the winter dropping from 0.599 to 0.517 (t-test; $t=3.27$, $p=0.002$). Average lengths and condition factor of 1+ coho showed no significant difference from fall to early spring (Fig. 26). However, the fall sample size of second year coho was small, with an n value of two.

Table 17. Population estimates of salmonids captured during a mark-recapture study of Delair Pond in fall (Oct. 10 and Nov. 6, 2010) and early spring (March 18 and 23, 2011), with 95% confidence. Coho were separated into juveniles (0+) and second year class (1+), while Chinook and sockeye and are only second year class (1+).

Species	Early Fall		Early Spring	
	Population Estimates	95% Confidence Intervals	Population Estimates	95% Confidence Intervals
Chinook (1+)	9*	n/a	0	n/a
Coho (0+)	57**	n/a	17	n/a***
Coho (1+)	2**	n/a	13*	n/a
Sockeye (1+)	19**	n/a	27*	n/a
cutthroat trout	n/a	n/a	1**	n/a
steelhead	n/a	n/a	1	n/a***

* minimum estimate, no recaptures during recapture phase
** minimum estimate, no mark data
*** sample size too small

Table 18. Mean lengths and weights of salmonids on Delair pond during Fall (Oct. 10 and Nov. 6, 2010) and Spring (March 18 and 23, 2011), with 95% confidence intervals. Range is given for sample sizes less than 10. Coho were separated into juveniles (0+) and second year class (1+), while Chinook and sockeye are only second year class (1+).

Species	Early Fall				
	Sample Size (n)	Mean Length (mm)	95% Confidence Intervals	Mean Weight (g)	95% Confidence Intervals
Chinook (1+)	9	110.1	105 – 115	7.94	7.0 – 9.0
coho (0+)	57	110.5	108.5 - 112.6	8.17	7.73 - 8.61
coho (1+)	2	205.0	190 – 220	40.50	37.5 – 43.5
sockeye (1+)	19	140.3	126.1 – 154.5	16.92	14.97– 18.88
Species	Early Spring				
	Sample Size (n)	Mean Length (mm)	95% Confidence Intervals	Mean Weight (g)	95% Confidence Intervals
coho (yr 1)	11	116.2	110.5 – 121.9	8.27	7.38 – 9.17
coho (yr 2)	11	195.5	187.2 – 203.7	38.09	34.06 – 42.12
sockeye (yr 2)	27	154.8	151.4 – 158.2	17.57	16.40 – 18.75
cutthroat	1	395.0	n/a	303.00	n/a
steelhead	1	275.0	n/a	107.50	n/a

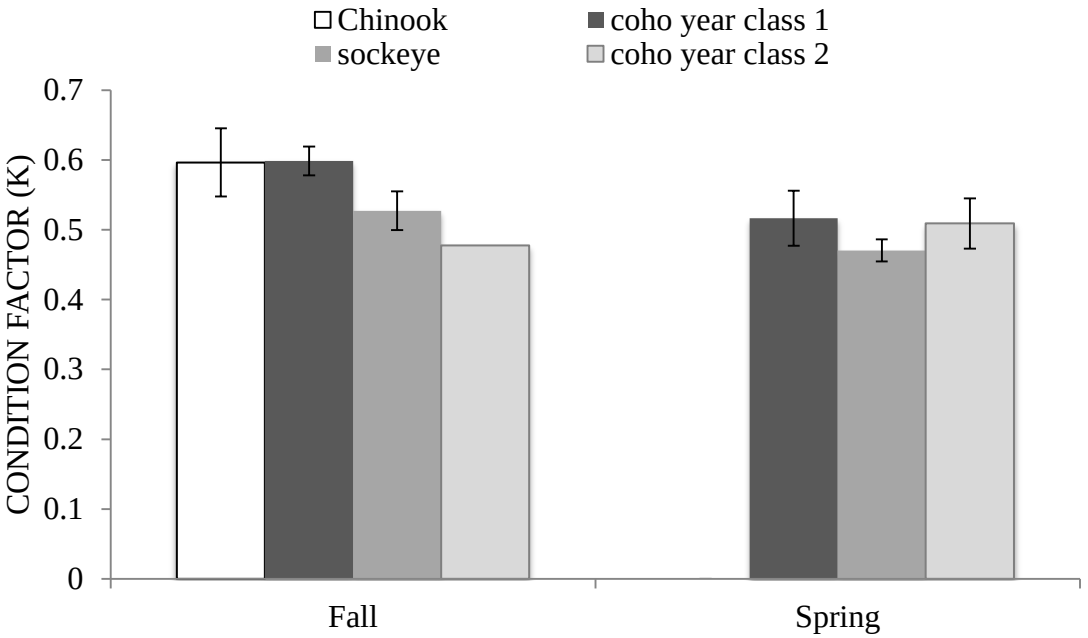

Figure 25. Mean condition factor for salmonids from Delair Pond during the fall (Oct. 10 and Nov. 6, 2010) and spring (March 18 and 23, 2011) sampling, with 95% confidence intervals. No confidence intervals could be obtained for coho year class two due to a sample size of two.

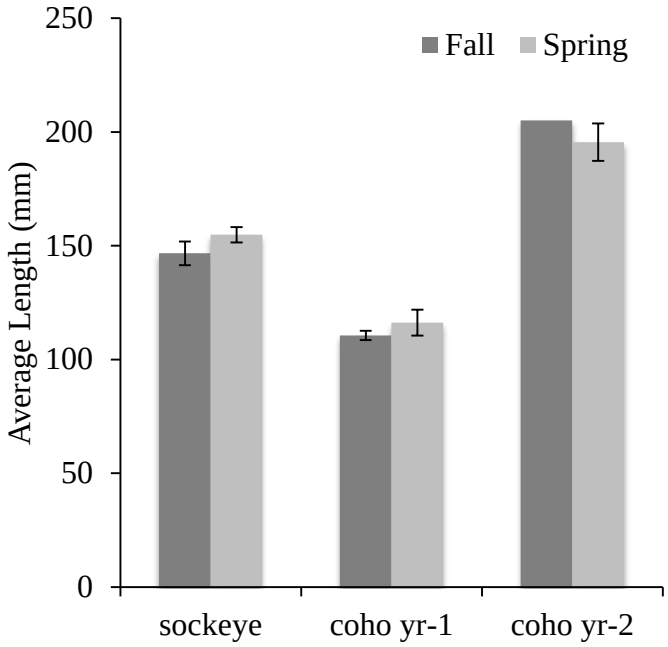

Figure 26. Fall and spring average lengths of sockeye and coho (year classes 1 (0+) and 2 (1+)) from Delair Pond during the 2010/2011 study, with 95% confidence intervals. No confidence intervals for fall year class 2 coho because the sample size was too small at n=2.

5.4 Fraser River Seine Site

5.4.1 Physical Parameters

During the fall sample session, Fraser River discharge at Hope (Fig. 27) was 1475 m^3/s. During the spring Fraser River assessment, Fraser River discharge at Hope (Fig. 28) was 806 m^3/s on March 18, 2011. Water-surface temperature, taken with a handheld thermometer during the fall, on November 6, 2010, was 7°C during both day and night seine hauls. Water surface temperatures declined by early spring and they were 2°C during both day and night seine hauls.

Temperature data for this site was also collected with a Tidbit v2. data logger. The temperature declined steadily after the Tidbit was placed into the mainstem Fraser River, dropping to 4°C on October 17, 2010, before climbing again and remaining relatively consistent until early November. Subsequently, fluctuations significantly above and below 0°C suggest that the flows of the Fraser River dropped below the elevation of the Tidbit and it was then recording air temperature (Fig. 29). The water temperature then fluctuated throughout the winter before beginning to increase in early spring.

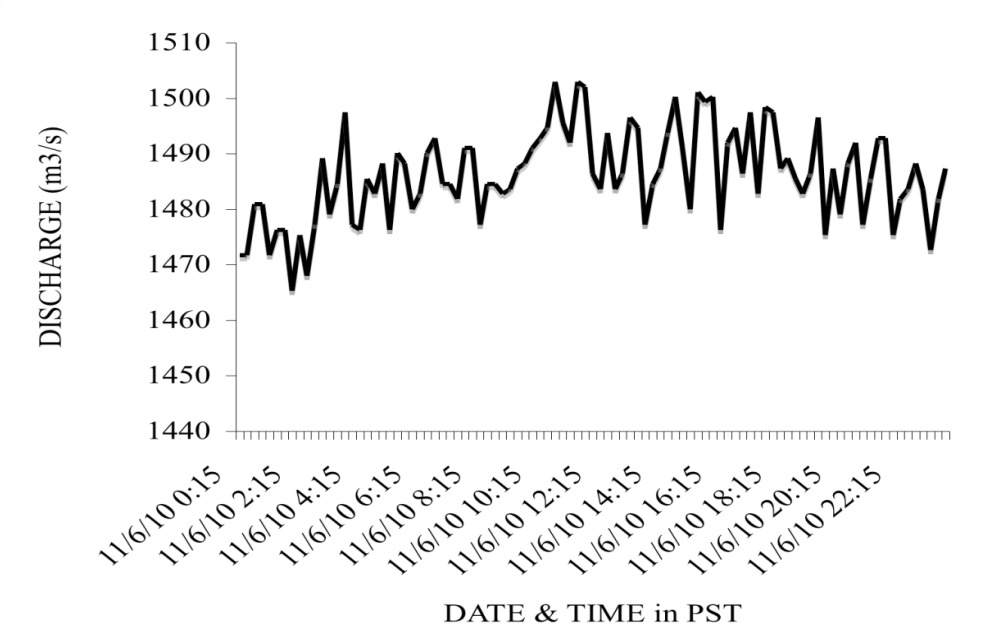

Figure 27. Real-time hydrometric data for water discharge for the Fraser River at Hope Station on Nov. 6, 2010. Source: Environment Canada, 2010.

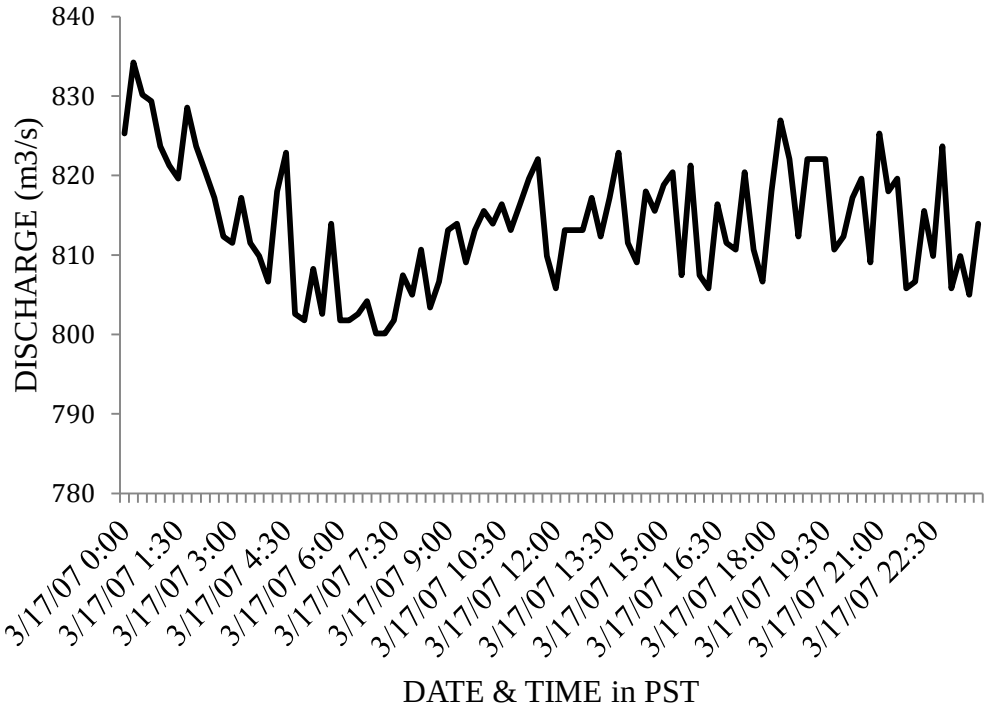

Figure 28. Real-time hydrometric data for water discharge for the Fraser River at Hope Station on March 18, 2011. Source: Environment Canada.

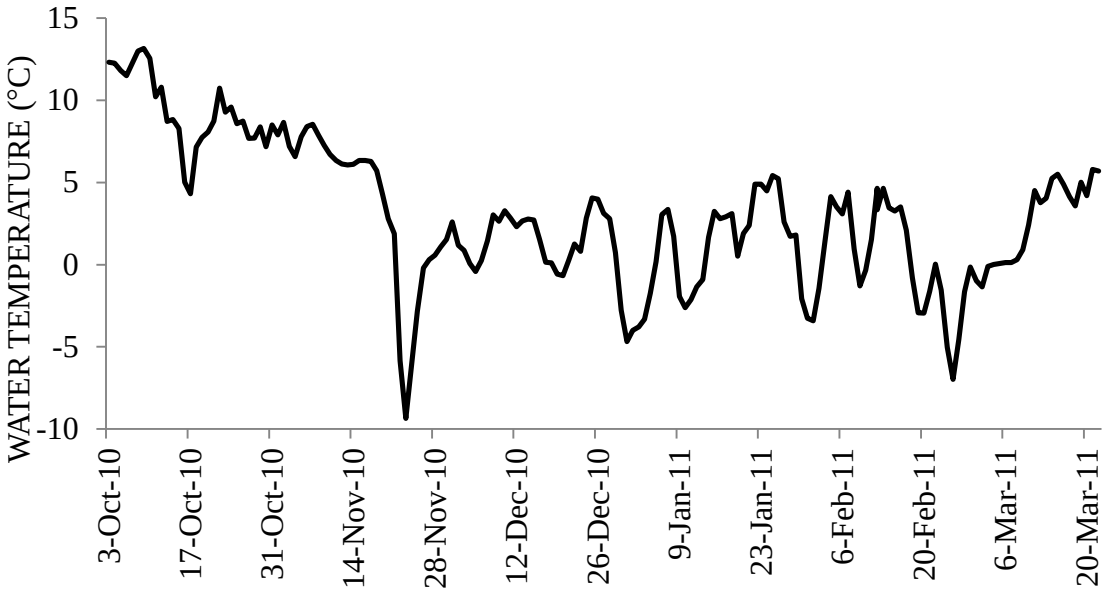

Figure 29. Water temperature for the Fraser River from data collected from a Tidbit v2 data logger from October 9, 2010 to March 22, 2011.

5.4.2 Fish Parameters

Six species from four families (Salmonidae, Cyprinidae, Catostomidae, and Cottidae) of fish were caught from the Fraser River mainstem in the day and night seine hauls during the fall 2010 sampling session (Table 19). Chinook and mountain whitefish were the only salmonids caught, with the mountain whitefish only being captured during the day seine (one fish). Redside shiner and prickly sculpin were only caught during the night seine and one largescale sucker was caught during the day seine. About equal numbers of fish were caught during the day and night fall seines. Based on small sizes of the individuals (McPhail, 2007; Table 20), mountain whitefish, leopard dace, redside shiner, and most prickly sculpin were juveniles, with some leopard dace being definite young-of-the-year. Some of the prickly sculpin individuals were large enough to have been sexually mature. The single largescale sucker that was captured was a young-of-the-year at 38mm in length.

Juvenile Chinook lengths ranged from 56-98mm during the day sampling and 74-102mm during the night seine. In total for night and day, the Fraser River Chinook captured in the

fall seine sessions were found to have an average length of 85.0mm and weight of 3.50g. Average condition factor (K) for Chinook in the Fraser River mainstem during the fall of 2010 was 0.54. No Chinook were caught during the spring sampling on the Fraser River.

In the spring, seven species from four families of fish (Salmonidae, Cyprinidae, Catostomidae, and Cottidae) were caught from the Fraser River mainstem day and night seine hauls (Table 19). Unlike the fall sampling, where about equal numbers of fish were caught during the day and night seines, almost double the number of fish were caught during the spring night seine compared to the day (with 64 and 33 being caught, respectively). No Chinook were caught in the spring. However, 52 chum young-of-the-year were caught in both day and night early spring seines. Based on their larger sizes (Table 20; McPhail, 2007), the three mountain whitefish, and two mountain suckers caught were sexually mature. All other species were juveniles based on the smaller lengths of the individuals (Table 20; McPhail, 2007), with the leopard dace, longnose dace, and unknown specimen (referred to as "B" in this report) being potential young-of-the-year.

Table 19. Fishes caught in the Fraser River mainstem day and night seine sampling during the 2010/2011 study. One young-of-the-year fish was not identified and labeled as Unknown B.

Species	November 6, 2010	November 6, 2010	March 18, 2011	March 18, 2011
	Day	Night	Day	Night
Chinook	27	31	0	0
chum	0	0	20	32
mountain whitefish	1	0	1	2
largescale sucker	1	0	0	0
mountain sucker	0	0	1	1
prickly sculpin	0	7	9	22
leopard dace	19	3	0	5
redside shiner	0	2	0	0
longnose dace	0	0	2	1
Unknown B	0	0	0	1
Total Fishes	48	43	33	64

Table 20. Mean lengths and weights, with 95% confidence intervals, for fishes caught during the day and night seines from the Fraser River mainstem during the 2010/2011 study. For species with fewer than 15 individuals, range is given instead of confidence intervals.

Species	November 6, 2010 (Day)				
	Sample Size (n)	Mean Length (mm)	95% Confidence Intervals	Mean Weight	95% Confidence Intervals
Chinook	27	79.4	74.6 - 84.1	2.80	2.30 - 3.30
mountain whitefish	1	135.0	n/a	11.50	n/a
leopard dace	19	28.3	26.4 - 30.2	0.50	0.5
largescale sucker	1	38.0	n/a	0.50	n/a
	November 6, 2010 (Night)				
Chinook	31	89.9	87.4 - 92.5	4.15	3.86 - 4.43
redside shiner	2	63.0	59 - 67	1.50	1.5
prickly sculpin	7	82.9	55 - 122	3.29	1.0 – 8.0
leopard dace	3	32.7	26 - 36	0.5	0.5
	March 18, 2011 (Day)				
chum	20	37.9	36.9 – 38.9	0.50	0.50 – 0.50
mountain whitefish	1	239	n/a	74.5	n/a
mountain sucker	1	415	n/a	325.0	n/a
prickly sculpin	9	105.8	86 - 142	7.83	3.0 – 16.0
longnose dace	2	35.5	35 -36	0.50	0.5
	March 18, 2011 (Night)				
chum	33	37.1	36.4 – 37.7	0.50	0.50 – 0.50
mountain whitefish	2	191.5	153 - 230	35.75	15.5 – 56.0
mountain sucker	1	421	n/a	406.0	n/a
prickly sculpin	22	98.0	90.7 – 105.4	6.09	4.86 – 7.32
leopard dace	5	36.0	26 - 51	0.50	0.5
longnose dace	1	22	n/a	0.5	n/a
Unknown B	1	18	n/a	0.5	n/a

6.0 Discussion

Often referred to as “The Heart of the Fraser”, the gravel reach, stretching from Hope to Mission, is recognized as the most biologically productive stretch of the Fraser River, supporting a wide variety of fish species (Rosenau and Angelo, 2007). As the river leaves

its confines in the Fraser Canyon, the widened valley bottom and complex morphology of the floodplain represent the most habitat diverse sub-section of the gravel reach (Rempel, 2004). Our study looked at some of the important off-channel habitats in this sub-section of the reach, including Tom Berry Gravel Pit and Delair Pond, which were located just downstream of Hope, BC. This area was also studied prior to our study by BCIT Fish, Wildlife and Recreation students during 2008/2009 and 2009/2010, which provided valuable data for comparisons among the years.

6.1 Salmonid Comparisons for the 2010/2011 Sampling Sites

Juvenile Chinook were the only salmonid species caught consistently in the fall of 2010 in three of the four study sites including, Tom Berry Gravel Pit-1, Delair Pond, and the Fraser River. The majority of Chinook caught by seining were from the Fraser River in the day and night seines. Only six Chinook were caught in Tom Berry Gravel Pit-1, and nine in Delair Pond.

The size-range of juvenile Chinook salmon 2011 was bi-modal, probably representing two year classes. It is likely, the Chinook caught in Tom Berry Gravel Pit-1 and Delair Pond were in their second year, while the Chinook caught from the Fraser River were likely juveniles based on their lengths (McPhail, 2007). The average length of Fraser River Chinook was 85.0 mm; they had a significantly lower mean size than the 0+ juveniles caught in Tom Berry Gravel Pit-1 (113.8 mm) and Delair Pond (110.1 mm) (Fig 30; ANOVA; $F=29.30$, $p<0.001$; $t=6.03$, $p<0.001$; $t=5.31$, $p<0.001$). There was no significant difference in juvenile Chinook caught in Delair Pond and TBGP-1 (ANOVA, $t=0.57$, $p=0.571$).

We feel that the most likely explanation for the Chinook in Delair Pond and Tom Berry Gravel Pit-1 being larger than the mainstem Fraser River juvenile Chinook is that the former were in their second year (1+), while the main-channel juveniles were in their first year (0+). The Chinook in Delair and Tom Berry Gravel Pit-1 were trapped by the receding floodwaters and continued to grow, while the main-channel juveniles migrated

to the ocean once they reached a threshold size. There is a continual recruitment of growing, but smaller, fish to the area throughout the year, but which leave once they are large enough to go to sea (Murray and Rosenau, 1989). The fish trapped in Delair Pond and Tom Berry Gravel Pit likely were unable to escape back into the mainstem Fraser River due to a low primary water table from the 2010 spring/summer freshet and were subsequently trapped, aging into their second year.

Body condition factor is a measure of the quality of the habitat and available food for fish (Rosenau, 2010). We found no significant differences in mean condition factor for the juvenile Chinook sampled from these three sites (Fig. 31; ANOVA; $F=2.37$, $p=0.101$). Comparisons for this year's study sites differs to what was found by Bailey *et al*. (2010) in the 2009/2010 study where Chinook caught in the Fraser River were in better condition than those caught in Delair Pond. However, it coincides with results found by Frake *et al*. (2009) in the 2008/2009 study, where Delair Pond and Fraser River Chinook had similar condition factors.

All of the juvenile sockeye that were caught from Delair Pond, as well as a number of the juvenile coho, caught were found to be in their second year as determined by scale analysis. It is likely that, due to the low discharge volume and water level height of the Fraser during the 2010 spring/summer freshet (Figs. 4 and 5), there was low connectivity-time between the Fraser River and Delair Pond hence very few fish entered from the Fraser River, and many that were in the pond became trapped. Thus, it appears that many of the fish that were in Delair Pond did not escape back into the Fraser River and were subsequently trapped in Delair Pond for another winter. Further evidence for this were that a number of fish that we caught had healed-over caudal marks from last-year's research program. It is also important to point out that all of the sockeye and Chinook, and some of the coho that were caught were of smolt size prior to their normal spring-outmigration timing. No 0+ sockeye or Chinook were captured during the study, so it is unknown whether any juvenile sockeye entered the pond.

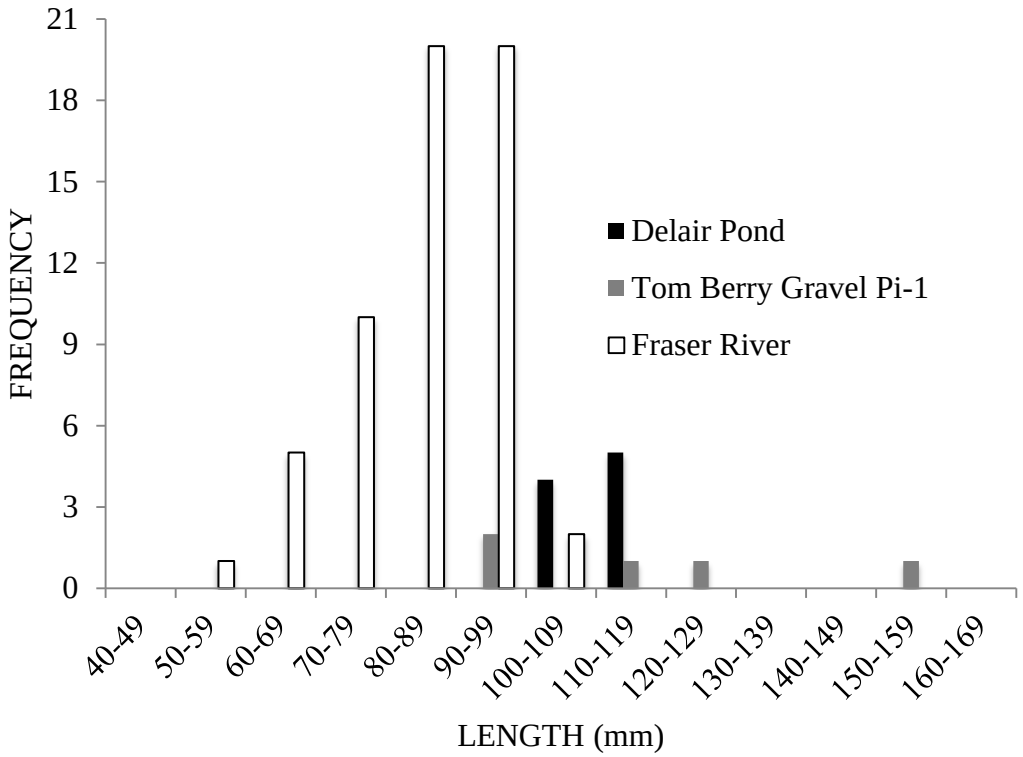

Figure 30. Frequency of lengths of Chinook caught in Tom Berry Gravel Pit-1, Delair Pond, and the Fraser River mainstem, during fall 2010.

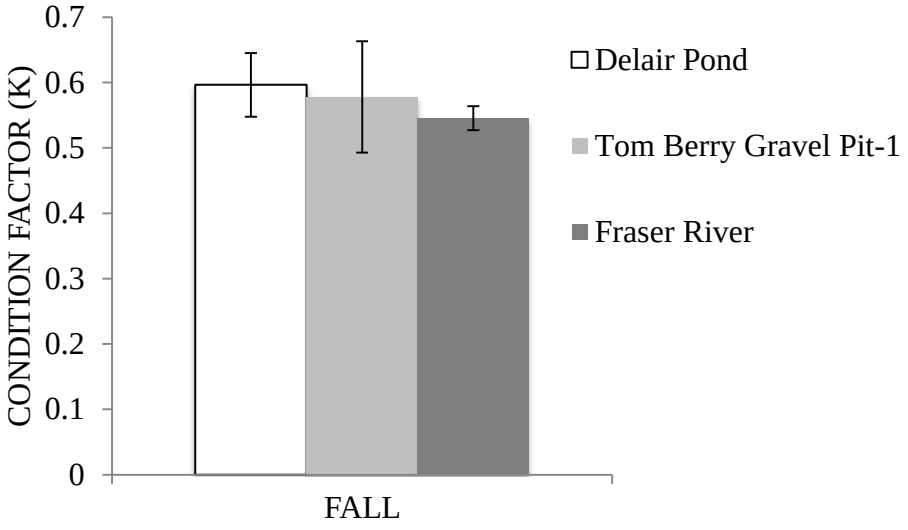

Figure 31. Average condition factor (K) of Chinook caught in Delair Pond, Tom Berry Gravel Pit-1 and the Fraser River mainstem, with 95% confidence intervals.

6.2 Salmonid Comparisons among Study Years

Three salmonid species were consistently caught in Delair Pond throughout the three years of BCIT Fish Wildlife and Recreation Program study, including Chinook, coho, and sockeye, although the former were only caught only in the fall and not spring in the current 2010/2011 assessments. The sockeye that were caught in the 2008/2009, and 2009/2010, studies were 0+ juveniles (Frake *et al.*, 2009 and Bailey *et al*., 2010). Based on size and analysis of scales taken during the recapture phase of the spring 2010/2011 study, all sockeye caught in Delair during the 2010/2011 study were likely in their second year, and therefore no further comparisons on their length and condition were made (Figs 32 and 33).

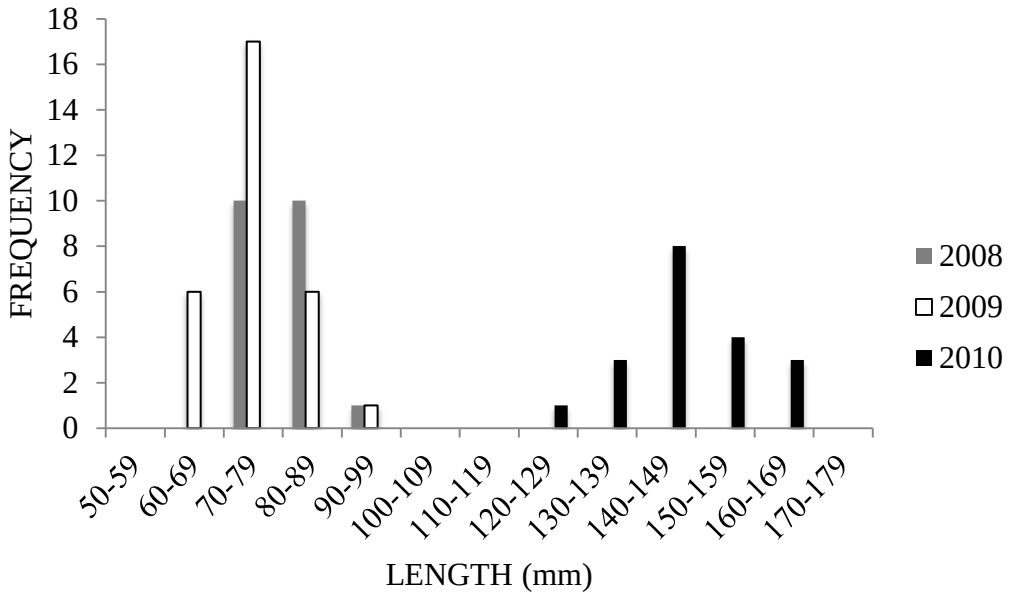

Figure 32. Length-frequency of juvenile sockeye caught from Delair Pond fall 2008 (Frake *et al.*, 2009), 2009 (Bailey *et al*., 2009), and 2010.

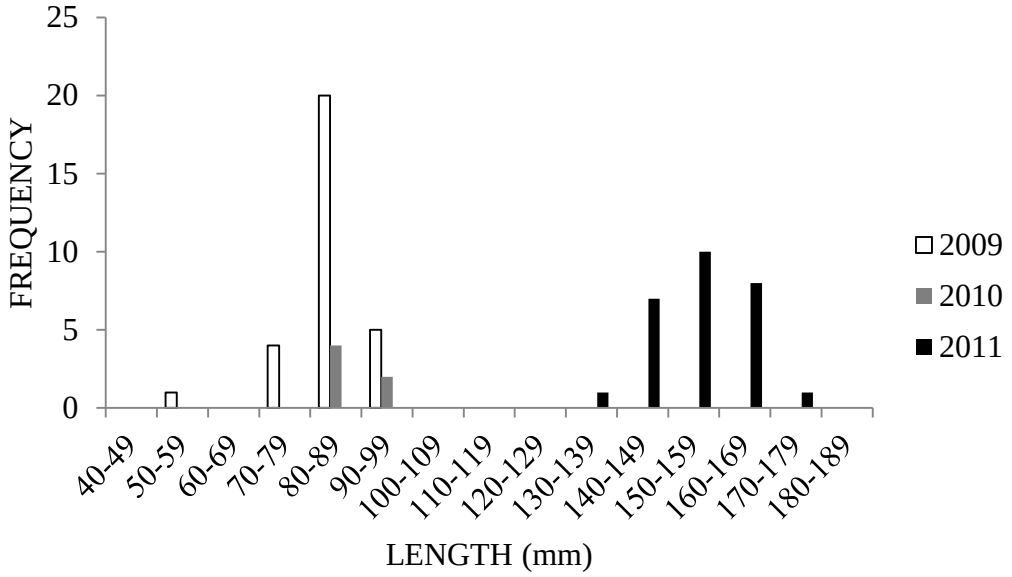

Figure 33. Length-frequency of juvenile sockeye caught from Delair Pond spring 2009 (Frake *et al.*, 2009), 2010 (Bailey *et al*., 2009), and 2011.

6.2.1 Salmonid Lengths

Comparing average Chinook lengths for the fall sampling in Delair Pond there is a significant difference in this size parameter among the years (ANOVA; $F=84.41$ $p<0.001$; Fig. 34). The average length of Chinook in 2008 was 80.6 mm, in 2009 was 75.9 mm, and in 2010 was 110.1 mm. The slight increase in Chinook length between 2008 and 2009 (ANOVA; $t=2.58$, $p=0.012$) may be due to the higher water levels witnessed in 2008 when compared with 2009 (Frake *et al.*, 2009 and Bailey *et al*., 2010) allowing fish access to more of the riparian area, giving them more access to important food sources chironomids and terrestrial insects (McPhail, 2007). Chinook caught in 2010 were significantly larger than those caught in 2008 (ANOVA; $t=11.10$, $p<0.001$) and the fish sampled in 2009 (ANOVA, $t=12.85$, $p<0.001$). Based on lengths of fish, and Chinook dislike of off-channel habitat, we presume that the Chinook caught in our study year were larger than the previous years because they were 1+ Chinook while, they were 0+ in the previous two studies. This is likely due to the short connectivity duration between the Fraser River and Delair Pond, presumably not allowing Chinook to re-enter the Fraser River mainstem from Delair Pond.

We found that there were two age classes of juvenile coho utilizing Delair Pond in the 2010/2011 study. The second year coho (1+) that were caught in fall and spring were all of a size and color that indicated that they were smolts. Comparing juvenile coho among the three study years shows a significant difference in the average body length in the fall (Fig. 35; ANOVA; $F=151.5$, $p<0.001$) and the spring (Fig. 36; ANOVA; $F=34.36$, $p<0.001$). The average length of coho in 2008/2009 was 81.4 mm in the fall and 90.1 mm in the spring, in 2009/2010 was 86.4 mm in the fall and 91.8 mm in the spring, and in 2010/2011 was 110.5 mm in the fall and 116.2 in the spring. There was no significant difference between the 2008/2009 and 2009/2010 coho lengths in either fall or early spring (ANOVA; $t=2.31$, $p=0.02$; $t=0.71$, $p=0.48$). There was, however, a significant difference in average coho lengths for both fall and spring when comparing 2010/2011 with the other years. (ANOVA; 2008/2009 compared with 2010/2011, fall $t=15.47$, $p<0.001$, spring $t=7.94$, $p<0.001$; 2009/2010 compared with 2010/2011, fall $t=12.82$, $p<0.001$, spring $t=7.43$, $p<0.001$). With the water levels in Delair Pond and the Fraser River freshet being much lower in 2010 than they were in the previous years, the population numbers of coho was also much lower in 2010. This is likely due to the short connectivity-duration between the Fraser River and its floodplain thus allowing very few coho to enter Delair Pond. With a small density of coho as well as Chinook, there were likely more available resources, thus allowing the coho to grow in size faster.

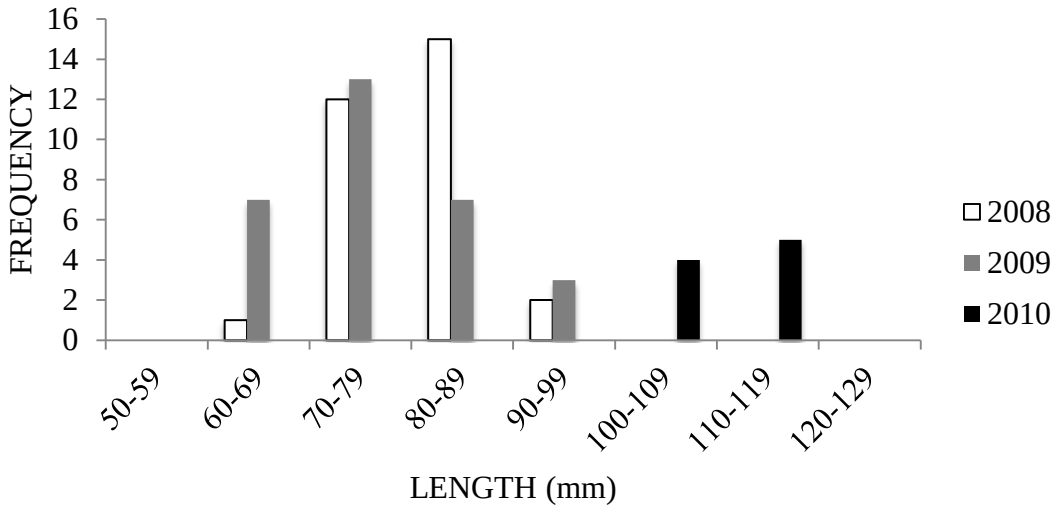

Figure 34. Length-frequency of juvenile Chinook caught from Delair Pond fall 2008 (Frake *et al.*, 2009), 2009 (Bailey *et al*., 2009), and 2010.

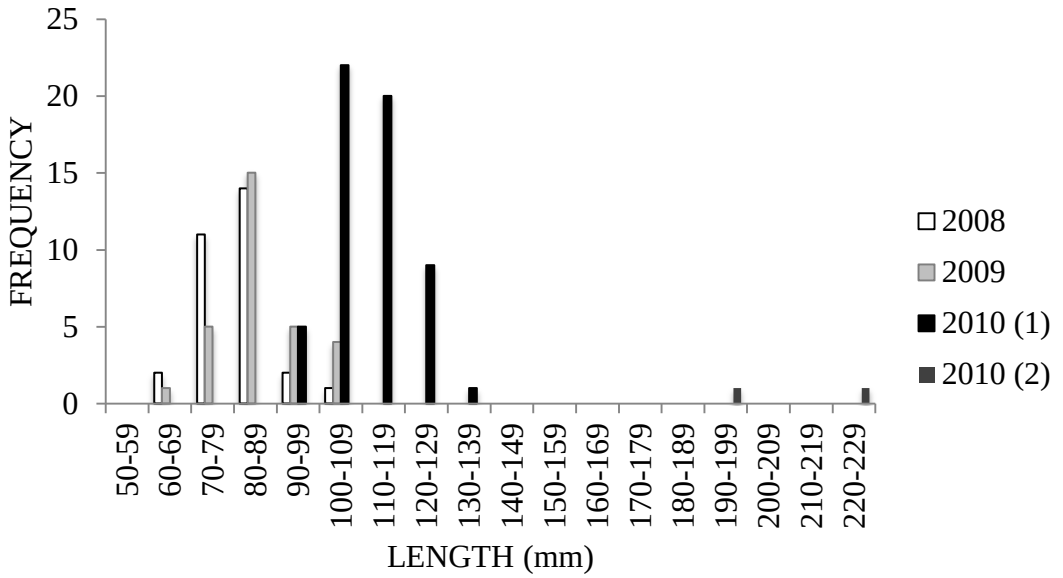

Figure 35. Length-frequency of coho caught in Delair Pond fall 2008 (Frake *et al*., 2009), 2009 (Bailey *et al*., 2010), and 2010. 2010 fish are divided into juvenile coho (1) and second year coho (2).

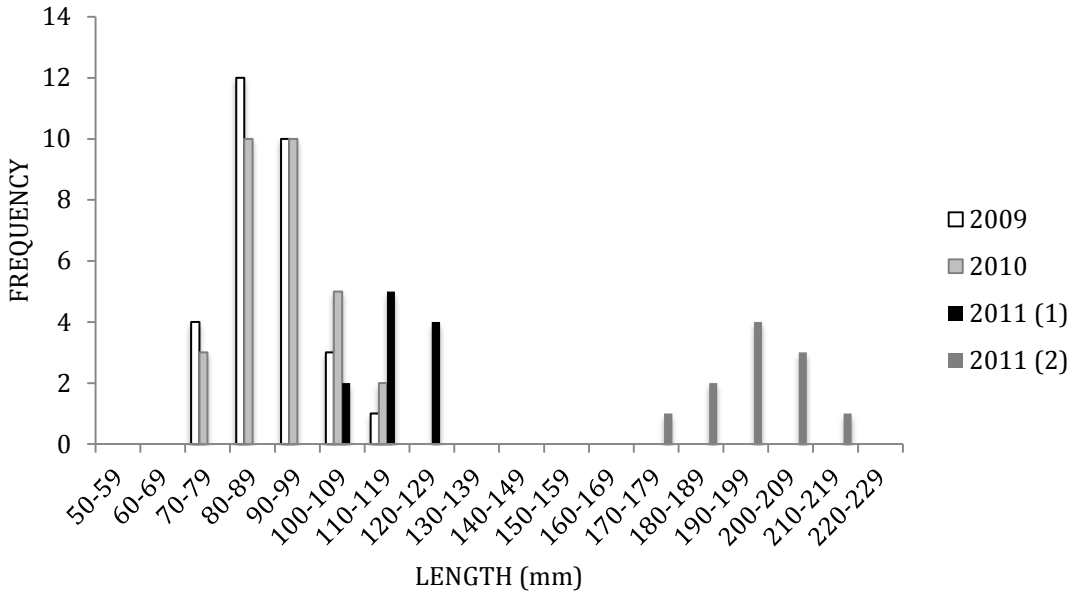

Figure 36. Length-frequency of coho caught in Delair Pond spring 2009 (Frake *et al*., 2009), 2010 (Bailey *et al*., 2010), and 2011. 2011 fish are divided into juvenile coho (1) and second year coho (2).

Comparing all data for Fraser River day and night seine sampling conducted in 2008 (Frake *et al*. 2009), 2009 (Bailey *et al*. 2010), and 2010 (Fig. 37), there were significant differences among juvenile Chinook lengths for the three years (ANOVA, $F=31.72$ $p<0.001$). Chinook caught in 2008 averaged 91.4 mm and were significantly larger than those caught in 2009, which averaged 75.5 mm (ANOVA, $t=7.38$, $p<0.001$). Furthermore, Chinook sampled in 2010 averaged 85.0 mm and were significantly larger than those caught in 2009 (ANOVA, $t=5.63$, $p<0.001$) but smaller than those captured in 2008 (ANOVA, $t=2.95$, $p=0.004$).

A combination of differences in Fraser River water levels, discharges, and temperatures may have been why Chinook lengths were different among the years fish were sampled. Spring/summer freshet water levels and discharges were higher-than-average in 2008, approximately average in 2009, and lower-than-average in 2010 (Figs. 4 and 5). The higher water levels may allow fish more access to the productive riparian areas for longer periods of time, which could potentially enhance growth (Junk *et al*., 1989). High water temperatures can reduce and halt fish growth (McPhail, 2007). While water temperature

data cannot be obtained for the past three years from the Environment Canada Hydrometric Fraser River at Hope Station, it is possible but unknown that water temperature could have played a role in the shorter length of Chinook from 2009.

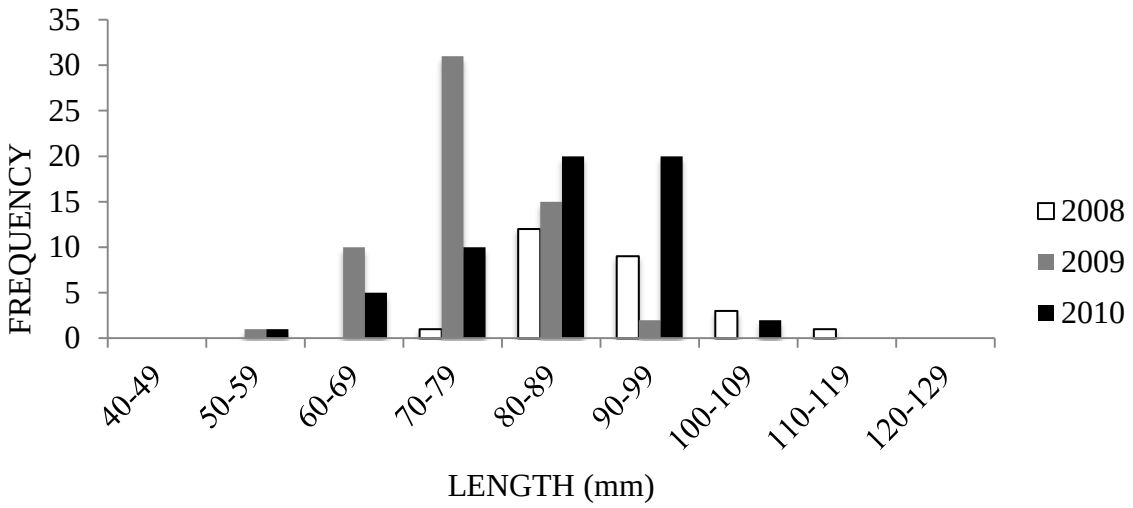

Figure 37. Length-frequency of Chinook caught in the Fraser River fall 2008 (Frake *et al*., 2009), 2009 (Bailey *et al*., 2010), and 2010.

6.2.2 Salmonid Condition

Comparisons of juvenile Chinook condition factor for fish caught from Delair Pond in 2008 (Frake *et al*., 2009), 2009 (Bailey *et al*., 2010), and 2010 (Fig. 38) showed significant differences (ANOVA; $F=17.90$, $p<0.001$). While Chinook in 2008 and 2009 showed no significant difference (ANOVA; $t=1.92$, $p=0.059$), and with condition factor means of 1.23 and 1.09 respectively they appeared to be in relative good health, those juveniles caught from Delair Pond in 2010 however, had poor health, with a mean of 0.60. This value was significantly different from the condition factor of those caught in 2008 (ANOVA; $t=5.98$, $p<0.001$) and 2009 (ANOVA; $t=4.68$, $p<0.001$).

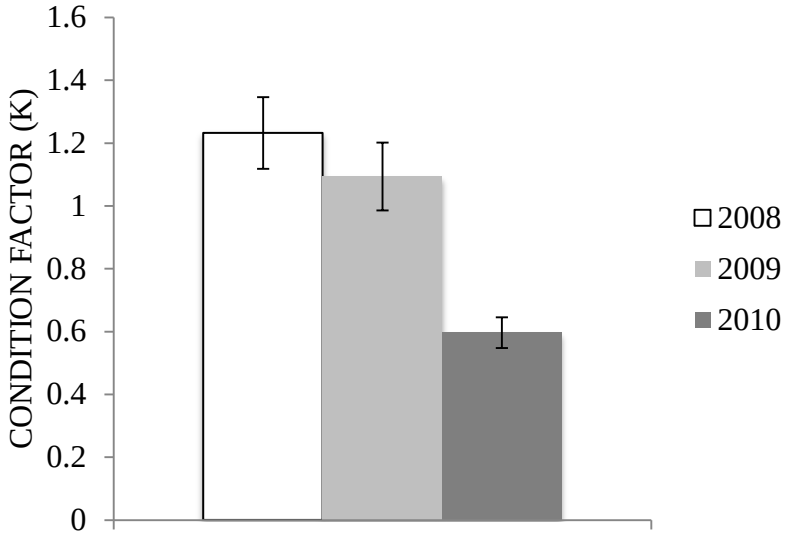

Figure 38. Average condition factor of Chinook caught in Delair Pond during the fall 2008 (Frake *et al*., 2009), 2009 (Bailey *et al*, 2010), and 2010 study, with 95% confidence intervals.

Comparing juvenile coho from Delair Pond for the fall among the past three years of study showed a significant difference in mean condition factor (Fig. 39; ANOVA, $F=407.8$, $p<0.001$). Average condition factor in 2008 was 1.18, and while 2009 coho were still relatively healthy, with a condition factor of 1.09, they show a slightly different mean than 2008 (ANOVA; $t=3.25$, $p=0.002$). The average condition factor for Delair Pond fall coho in 2010 indicates that the fish were in poor health, with an average K factor of 0.60. This is significantly lower than the average K factor from 2008 (ANOVA; $t=25.13$, $p<0.001$) and 2009 (ANOVA; $t=21.41$, $p<0.001$). In the spring, there was also a significant difference in average condition factor for juvenile coho amongst the three years for Delair Pond (ANOVA; $F=124.59$, $p<0.001$). Condition factor for spring 2009 and 2010 showed no significant difference (ANOVA, $t=2.17$, $p=0.03$), with averages at 1.03 and 0.98, respectively. However, much like the fall, condition factor for the spring 2011 juvenile coho were significantly poorer than for the previous years (ANOVA; $t=15.34$, $p<0.001$; $t=13.75$, $p<0.001$), with a K factor of 0.52, indicating poor health.

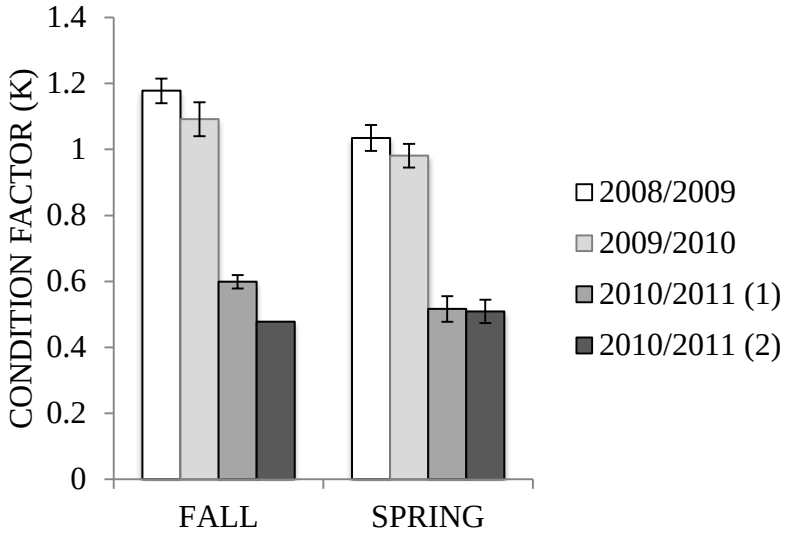

Figure 39. Avergae condition factor (K) for coho caught from Delair Pond in fall and spring during the 2008/2009 (Frake *et al*., 2009), 2009/2010 (Bailey *et al*., 2010), and 2010/2011 studies, with 95% confidence. Coho caught in 2010/2011 were separated into 0+ juveniles (1) and 1+ second year fish (2).

When comparing juvenile Chinook condition factors amongst years for fish captured from the Fraser River (Fig. 40), we found that there were significant differences (ANOVA; $F=364.44$, $p<0.001$). Chinook caught in 2009 appear to have fared the best when compared to those caught in 2008 (ANOVA; $t=6.99$, $p<0.001$) and 2010 (ANOVA; $t=26.74$, $p<0.001$). Furthermore, Chinook in 2008 also appeared to have fared better to those caught in 2010 (ANOVA; $t=13.97$, $p<0.001$). Chinook caught from the Fraser River in 2008 and 2009 both had good condition factors of 1.11 and 1.39, respectively. Chinook in 2010 appeared to be in poor condition, with an average K of 0.55.

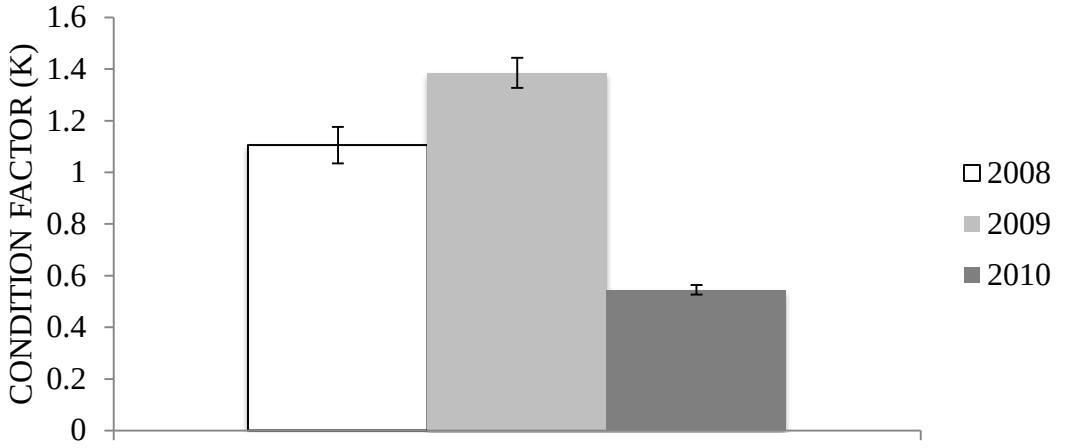

Figure 40. Average condition factor for Chinook caught from the Fraser during fall seines in 2008 (Frake *et al*., 2009), 2009 (Bailey *et al.,* 2010), and 2010, with 95% confidence intervals. These data include pooled day and night seine sampling.

The low condition factor observed in the 2010/2011, in compared to the last two years of study in Delair Pond and the Fraser River (for all salmonids), may be due to the low flood regime witnessed during the 2010 spring/summer freshet. Low water levels could potentially disallow fish from entering riparian areas during freshet times to access important food sources, giving them a better length to weight ratio, and thus a better condition factor. Another consideration for low condition factor observed during this year's study when compared to the previous years is the flood pulse concept provided by Junk *et al*. (1989). River discharge during seasonal freshet provides high levels of nutrients that cycle and interact with the floodplain and main-channel through lateral exchange of water and sediments, which attribute to the production within that floodplain (Junk *et al*., 1989). Due to a low freshet discharge this year when compared to the past two years of study, there has been a limited interaction between floodplain habitats and the mainstem of the Fraser River, thus not allowing fish in off-channel habitat the nutrients needed to reach healthy body condition levels. This is supported by the relatively healthy salmonid populations recorded in the previous two studies, which correspond to average and above average hydrographs.

6.3 Restoration Potential of Tom Berry Gravel Pit

TBGP is in need of restoration to improve the quality of salmonid habitat. The location of the site within the gravel reach allows for great potential and diversity of species if managed properly. Restoration could not only provide ideal habitat for salmonids, but prevent mortalities that occur when fish become trapped in the shallow basins that dry up later in the fall and spring. Since basins often become isolated in low water levels, it would be beneficial to increase the depth of the basins to maintain fish survival throughout the year. Ideally, the basins would be connected to form one continuous pond where fish could migrate throughout as water levels decline.

To prevent fish die-off and improve habitat quality for salmonids it is recommended that a constant source of water flow be added to increase oxygen levels and maintain lower water temperatures. Connectivity with the Fraser River mainstem would be important, as having a constant source of water to the Fraser might encourage ingress and egress of fish. Another option would be to look into the possibility of building an infiltration gallery connected to the Silverhope Creek. The infiltration gallery would draw water into TBGP via a culvert, which would assist in creating a constant water flow and lower water temperatures, as well as potentially bringing in migrating coho from the Silverhope.

Some other points to consider are the control of invasive fish species. Sites should be managed to maintain appropriate conditions for target species, and therefore decrease the potential of invasive species which favour different conditions. Also, the presence of beaver lodges and dams within the site could disrupt or block the constant water flow that is required for the purpose of restoration.

7.0 Conclusions

TBGP and Delair pond are historically, physically and morphologically different examples of off-channel habitats, which are connected to the mainstem of the Fraser during spring freshet. TBGP is a historic gravel quarry while Delair Pond is an artificially constructed pond at the end of a man-made side channel. Both habitats are used by fishes during freshet, and when water levels drop, fish can and usually are trapped within the ever-shrinking ponds and are forced to overwinter.

Off-channel habitats are important for many fish species when they provide adequate conditions for survival. It is apparent that many species of fish found within the Fraser River mainstem utilize these off-channel habitats as many of the same species were found in both study sites. The Fraser River hydrograph plays an important role in maintaining these habitats, but during low freshet years can cause poor survival conditions. The past three study years highlight the importance of the Fraser River hydrograph in maintaining overwintering survival and body condition of fishes. During the past two study years the hydrograph was average and above, and fish health and survival was good. However, during the 2010/2011 study, the Fraser River hydrograph was below average and fish health and diversity was significantly lower than in previous years. In an effort to maintain quality habitats and prevent overwinter fish kills, these sites must be managed according to seasonally low water levels.

8.0 Recommendations

Delair Pond and Side Channel provide overwintering habitat for fishes that utilize off-channel habitat. Consistent with the last two studies, we recommend that restoration of the site be undertaken by grading the channel to allow fish to move downstream towards the Fraser River as flood waters recede, allowing fewer fish to become trapped in the pond. It is our belief that as the channel dries up, fish are stranded in small isolated puddles, not making it into Delair Pond. While deepening or lengthening the pond, or adding additional ponds will increase the amount of space available for fishes, it may increase the amount of fishes that enter and become subsequently trapped in the pond. Many of these trapped fish overwintering in these sites will still become mortalities, especially when considering below average flood years where fish are unable to re-enter the Fraser River and are forced to spend another winter in the pond, seriously hampering their overall health.

Like Delair Pond, Tom Berry Gravel Pit provides overwintering habitat for fish. The site is owned by the Ministry of Transportation and Infrastructure and was a previous gravel quarry for the building of the Coquihalla Highway. With interest from the Ministry of Transportation, the site could be restored to enhance the habitat productivity for fish and other species that utilize the site.

Further studies of off-channel habitat in the gravel reach of the Fraser River provides information on the importance of these sites to the continued productivity of this section of the Fraser River. With three years of baseline data on Delair Pond, we recommend the site is continued in any FWR study conducted on off-channel habitat in the Heart of the Fraser. We also recommend studying additional off-channel sites to determine their role in the floodplain ecosystem and how their productivity relates to that of Delair Pond.

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Appendices

Appendix 1 – Contacts

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Appendix 2 – Data Management

Field data were collected and transcribed on site cards (Appendix 7). Environmental parameters, including air and water temperature, dissolved oxygen, turbidity, conductivity, and pH, were recorded where possible at every site visit for every water body for each study site.

Data cards (Appendix 8) were also used for fish capture information; on these we recorded species, fork length or total length, weight, marks, comments, and mortalities. During recapture, a tally sheet (Appendix 9) was used to record marked or unmarked fishes. The physical information of the fishes included all salmonids and the first 30 of every non-salmonid species captured was recorded.

Google Documents, under the Gmail account (bcit.hope.project@gmail.com), was used to share all files, including all collected data, field cards, photos, draft submissions, etc. Data were also backed up on a hard drive.

Appendix 3 – Expenditures and Budget

Equipment was provided from the existing British Columbia Institute of Technology supply, with any additional requirements being purchased by the institute. Scientific permits were not required as project activities were authorized by Sam Gidora, Department of Oceans and Fisheries Canada, Oceans and Habitat Enhancement Branch. Transportation costs for the study period was as follows:

Fall sampling session mileage and travel costs using a rate of $0.51/km.

Date	From	To	Km	Cost ($)
Sept 18th	BCIT	Delair	143.5	73.19
Sept 18th	Delair	Connal's	4	2.04
Sept 18th	Connal's	TBGP	7	3.57
Sept 18th	TBGP	BCIT	141	71.91
Oct 1st	BCIT	Connal's	147.5	75.23
Oct 2nd	Connal's	TBGP	3	1.53
Oct 2nd	TBGP	Connal's	3	1.53
Oct 3rd	Connal's	TBGP	3	1.53
Oct 3rd	TBGP	Connal's	3	1.53
Oct 3rd	Connal's	BCIT	147.5	75.23
Oct 8th	BCIT	Connal's	147.5	75.23
Oct 9th	Connal's	TBGP	3	1.53
Oct 9th	TBGP	Connal's	3	1.53
Oct 10th	Connal's	Delair	4	2.04
Oct 10th	Delair	Connal's	4	2.04
Oct 10th	Connal's	BCIT	147.5	75.23
Oct 16th	BCIT	Connals	147.5	75.23
Oct 16th	Connal's	TBGP	3	1.53
Oct 16th	TBGP	Connal's	3	1.53
Oct 17th	Connal's	TBGP	3	1.53
Oct 17th	TBGP	Connal's	3	1.53
Oct 17th	Connal's	BCIT	147.5	75.23
Nov 6th	BCIT	Connal's	147.5	75.23
Nov 6th	Connal's	TBGP	3	1.53
Nov 6th	TBGP	Connal's	3	1.53
Nov 7th	Connal's	Fraser	5	2.55
Nov 7th	Fraser	TBGP	1	0.51
Nov 7th	TBGP	Connal's	3	1.53
Nov 7th	Connal's	BCIT	147.5	75.23
Nov 11th	BCIT	Connal's	147.5	75.23
Nov 11th	Connal's	TBGP	3	1.53
Nov 11th	TBGP	Connal's	3	1.53
Nov 12th	Connal's	TBGP	3	1.53
Nov 12th	TBGP	Connal's	3	1.53
Nov 13th	Connal's	TBGP	3	1.53
Nov 13th	TBGP	Connal's	3	1.53
Nov 14th	Connal's	TBGP	3	1.53
Nov 14th	TBGP	BCIT	144.5	73.70
Nov 20th	BCIT	Connal's	147.5	75.23
Nov 20th	Connal's	TBGP	3	1.53
Nov 20th	TBGP	Connal's	3	1.53
Nov 21th	Connal's	TBGP	3	1.53
Nov 21th	TBGP	Connal's	3	1.53
Nov 21th	Connal's	BCIT	147.5	75.23
		Total	2148.5	1095.74

Spring sampling session mileage and travel costs using a rate of $0.51/km.

Date	From	To	Km	Cost
Jan 5th	BCIT	Connal's	147.5	76.7
Jan 5th	Connal's	TBGP	3	1.56
Jan 5th	TBGP	Connal's	3	1.56
Jan 5th	Connal's	BCIT	147.5	76.7
Mar 5th	bcit	Connal's	147.5	76.7
Mar 5th	Connal's	tbgp	3	1.56
Mar 5th	TBGP	Connal's	3	1.56
Mar 5th	Connal's	bcit	147.5	76.7
Mar 18th	BCIT	Connal's	147.5	76.7
Mar 18th	Connal's	Delair's	4	2.08
Mar 18th	Delair's	Connal's	4	2.08
Mar 19th	Connal's	TBGP	3	1.56
Mar 19th	TBGP	Connal's	3	1.56
Mar 20th	Connal's	TBGP	3	1.56
Mar 20th	TBGP	Connal's	3	1.56
Mar 20th	Connal's	BCIT	147.5	76.7
Mar 26th	BCIT	Connal's	147.5	76.7
Mar 26th	Connal's	TBGP	3	1.56
Mar 26th	TBGP	Connal's	3	1.56
Mar 27th	Connal's	TBGP	3	1.56
Mar 27th	TBGP	Connal's	3	1.56
Mar 27th	Connal's	BCIT	147.5	76.7
			Total	636.48

Appendix 4 – Equipment

The equipment required to undertake this project was obtained from a variety of sources (Table 1). These materials were largely loaned from the BCIT FWR program.

Equipment	Purpose	Source
Seine net	Fish capture	BCIT Compound
40 Minnow traps	Fish Capture	BCIT Compound
Salmon roe	Bait for minnow traps	Marvin Rosenau
Large-fish measuring board	Data collection	BCIT Compound
Small-fish measuring board	Data collection	BCIT Compound
Eslon tape	Data collection	BCIT Compound
SensIon 156 Dissolved O_2 meter	Data collection	Chem. Department
3 Tidbit vs Temp dataloggers	Data collection	Bob Gunn
Hach 2100P Turbidity meter	Data collection	Chem. Department
Data sheets	Data collection	Personal supplies
Electronic scale	Data collection	BCIT Compound
Thermometer	Data collection	Personal supplies
Scissors (4)	Fin clipping	BCIT Compound
Viewing boxes (2)	Fish ID	BCIT Compound
Folding table	Fish Processing	BCIT Compound
Concrete blocks (8)	Hold tidbits and depth measures in place	Home Depot/BCIT
Metal garden stakes	Hold up seine net to retain fish for processing	Home Depot/BCIT
Net repair gear	In case of net snags	BCIT Compound
Inflatable boat and paddle	Multi-purpose	BCIT Compound
Pump	Inflate Boat	BCIT Compound
Collapsible shelter	Block elements from fishes being processed	BCIT Compound
Flags	Mapping	BCIT Compound
Weighted Eslon	Mapping	BCIT Compound
GPS (Pro XLT)	Mapping	Wayne Horvath
Extra rope	Multi-purpose	BCIT Compound
Waders and boots	Personal gear	Personal supplies
Formalin	Preserve voucher samples	Bob Gunn
Life jackets	Safety	BCIT Compound
Throw bag	Safety	BCIT Compound
Pole seine	Seining small isolated ponds	BCIT Compound
Mallet	Set up metal garden stakes	Personal Supplies
Wheel barrow	Transport gear	BCIT Compound
Buckets	Transport/hold fish	BCIT Compound

Appendix 5 – Permits

LICENSE OF GRAVEL PIT LAND

IN PURSUANCE OF THE MINISTRY OF TRANSPORTATION AND HIGHWAYS ACT, R.S.B.C. 1996, C. 311

THIS AGREEMENT dated for reference October 1, 2010.

BETWEEN:

HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA, as represented by the Minister of Transportation (the "Province")

AND:

BC Institute of Technology, BCIT Fish Wildlife & Recreation Project - Fish Sampling, 3700 Willingdon Avenue, Burnaby, British Columbia, V5G 3H2 (the "Licensee")

WHEREAS

A. The Licensee wishes to use and occupy and the Province wishes to grant to the Licensee a license to use and occupy certain lands (herein defined) for the purpose of the Event (herein defined).

NOW THEREFORE in consideration of the premises and the covenants and agreements contained herein and the sum of $1.00 now paid by the Licensee to the Province (the receipt and sufficiency of which is hereby acknowledged by the Province) the parties agree as follows:

1. **DEFINITIONS**

1.1 In this Agreement, unless the context otherwise requires:

(a) **"Controlled Areas"** means those areas situated within the License Area and identified as controlled areas on the sketch plan attached as Schedule "1" to this Agreement;

(b) **"Event"** means the production, presentation, hosting, and winding up of and the invitation of and hosting of persons, including, the general public, to the ;

(c) **"License Area"** means that part of the lands and premises legally described as follows:

Parcel Identifier: 006-437-440
Lot 1, District Lot 1172 and of Section 8, Township 5, Range 26, West of 6th Meridian, Yale Division Yale District, Plan 11076, Except Plans 32544 and KAP50175

and having an approximate area of 1.04 hectares and designated in heavy black line on the sketch plan attached as Schedule "1" to this Agreement, and excluding those portions designated as archaeological sites on the map attached in Schedule "3" to this Agreement;

(d) **"Licensee Representative"** means the person designated by the Licensee as such pursuant to this Agreement, and includes alternates authorized as such in accordance with the terms of this Agreement;

(e) **"Material"** means gravel, sand, and dirt, including without limitation, pit-run granular aggregate, winter abrasive, crush, sealcoat and any other aggregate which may be processed from Pit-Run and includes any by-products resulting from the processing of Pit-Run;

(f) **"Ministry Representative"** means the person designated by the Province as such pursuant to this Agreement, and includes alternates authorized as such in accordance with the terms of this Agreement;

(g) **"Parking Areas"** means those lands situated within the License Area and identified as parking areas on the sketch plan attached as Schedule **"1"** to this Agreement;

(h) **"Pollutant"** means

(i) any hazardous, toxic, dangerous and potentially dangerous material or substance, any liquid or gaseous material and any other substance which is reasonably capable of causing pollution or contamination to air, land or water, and

(ii) all substances and materials defined as "waste" in the Waste Management Act, R.S.B.C. 1996, c. 482, as it may be amended from time to time, or any enactment relating to the environment, and the regulations enacted under the Waste Management Act or any such enactment;

(j) **"Public Galleries"** means those lands situated within the License Area and identified as public galleries on the sketch plan attached as Schedule "1" to this Agreement;

(k) **"Term"** means the period of time which will, notwithstanding the date of execution and delivery of this Agreement, be conclusively deemed to commence at 6:00AM inclusive on the following dates of **October 2-3, 9-10, 16-17, November 11-14, 2010 and March 12-15, 19-20, 26-27, 2011** and end at 10:00 PM on March 27, 2011, or such date of earlier termination or cancellation as may be established in accordance with the terms of this Agreement;

(l) **'Traffic Management Plan'** means the plan attached in Schedule '2' of this Agreement; and

(l) **'Vehicle'** includes without limitation,
(i) a "vehicle" as that term is defined in the *Motor Vehicle Act*, R.S.B.C. 1996, c.318,
(ii) an all terrain vehicle, and
(iii) an all terrain cycle.

2. GRANT AND TERM

2.1 Subject to the terms of this Agreement, the Province grants to the Licensee a license to enter on and occupy the License Area during the Term for the purpose of the Event, subject to and in accordance with the terms and conditions of this Agreement.

3. LIMITS ON LICENSE

3.1 The Licensee acknowledges and agrees that this Agreement does not grant to the Licensee any proprietary or property rights or interests in the License Area.

4. **LICENSEE'S COVENANTS**

4.1 The Licensee covenants with the Province that the Licensee will

(a) enter upon and occupy the License Area solely for the purpose set out in Article 2 of this Agreement;

(b) ensure that any and all Vehicles entering onto the License Area for or in connection with the Event are fully insured in accordance with all applicable laws and regulations relating to automobile liability insurance and all applicable policies of the Insurance Corporation of British Columbia, and without limiting the generality of the foregoing, ensure that all participants in the Event,
   (i) obtain and maintain automobile liability insurance that includes coverage for participation in all events, races, climbs and activities comprising the Event, and that is in an amount not less than $5,000,000 (FIVE MILLION) inclusive per occurrence, and
   (ii) hold, in connection with the Vehicles participating in the Event, the requisite certificates and documentation, of registration and otherwise, including without limitation, as required under the Motor Vehicle Act, R.S.B.C. 1996, c.318, and regulations enacted thereunder, and the Motor Vehicle (All Terrain) Act, R.S.B.C. 1996, c.319, and regulations enacted thereunder;

(c) not permit, allow or otherwise suffer any person,
   (i) who has not received the prior authorization of the Licensee to enter the Controlled Areas,
   (ii) who is a spectator to enter any part of the License Area other than the Public Galleries, or
   (iii) to park in any part of the License Area other than the Parking Areas;

(d) comply with and perform the Traffic Management Plan set out in Schedule "2" of this Agreement, and any directives or instructions that may, from time to time, be issued by any member of the Royal Canadian Mounted Police, the provincial police force or an applicable municipal police force, as the case may be;

(e) at all times during the Term,
   (i) provide adequate security for the License Area, and not remove, cause to be removed or suffer or permit the removal of any Material from the License Area,
   (ii) permit the Province, its servants, agents and authorized representatives to enter upon the License Area at any time for any purpose, and
   (iii) prevent entry to the License Area by any person, other than spectators, and participants in the Event, employees, workers, servants, agents, and invitees of the Licensee, law enforcement authorities, and members of the general public in connection with the Event;

(f) keep the License Area at all times in a safe, clean and sanitary condition satisfactory to the Province and in a state of repair and condition as would a prudent and careful owner in occupation, and at least equivalent to the state of repair and condition of the License Area at the commencement of the Term, save for damage by lightning and tempest and, on the expiration or sooner termination of the Term, yield up the License Area in equivalent repair and condition to the repair and condition in which the License Area would have been kept by a prudent and careful owner in occupation during the Term, save for damage by lightning and tempest;

(g) not, without the prior written consent of the Province,
   (i) erect or cause to be erected on the License Area any building, structure or other improvement of any nature or kind whatsoever; and
   (i) move, remove, place, maintain, or cause or suffer to be moved, removed, placed or maintained any improvement or fixture in or on the License Area; and

   any such consent of the Province does not constitute any representation or warranty, express or implied, or any of any kind assurance whatsoever, as to the state, condition, design, operation, or fitness for purpose or suitability for use of any such building, structure, fixture, or improvement;

(h) in such a manner as the Licensee, exercising the standard of care, expertise, skill and diligence required in law, considers necessary, produce, present, manage, administer, host and operate the Event, to ensure the health and safety of the public, including without limitation, spectators, and participants in the Event, and the employees, workers, servants, agents and invitees of the Licensee;

(i) not be subject to the control of the Province with respect to the manner in which it produces, presents, manages, administers, hosts and operates the Event;

(j) observe, abide by and comply with all laws, bylaws, orders, approvals, regulations, directions, standards, ordinances and rules, of any governmental authority or agency in any way relating or applicable, directly or indirectly, to the Licensee, this Agreement, the License Area, the production, presentation, management, administration, hosting and operation of the Event, or the Licensee's use and occupation of the License Area in connection with the Event, including without limitation:

   (i) produce, present, manage, administer, host and operate the Event, and maintain the License Area in a condition and state of operation that complies at all times with all such laws, bylaws, orders, regulations, directions, standards, ordinances and rules, including without limitation, laws, by-laws, or regulations relating to Pollutants and the protection of the environment, applicable to the Event, the License Area, or the Licensee;

   (ii) ensure that the production, presentation, management, administration, hosting and operation of the Event, complies with all laws, bylaws, orders, regulations, directions, standards, ordinances and rules of any governmental authority applicable to the health and safety of the public, spectators, invitees and participants in the Event, to the safe operation of the Event, and to occupational health and safety, including without limitation, the Motor Vehicle Act, R.S.B.C. 1996, c.318, and regulations enacted thereunder, the Motor Vehicle (All Terrain) Act, R.S.B.C. 1996, c.319, and regulations enacted thereunder, the Workers Compensation Act, R.S.B.C. 1996, c. 492, the British Columbia Regulation 296/97 entitled "Occupational Health and Safety Regulation", the Mines Act, R.S.B.C. 1996, c. 293, and the health, safety and reclamation code as may be established from time to time under the Mines Act; and

(iii) ensure that the employees, workers, servants, agents and invitees of the Licensee are instructed in the terms of such laws, bylaws, orders, regulations, directions, standards, ordinances and rules, applicable to occupational health and safety and to the safe production, presentation, management, administration, hosting, and operation of the Event, including without limitation the Workers Compensation Act, R.S.B.C. 1996, c. 492, the British Columbia Regulation 296/97 entitled "Occupational Health and Safety Regulation", the Mines Act, R.S.B.C. 1996, c. 293, and the health, safety and reclamation code;

(k) obtain, maintain, observe, and comply with all licenses, agreements, consents, approvals or authorities issued by any competent governmental authority or agency that are necessary in connection with the Licensee, the License Area, the production, presentation, management, administration, hosting, and operation of the Event, the Licensee's use and occupation of the License Area, or this Agreement;

(l) not commit or suffer any willful or voluntary waste, spoil or destruction on the License Area, and not do or suffer to be done on the License Area anything that may be or become a nuisance or annoyance to any owner or occupier of adjoining lands or lands in the vicinity of the License Area;

(m) observe and perform all terms and provisions of this Agreement and not do or suffer to be done anything contrary to any term or provision of this Agreement;

(n) not obstruct, interfere with, or otherwise impede, or suffer, permit, or allow the operation, production, implementation, administration, hosting, and presentation of the Event, to obstruct, interfere with or otherwise impede the operation of those parts of the public highways adjacent to the License Area;

(o) not erect or install or otherwise suffer or cause to be erected or installed advertising signage of any kind whatsoever on the License Area without the prior written consent of the Province;

(p) keep the Lands free of all Pollutants and

(i) not cause, suffer, or permit the License Area or any part thereof to be used for storage, handling, transportation, or disposal of Pollutants;

(ii) promptly, upon becoming aware of any deposit, spill, discharge, or release of a Pollutant on the License Area, or of any event on or affecting the License Area which constitutes an offense or a breach, or is reportable under any laws, by-laws, or regulations relating to Pollutants and the protection of the environment,

(A) give written notice to the Province of the deposit, spill, discharge, or release;

(B) comply with all lawful orders or requests from the Province, or any government authority relating to the deposit, spill, discharge, release or any such event; and

(C) undertake and complete all removal and remedial actions necessary to contain, remove and clean up any Pollutant that may have been deposited or spilled in, under or upon the License Area as a result of that event, and that removal shall be to the reasonable satisfaction of the Province, and if the Licensee does not comply with any lawful orders or requests described in clause (B) of this subsection, the Province may undertake to carry out such lawful orders and requests and the Licensee will immediately pay to the Province all costs and expenses incurred by the Province in so doing.

(q) undertake and perform all investigations, assessments and reviews necessary to identify, eliminate or control hazards to the health or safety of all persons on the License Area, including without limitation, participants in and spectators of the Event, arising in connection with the state, design, or condition of the License Area, the production, presentation, management, administration, hosting, and operation of the Event, the use or occupation of the License Area by the Licensee, or this Agreement; and

(r) provide, maintain, and have available, at all times sufficient staff with all necessary training and certifications, facilities, materials, appropriate equipment and expertise to ensure the safe and lawful production, presentation, management, administration, hosting, and operation of the Event on the License Area.

5. **INSURANCE**

5.1 The Licensee will, without limiting its obligations or liabilities under this Agreement, at its own expense, obtain, provide, and maintain during the Term with insurers licensed in British Columbia, insurance in content, forms and amounts acceptable to the Province and the Licensee will effect and keep in force during the Term

(a) comprehensive or commercial general liability insurance in an amount not less than $5,000,000.00 (FIVE MILLION DOLLARS) inclusive per occurrence against bodily injury, death, and property damage, occurring on, in or about the Lands and including liability assumed under contract, for claims arising out of any accident or occurrence on, in or about the Lands, and the policy of insurance will be endorsed to include Land and Water British Columbia Inc., Her Majesty the Queen in Right of the Province of British Columbia, as represented by the Minister of Transportation together with any employees, agents and servants of the Minister, as Additional Named Insureds;

(b) automobile liability insurance in respect to any Vehicles operated by the Licensee or on behalf of the Licensee on the Lands or in connection with this Agreement in an amount not less than $5,000,000.00 (FIVE MILLION DOLLARS) inclusive per occurrence; and

(c) all risks property insurance against loss or damage to improvements, furniture, fittings, fixtures, appurtenances, machinery, equipment, stock-in-trade and merchandise on, in or about the Lands, which policy of insurance will contain a waiver of subrogation that in the event of a loss and upon payment of any claim, the insurer will waive its right of subrogation against Land and Water British Columbia Inc., Her Majesty the Queen as represented by the Minister of Transportation or any of the employees, servants or agents of the Minister, and a loss payable clause directing payment to the Minister of Transportation.

5.2 Notwithstanding section 5.1, the Province may at any time or times, by notice in writing delivered to the Licensee, require that the insurance or the amount of the insurance set out in this Article, be changed, or that other insurance in addition to the insurance set out in this Article be obtained and maintained, and the Licensee will make such change or changes and obtain and maintain such additional insurance as may be described or set out in the written notice.

5.3 The Licensee will deliver to the Province prior to execution of this Agreement by the parties evidence of insurance issued to comply with the insurance requirements set out in this Article, by way of a duly completed Ministry Certificate of Insurance (H-111) and, on the request of the Province, a duly executed Insurance Corporation of British Columbia form, (an APV47 or APV250, as the case may be) and the Licensee will, on the request of the Province, made at any time or times, deliver to the Province evidence, by way of a duly completed Ministry Certificate of Insurance and duly executed Insurance Corporation of British Columbia form, (an APV47 or APV250, as the case may be), that the insurance remains in force and effect or evidence of renewal of the insurance, as the case may be.

5.4 The Licensee will deliver to the Province, on the request of the Province, made at any time or times, the original version or duly executed certified copies of all current insurance policies and endorsements.

5.5 The Licensee will not cancel, reduce, materially alter or change the insurance required under this Article without prior written notice delivered to the Province.

6. RISK, RESPONSIBILITY, INDEMNITY AND RELEASE

6.1 The Licensee acknowledges the risks and hazards inherent in the production, presentation, management, administration, hosting, and operation of the Event and the use and occupation of the License Area and agrees that the production, presentation, management, administration, hosting, and operation of the Event, the entry on the License Area, and the use and occupation of the License Area by the Licensee, its employees, servants, agents, licensees, invitees, participants, spectators, and members of the general public are entirely the responsibility of, and at the risk of the Licensee, and not that of the Province.

6.2 The Licensee covenants with the Province that the Licensee will indemnify and save harmless Land and Water British Columbia Inc., and the Province

(a) from and against all losses, damages, costs and liabilities, including fees of solicitors and other professional advisors, made against or incurred, suffered or sustained by the Province, at any time or times (whether before or after the cancellation, expiration or termination of this Agreement) where the same or any of them are sustained in connection with, are based upon or arise out of or from any:

(i) breach, violation or non-performance by the Licensee of any term in this Agreement, or

(ii) personal and bodily injury, death or damage occurring or happening on or off, or in or about the License Area by virtue of the production, presentation, management, administration, hosting, and operation of the Event, and the use or occupation of the License Area by the Licensee, its employees, servants, agents, licensees, invitees, participants, spectators, and members of the general public, including without limitation, under this Agreement, and

(b) from any fines, penalties or expenses levied or charged against the Province or the Licensee by any governmental authority, court or board pursuant to any law, by-law or regulation for the protection of the environment as a result of the use or occupation of the License Area by the Licensee, the production, presentation, management, administration, and operation of the Event, or the acts or omissions of the Licensee, its employees, servants, agents, licensees, invitees, or members of the public, on or in connection with the License Area, including without limitation, under this Agreement,

which indemnity will survive the expiration or sooner termination or cancellation of this Agreement.

6.3 The Licensee agrees that in consideration of the sum of $1.00 and other valuable consideration now paid by the Province to the Licensee (the receipt and sufficiency of which is hereby acknowledged by the Licensee), the Licensee hereby releases, acquits and forever discharges Land and Water British Columbia Inc., and the Province from and against any and all claims, actions, liabilities, or demands of any sort whatsoever which may be brought or may arise, directly or indirectly, in connection with the Licensee, this Agreement, the production, presentation, management, administration, hosting, and operation of the Event, and the use or occupation of the License Area.

7. ASSIGNMENT AND SUBLET

7.1 The Licensee will not assign this Agreement, any interest in this Agreement, or its rights, duties, or obligations under this Agreement, in whole or in part, or grant a license or permit to occupy the License Area, or any part of the License Area, to any other person.

8. REPRESENTATIONS AND WARRANTIES

8.1 The Province does not make or give any representations or warranties, express or implied, of any kind whatsoever, in connection with the License Area, this Agreement, the production, presentation, management, administration, hosting, and operation of the Event on the License Area, or the use or occupation of the License Area by the Licensee, including without limitation,

(a) as to the state, condition, design, operation or fitness for purpose or suitability for use of the License Area for the production, presentation, management, administration, hosting, and operation of the Event, and the use or occupation of the License Area by the Licensee, its employees, servants, agents, licensees, invitees, participants, spectators, and members of the general public, including without limitation, under this Agreement, or anything else whatsoever;

(b) the presence or absence, and the deposit or spill, of a Pollutant on the License Area; or

(c) the occurrence of any event on or affecting the License Area which constitutes an offense or a breach, or is reportable under any laws, by-laws, or regulations relating to Pollutants and the protection of the environment.

8.2 The Licensee represents and warrants to the Province on the execution of this Agreement and at all times thereafter during the Term of this Agreement, with the knowledge that the Province will rely upon these warranties and representations in entering into this Agreement that,

(a) the Licensee has inspected the Lands and is fully aware of the state, condition, design, operation and fitness for purpose and suitability for use of the License Area, including without limitation, for the production, presentation, management, administration, hosting, and operation of the Event, and the use or occupation of the License Area by the Licensee, its employees, servants, agents, licensees, invitees, participants, spectators, and members of the general public; and

(b) the Licensee holds all permits, licenses, consents and authorities issued by any federal, provincial, regional, local, or municipal government or agency, that are necessary in connection with the production, presentation, management, administration, hosting, and operation of the Event, including without limitation, on the License Area.

8.3 All terms of this Agreement and all certificates and other documents delivered by or on behalf of the Licensee are material and will conclusively be deemed to have been relied upon by the Province, notwithstanding any prior or subsequent investigation by the Province.

9. TERMINATION

9.1 Notwithstanding any other provision of this Agreement, the Province may, in its sole discretion, terminate this Agreement upon one day written notice of termination to the Licensee and the Licensee will quit and deliver possession of the License Area to the Province in accordance with the terms of this Agreement and the Licensee acknowledges and agrees that it will make no claim for compensation, in damages or otherwise, including without limiting the generality of the foregoing, no claim for lost profits or other consequential loss, as a result of the termination of this Agreement under this Article.

9.2 The Licensee covenants with the Province that, on the expiration or earlier termination of this Agreement, the Licensee will

(a) peaceably quit and deliver possession of the License Area to the Province in a safe, clean and sanitary condition to the satisfaction of the Province;

(b) if required by the Province, restore the gravel shoulders of those parts of the public highways adjacent to the License Area to a safe, clean and clear condition, to the reasonable satisfaction of the Province, including by ensuring that gravel, sand, rocks, and dirt that may be tracked onto the shoulder area of such highways from the License Area in connection with the Event, is removed to the reasonable satisfaction of the Province;

(c) at its own cost, dismantle and remove all equipment, apparatus, things and improvements or fixtures of the Licensee at the License Area and repair all damage to the License Area caused by the dismantling and removal of such equipment, apparatus and other improvements or fixtures;

(d) remove all fencing that has been installed by the Licensee under this Agreement;

(e) if required by the Province, dismantle and remove any grand stands or galleries situated in the License Area,

and all right and interest of the Licensee in the License Area will cease and vest in the Province at that time and, to the extend necessary, this covenant will survive the expiration or earlier termination of this Agreement.

9.3 Any equipment, apparatus and other improvements or fixtures of the Licensee remaining at the License Area later than 14 days after expiration or termination of this Agreement will be absolutely forfeited to and become the property of the Province, and may be removed from the License Area by the Province and the Licensee will pay to the Province, on demand, all expenses incurred by the Province, including the costs of removal.

10. DEFAULT

10.1 The Province and the Licensee agree that if,

(a) the Licensee fails to perform, comply with, or observe any of the covenants, agreements, conditions or provisos contained in the Agreement on the part of the Licensee to be performed, complied with, or observed;

(b) in the opinion of the Province, the Licensee fails to make reasonable and diligent use of the License Area for the purpose permitted by this Agreement, and the failure continues for a period of one day after the Province gives written notice to the Licensee of the nature of the failure;

then the Province may enter upon the License Area or any part of it in the name of the whole, and this Agreement will, at the option of the Province and with or without entry, terminate, and all the rights of the Licensee with respect to the License Area will be absolutely forfeited and will lapse.

11. GENERAL PROVISIONS

11.1 The Licensee acknowledges and agrees with the Province that

(a) the Province is under no obligation, express or implied, to provide assistance of whatsoever nature or kind, to the Licensee, including without limitation, to provide access, services, financial assistance or contribution, in connection with obtaining any and all approvals, permits, or authorizations that may be required in connection with this Agreement, or the use of the License Area for the purpose set out in Article 2 of this Agreement; and

(b) nothing in this Agreement constitutes the Licensee as the agent, joint venturer or partner of the Province or gives the Licensee any authority or power to bind the Province in any way.

11.2 On execution of this Agreement, the Province will designate a Ministry Representative and will deliver notice thereof to the Licensee.

11.3 On execution of this Agreement, the Licensee will deliver to the Ministry Representative and to the local law enforcement agency, the name of the Licensee Representative and will, forthwith, upon any such change in designation occurring, deliver written notice to the Ministry Representative and to the local law enforcement agency, of every change in designation of persons designated as the Licensee Representative under this Agreement.

11.4 The Licensee will ensure that the Licensee Representative remains on the License Area at all times during the Term, while the Event is in operation.

12. NOTICE

12.1 Any notice, document or communication required or permitted to be given under this Agreement must be in writing and will be deemed to have been given if delivered by hand, facsimile, courier or double registered mail to the party to whom it is given as follows:

(a) if to the Province, then to:
Ministry of Transportation & Infrastructure,
Lower Mainland District Office
Suite 200 - 1065 Columbia Street
New Westminster, B.C. V3M 6H7
Facsimile: (604) 660-8371

(b) if to the Licensee, then to:

(i) to the Licensee Representative; or

(ii) to
BC Institute of Technology
BCIT Fish Wildlife & Recreation Project - Fish Sampling
3700 Willingdon Avenue
Burnaby, BC V5G 3H2
Attention: Stephanie Ellis, Student 778-988-4743

13. MISCELLANEOUS

13.1 In this Agreement any reference to a party includes that party's heirs, executors, administrators, successors and assigns and the terms and provisions of this Agreement will extend to, be binding upon and enure to the benefit of the parties, their successors and permitted assigns.

13.2 It is expressly agreed that all grants, covenants, conditions provisos, rights, powers, privileges and liabilities contained herein will be read upon and undertaken by the parties hereto for themselves and their respective heirs, executors, administrators, successors, agents, and employees.

13.3 No term, condition, covenant or other provision of this Agreement will be considered to have been waived by the Province unless the waiver is expressed in writing by the Province. The waiver by the Province of any breach by the Licensee of any term, condition, covenant or other provision of this Agreement will not be construed as or constitute a waiver of any further or other breach of the same or any other term, condition, covenant or other provision and the consent or approval of the Province to any act by the Licensee requiring the consent or approval of the Province will not be considered to waive or render unnecessary the consent or approval of the Province to any subsequent same or similar act by the Licensee.

13.4 If any section of this Agreement, or any part of a section, is found to be illegal or unenforceable, that section or part of a section, as the case may be, will be considered separate and severable and the remaining section or part of a section, as the case may be, will not be affected and will be enforceable to the fullest extent permitted by law.

13.5 This Agreement may only be amended by subsequent agreement in writing executed on behalf of the Province and the Licensee.

13.6 Any reference to "this Agreement" means this instrument and all of the Schedules attached to it and any reference to any article, section, subsection or paragraph by number is a reference to the appropriate article, section, subsection or paragraph in this Agreement.

13.7 No remedy conferred upon or reserved to the Province is exclusive of any other remedy in this Agreement or provided by law, but that remedy will be in addition to any other remedy in this Agreement or any other remedy then existing at law, in equity, or by statute.

13.8 Time is of the essence of this Agreement.

14. **INTERPRETATION**

14.1 In this Agreement, 'person' includes a corporation, firm, association and any other legal entity and wherever the singular or masculine is used it will be construed as if the plural, the feminine or the neuter, and wherever the plural or the feminine or the neuter is used it wil be construed as the singular or masculine, as the case may be, had been used where the context or the parties so require.

14.2 The captions and headings containec in this Agreement are for convenience only and do not form a part of this Agreement and in no way define, limit, alter or enlarge the scope, meaning or intent of any provision of this Agreement.

14.3 In this Agreement, the words "including" and "includes", when following any general term or statement, are not to be construed as limiting the general term or statement to the specific items or matters set forth or to similar items or matters, but rather as permitting the general term or statement to refer to all other items or matters that could reasonably fall within the broadest possible scope of the general term or statement.

14.4 This Agreement will be governed by and construed and interpreted in accordance with the laws of the Province of British Columbia.

14.5 Where there is a reference to an enactment of the Province of British Columbia or of Canada in this Agreement, that reference will include a reference to every amendment to it, every regulation made under it, any subsequent enactment of like effect, and any enactment passed in substitution therefore or in replacement thereof, and, unless otherwise indicated, all enactments referred to in this Agreement are enactments of the Province of British Columbia.

14.6 Each schedule attached to this Agreement is an integral part of this Agreement as if set out at length in the body of this Agreement.

14.7 This Agreement constitutes the entire agreement between the parties. No understandings, representations, contracts or agreements, oral or otherwise, exist between the parties with respect to the subject matter of this Agreement except as expressly set out in this Agreement. The Licensee agrees that in entering into this Agreement it has not and does not rely upon any previous representation of the Province, or of servants, employees, agents, or representatives of the Province, whether expressed or implied, or upon any inducement or agreement of any kind or nature. All prior understandings, negotiations, representations, contracts or agreements are hereby cancelled.

14.8 Each of the parties will, upon the reasonable request of the other, make, do, execute or cause to be made, done or executed all further and other lawful acts, deeds, things, devices, documents, instruments and assurances whatever for the better or more perfect and absolute performance of the terms and conditions of this Agreement.

WITNESS WHEREOF, the parties have executed this Agreement as follows:

SIGNED on behalf of **Her Majesty the Queen** in right of the **Province of British Columbia** by a duly authorized representative of the Minister of Transportation and Infrastructure on October 1, 2010, in the presence of:

Ken Lukawesky
Gravel Project Manager
Minister of Transportation and Infrastructure

Glenn W. Callander
Area Development & Operations Technician
Minister of Transportation and Infrastructure

(Witness)

Per: BC Institute of Technology
Authorized Signatory

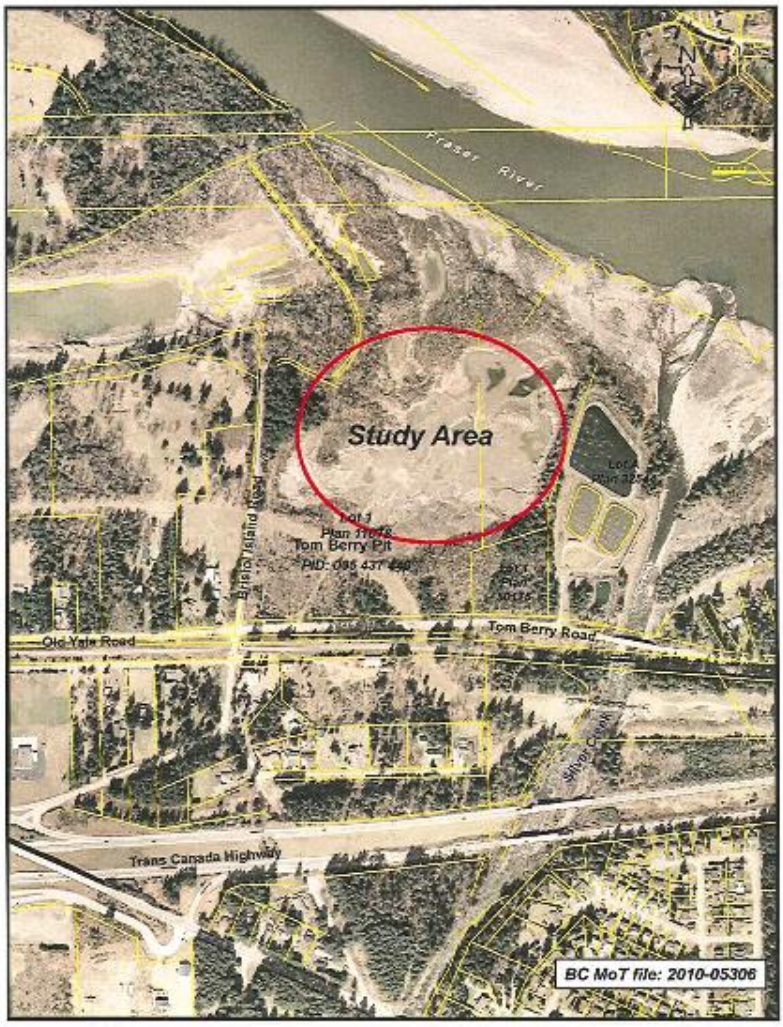
(Signature)

(Date of Signature)

(Title)

SCHEDULE "1"

Lands



Schedule "A"

Terms and Conditions

1. The requirements of the Ministry of Transportation & Infrastructure, Area Manager, Anne Hazelwood at 604-869-7328 (office) 604-860-3011 (mobile), the local police authority and other applicable local municipal authorities must be complied with.

2. Liability coverage is required to the amount of $2,000,000.00. The name insured shall include Her Majesty the Queen in the right of the Province of British Columbia as represented by the Minister of Transportation and Infrastructure, and any of his/her employees or agents.

3. This agreement does not relieve the BCIT Fish Wildlife & Recreation Project, of any obligation with regard to adherence to the Motor Vehicle Act or any other Act or Regulation with respect to the Fish Sampling Project.

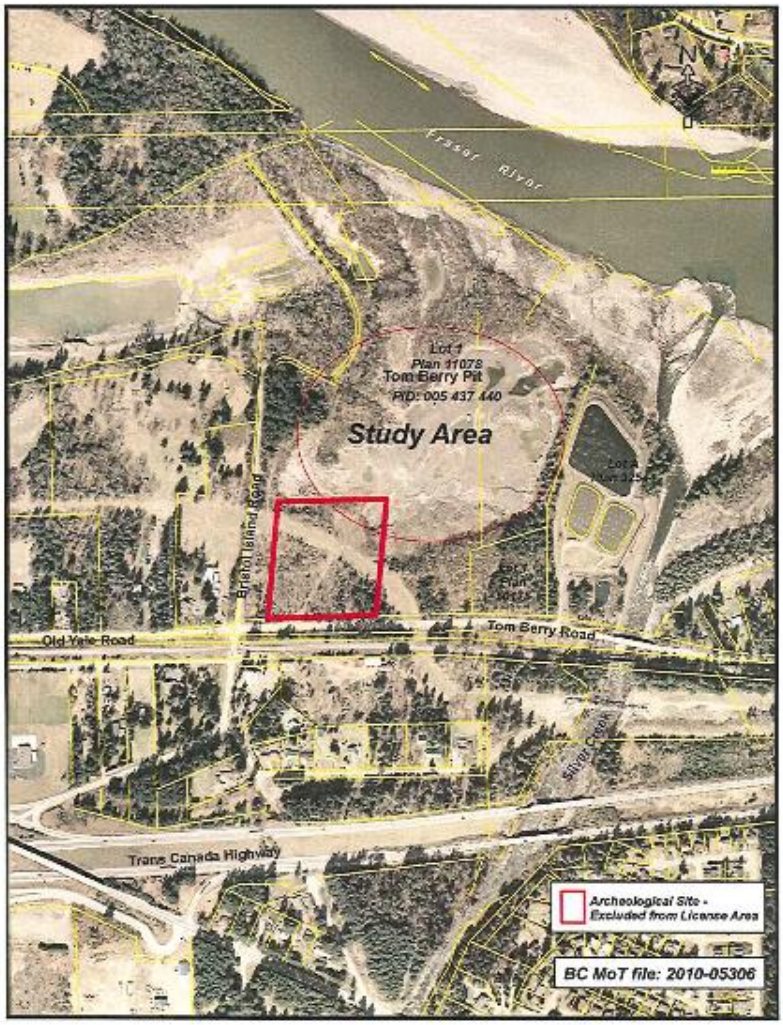
4. The BCIT Fish Wildlife & Recreation Project is responsible to ensure that all WCB regulations are adhered to.

5. All emergency services, ambulance, fire, etc., to be provided with access, in case of an emergency. The BCIT Fish Wildlife & Recreation Project team shall yield the right of way to emergency vehicles at all times.

6. The permit area and parking lot must be left clean and tidy, and in its original condition, or better. The BCIT Fish Wildlife & Recreation Project team are responsible for the clean-up and removal of all litter.

SCHEDULE "3"

Map of Archeological Site Excluded from the License Area



Appendix 6 – Fisheries and Oceans Canada Permit

Fisheries and Oceans | Pêches et Océans

100 Annacis Parkway,
Delta, BC V3M 6A2

September 28, 2010

To whom it may concern,

Students from the BCIT Fish, Wildlife and Recreation Program have DFO permission to undertake a juvenile mark/recapture fish population assessment study of off-channel habitats of the Fraser River flood-plain near Hope B.C.

For questions please contact the undersigned.

Sam Gidora
Senior Biological Technician
Resource Restoration Division
Lower Fraser Area
Sam.Gidora@dfo-mpo.gc.ca
604-666-6841 (office)
604-833-0005 (cell)

Appendix 7 – Site Cards

Site Card			
Date:	Site Name:	Crew:	
Start Time:	End Time:	Weather:	
Capture/Recapture Method:		Air temperature:	
Wetted Width:		Depth:	
Fraser Discharge at Hope:		Ice Cover:	
Water Quality			
Temperature:	Conductivity:	Turbidity:	pH:
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L

Species	Clipped	Recap	Mortalities	Total
Chinook				
coho				
sockeye				
northern pikeminnow				
largescale sucker				
peamouth chub				
redside shiner				
prickly sculpin				
common carp				
cutthroat trout				
rainbow trout				

Comments:

Appendix 8 – Data Sheets

Date:	Site:	Crew:	Weather:
Time processing started:		Time processing finished:	
Species:		Mortality:	

#	length (mm)	weight (g)	clip	comments
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

Additional marked:	Total count:
Dead:	Mean length:
Recapture:	Mean weight:

Appendix 9 – Recapture Sheets

Date:	Site:	Crew:	Start time:	End time:

Species	Marked	Not Marked
Chinook		
coho		
sockeye		
redside shiner		
peamouth chub		
prickly sculpin		
largescale sucker		
mountain whitefish		

Appendix 10 – Data Sheets: Tom Berry Gravel Pit 1, Oct. 2, 2010

Site Card			
Date: Oct. 2, 2010	Site Name: TBGP 1	Crew: CM, SE, HH	
Start Time: 14:45	End Time: 18:30	Weather: sunny, warm	
Capture/Recapture Method: capture, comparative seine		Air temperature: 22 °C	
Wetted Width: n/a		Depth: n/a	
Fraser Discharge at Hope: 3266.68m^3/s		Ice Cover: n/a	
Water Quality			
Temperature: 16.6 (average)	Conductivity: n/a	Turbidity: n/a	pH: n/a
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
n/a	n/a	n/a	n/a

Species	Clipped/Caught	Recaptures	Mortalities	Total
Chinook	5		0	5
minnow spp.	116		87	203
prickly sculpin	1		0	1

Comments: did not have the water quality meters. Had to stop counting fish, water too warm, losing daylight, fish started dying, released uncounted minnow species. Estimated >1000 minnow species. Counted redside shiners and peamouth chubs as one species.

Chinook

Date: October 2, 2010	Site: TBGP 1	Crew: CM, SE, HH	Weather: sunny, warm
Time processing started: 14:45		Time processing finished: 18:30	
Species: Chinook		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	123	8.50	UC	
2	150	20.00	UC	
3	110	8.00	UC	
4	96	5.50	UC	
5	90	4.50	UC	
6				
7				
8				
9				
10				

Additional marked:	0	Total count:	5
Dead:	0	Mean length:	113.8 mm
Recapture:	n/a	Mean weight:	9.30 g

prickly sculpin

Date: October 2, 2010	Site: TBGP 1	Crew: CM, SE, HH	Weather: sunny, warm
Time processing started: 14:45		Time processing finished: 18:30	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	44	0.5		
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	44.0 mm
Recapture:	n/a	Mean weight:	0.50 g

minnow species (redside shiner & peamouth chub)

Date: October 2, 2010	Site: TBGP 1	Crew: CM, SE, HH	Weather: sunny, warm
Time processing started: 14:45		Time processing finished: 18:30	
Species: minnow species		Mortality: 87	

#	length (mm)	weight (ounces)	clip	comments
1	34	0.5	UC	
2	35	0.5	UC	
3	35	0.5	UC	
4	36	0.5	UC	
5	39	0.5	UC	
6	39	0.5	UC	
7	39	0.5	UC	
8	40	0.5	UC	
9	40	0.5	UC	
10	40	1.0	UC	
11	40	0.5	UC	
12	40	0.5	UC	
13	41	0.5	UC	
14	41	0.5	UC	
15	41	0.5	UC	
16	41	0.5	UC	
17	41	0.5	UC	
18	42	0.5	UC	
19	43	0.5	UC	
20	43	0.5	UC	
21	43	0.5	UC	
22	43	0.5	UC	
23	43	0.5	UC	
24	44	0.5	UC	
25	44	0.5	UC	
26	44	0.5	UC	
27	45	0.5	UC	
28	45	0.5	UC	
29	45	0.5	UC	
30	46	0.5	UC	
31	46	0.5	UC	
32	46	0.5	UC	
33	46	0.5	UC	
34	46	1.0	UC	
35	46	0.5	UC	
36	46	0.5	UC	
37	49	0.5	UC	
38	50	0.5	UC	
39	51	1.0	UC	
40	51	1.0	UC	

41	52	1.0	UC	
42	53	0.5	UC	
43	54	1.0	UC	
44	55	1.0	UC	
45	55	1.0	UC	
46	56	1.0	UC	
47	56	1.0	UC	
48	56	1.0	UC	
49	56	1.5	UC	
50	57	1.0	UC	
51	57	1.0	UC	
52	59	1.0	UC	
53	59	1.0	UC	
54	59	1.0	UC	
55	60	1.0	UC	
56	60	1.0	UC	
57	60	1.0	UC	
58	60	1.0	UC	
59	60	1.0	UC	
60	60	1.5	UC	
61	60	1.5	UC	
62	61	1.0	UC	
63	61	1.0	UC	
64	61	1.0	UC	
65	62	1.0	UC	
66	63	1.5	UC	
67	63	1.5	UC	
68	63	1.5	UC	
69	63	2.5	UC	
70	64	1.0	UC	
71	64	1.0	UC	
72	64	1.5	UC	
73	64	1.0	UC	
74	64	1.5	UC	
75	65	1.0	UC	
76	65	1.0	UC	
77	65	1.0	UC	
78	69	1.0	UC	
79	75	2.5	UC	
80	90	4.0	UC	
81	91	5.0	UC	
82	93	5.0	UC	
83	95	6.0	UC	
Additional marked:	33		Total count:	83+33=116
Dead:	87		Mean length:	53.5 mm
Recapture:			Mean weight:	1.05 g

Appendix 11 – Data Sheets: Tom Berry Gravel Pit 2, Oct. 2, 2010

Site Card			
Date: Oct. 2, 2010	Site Name: TBGP 2	Crew: CM, SE, HH	
Start Time: n/a	End Time: n/a	Weather: sunny, warm	
Capture/Recapture Method: n/a		Air temperature: 22 °C	
Wetted Width: n/a		Depth: n/a	
Fraser Discharge at Hope: 3266.68m^3/s		Ice Cover: n/a	
Water Quality			
Temperature: 18	Conductivity: n/a	Turbidity: n/a	pH: n/a
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
n/a	n/a	n/a	n/a

Comments: during reconnaissance of the site, TBGP 2 was 4 separate small ponds. They were now all connected.

Appendix 13 – Data Sheets: Tom Berry Gravel Pit 1, Oct. 3, 2010

Site Card			
Date: Oct. 3, 2010	Site Name: TBGP 1	Crew: CM, SE, HH, KP	
Start Time: n/a	End Time: n/a	Weather: overcast, slight drizzle	
Capture/Recapture Method: n/a		Air temperature: 15 °C	
Wetted Width: n/a		Depth: n/a	
Fraser Discharge at Hope: 3233.92m^3/s		Ice Cover: n/a	
Water Quality			
Temperature: 17 °C	Conductivity: 35.5, 34.5, 32.6, 26.9(spring) mg/L	Turbidity:5, 4, 2, 1 NTU	pH: 7.1, 6.8, 7.4, 7(spring)
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
morning	surface	17.7	9.78
morning	surface	17.4	9.16
morning	surface	16.8	9.27
morning	surface	11.1 (spring)	6.79

Appendix 14 – Data Sheets: Tom Berry Gravel Pit 2, Oct. 3, 2010

Site Card			
Date: Oct. 3, 2010	Site Name: TBGP 2	Crew: CM, SE, HH, KP	
Start Time: 11:00	End Time: 16:00	Weather: overcast, slight drizzle	
Capture/Recapture Method: capture		Air temperature: 15 °C	
Surface area: 2235m^2		Depth: -3.7cm drop from morning to afternoon	
Fraser Discharge at Hope: 3233.92m^3/s		Ice Cover: n/a	
Water Quality			
Temperature: 18 °C	Conductivity: 40.8mg/L	Turbidity: 3NTU	pH: 6.9
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
morning (~09:00)	surface	18	7.68
afternoon (~16:00)	surface	19.3	6.71

Species	Clipped/caught	Recap	Mortalities	Total
minnow spp.	736		16	752
largescale sucker	21		0	21
prickly sculpin	147		1	148
common carp	90		1	91

Comments: witnessed a big eating a minnow. Dead frog on site. Counted redside shiners and peamouth chubs as one species.

common carp

Date: October 3, 2010	Site: TBGP 2	Crew: CM, SE, HH, KP	Weather: overcast, slight drizzle
Time processing started: 11:00		Time processing finished: 16:00	
Species: common carp		Mortality: 1	

#	length (mm)	weight (g)	clip	comments
1	72	6.0	UC	
2	50	1.0	UC	
3	95	12.5	UC	
4	97	9.0	UC	
5	90	9.0	UC	
6	75	5.0	UC	
7	158	43.5	UC	
8	59	3.0	UC	
9	54	2.0	UC	
10	41	2.0	UC	
11	56	2.0	UC	
12	45	2.0	UC	
13	33	0.5	UC	
14	40	0.5	UC	
15	45	1.0	UC	
16	45	1.0	UC	
17	100	13.0	UC	
18	40	0.5	UC	
19	75	4.5	UC	
20	48	1.5	UC	
21	64	3.5	UC	
22	48	1.5	UC	
23	55	2.5	UC	
24	52	2.5	UC	
25	45	1.0	UC	
26	45	1.0	UC	
27	35	0.5	UC	
28	65	3.0	UC	
29	44	1.5	UC	
30	51	1.5	UC	

Additional marked:	60	Total count:	60+30= 90
Dead:	1	Mean length:	60.7 mm
Recapture:	n/a	Mean weight:	4.60 g

prickly sculpin

Date: October 3, 2010	Site: TBGP 2	Crew: CM, SE, HH, KP	Weather: overcast, slight drizzle
Time processing started: 11:00		Time processing finished: 16:00	
Species: prickly sculpin		Mortality: 1	

#	length (mm)	weight (g)	clip	comments
1	55	1.0		
2	61	1.5		
3	55	1.5		
4	35	0.5		
5	40	0.5		
6	34	0.5		
7	41	0.5		
8	39	0.5		
9	33	0.5		
10	42	1.0		
11	41	0.5		
12	31	0.5		
13	30	0.5		
14	55	1.0		
15	40	0.5		
16	49	1.0		
17	49	0.5		
18	32	0.5		
19	65	1.5		
20	46	0.5		
21	49	0.5		
22	65	1.5		
23	51	0.5		
24	40	0.5		
25	35	0.5		
26	46	0.5		
27	38	0.5		
28	40	0.5		
29	31	0.5		
30	39	0.5		

Additional marked:	117	Total count:	117+30= 147
Dead:	1	Mean length:	43.6 mm
Recapture:	n/a	Mean weight:	0.70 g

largescale sucker

Date: October 3, 2010	Site: TBGP 2	Crew: CM, SE, HH, KP	Weather: overcast, slight drizzle
Time processing started: 11:00		Time processing finished: 16:00	
Species: largescale sucker		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	80	3.0	UC	
2	81	3.5	UC	
3	79	3.0	UC	
4	80	3.5	UC	
5	83	3.0	UC	
6	80	3.0	UC	
7	90	4.5	UC	
8	87	3.5	UC	
9	90	4.0	UC	
10	81	4.0	UC	
11	91	4.0	UC	
12	85	3.0	UC	
13	85	4.5	UC	
14	74	2.5	UC	
15	84	3.5	UC	
16	75	3.5	UC	
17	93	4.0	UC	
18	85	3.5	UC	
19	84	3.5	UC	
20	80	3.0	UC	
21	90	4.5	UC	
22				
23				
24				
25				
26				
27				
28				
29				
30				

Additional marked:	0	Total count:	21
Dead:	0	Mean length:	83.7 mm
Recapture:	n/a	Mean weight:	3.55 g

minnow species

Date: October 3, 2010	Site: TBGP 2	Crew: CM, SE, HH, KP	Weather: overcast, slight
Time processing started: 11:00		Time processing finished: 16:00	
Species: minnow species		Mortality: 16	

#	length (mm)	weight (g)	clip	comments
1	22	0.5	UC	
2	28	0.5	UC	
3	29	0.5	UC	
4	29	0.5	UC	
5	31	0.5	UC	
6	31	0.5	UC	
7	31	0.5	UC	
8	31	0.5	UC	
9	32	0.5	UC	
10	33	0.5	UC	
11	33	0.5	UC	
12	33	0.5	UC	
13	33	0.5	UC	
14	34	0.5	UC	
15	34	1.0	UC	
16	34	0.5	UC	
17	34	0.5	UC	
18	34	0.5	UC	
19	35	0.5	UC	
20	35	0.5	UC	
21	35	0.5	UC	
22	35	0.5	UC	
23	35	0.5	UC	
24	35	0.5	UC	
25	35	0.5	UC	
26	35	0.5	UC	
27	35	0.5	UC	
28	35	0.5	UC	
29	36	0.5	UC	
30	36	0.5	UC	
31	36	0.5	UC	
32	36	0.5	UC	
33	36	0.5	UC	
34	36	0.5	UC	
35	37	0.5	UC	
36	37	0.5	UC	
37	38	0.5	UC	
38	38	0.5	UC	
39	38	0.5	UC	
40	39	0.5	UC	

41	39	0.5	UC	
42	39	0.5	UC	
43	40	0.5	UC	
44	40	0.5	UC	
45	40	0.5	UC	
46	40	0.5	UC	
47	40	0.5	UC	
48	40	0.5	UC	
49	40	0.5	UC	
50	41	0.5	UC	
51	42	0.5	UC	
52	49	0.5	UC	
53	50	1.0	UC	
54	51	1.0	UC	
55	55	1.0	UC	
56	60	1.5	UC	
57	60	1.0	UC	
58	65	2.5	UC	
59	70	2.5	UC	
60	72	2.5	UC	
61	81	3.5	UC	
62	81	4.0	UC	

Additional marked:	674	Total count:	674+62= 736
Dead:	16	Mean length:	40.2 mm
Recapture:	n/a	Mean weight:	0.76 g

Appendix 16 – Data Sheets: Tom Berry Gravel Pit 1, Oct. 9, 2010

Site Card			
Date: Oct. 9, 2010	Site Name: TBGP 1	Crew: CM, SE, HH, MT	
Start Time: n/a	End Time: n/a	Weather: overcast, rain	
Capture/Recapture Method: n/a		Air temperature: 15.3 °C	
Wetted Width:		Depth: gauge placed at 46.7 cm	
Fraser Discharge at Hope: 2193.16m^3/s		Ice Cover: n/a	
Water Quality			
Temperature: 15 °C	Conductivity: 76.3, 76, 83.1 mg/L	Turbidity: 2NTU	pH: 6.8,6.9,7.4
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
morning	at surface	15.1	104.4
morning	at surface	15.2	100.1
morning	at surface	15.2	105.6

Appendix 17 – Data Sheets: Tom Berry Gravel Pit 2, Oct. 9, 2010

Site Card			
Date: Oct. 9, 2010	Site Name: TBGP 2	Crew: CM, SE, HH, MT	
Start Time: 12:00	End Time: 16:00	Weather: overcast, rain	
Capture/Recapture Method: recapture		Air temperature: 15.3 °C	
Wetted Width:		Depth: -8.4cm; gauge placed at 62.8cm; -1.6cm drop from morning to afternoon	
Fraser Discharge at Hope: 2193.16m^3/s		Ice Cover: n/a	
Water Quality			
Temperature: 16 °C	Conductivity: 41.4 mg/L	Turbidity: 2NTU	pH: 7.3
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
morning	at surface	15.9	107.1
afternoon	at surface	16.8	104.1

Species	Caught	Recap	Mortalities	Total
largescale sucker	1	1	o	1
peamouth chub	61	13	1	62
redside shiner	495	79	11	506
prickly sculpin	128	n/a	6	134
common carp	14	2	2	16

Comments: scale was less accurate (only measured to the gram)

largescale sucker

Date: Oct. 09, 2010	Site: TBGP 2	Crew: CM, SE, HH, MT	Weather: overcast, rainy
Time processing started: 12:00		Time processing finished: 16:15	
Species: largescale sucker		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	87	5.0		
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	87.0 mm
Recapture:	1	Mean weight:	5.00 g

prickly sculpin

Date: October 09, 2010	Site: TBGP 2	Crew: SE, HH, CM, MT	Weather: overcast, rainy
Time processing started:12:00		Time processing finished: 4:15	
Species: prickly sculpin		Mortality: 6	

#	length (mm)	weight (g)	clip	comments
1	47	0.5		
2	54	2.0		
3	47	0.5		
4	46	0.5		
5	40	0.5		
6	42	0.5		
7	53	2.0		
8	54	2.0		
9	39	0.5		
10	40	1.0		
11	39	1.0		
12	36	0.5		
13	44	0.5		
14	33	0.5		
15	36	0.5		
16	52	1.5		
17	39	0.5		
18	42	0.5		
19	33	0.5		
20	46	1.0		
21	32	0.5		
22	46	0.5		
23	39	0.5		
24	66	3.0		
25	33	0.5		
26	69	3.0		
27	41	0.5		
28	77	4.0		
29	68	3.0		
30	28	0.5		

Additional marked:	98	Total count:	98+30= 128
Dead:	6	Mean length:	45.4 mm
Recapture:	n/a	Mean weight:	1.10 g

common carp

Date: October 09, 2010	Site: TBGP 2	Crew :CM, SE, HH, MT	Weather: overcast, rainy
Time processing started:12:00		Time processing finished: 16:15	
Species: common carp		Mortality: 2	

#	length (mm)	weight (g)	clip	comments
1	54	3.0		
2	49	3.0		
3	47	2.0		caudal ripped
4	45	1.0		
5	39	1.0		
6	62	5.0		
7	94	16.0		
8	42	2.0		
9	98	15.0		
10	56	2.0		
11	44	2.0		
12	50	4.0		
13	84	13.0		
14	55	4.0		
15				
16				
17				
18				
19				
20				

Additional marked:	0	Total count:	14
Dead:	2	Mean length:	58.5 mm
Recapture:	2	Mean weight:	5.21 g

peamouth chub

Date: October 09, 2010	Site: TBGP 2	Crew: CM, SE, HH, MT	Weather: overcast, rainy
Time processing started:12:00		Time processing finished: 16:15	
Species: peamouth chub		Mortality: 1	

#	length (mm)	weight (g)	clip	comments
1	72	5.0		
2	65	3.0		
3	55	2.0		
4	57	2.0		
5	69	3.5		
6	67	2.0		
7	62	2.5		
8	72	3.0		
9	75	4.0		
10	84	7.0		
11	76	4.0		
12	70	5.0		
13	84	6.0		
14	80	4.0		
15	70	4.0		
16	60	2.0		
17	56	2.0		
18	57	2.0		
19	55	2.0		
20	86	7.0		
21	64	4.0		
22	62	3.0		
23	78	5.0		
24	56	2.0		
25	63	3.0		
26	68	4.0		
27	82	5.0		
28	78	5.0		
29	83	5.0		
30	66	3.0		

Additional marked:	31	Total count:	31+30= 61
Dead:	1	Mean length:	69.1 mm
Recapture:	13	Mean weight:	3.70 g

redside shiner

Date: October 09, 2010	Site: TBGP 2	Crew: SE, HH, CM, MT	Weather: overcast, rainy
Time processing started:12:00		Time processing finished: 16:15	
Species: redside shiner		Mortality:11	

#	length (mm)	weight (g)	clip	comments
1	33	2.0		
2	45	2.0		
3	38	1.0		
4	32	0.5		
5	37	0.5		
6	37	0.5		
7	39	0.5		
8	39	1.0		
9	36	0.5		
10	35	0.5		
11	31	0.5		
12	40	1.5		
13	39	0.5		
14	39	0.5		
15	40	1.0		
16	55	0.5		
17	33	0.5		
18	39	0.5		
19	43	1.5		
20	32	0.5		
21	34	0.5		
22	35	0.5		
23	34	0.5		
24	35	0.5		
25	35	0.5		
26	36	1.0		
27	35	1.0		
28	35	1.0		
29	31	1.0		
30	30	1.0		

Additional marked:	465	Total count:	465+30= 495
Dead:	11	Mean length:	36.7 mm
Recapture:	79	Mean weight:	0.80 g

Recapture Data

Date: Oct. 9, 2010	Site: TBGP 2	Crew: CM, SE. HH, MT	Start time: 12:00	End time: 16:15

Species	Marked	Not Marked
peamouth chub	13	48
prickly sculpin	n/a	128
largescale sucker	1	0
redside shiner	79	416
common carp	2	12

Appendix 19 – Data Sheets: Delair Pond, Oct. 10, 2010

Site Card			
Date: Oct. 10, 2010	Site Name: Delair	Crew: CM, SE, HH, CH, MT	
Start Time: 10:30	End Time: 10:55	Weather: overcast	
Capture/Recapture Method: capture		Air temperature: 14 °C	
Surface Area: 1760m^2		Depth: n/a	
Fraser Discharge at Hope: 2291.12m^3/s		Ice Cover: none	
Water Quality			
Temperature: 14 °C	Conductivity: 167.1mg/L	Turbidity: 2NTU	pH: 6.8
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
morning	at surface	13.8	86.2

Species	Clipped	Recap	Mortalities	Total
Chinook	2		0	2
redside shiner	51		0	51
prickly sculpin	3		0	3

Comments: dragged a log through the first seine, caught no fish. Second seine was very nice. Suspected lack of fish caught was due to high water levels and warm water temperatures.

Chinook

Date: Oct. 10, 2010	Site: Delair	Crew: CM, SE, HH, CH, MT	Weather: overcast
Time processing started: 10:30		Time processing finished: 10:55	
Species: Chinook		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	114	7.0	uc	
2	105	7.0	uc	
3				
4				
5				

Additional marked:	0	Total count:	2
Dead:	0	Mean length:	109.5 mm
Recapture:	n/a	Mean weight:	7.00 g

redside shiner

Date: Oct. 10, 2010	Site: Delair	Crew: CM, SE, HH, CH, MT	Weather: overcast
Time processing started: 10:30		Time processing finished: 10:55	
Species: redside shiner		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	54	1.0	UC	
2	48	0.5	UC	
3	52	1.0	UC	
4	53	1.0	UC	
5	55	0.5	UC	
6	47	0.5	UC	
7	53	0.5	UC	
8	50	0.5	UC	
9	52	0.5	UC	
10	54	0.5	UC	
11	43	0.5	UC	
12	48	0.5	UC	
13	61	1.0	UC	
14	52	1.0	UC	
15	50	0.5	UC	
16	54	1.0	UC	
17	45	0.5	UC	
18	45	0.5	UC	
19	52	0.5	UC	
20	55	1.0	UC	
21	110	8.5	UC	
22	47	0.5	UC	
23	52	0.5	UC	
24	48	0.5	UC	
25	52	0.5	UC	
26	51	1.0	UC	
27	45	0.5	UC	
28	45	0.5	UC	
29	50	0.5	UC	
30	51	0.5	UC	

Additional marked:	21	Total count:	21+30= 51
Dead:	0	Mean length:	52.5 mm
Recapture:	n/a	Mean weight:	0.90 g

prickly sculpin

Date: Oct. 10, 2010	Site: Delair	Crew: CM, SE, HH, CH, MT	Weather: overcast
Time processing started: 10:30		Time processing finished: 10:55	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	33	0.5		
2	55	1.0		
3	50	0.5		
4				
5				
6				
7				
8				
9				
10				

Additional marked:	0	Total count:	3
Dead:	0	Mean length:	46.0 mm
Recapture:	n/a	Mean weight:	0.67 g

Appendix 20 – Data Sheets: Fraser River (day), Nov. 6, 2010

Site Card			
Date: Nov. 6, 2010	Site Name: Fraser River (day)	Crew: CM, SE, HH, DB	
Start Time: 12:02	End Time: 12:52	Weather: overcast with sun	
Capture/Recapture Method: comparative seine		Air temperature: 11°C	
Wetted Width: n/a		Depth: n/a	
Fraser Discharge at Hope: 1483.64m^3/s		Ice Cover: none	
Water Quality			
Temperature: 7°C	Conductivity: n/a	Turbidity: n/a	pH: n/a
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
n/a	n/a	n/a	n/a

Species	Clipped/Caught	Recap	Mortalities	Total
Chinook	27		0	27
mountain whitefish	1		0	1
largescale sucker	1		0	1
leopard dace	19		0	19

Comments:

Chinook

Date: Nov. 6, 2010	Site: Fraser River (day)	Crew: CM, SE, HH, DB	Weather: overcast with sunny periods
Time processing started: 12:02		Time processing finished:12:52	
Species: Chinook		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	93	4.50		
2	89	4.50		
3	81	2.50		
4	74	2.00		
5	64	1.50		
6	80	2.50		
7	93	4.00		
8	85	3.50		
9	86	4.00		
10	69	1.50		
11	72	2.00		
12	98	4.00		
13	92	4.00		
14	95	5.00		
15	94	4.00		
16	80	3.00		
17	75	2.50		
18	87	3.50		UC clipped
19	95	4.50		
20	75	2.50		
21	63	1.00		
22	62	1.00		
23	76	2.00		
24	73	2.00		
25	72	2.00		
26	64	1.00		
27	56	1.00		
28				
29				
30				

Additional caught:	0	Total count:	27
Dead:	0	Mean length:	79.4 mm
Recapture:	n/a	Mean weight:	2.80 g

mountain whitefish

Date: Nov. 6, 2010	Site: Fraser River (day)	Crew: CM, SE, HH, DB	Weather: overcast with sunny periods
Time processing started: 12:02		Time processing finished: 12:52	
Species: mountain whitefish		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	135	11.5		
2				
3				
4				
5				

Additional caught:	0	Total count:	1
Dead:	0	Mean length:	135.0 mm
Recapture:	n/a	Mean weight:	11.50 g

largescale sucker

Date: Nov. 6, 2010	Site: Fraser River (day)	Crew: CM, SE, HH, DB	Weather: overcast with sunny periods
Time processing started: 12:02		Time processing finished: 12:52	
Species: largescale sucker		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	38	<0.5		voucher sample ID by Dr. Rosenau
2				
3				
4				
5				

Additional caught:	0	Total count:	1
Dead:	0	Mean length:	38 mm
Recapture:	n/a	Mean weight:	<0.5 g

leopard dace

Date: Nov. 6, 2010	Site: Fraser River (day)	Crew: CM, SE, HH, DB	Weather: overcast with sunny periods
Time processing started: 12:02		Time processing finished: 12:52	
Species: leopard dace		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	29	<0.5		
2	23	<0.5		
3	32	<0.5		
4	29	<0.5		
5	22	<0.5		
6	36	<0.5		
7	32	<0.5		
8	33	<0.5		
9	19	<0.5		
10	28	<0.5		
11	28	<0.5		
12	31	<0.5		
13	29	<0.5		
14	29	<0.5		
15	27	<0.5		
16	30	<0.5		
17	29	<0.5		
18	26	<0.5		
19	26	<0.5		
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

Additional caught:	0	Total count:	19
Dead:	0	Mean length:	28.3 mm
Recapture:	n/a	Mean weight:	<0.50 g

Appendix 21 – Data Sheets: Delair Pond, Nov. 6, 2010

Site Card			
Date: Nov. 6, 2010	Site Name: Delair	Crew: CM, SE, HH, DB	
Start Time: 15:54	End Time: 17:49	Weather: partly cloudy	
Capture/Recapture Method: recapture		Air temperature: 14°C	
Surface Area: 898m^2		Depth: n/a	
Fraser Discharge at Hope: 1483.64m^3/s		Ice Cover: none	
Water Quality			
Temperature: 12°C	Conductivity:	Turbidity:	pH:
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L

Species	Clipped/Caught	Recap	Mortalities	Total
Chinook	7	0	0	7
coho	59	n/a	0	59
sockeye	19	n/a	0	19
redside shiner	391	14	1	392
prickly sculpin	11	n/a	0	11

Comments:

Chinook

Date: Nov. 6, 2010	Site: Delair	Crew: CM, SE, HH, DB	Weather: partly cloudy
Time processing started: 15:54		Time processing finished: 17:49	
Species: Chinook		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	108	7.5		
2	110	8.0		
3	112	8.0		
4	115	9.0		
5	110	8.5		
6	109	7.5		
7	108	9.0		
8				
9				
10				

Additional caught:	0	Total count:	7
Dead:	0	Mean length:	110.3 mm
Recapture:	0	Mean weight:	8.21 g

coho

Date: Nov. 6, 2010	Site: Delair	Crew: CM, SE, HH, DB	Weather: partly cloudy
Time processing started: 15:54		Time processing finished: 17:49	
Species: coho		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	106	7.5		
2	109	7.0		
3	120	11.0		
4	121	10.0		
5	105	8.0		
6	119	10.5		
7	110	7.5		UC last year
8	120	10.0		
9	124	11.0		
10	112	9.5		
11	93	5.0		
12	95	6.0		
13	98	6.5		
14	114	9.0		
15	115	9.5		
16	107	9.5		
17	109	8.0		
18	109	8.5		
19	105	7.0		
20	116	9.0		
21	113	9.0		
22	104	9.0		
23	105	7.0		
24	130	14.5		
25	107	7.5		
26	110	7.5		
27	104	8.5		
28	111	8.0		
29	111	7.5		
30	127	11.5		
31	103	7.5		
32	99	6.0		
33	113	9.5		
34	111	8.5		
35	116	8.5		
36	109	7.0		
37	114	8.0		
38	105	7.0		
39	115	9.0		
40	100	6.0		

41	108	7.5		
42	107	5.5		
43	120	10.0		
44	120	9.0		
45	108	7.5		
46	104	6.5		
47	115	9.0		
48	104	6.0		
49	110	7.0		
50	118	8.5		
51	121	9.0		
52	106	6.5		
53	111	7.5		
54	111	7.5		
55	99	6.0		
56	122	9.0		
57	103	6.5		
58	220	43.5		
59	190	37.5		
60				

Additional caught:	0	Total count:	59
Dead:	0	Mean length:	113.7 mm
Recapture:	n/a	Mean weight:	9.26 g

sockeye

Date: Nov. 6, 2010	Site: Delair	Crew: CM, SE, HH, DB	Weather: partly cloudy
Time processing started: 15:54		Time processing finished: 17:49	
Species: sockeye		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	160	19.5		
2	135	16.0		UC last yr
3	122	8.0		
4	163	22.5		
5	155	21.5		
6	132	11.5		LC last yr
7	155	17.5		
8	190	37.5		
9	156	22.0		
10	145	17.5		
11	143	15.5		
12	139	14.0		
13	142	17.0		
14	147	17.5		
15	220	43.5		
16	142	15.5		
17	165	24.5		
18	146	15.5		
19	145	15.5		
20	144	12.0		
21	151	18.5		
22				
23				
24				
25				

Additional caught:	0	Total count:	21
Dead:	0	Mean length:	152.2 mm
Recapture:	0	Mean weight:	19.17 g

redside shiner

Date: Nov. 6, 2010	Site: Delair	Crew: CM, SE, HH, DB	Weather: partly cloudy
Time processing started: 15:54		Time processing finished: 17:49	
Species: redside shiner		Mortality: 1	

#	length (mm)	weight (g)	clip	comments
1	45	0.5		
2	109	7.5		
3	41	0.5		
4	51	1.0		
5	54	1.0		
6	49	1.0		
7	51	1.0		
8	49	0.5		
9	48	0.5		
10	51	1.0		
11	53	1.0		
12	55	1.0		
13	45	0.5		
14	46	0.5		
15	53	0.5		
16	51	1.0		
17	50	1.0		
18	53	1.0		
19	49	0.5		
20	51	1.0		
21	48	0.5		
22	51	0.5		
23	44	0.5		
24	52	1.0		
25	44	0.5		
26	42	0.5		
27	43	0.5		
28	47	1.0		
29	51	1.0		
30	51	1.0		

Additional caught:	361	Total count:	361+30= 391
Dead:	1	Mean length:	50.9 mm
Recapture:	14	Mean weight:	0.98 g

prickly sculpin

Date: Nov. 6, 2010	Site: Delair	Crew: CM, SE, HH, DB	Weather: partly cloudy
Time processing started: 15:54		Time processing finished: 17:49	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	169	32.5		
2	53	1.0		
3	36	0.5		
4	39	0.5		
5	31	0.5		
6	30	0.5		
7	31	0.5		
8	37	0.5		
9	69	2.0		
10	57	1.0		
11	47	0.5		
12				
13				
14				
15				
16				
17				
18				
19				
20				

Additional caught:	0	Total count:	11
Dead:	0	Mean length:	54.5 mm
Recapture:	n/a	Mean weight:	3.64 g

Recapture Data

Date: Nov. 6, 2010	Site: Delair	Crew: CM, SE, HH, DB	Start time: 15:54	End time: 17:49

Species	Marked	Not Marked
Chinook	0	7
coho	n/a	59
sockeye	n/a	19
redside shiner	14	377
prickly sculpin	n/a	11

Appendix 22 – Data Sheets: Fraser River (night), Nov. 6, 2010

Site Card			
Date: Nov. 6, 2010	Site Name: Fraser River (night)	Crew: CM, SE, HH, DB	
Start Time: 23:10	End Time: 23:40	Weather: slight rain	
Capture/Recapture Method: comparative seine		Air temperature: 9°C	
Wetted Width: n/a		Depth: n/a	
Fraser Discharge at Hope: 1472.6m^3/s		Ice Cover: none	
Water Quality			
Temperature: 7°C	Conductivity: n/a	Turbidity: n/a	pH: n/a
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
n/a	n/a	n/a	n/a

Species	Clipped/caught	Recap	Mortalities	Total
Chinook	31		0	31
redside shiner	2		0	2
prickly sculpin	7		0	7
leopard dace	3		0	3

Comments: decaying adult sockeye swimming close to shore while we were processing fish. Great blue heron flew by the study site.

Chinook

Date: Nov. 6, 2010	Site: Fraser River (night)	Crew: CM, SE, HH, DB	Weather: slight rain
Time processing started: 23:10		Time processing finished: 23:40	
Species: Chinook		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	96	5.0		
2	97	4.5		
3	87	4.0		
4	95	4.5		
5	95	4.5		
6	85	4.0		
7	96	3.5		
8	98	4.5		
9	88	4.0		
10	89	3.5		
11	94	4.5		
12	86	3.5		
13	83	3.5		
14	89	4.0		
15	74	2.5		
16	88	4.5		
17	82	4.0		
18	94	4.5		
19	99	5.0		
20	79	2.5		
21	90	4.5		
22	84	4.0		
23	74	2.5		
24	101	5.5		
25	102	6.0		
26	83	3.5		
27	89	4.0		
28	94	4.5		
29	96	5.0		
30	86	4.0		
31	95	4.5		

Additional caught:	0	Total count:	31
Dead:	0	Mean length:	89.9 mm
Recapture:	n/a	Mean weight:	4.15 g

redside shiner

Date: Nov. 6, 2010	Site: Fraser River (night)	Crew: CM, SE, HH, DB	Weather: slight rain
Time processing started: 23:10		Time processing finished: 23:40	
Species: redside shiner		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	59	1.5		
2	67	1.5		
3				
4				
5				
6				
7				
8				
9				
10				

Additional marked:	0	Total count:	2
Dead:	0	Mean length:	63.0 mm
Recapture:	n/a	Mean weight:	1.50 g

prickly sculpin

Date: Nov. 6, 2010	Site: Fraser River (night)	Crew: CM, SE, HH, DB	Weather: slight rain
Time processing started: 23:10		Time processing finished: 23:40	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	81	2.5		
2	122	8.0		
3	74	2.0		
4	69	2.0		
5	93	4.0		
6	86	3.5		
7	55	1.0		
8				
9				
10				

Additional caught:	0	Total count:	7
Dead:	0	Mean length:	82.9 mm
Recapture:	n/a	Mean weight:	3.29 g

leopard dace

Date: Nov. 6, 2010	Site: Fraser River (night)	Crew: CM, SE, HH, DB	Weather: slight rain
Time processing started: 23:10		Time processing finished: 23:40	
Species: leopard dace		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	36	0.5		
2	36	0.5		
3	26	0.5		
4				
5				
6				
7				
8				
9				
10				

Additional marked:	0	Total count:	3
Dead:	0	Mean length:	32.7 mm
Recapture:	n/a	Mean weight:	0.50 g

Appendix 23 – Data Sheets: Tom Berry Gravel Pit 1, Nov. 7, 2010

Site Card			
Date: Nov. 7, 2010	Site Name: TBGP 1	Crew: CM, HH, SE	
Start Time: 12:30	End Time: 13:50	Weather: partly cloudy	
Capture/Recapture Method: comparative seine		Air temperature: 12°C	
Wetted Width: n/a		Depth: -113cm	
Fraser Discharge at Hope: 1527.8m^3/s		Ice Cover: none	
Water Quality			
Temperature: 10°C	Conductivity: n/a	Turbidity: n/a	pH: n/a
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
n/a	n/a	n/a	n/a

Species	Clipped/caught	Recap	Mortalities	Total
peamouth chub	25		0	25
redside shiner	24	1	1	25
prickly sculpin	4		0	4

Comments: 13 great blue herons flew overhead while processing fish at the site. Seine got caught on a rock and then dragged up lots of mud.

peamouth chub

Date: Nov. 7, 2010	Site: TBGP 1	Crew: CM, HH, SE	Weather: partly cloudy
Time processing started: 12:30		Time processing finished: 13:50	
Species: peamouth chub		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	60	1.0		
2	60	1.0		
3	60	1.0		
4	67	1.5		
5	61	1.5		
6	60	1.0		
7	63	1.5		
8	65	1.5		
9	61	1.0		
10	59	1.0		
11	64	1.0		
12	62	1.0		
13	61	1.0		missing scales
14	64	1.5		
15	62	1.0		
16	55	1.0		
17	61	1.0		
18	58	1.0		blood on nose
19	60	1.0		
20	59	1.0		
21	43	0.5		
22	60	1.0		blood on nose
23	58	1.0		
24	61	1.0		
25	59	1.0		
26				
27				
28				
29				
30				

Additional caught:	0	Total count:	25
Dead:	0	Mean length:	60.1 mm
Recapture:	0	Mean weight:	1.08 g

redside shiner

Date: Nov. 7, 2010	Site: TBGP 1	Crew: CM, HH, SE	Weather: partly cloudy
Time processing started: 12:30		Time processing finished: 13:50	
Species: redside shiner		Mortality: 1	

#	length (mm)	weight (g)	clip	comments
1	39	0.5		
2	42	0.5		
3	40	0.5		
4	38	0.5		UC
5	45	0.5		
6	49	1.0		
7	44	0.5		
8	41	0.5		
9	45	0.5		blood in lower left orbital
10	51	0.5		
11	38	0.5		frayed caudal
12	46	0.5		
13	41	0.5		
14	43	0.5		
15	39	0.5		
16	48	0.5		
17	42	0.5		
18	45	0.5		
19	44	0.5		
20	39	0.5		
21	38	0.5		
22	42	0.5		
23	40	0.5		
24	35	0.5		
25				
26				
27				
28				
29				
30				

Additional caught:	0	Total count:	24
Dead:	1	Mean length:	42.3 mm
Recapture:	1	Mean weight:	0.52 g

prickly sculpin

Date: Nov. 7, 2010	Site: TBGP 1	Crew: CM, HH, SE	Weather: partly cloudy
Time processing started: 12:30		Time processing finished: 13:50	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	37	0.5		
2	37	0.5		
3	49	0.5		
4	34	0.5		
5				
6				
7				
8				
9				
10				

Additional caught:	0	Total count:	4
Dead:	0	Mean length:	39.3 mm
Recapture:	n/a	Mean weight:	0.50 g

Appendix 24 – Data Sheets: Tom Berry Gravel Pit 2, Nov. 7, 2010

Site Card			
Date: Nov. 7, 2010	Site Name: TBGP 2	Crew: CM, HH, SE	
Start Time: n/a	End Time: n/a	Weather: partly cloudy	
Capture/Recapture Method: n/a		Air temperature: 12°C	
Wetted Width: n/a		Depth: -109cm, replaced gauge to 44.3cm	
Fraser Discharge at Hope: 1527.8m^3/s		Ice Cover: none	
Water Quality			
Temperature: n/a	Conductivity: n/a	Turbidity: n/a	pH: n/a
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
n/a	n/a	n/a	n/a
Surface Area			
a: 356.50m^2	b: 98.92m^2	c: 112.12m^2	d: 131.43m^2

Appendix 25 – Data Sheets: Tom Berry Gravel Pit, Nov. 11, 2010

Site Card			
Date: Nov. 11, 2010	Site Name: TBGP	Crew: CM, SE, HH, MT	
Start Time: n/a	End Time: n/a	Weather: cloudy and sunny	
Capture/Recapture Method: n/a		Air temperature: 7°C	
Wetted Width: n/a		Depth: -2.1(TBGP2); reset gauge to 60.8cm (TBGP1)	
Fraser Discharge at Hope: 1487.32m^3/s		Ice Cover:none	
Temperature °C			
TBGP 1: 6.5	TBGP 2a: 7	TBGP 2b: 7.5	TBGP 2c: 7
	TBGP 2d: 8, 7		
Comments: baited minnow traps			

Appendix 26 – Data Sheets: Tom Berry Gravel Pit 1, Nov. 12, 2010

Site Card			
Date: Nov. 12, 2010	Site Name: TBGP 1	Crew: CM, HH, SE, MT	
Start Time: 09:50	End Time: 12:10	Weather: overcast windy	
Capture/Recapture Method: minnow trapping		Air temperature: 8°C	
Wetted Width:		Depth: -0.4cm	
Fraser Discharge at Hope: 1480.88m^3/s		Ice Cover: none	
Water Quality			
Temperature: 7°C	Conductivity: n/a	Turbidity: n/a	pH: n/a
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
n/a	n/a	n/a	n/a

Species	Clipped	Recap	Mortalities	Total
coho	1		0	1
peamouth chub	31		0	31
redside shiner	30		0	30
prickly sculpin	29		0	29
common carp	7		0	7

Comments:

coho

Date: Nov. 12, 2010	Site: TBGP 1	Crew: CM, HH, SE	Weather: overcast, windy
Time processing started: 09:50		Time processing finished: 12:10	
Species: coho		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	92	4.5		
2				
3				
4				
5				

Additional caught:	0	Total count:	1
Dead:	0	Mean length:	92.0 mm
Recapture:	n/a	Mean weight:	4.50 g

peamouth chub

Date: Nov. 12, 2010	Site: TBGP 1	Crew: CM, HH, SE	Weather: overcast, windy
Time processing started: 09:50		Time processing finished: 12:10	
Species: peamouth chub		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	63	1.0		
2	60	1.0		
3	64	1.0		
4	60	1.0		
5	60	1.0		
6	58	1.0		
7	60	1.0		LC clip
8	67	1.5		
9	60	1.0		
10	60	1.0		
11	63	1.0		
12	56	1.0		
13	59	1.0		
14	50	0.5		
15	61	1.0		
16	61	1.5		
17	64	1.0		
18	58	1.0		
19	60	1.0		
20	62	1.0		
21	65	1.0		
22	64	1.5		
23	58	1.0		
24	65	1.0		
25	62	1.0		
26	57	1.0		
27	60	1.0		
28	67	1.5		
29	60	1.0		
30	62	1.0		
31	57	0.5		

Additional caught:	0	Total count:	31
Dead:	0	Mean length:	60.7 mm
Recapture:	n/a	Mean weight:	1.03 g

redside shiner

Date: Nov. 12, 2010	Site: TBGP 1	Crew: CM, HH, SE	Weather: overcast, windy
Time processing started: 09:50		Time processing finished: 12:10	
Species: redside shiner		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	50	1.0		
2	48	1.0		
3	47	0.5		
4	109	9.0		
5	96	5.5		
6	91	4.5		
7	104	7.5		
8	80	3.5		
9	99	6.5		
10	46	0.5		
11	82	3.5		
12	100	6.5		
13	93	4.5		
14	101	5.5		
15	95	4.5		
16	42	0.5		
17	84	3.5		
18	47	0.5		
19	42	0.5		
20	113	6.5		
21	49	0.5		
22	43	0.5		
23	107	7.5		
24	44	0.5		
25	46	0.5		
26	49	1.0		
27	106	8.5		
28	93	5.5		
29	45	0.5		
30	44	0.5		

Additional caught:	0	Total count:	30
Dead:	0	Mean length:	73.2 mm
Recapture:	n/a	Mean weight:	3.37 g

prickly sculpin

Date: Nov. 12, 2010	Site: TBGP 1	Crew: CM, HH, SE	Weather: overcast, windy
Time processing started: 09:50		Time processing finished: 12:10	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	65	1.5		
2	65	1.5		
3	116	10.0		
4	115	9.0		
5	59	1.0		
6	59	1.0		
7	103	8.0		
8	70	2.0		
9	64	1.5		
10	94	5.0		
11	44	0.5		
12	110	8.0		
13	101	5.5		
14	62	1.0		
15	70	2.0		
16	86	3.5		
17	64	1.0		
18	56	1.0		
19	32	0.5		
20	93	4.5		
21	106	7.5		
22	98	5.0		
23	103	6.0		
24	114	8.5		
25	108	9.0		
26	88	4.0		
27	100	6.5		
28	105	8.0		
29	92	4.5		
30				

Additional caught:	0	Total count:	29
Dead:	0	Mean length:	84.2 mm
Recapture:	n/a	Mean weight:	4.38 g

common carp

Date: Nov. 12, 2010	Site: TBGP 1	Crew: CM, HH, SE	Weather: overcast, windy
Time processing started: 09:50		Time processing finished: 12:10	
Species: common carp		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	73	4.5		
2	69	3.0		
3	53	2.0		
4	80	6.0		
5	49	1.5		
6	65	3.0		
7	57	2.5		
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Additional caught:	0	Total count:	7
Dead:	0	Mean length:	63.7 mm
Recapture:	n/a	Mean weight:	3.21 g

Appendix 27 – Data Sheets: Tom Berry Gravel Pit 2, Nov. 20, 2010

Site Card			
Date: Nov. 20, 2010	Site Name: TBGP 2	Crew: CM, HH, SE	
Start Time: n/a	End Time: n/a	Weather: overcast, windy	
Capture/Recapture Method: n/a		Air temperature: -3°C	
Wetted Width:		Depth: +16cm	
Fraser Discharge at Hope:		Ice Cover: up to 3cm thick in some areas	
Temperature °C			
a: -1	b: -1	c: 1	d: 1
Comments: had to use a kayak to break up the ice for bathymetric data			

Appendix 28 – Data Sheets: Delair Pond, March 18, 2011

Site Card			
Date: March 18 2011	Site Name: Delair	Crew: HH, CM, SE, JW, SW, AD, MT, MC	
Start Time: 12:00	End Time: 13:30	Weather: Overcast	
Capture/Recapture Method: capture		Air temperature: 10°C	
Surface Area: 867m^2		Depth: n/a	
Fraser Discharge at Hope: 846.71m^3/s		Ice Cover: None	
Water Quality			
Temperature: 7.6°C	Conductivity: 66.9 mg/L	Turbidity: n/a	pH: 7.2
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
11:30	Surface	7.6	88

Species	Clipped	Recap	Mortalities	Total
coho	13	n/a	0	14
sockeye	20	n/a	0	20
rainbow trout	1	n/a	0	1
redside shiner	357	n/a	2	359
prickly sculpin	23	n/a	0	23

Comments:

sockeye

Date: March 18 2011	Site: Delair	Crew: SE, HH, CM, JW, SW, AD, MT, MC	Weather: Partly cloudy
Time processing started: 12:00		Time processing finished: 13:30	
Species: sockeye		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	164	20.0	LC	
2	157	19.0	LC	
3	152	15.5	LC	
4	159	20.5	LC	
5	165	20.5	LC	
6	158	18.5	LC	
7	146	15.5	LC	
8	170	22.5	LC	
9	160	18.0	LC	
10	164	20.5	LC	
11	160	19.0	LC	
12	155	18.5	LC	
13	166	19.5	LC	
14	149	15.5	LC	
15	141	12.5	LC	
16	155	15.0	LC	
17	145	11.5	LC	
18	155	17.0	LC	
19	154	16.0	LC	
20	163	20.0	LC	
21				
22				
23				
24				
25				

Additional marked:	0	Total count:	20
Dead:	0	Mean length:	156.9 mm
Recapture:	n/a	Mean weight:	17.75 g

coho

Date: March 18 2011	Site: Delair	Crew: SE, HH, CM, JW, SW, AD, MT, MC	Weather: Partly cloudy
Time processing started: 12:00		Time processing finished: 13:30	
Species: coho		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	119	7.0	LC	
2	128	10.0	LC	
3	120	8.5	LC	
4	120	9.0	LC	
5	116	8.0	LC	
6	110	7.0	LC	
7	127	9.0	LC	
8	207	44.0	LC	
9	204	40.0	LC	
10	183	26.0	LC	
11	183	32.0	LC	
12	209	43.0	LC	
13	210	44.0	LC	
14	198	37.0	LC	
15				
16				
17				
18				
19				
20				

Additional marked:	0	Total count:	14
Dead:	0	Mean length:	159.6 mm
Recapture:	n/a	Mean weight:	23.18 g

rainbow trout

Date: March 18 2011	Site: Delair	Crew: SE, HH, CM, JW, SW, AD, MT, MC	Weather: Partly cloudy
Time processing started: 12:00		Time processing finished: 13:30	
Species: rainbow trout		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	286	107.0	LC	
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	286.0 mm
Recapture:	n/a	Mean weight:	107.00 g

prickly sculpin

Date: March 18 2011	Site: Delair	Crew: SE, HH, CM, JW, SW, AD, MT, MC	Weather: Partly cloudy
Time processing started: 12:00		Time processing finished: 13:30	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	37	0.5		
2	37	0.5		
3	35	0.5		
4	20	0.5		
5	36	0.5		
6	36	0.5		
7	52	1.0		
8	60	1.0		
9	35	0.5		
10	34	0.5		
11	44	0.5		
12	37	0.5		
13	34	0.5		
14	23	0.5		
15	37	0.5		
16	28	0.5		
17	64	1.5		
18	49	1.0		
19	40	0.5		
20	40	0.5		
21	29	0.5		
22	32	0.5		
23	31	0.5		
24				
25				
26				
27				
28				
29				
30				

Additional marked:	0	Total count:	23
Dead:	0	Mean length:	37.8 mm
Recapture:	n/a	Mean weight:	0.61 g

redside shiner

Date: March 18 2011	Site: Delair	Crew: SE, HH, CM, JW, SW, AD, MT, MC	Weather: Partly cloudy
Time processing started: 12:00		Time processing finished: 13:30	
Species: redside shiner		Mortality: 2	

#	length (mm)	weight (g)	clip	comments
1	53	1.0	LC	
2	103	6.5	LC	
3	50	0.5	LC	
4	48	0.5	LC	
5	52	0.5	LC	
6	51	0.5	LC	
7	51	0.5	LC	
8	89	4.5	LC	
9	51	0.5	LC	
10	54	0.5	LC	
11	55	0.5	LC	
12	53	0.5	LC	
13	52	0.5	LC	
14	48	0.5	LC	
15	44	0.5	LC	
16	46	0.5	LC	
17	49	0.5	LC	
18	49	0.5	LC	
19	49	0.5	LC	
20	42	0.5	LC	
21	47	0.5	LC	
22	43	0.5	LC	
23	53	0.5	LC	
24	45	0.5	LC	
25	105	7.0	LC	
26	56	0.5	LC	
27	54	0.5	LC	
28	45	0.5	LC	
29	47	0.5	LC	
30	46	0.5	LC	

Additional marked:	327	Total count:	30 + 327 =357
Dead:	2	Mean length:	54.3 mm
Recapture:	n/a	Mean weight:	1.07 g

Appendix 29 – Data Sheets: Fraser River (day), March 18, 2011

Site Card			
Date: March 18, 2011	Site Name: Fraser River (day)	Crew: HH, CM, SE, JW, SW, AD, MT, MC	
Start Time: 16:15	End Time: 17:30	Weather: Overcast	
Capture/Recapture Method: Comparative Seine		Air temperature: 10 °C	
Wetted Width: N/A		Depth: N/A	
Fraser Discharge at Hope: 805.816m³/s		Ice Cover: None	
Water Quality			
Temperature: 2°C	Conductivity: N/A	Turbidity: N/A	pH: N/A
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
N/A	N/A	N/A	N/A

Species	Caught	Recap	Mortalities	Total
chum	20	n/a	0	20
mountian whitefish	1	n/a	0	1
mountian sucker	1	n/a	0	1
prickly sculpin	9	n/a	0	9
longnose dace	2	n/a	0	2

Comments: water was murky, lots of sediment

chum

Date: March 18, 2011	Site: Fraser River (day)	Crew: HH, CM, SE, JW, SW, AD, MT, MC	Weather: Partly cloudy
Time processing started: 16:15		Time processing finished: 17:30	
Species: chum		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	40	0.5		
2	37	0.5		
3	37	0.5		
4	45	0.5		
5	39	0.5		
6	37	0.5		
7	38	0.5		
8	38	0.5		
9	38	0.5		
10	39	0.5		
11	38	0.5		
12	35	0.5		
13	35	0.5		
14	39	0.5		
15	37	0.5		
16	38	0.5		
17	39	0.5		
18	37	0.5		
19	36	0.5		
20	36	0.5		
21				
22				
23				
24				
25				

Additional marked:	0	Total count:	20
Dead:	0	Mean length:	37.9 mm
Recapture:	n/a	Mean weight:	0.50 g

mountain whitefish

Date: March 18, 2011	Site: Fraser River (day)	Crew: SE, HH, CM, JW, SW, AD, MT, MC,	Weather: Partly cloudy
Time processing started: 16:15		Time processing finished: 17:30	
Species: mountain whitefish		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	239	74.5		
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	239.0 mm
Recapture:	n/a	Mean weight:	74.50 g

mountain sucker

Date: March 18, 2011	Site: Fraser River (day)	Crew: CM, HH, SE, JW, SW, AD, MT, MC	Weather: Partly cloudy
Time processing started: 16:15		Time processing finished: 17:30	
Species: mountain sucker		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	415	325.0		
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	415.0 mm
Recapture:	n/a	Mean weight:	325.00 g

prickly sculpin

Date: March 18, 2011	Site: Fraser River (day)	Crew: SE, HH, CM, JW, SW, AD, MT, MC	Weather: Partly cloudy
Time processing started: 16:15		Time processing finished: 17:30	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	91	4.0		
2	102	6.5		
3	93	5.0		
4	132	16.0		
5	142	15.0		
6	93	4.5		
7	121	10.5		
8	92	6.0		
9	86	3.0		
10				
11				
12				
13				
14				
15				

Additional marked:	0	Total count:	9
Dead:	0	Mean length:	105.8 mm
Recapture:	n/a	Mean weight:	7.83 g

longnose dace

Date: March 18, 2011	Site: Fraser River (day)	Crew: SE, HH, CM, JW, SW, AD, MT, MC	Weather: Partly cloudy
Time processing started: 16:15		Time processing finished: 17:30	
Species: longnose dace		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	35	0.5		
2	36	0.5		
3				
4				
5				

Additional marked:	0	Total count:	2
Dead:	0	Mean length:	35.5 mm
Recapture:	n/a	Mean weight:	0.50 g

Appendix 30 – Data Sheets: Fraser River (night), March 18, 2011

Site Card			
Date: Mar 18, 2011	Site Name: Fraser- Night	Crew: SE, HH, CM, JW, SW, AD, MT, MC	
Start Time: 23:00	End Time: 00:15am	Weather: Overcast, windy	
Capture/Recapture Method: comparative seine		Air temperature: 7°C	
Wetted Width: N/A		Depth: N/A	
Fraser Discharge at Hope: 813.89m³/s		Ice Cover: None	
Water Quality			
Temperature: 2°C	Conductivity: N/A	Turbidity: N/A	pH: N/A
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
N/A	N/A	N/A	N/A

Species	Caught	Recap	Mortalities	Total
chum	32	n/a	0	32
mountain whitefish	2	n/a	0	2
mountain sucker	1	n/a	0	1
prickly sculpin	22	n/a	0	22
leopard dace	5	n/a	0	5
longnose dace	1	n/a	0	1
unknown B	1	n/a	0	1

Comments:

chum

Date: Mar 18, 2011	Site: Fraser River - (night)	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 23:00		Time processing finished: 00:15	
Species: chum		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	42	0.5		
2	40	0.5		
3	36	0.5		
4	37	0.5		
5	37	0.5		
6	37	0.5		
7	36	0.5		
8	34	0.5		
9	32	0.5		
10	35	0.5		
11	36	0.5		
12	38	0.5		
13	36	0.5		
14	36	0.5		
15	38	0.5		
16	40	0.5		
17	36	0.5		
18	37	0.5		
19	37	0.5		
20	37	0.5		
21	40	0.5		
22	37	0.5		
23	37	0.5		
24	36	0.5		
25	37	0.5		
26	37	0.5		
27	35	0.5		
28	37	0.5		
29	40	0.5		
30	37	0.5		
31	39	0.5		
32	37	0.5		

Additional marked:	0	Total count:	32
Dead:	0	Mean length:	37.1 mm
Recapture:	n/a	Mean weight:	0.50 g

mountain whitefish

Date: Mar 18, 2011	Site: Fraser River - (night)	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 23:00		Time processing finished: 00:15	
Species: mountain whitefish		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	153	15.5		
2	230	56.0		
3				
4				
5				

Additional marked:	0	Total count:	2
Dead:	0	Mean length:	191.5 mm
Recapture:	n/a	Mean weight:	35.75 g

mountain sucker

Date: Mar 18, 2011	Site: Fraser River - (night)	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 23:00		Time processing finished: 00:15	
Species: mountain sucker		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	421	406.0		Approx. weight on scale, fish to big
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	421 mm
Recapture:	n/a	Mean weight:	406.0 g

prickly sculpin

Date: Mar 18, 2011	Site: Fraser River (night)	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 23:00		Time processing finished: 00:15	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	93	5.0		
2	110	7.0		
3	94	4.5		
4	96	6.0		
5	60	1.5		
6	105	8.0		
7	85	5.0		
8	109	7.5		
9	93	6.0		
10	104	6.5		
11	96	4.5		
12	98	6.0		
13	115	9.0		
14	110	6.0		
15	112	10.5		
16	133	12.5		
17	71	2.0		
18	95	5.5		
19	90	4.5		
20	80	3.0		
21	86	3.0		
22	122	10.5		
23				
24				
25				
26				
27				
28				
29				
30				

Additional marked:	0	Total count:	22
Dead:	0	Mean length:	98.0 mm
Recapture:	n/a	Mean weight:	6.09 g

leopard dace

Date: Mar 18, 2011	Site: Fraser River - (night)	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 23:00		Time processing finished: 00:15	
Species: lepoard dace		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	44	0.5		
2	51	0.5		
3	29	0.5		
4	26	0.5		
5	30	0.5		
6				
7				
8				
9				
10				

Additional marked:	0	Total count:	5
Dead:	0	Mean length:	36.0 mm
Recapture:	n/a	Mean weight:	0.50 g

longnose dace

Date: Mar 18, 2011	Site: Fraser River - (night)	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 23:00		Time processing finished: 00:15	
Species: longnose dace		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	22	0.5		
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	22.0 mm
Recapture:	n/a	Mean weight:	0.50 g

unknown B

Date: Mar 18, 2011	Site: Fraser River - (night)	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 23:00		Time processing finished: 00:15	
Species: unknown B		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	18	0.5		
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	18.0 mm
Recapture:	n/a	Mean weight:	0.50 g

Appendix 31 – Data Sheets: Tom Berry Gravel Pit 1, March 19, 2011

Site Card			
Date: Mar 19, 2011	Site Name: TBGP1	Crew: SE, HH, CM, JW, SW, AD, MT, MC	
Start Time: 11:10am	End Time: 12:40	Weather: Overcast	
Capture/Recapture Method: Comparative seine		Air temperature: 10°C	
Wetted Width: N/A		Depth: gause read 30.1 cm	
Fraser Discharge at Hope: 856.87m³/s		Ice Cover: None	
Water Quality			
Temperature: 10.6°C	Conductivity: 30.5 mg/L	Turbidity: n/a	pH: n/a
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
	n/a	n/a	n/a

Species	Caught	Recap	Mortalities	Total
largescale sucker	1	n/a	0	1
prickly sculpin	438	n/a	0	438
common carp	10	n/a	0	10
peamouth chub	90	n/a	0	90
redside shiner	46	n/a	1	47

Comments: common carp were all caught in basin 2, they were too large to weigh, two were taken as voucher samples.

common carp

Date: Mar 19, 2011	Site: TBGP1	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 11:10		Time processing finished: 12:40	
Species: common carp		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	580	scale to small		
2	568	1602.5		voucher sample
3	579	scale to small		
4	541	scale to small		
5	486	scale to small		
6	595	2021.0		voucher sample
7	486	scale to small		
8	537	scale to small		
9	549	scale to small		
10	545	scale to small		
11				
12				
13				
14				
15				

Additional marked:	0	Total count:	10
Dead:	0	Mean length:	546.6 mm
Recapture:	n/a	Mean weight:	1811.75 g

largescale sucker

Date: Mar 19, 2011	Site: TBGP1	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 11:10		Time processing finished: 12:40	
Species: largescale sucker		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	357	243.5		
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	357.0 mm
Recapture:	n/a	Mean weight:	243.50 g

peamouth chub

Date: Mar 19, 2011	Site: TBGP1	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 11:10		Time processing finished: 12:40	
Species: peamouth chub		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	63	1.0		
2	61	1.0		
3	63	1.0		
4	60	1.0		
5	63	1.0		
6	67	1.0		
7	65	1.0		
8	56	1.0		
9	59	0.5		
10	62	1.0		
11	60	1.0		
12	64	1.0		
13	63	1.0		
14	59	1.0		
15	57	1.0		
16	56	0.5		
17	64	1.0		
18	65	1.0		
19	65	1.0		
20	64	1.0		missing eye/bloody socket
21	55	0.5		
22	58	1.0		
23	48	0.5		
24	62	1.0		
25	61	1.0		
26	64	1.0		
27	56	0.5		
28	51	1.0		
29	63	1.0		
30	59	1.0		

Additional marked:	60	Total count:	30 + 60 = 90
Dead:	0	Mean length:	60.4 mm
Recapture:	n/a	Mean weight:	0.92 g

redside shiner

Date: Mar 19, 2011	Site: TBGP1	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 11:10		Time processing finished: 12:40	
Species: redside shiner		Mortality: 1	

#	length (mm)	weight (g)	clip	comments
1	49	0.5		
2	47	0.5		
3	46	0.5		
4	37	0.5		
5	37	0.5		
6	47	0.5		
7	45	0.5		
8	46	0.5		
9	45	0.5		
10	44	0.5		
11	35	0.5		
12	46	0.5		
13	50	0.5		
14	38	0.5		
15	41	0.5		
16	30	0.5		
17	39	0.5		
18	33	0.5		
19	33	0.5		
20	38	0.5		
21	44	0.5		
22	45	0.5		
23	43	0.5		
24	42	0.5		
25	43	0.5		
26	41	0.5		
27	31	0.5		
28	34	0.5		
29	43	0.5		
30	30	0.5		

Additional marked:	16	Total count:	30 + 16 = 46
Dead:	1	Mean length:	40.7 mm
Recapture:	n/a	Mean weight:	0.50 g

prickly sculpin

Date: Mar 19, 2011	Site: TBGP1	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 11:10		Time processing finished: 12:40	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	32	0.5		
2	36	0.5		
3	33	0.5		
4	36	0.5		
5	34	0.5		
6	42	0.5		
7	40	0.5		
8	44	0.5		
9	46	0.5		
10	40	0.5		
11	31	0.5		
12	34	0.5		
13	50	0.5		
14	35	0.5		
15	44	0.5		
16	33	0.5		
17	41	0.5		
18	43	0.5		
19	35	0.5		
20	42	0.5		
21	30	0.5		
22	32	0.5		
23	40	0.5		
24	41	0.5		
25	39	0.5		
26	44	0.5		
27	45	0.5		
28	37	0.5		
29	30	0.5		
30	40	0.5		

Additional marked:	408	Total count:	408 + 30 = 438
Dead:	0	Mean length:	38.3 mm
Recapture:	n/a	Mean weight:	0.50 g

Appendix 32 – Data Sheets: Tom Berry Gravel Pit 2, March 19, 2011

Site Card			
Date: Mar 20, 2011	Site Name: TBGP2	Crew: SE, HH, CM, JW, SW, AD, MT, MC	
Start Time: 10:30	End Time: 10:45	Weather: high clouds and sunny, breezy	
Capture/Recapture Method: Minnow Traps		Air temperature: 10°C	
Wetted Width: N/A		Depth:gauge read 51.0cm	
Fraser Discharge at Hope: 856.87m³/s		Ice Cover: None	
Water Quality			
Temperature: 6.6°C	Conductivity: 25.2 mg/L	Turbidity: n/a	pH: 6.9
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
10:30	Surface	6.6	13.2

Species	Caught	Recap	Mortalities	Total
prickly sculpin	1	n/a	0	1

Comments: only TBGP2a had water. One prickly sculpin was witnessed swimming around outside the traps.

prickly sculpin

Date: Mar 19, 2011	Site: TBGP2	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 12:30		Time processing finished: 12:40	
prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	46	0.5		
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	46.0 mm
Recapture:	n/a	Mean weight:	0.50 g

Appendix 33 – Data Sheets: Tom Berry Gravel Pit 1, March 20, 2011

Site Card			
Date: Mar 20, 2011	Site Name: TBGP1	Crew: SE, HH, CM, JW, SW, AD, MT, MC	
Start Time: 10:45	End Time: 12:00	Weather: Overcast	
Capture/Recapture Method: Minnow Traps		Air temperature: 11.3°C	
Wetted Width: N/A		Depth: gauge reads 31.5 cm	
Fraser Discharge at Hope: 872.29m³/s		Ice Cover: None	
Water Quality			
Temperature: 6.7°C	Conductivity: 32.0 mg/L	Turbidity: n/a	pH: 7.2
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
11:00	surface	6.7	12.2

Species	Caught	Recap	Mortalities	Total
largescale sucker	1	n/a	0	1
prickly sculpin	59	n/a	0	59
peamouth chub	49	n/a	0	49
redside shiner	45	n/a	1	45

Comments:

largescale sucker

Date: Mar 20, 2011	Site: TBGP1	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 10:45		Time processing finished: 12:00	
Species: largescale sucker		Mortality:	

#	length (mm)	weight (g)	clip	comments
1	80	2.0		
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	80.0 mm
Recapture:	n/a	Mean weight:	2.00 g

prickly sculpin

Date: Mar 20, 2011	Site: TBGP1	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 10:45		Time processing finished: 12:00	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	94	4.5		
2	119	12.0		
3	114	9.5		
4	110	8.0		
5	118	7.5		
6	100	7.0		
7	81	2.5		
8	94	3.5		
9	117	10.0		
10	101	6.0		
11	106	8.0		
12	99	5.5		
13	114	9.0		
14	106	8.5		
15	120	9.0		
16	112	9.5		
17	96	5.0		
18	54	0.5		
19	109	7.5		
20	115	10.0		
21	87	3.5		
22	50	0.5		
23	92	3.5		
24	95	5.0		
25	58	0.5		
26	64	1.0		
27	51	0.5		
28	110	10.5		
29	113	9.5		
30	79	2.5		

Additional marked:	29	Total count:	30 + 29 = 59
Dead:	0	Mean length:	95.9 mm
Recapture:	n/a	Mean weight:	6.00 g

peamouth chub

Date: Mar 20, 2011	Site: TBGP1	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 10:45		Time processing finished: 12:00	
Species: peamouth chub		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	57	1.0		
2	65	1.0		
3	69	1.0		
4	71	1.5		
5	62	1.0		
6	65	1.5		
7	58	1.0		
8	62	1.0		
9	64	1.0		
10	64	1.0		
11	62	1.0		
12	62	1.0		
13	64	1.0		
14	64	1.0		
15	56	1.0		
16	57	1.0		
17	64	0.5		
18	64	1.0		
19	65	1.0		
20	59	1.0		
21	64	1.0		
22	65	1.0		
23	59	1.0		
24	58	1.0		
25	63	1.0		
26	58	1.0		
27	66	1.0		
28	60	1.0		
29	64	1.0		
30	61	1.0		

Additional marked:	19	Total count:	30 + 19 = 49
Dead:	0	Mean length:	62.4 mm
Recapture:	n/a	Mean weight:	1.02 g

redside shiner

Date: Mar 20, 2011	Site: TBGP1	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 10:45		Time processing finished: 12:00	
Species: redside shiner		Mortality: 1	

#	length (mm)	weight (g)	clip	comments
1	91	5.0		
2	102	6.5		
3	38	0.5		
4	50	0.5		
5	45	0.5		
6	47	0.5		
7	48	0.5		
8	42	0.5		
9	40	0.5		
10	46	0.5		
11	96	5.0		
12	41	0.5		
13	40	0.5		
14	74	3.0		
15	76	1.5		
16	87	5.5		
17	38	0.5		
18	101	6.5		
19	96	4.0		
20	87	4.0		
21	93	5.0		
22	94	4.5		
23	100	7.0		
24	93	5.5		
25	102	5.5		
26	105	6.5		
27	86	3.5		
28	97	5.5		
29	104	7.0		
30	78	3.0		

Additional marked:	14	Total count:	30 + 14 = 44
Dead:	1	Mean length:	74.5 mm
Recapture:	n/a	Mean weight:	3.31 g

Appendix 34 – Data Sheets: Delair Pond, March 23, 2011

Site Card			
Date: Mar 23, 2011	Site Name: Delair	Crew: HH, KM, WH	
Start Time: 1:30	End Time: 2:45	Weather: Sunny	
Capture/Recapture Method: recapture		Air temperature: 13°C	
Wetted Width: N/A		Depth: n/a	
Fraser Discharge at Hope: 809.326m³/s		Ice Cover: None	
Water Quality			
Temperature: 8°C	Conductivity: n/a	Turbidity: n/a	pH: n/a
Dissolved Oxygen			
Time	Depth (m)	Temp °C	mg/L
n/a	n/a	n/a	n/a

Species	Caught	Recap	Mortalities	Total
coho	10	2	0	10
sockeye	7	0	0	7
cutthroat trout	1	0	0	1
rainbow trout	1	1	0	1
largescale sucker	20	0	0	20
prickly sculpin	29	n/a	0	29
northern pikeminnow	2	0	0	2
redside shiner	368	173	0	368

Comments: used a non-electronic scale in the field. Voucher samples (3 suckers, pikeminnows, and all salmonids were measured in the lab with an electronic sale).

coho

Date: Mar 23, 2011	Site: Delair	Crew: CM, HH, WH	Weather: partly cloudy
Time processing started: 1:30		Time processing finished: 14:45	
Species: coho		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	121	10.0		
2	101	6.0		
3	104	6.5		
4	118	9.0		
5	115	9.0		
6	110	8.0		
7	198	42.5		
8	190	38.5		
9	196	41.0		
10	172	31.0		
11	unknown	unknown		escapee
12	unknown	unknown		escapee
13				
14				
15				
16				
17				
18				
19				
20				

Additional marked:	0	Total count:	12
Dead:	0	Mean length:	142.5 mm
Recapture:	2	Mean weight:	20.15 g

sockeye

Date: Mar 23, 2011	Site: Delair	Crew: CM, HH, WH	Weather: partly cloudy
Time processing started: 1:30		Time processing finished: 14:45	
Species: sockeye		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	160	21.0		
2	145	15.0		
3	147	16.5		
4	157	21.0		
5	153	19.5		
6	146	14.0		
7	134	12.5		
8				
9				
10				

Additional marked:	0	Total count:	7
Dead:	0	Mean length:	148.9 mm
Recapture:	0	Mean weight:	17.07 g

cutthroat trout

Date: Mar 23, 2011	Site: Delair	Crew: CM, HH, WH	Weather: partly cloudy
Time processing started: 1:30		Time processing finished: 14:45	
Species: cutthroat trout		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	395	303.0		pregnant
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	395.0 mm
Recapture:	0	Mean weight:	303.00 g

rainbow trout

Date: Mar 23, 2011	Site: Delair	Crew: CM, HH. WH	Weather: partly cloudy
Time processing started: 1:30		Time processing finished: 14:45	
Species: rainbow trout		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	275	107.5		recap
2				
3				
4				
5				

Additional marked:	0	Total count:	1
Dead:	0	Mean length:	275 mm
Recapture:	1	Mean weight:	107.50 g

largescale sucker

Date: Mar 23, 2011	Site: Delair	Crew: CM, HH, WH	Weather: partly cloudy
Time processing started: 1:30		Time processing finished: 14:45	
Species: largescale sucker		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	290	227.0		weighed on non-electronic scale
2	350	397.0		weighed on non-electronic scale
3	320	425.0		weighed on non-electronic scale
4	290	255.0		weighed on non-electronic scale
5	280	227.0		weighed on non-electronic scale
6	310	255.0		weighed on non-electronic scale
7	290	255.0		weighed on non-electronic scale
8	280	227.0		weighed on non-electronic scale
9	310	312.0		weighed on non-electronic scale
10	290	283.5		weighed on non-electronic scale
11	300	312.0		weighed on non-electronic scale
12	310	212.0		weighed on non-electronic scale
13	275	170.0		weighed on non-electronic scale
14	320	312.0		weighed on non-electronic scale
15	310	283.5		weighed on non-electronic scale
16	310	240.0		weighed on non-electronic scale
17	310	368.5		weighed on non-electronic scale
18	265	138.0		weighed on electronic scale
19	246	99.0		weighed on electronic scale
20	260	104.0		weighed on electronic scale
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

Additional marked:	0	Total count:	20
Dead:	0	Mean length:	295.8 mm
Recapture:	0	Mean weight:	255.13 g

prickly sculpin

Date: Mar 23, 2011	Site: Delair	Crew: CM, HH. WH	Weather: partly cloudy
Time processing started: 1:30		Time processing finished: 14:45	
Species: prickly sculpin		Mortality: 0	

#	length (mm)	weight (g)	clip	comments

Additional marked:	0	Total count:	29
Dead:	0	Mean length:	n/a mm
Recapture:	n/a	Mean weight:	n/a g

northern pikeminnow

Date: Mar 23, 2011	Site: Delair	Crew: CM, SE, HH, AD, JW, SW, MT, MC	Weather: partly cloudy
Time processing started: 1:30		Time processing finished: 14:45	
Species: northern pikeminnow		Mortality: 0	

#	length (mm)	weight (g)	clip	comments
1	195	40.0		
2	91	3.5		
3				
4				
5				

Additional marked:	0	Total count:	2
Dead:	0	Mean length:	143.0 mm
Recapture:	0	Mean weight:	21.75 g

redside shiner

Date: Mar 23, 2011	Site: Delair	Crew: CM, HH, WH	Weather: partly cloudy
Time processing started: 1:30		Time processing finished: 14:45	
Species: redside shiner		Mortality: 0	

Additional marked:	368	Total count:	368
Dead:	0	Mean length:	n/a mm
Recapture:	173	Mean weight:	n/a g