JUVENILE COHO STUDIES AT THE TELKWA RIVER KM 1010 AND KM 1011 PONDS 1999

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for

WATERSHED RESTORATION PROGRAM

PROVINCE OF B.C.

PACIFIC INLAND RESOURCES

NOVEMBER 1999

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1.0 INTRODUCTION

1.1 Background

Studies were conducted at two off-channel ponds located on the Telkwa River floodplain approximately 17 and 18 kms southwest of Smithers. The main pond complex is located at Km 1011 on the Telkwa Forest Road while a second area is located across the Telkwa River from Km 1010.

1.1.1 Km 1011 Ponds

The Km 1011 Ponds were constructed in 1993 by the Department of Fisheries and Oceans (DFO) as a pilot juvenile coho enhancement project. A special feature of the ponds was the development of culvert design features to prevent beavers from blocking outlet culverts and restricting fry recruitment into the ponds (Finnegan and Marshall 1997). The inlet channels were extended in 1995 as compensation for impacts of Pacific Northern Gas Ltd.'s pipeline crossing of the Telkwa River at this location. The total wetted area of the pond complex is 8700 m^2.

Further modifications of Km 1011 were undertaken in 1997, with the development of a connection between Channels 1 and 2 to increase the overwinter groundwater flows into Channel 2 (Figure 1). This connection was made to attempt to increase overwinter dissolved oxygen concentrations to more suitable levels for fish survival.

Coho populations have been monitored at Km 1011 for the past six years using a mark-and-recapture estimate for population estimates. The results to date indicate that the pond development has successfully created coho habitat. Estimates of pre-smolt coho numbers conducted in early May just prior to the outmigration period indicate that production in the ponds has increased from just over 200 coho pre-smolts prior to development to between 1100 and 2800 pre-smolts post-development (Bustard 1998).

Monitoring of the actual smolt out-migration as well as fry and yearling immigration has been undertaken since 1996. The smolt migration estimates have only been close to the pre-smolt mark-and-recapture estimates in one year. Problems with the pond outlet culvert during 1996 and the possibility the many of the smaller pre-smolts remained in the ponds for an extra year in 1998 may account for some of the differences observed.

Results from the upstream trapping indicated that newly-emerged coho fry and yearlings move upstream into the pond complex from mid-may through July. Results in 1998 indicated that both coho fry and yearling upstream migrant numbers were down sharply from past year, corresponding with poor coho spawner escapements in the upper Skeena tributaries for the previous two years.

1.1.2 Km 1010 Pond

The Km 1010 Pond complex was developed late in the fall of 1997. Trapping during early May 1998 indicated little use of the Km 1010 Ponds presumably due to poor access for upstream migrants past the outlet culvert (Bustard 1998). An upstream fry and yearling trap box as well as a downstream smolt trap box were installed in 1999 to determine timing and extent of fish movements in and out of this pond. These studies were conducted in conjunction with a proposal to improve access into the pond complex past the problem culvert.

1.2 Study Objectives

The study objectives for the 1999 work were as follows:

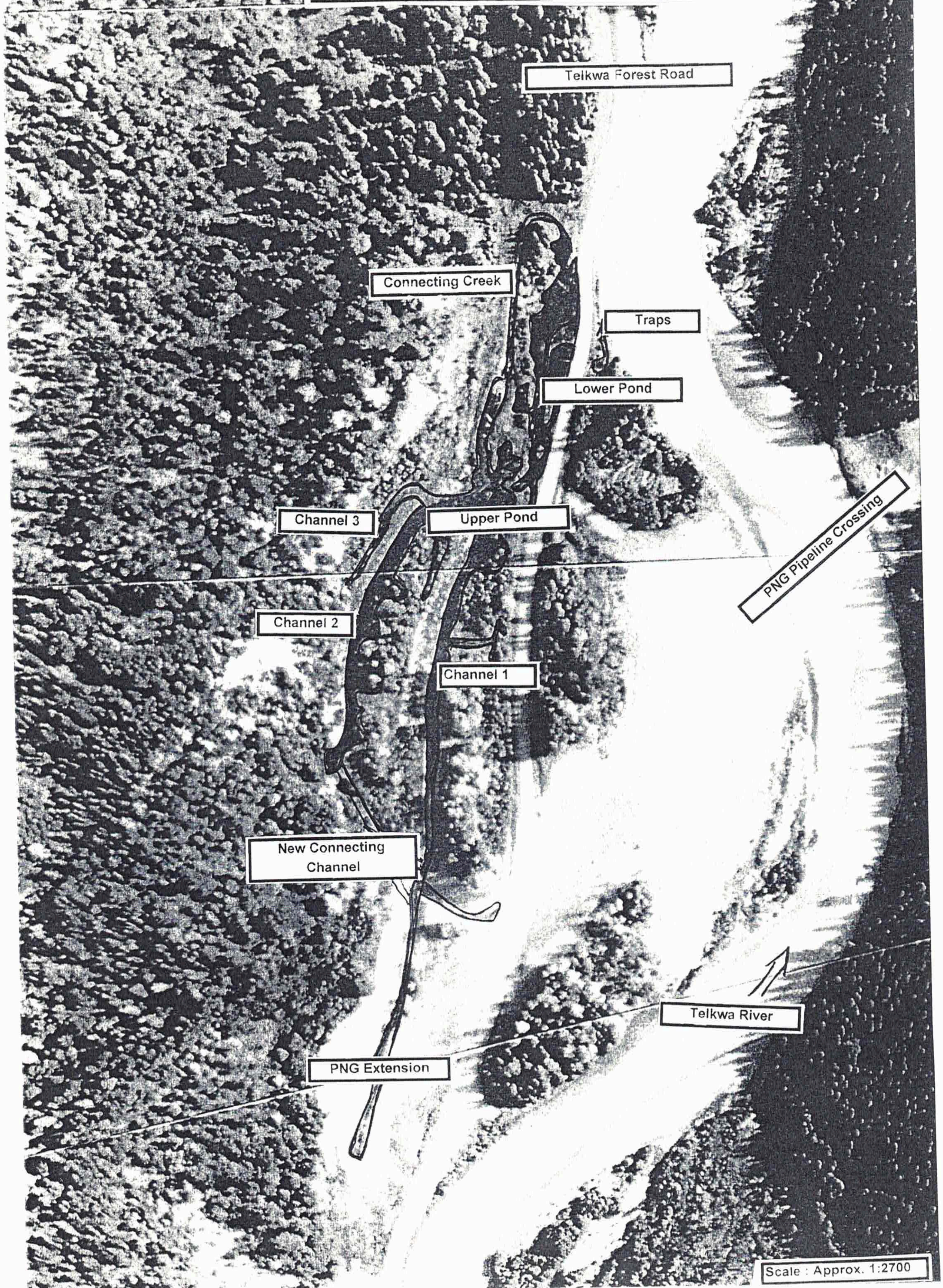
1.) To undertake a third year of measuring coho smolt out-migration from Km 1011 Ponds and a first year of assessing movements out of Km 1010 Pond.

2.) To compare mark-and-recapture population estimates to the actual number of coho smolts leaving the two systems.

3.) To measure the extent and timing of fish movements into the two pond complexes.

Funding for the project was provided by the Watershed Restoration Program (Province of B.C.) through Pacific Inland Resources Ltd,.

Figure 1. Aerial View of Km 1011 Ponds.



2.0 METHODS

2.1 Timing

Field studies were initiated on May 2 and continued at both locations until June 16th. A short intense rain associated with a very warm period of rapid snowmelt resulted in the a sharp rise in the Telkwa River flow level to the highest level in at least four years. Although these high flows only occurred for several days, they flooded out the Km 1011 fence. As well, high flows washed into the Km 1010 Ponds from upstream. No further measurements were conducted due to the incomplete data and unknown movements that would have occurred during the high flows around the fences at both locations.

2.2 Water Temperature and Discharge

Methods for recording water temperature and discharge at Km 1011 were identical to those used for the past three years and described in Bustard (1996). The staff gauge on the Telkwa River was left in place over-winter, so levels since 1997 correspond directly to each other.

Water temperatures were taken at the outlet to Km 1010 pond and water levels were recorded at a staff gauge installed at the culvert box at Km 1010. Discharge from Km 1010 Pond was too high to run all flows through the trap box installation similar to Km 1011. Instead some flows were passed through the outlet culvert, and suitable flow conditions through the downstream trap box were adjusted using a cover on the culvert.

Thermographs were installed at 0.5 m depth in the Km 1011 lower pond and near the outlet box on Km 1010 Pond from the beginning of May to October 15th at both locations.

A series of dissolved oxygen and temperature profiles were conducted at seven locations in Km 1011 Ponds on May 5. Similar measurements were made at Km 1010 Pond and inlet creek on May 10, just as the ponds were free of ice cover.

2.3 Mark-and-Recapture Estimates

2.3.1 Km 1011

Methods used to conduct population estimates were identical to those used in past years. The markings were conducted on May 3-4th and the recaptures were undertaken on May 10-11th, prior to the main smolt outmigration (based on observations at the downstream traps). All fish captured during this portion of the surveys were marked with an upper caudal clip.

A total of 75 minnow traps baited with roe were used for both the mark and the recapture phases.

Population estimates were conducted using the Chapman modification to the Peterson formula (Chapman 1951), and the 95% confidence intervals were calculated using the standard error of the estimate (Robson and Regier 1971). The estimates were separated by pond section and for coho less than and larger than 75 mm fork length[1]. This is the size break-off that has been used for the past five years to separate those coho probably remaining in the ponds for an additional year versus those expected to leave as smolts within the next six weeks.

2.3.2 Km 1010

Five minnow traps were set in Km 1010 on May 13th and again on May 20th to determine whether sufficient numbers of coho could be caught to make a mark-and-recapture estimate feasible. On both dates, no fish were captured, so we determined that a large trapping effort to obtain marked fish would not be worthwhile based on the low fish numbers present in the pond at Km 1010 in 1999.

2.4 Upstream and Downstream Traps

2.4.1 Km 1011

The same upstream and downstream trap box that was used for the past three years was installed in the short section of the outlet stream located between the road and the mainstem Telkwa River (Figure 1). A description of the trap configuration is given in Bustard (1996).

Trap boxes were operational by May 3, and were checked daily until June 16th when Telkwa River flows over-topped the downstream fence. The upstream box was also over-topped and not effectively fishing on May 24 and 25th.

The downstream box was operational until June 16th. However, we had a problem on May 23 and 24th when the screening in the downstream trap box was damaged by what we suspect was a mink. This was during the key smolt movement period, and we suspect that significant numbers of smolts were lost during this two-day period, affecting the final estimates of smolt numbers in 1999.

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[1] No fish less than 75 mm fork length were actually captured in the 1999 mark-and-recapture. Also, the large smolt size measured in 1998 suggested that some coho larger than 75 mm may remain in the ponds for an additional year.

The wire screening on the downstream box was reinforced with heavier gauge wire and a live trap was set for the remainder of the project. No mink was ever captured, and there were no further problems at the downstream trap.

All fish captured were sorted by species, counted, examined for marks (upper caudal clips from 1999 and right ventral clips from 1998 upstream yearlings) and released in the direction of capture. Fork lengths from a sample of fry (to a maximum of 30) were measured daily. All coho yearlings and smolts were measured to the nearest mm.

Representative weights were retained from 169 coho smolts and scales were retained from 46 coho smolts for aging. The results of the 1999 aging analysis are not available to date[2]. However, the age summaries from 56 coho smolts sampled in 1998 have been included in this report. Aging information for these fish was not available for the 1998 report.

2.4.2 Km 1010

Upstream and downstream trap boxes were installed adjacent to the culvert outlet at Km 1010. The trap designs were the same as those used at Km 1011 including a siphon from the pond to provide attraction water for the upstream box. The inlet trough to the downstream box was installed in a trench cut through the pond berm. The trap dimensions are the same as those outlined in Bustard (1996) for Km 1011.

Fine-meshed seine netting was installed across the pond inlet to collect conifer needles before they entered the downstream trap and plugged the screening. As well, wire fencing was installed around the trough inlet and trap box to prevent beavers from plugging the inlet. A wire fence was installed around the traps part way through the project to reduce porcupine damage.

All fish moving upstream and downstream in Km 1010 were handled similarly to the methods outlined for Km 1011. Weights were obtained from 44 coho smolts and scales were retained from 39 coho smolts. Age data is not available at the time of this report preparation.

2.5 Other Observations

Observations of wildlife species (including amphibians) associated with the pond complexes were collected at the sites and are summarized in Appendix 5 Tables 1 and 2.

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[2] Submitted to Greg Bonnell, Dept. of Fisheries and Oceans, Vancouver.

3.0 RESULTS

3.1 Water Temperature and Streamflow Summaries

Water temperatures collected during the studies are summarized in Figure 2 with a more complete record in Appendix 1 Tables 1 and 2.

Water temperatures in Km 1011 Pond rose from 8°C in early May to 18°C during late July and early August (Figure 2). Mean monthly water temperatures in Km 1011 were comparable to those recorded in the lower pond during 1996 and 1997, and emphasize that the summer of 1998 was unusually warm (Table 1). The Km 1011 Ponds have consistently been 5-7°C warmer than water temperatures in the mainstem Telkwa River.

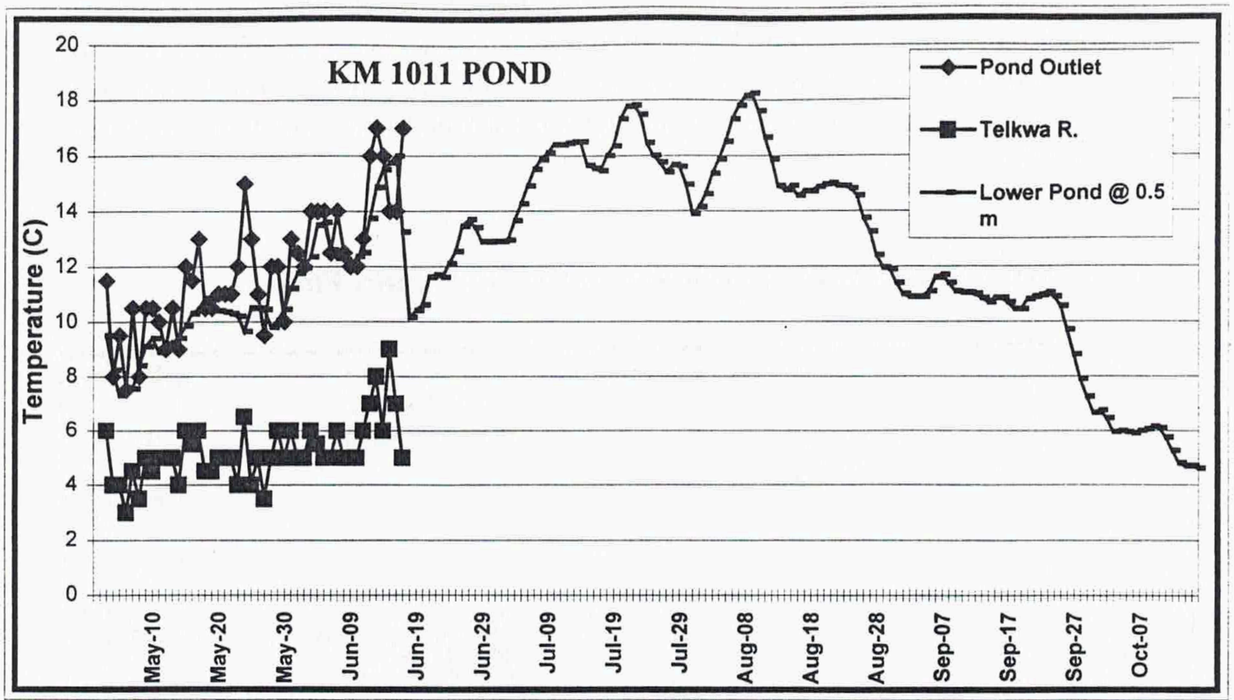
Table 1. Mean Monthly Water Temperatures in Km 1011 and Km 1010 Ponds Compared to the Mainstem Telkwa River for the Period of Record.

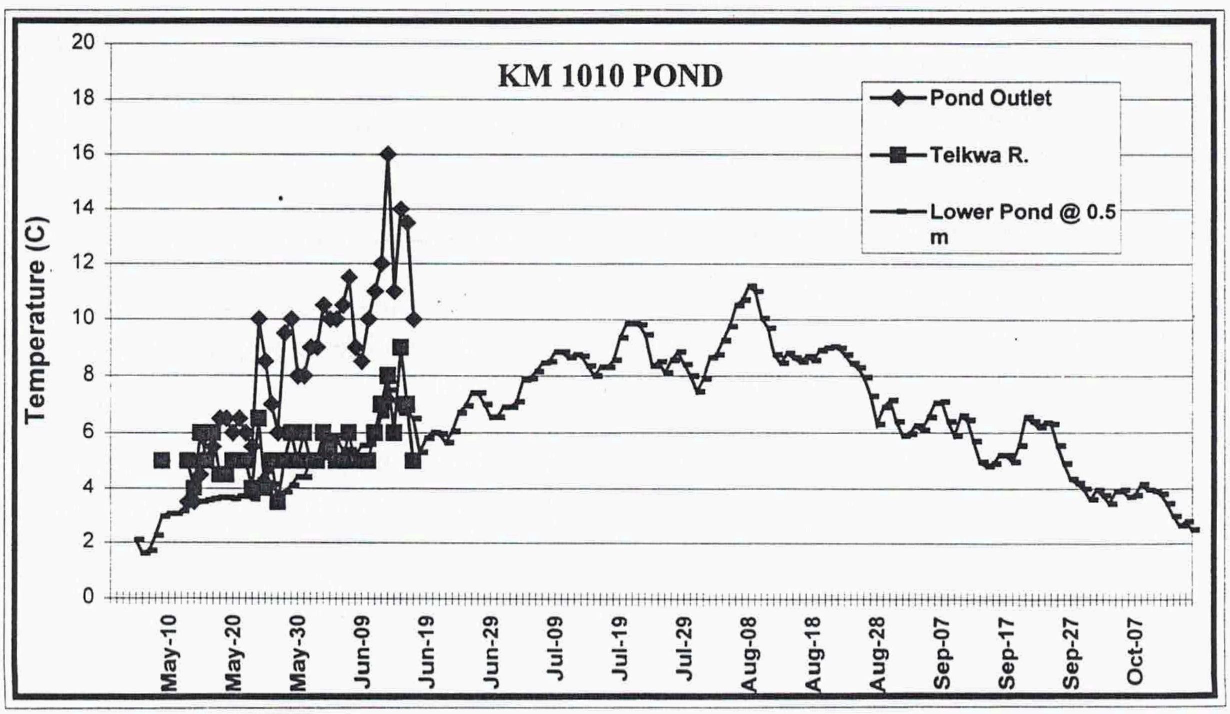
Month	Telkwa Ponds					Telkwa River			
	Km 1011				Km 1010				
	1996	1997	1998	1999	1999	1996	1997	1998	1999
May	10.2	10.6	13.4	9.7	3.5	6.3	5.6	6.0	4.8
June	12.5	13.0	16.3	12.8	6.2	6.5	7.9	9.7	6.0
July	14.7	14.8	17.3	15.7	8.5	8.5	10.4	11.2	nm[3]
Aug	13.8	14.6	15.3	14.9	8.7	nm	nm	nm	nm
Sept	11.1	10.8	11.6	10.3	5.6				
Oct (to 15th)				5.6	3.5				

Km 1010 still had ice cover during the first week of May. Mean monthly water temperatures rose from a cool 3.5°C during May to between 8 and 9°C in July and August (Table 1). The maximum daily temperature in the ponds was just over 11°C during early August. Water temperatures in the outlet creek were considerably warmer than in Km 1010 Pond with a maximum of 16°C recorded in mid-June prior to the end of the study (Figure 2).

[3] Not measured. The 1999 studies ended in mid-June due to flooding. All other years continued through July.

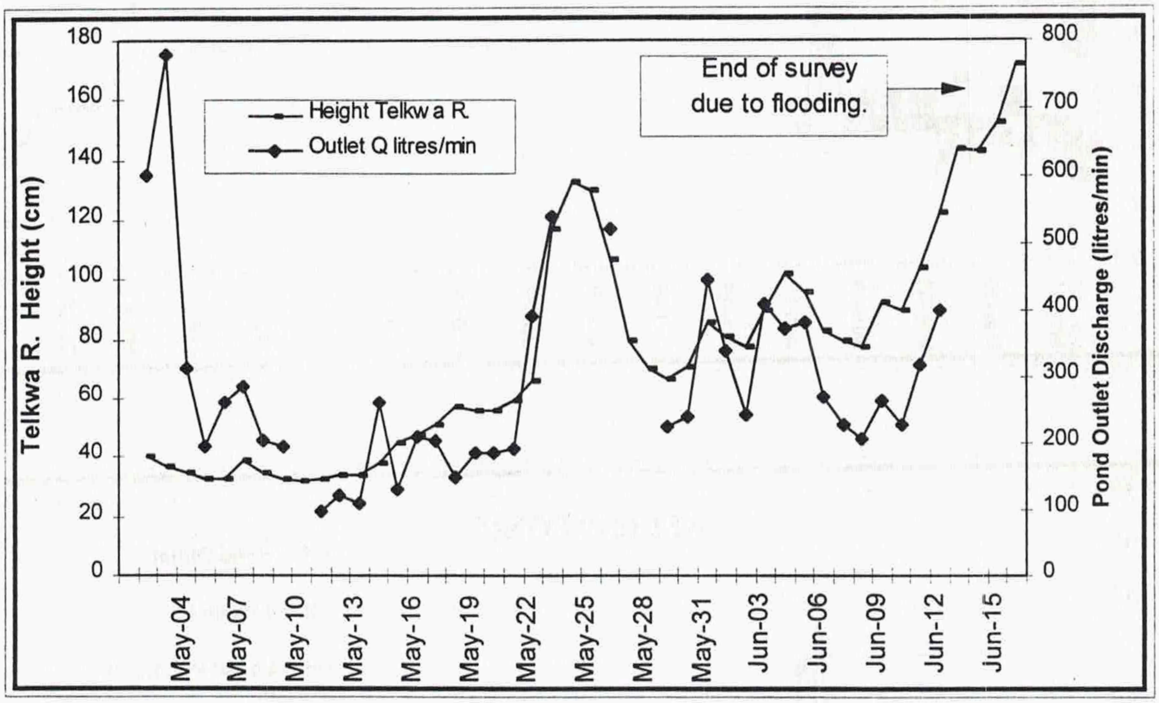
Figure 2. Water Temperatures in Km 1011 and Km 1010 Ponds and the Telkwa River 1999.





Km 1011 discharge estimates are summarized in Figure 3, with more detailed information provided in Appendix 1 Table 1. The outlet flows from Km 1011 Ponds were highest at the initiation of the project in early May, reflecting local run-off from the immediate pond area. After that date, outlet flows tended to track Telkwa River flows. The Telkwa River flows exceeded 180 cm on the gauge, the highest recorded since pond monitoring has been undertaken in the Telkwa.

Figure 3. Telkwa River Water Levels Versus Km 1011 Outlet Flows.



Discharge estimates at Km 1010 were not conducted since the streamflows were split between the downstream trap and the outlet culvert. The pond level was adjusted on a daily basis, with the excess flow directed through the culvert.

Dissolved oxygen measurements were conducted throughout both pond complexes during early May (Appendix 2 Tables 1 and 2). The results indicate that suitable dissolved oxygen levels were present in both pond complexes during this period (6-12 ppm range). Data from past years during early March indicates that low dissolved oxygen conditions can occur during the late winter in sections within both pond areas (Bustard 1998).

3.2 Fish Sampling Results

3.2.1 Pond Mark-and-Recapture Population Estimates

3.2.1 1 Km 1011 Population Estimates

Relatively small numbers of coho were captured throughout Km 1011 Pond complex during the mark-and-recapture population estimates in 1999 (Table 2). In total, only 205 coho were captured in the 150 traps set throughout the complex. This is less than one-half of the lowest number captured during past sampling at the same locations with the same or less effort (range from 547 to 1253 fish).

The catch per unit effort (CPUE) of 1.4 coho per trap is very low given the quality of the habitat and past sampling results. CPUE was highest in the lower pond and very low in the PNG extension channel where only a single coho was captured in 20 traps. Catches in this channel have been very low since the old channel was blocked and a new connecting channel was added off Channel 2, suggesting that coho are not recruiting into this section through the new channel.

Only a single peamouth chub was captured during the mark-and-recapture sampling. In the past a small number of rainbow trout and occasionally mountain whitefish and Dolly Varden have been sampled during the mark-and-recapture estimates. Together, these other species generally comprise less than 1% of the overall sample.

Table 3 summarizes the results of the population estimates by section. The total population estimate for all sections was 961 fish (95% confidence intervals of 448 to 1474). No fish smaller than 75 mm were sampled during the mark-and-recapture, and it assumed that most of the fish sampled would be leaving the ponds as smolts within six weeks of the early May estimates[4].

The total estimated population of coho in the ponds compared to previous sample results since 1993 is presented in Table 4. The results indicate that the overall estimate of coho was the lowest for all years since first estimates were made in 1993. The total absence of fish smaller than 75 mm was very unusual, and reflects the exceptionally low fry recruitment into the ponds during the summer of 1998. The estimate of 961 potential smolts for 1999 was the lowest since the pond construction (1994 onward). This estimate does fall within the lower end of the confidence interval range of the 1997 estimates.

The mean fork length of coho sampled in the mark-and-recapture estimates is shown in Table 5. The mean size of the >74 mm category was 116 mm. This indicates that the sample of coho present in the Km 1011 Ponds was comprised of much larger fish than in

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[4] Based on large smolt sizes noted in 1998, this assumption that all fish >74 mm leave as smolts probably results in an over-estimate of the number of smolts leaving the ponds.

Table 2. Summary of Coho Captured in Minnow Traps in Sections 1 to 8 of Km 1011 Ponds, May 1994 to 1999.

	Number of Traps						Coho Captured						Coho CPUE					
	1994	1995	1996	1997	1998	1999	1994	1995	1996	1997	1998	1999	1994	1995	1996	1997	1998	1999
1 Lower Pond	30	30	30	30	30	30	160	180	284	152	207	107	5.3	6.0	9.5	5.1	6.9	3.6
2 Creek-Debris	10	10	10	10	10	10	102	74	201	56	116	17	10.2	7.4	20.1	5.6	11.6	1.7
3 Creek-Rock	10	10	10	10	10	10	61	55	137	29	78	8	6.1	5.5	13.7	2.9	7.8	0.8
4 Upper Pond	20	20	20	20	20	20	99	92	234	56	73	30	5.0	4.6	11.7	2.8	3.7	1.5
5 Channel 1	20	20	20	20	20	20	98	54	141	36	76	14	4.9	2.7	7.1	1.8	3.8	0.7
6 Channel 2	20	20	18	20	20	20	115	92	84	55	84	11	5.8	4.6	4.7	2.8	4.2	0.6
7 Channel 3	20	18	10	20	20	20	130	110	84	63	77	17	6.5	6.1	8.4	3.2	3.9	0.9
8 PNG Extension			8	20	20	20			88	100	31	1			11.0	5.0	1.6	0.1
TOTAL	130	128	126	150	150	150	765	657	1253	547	742	205	5.9	5.1	9.9	3.6	4.9	1.4

Table 3. Juvenile Coho Population Estimates in Km 1011 Ponds, May 1999.

SECTION	SIZE CATEGORY[10]	M[5]	C[6]	R[7]	N[8]	SE (N)	95% C.I[9]
1	>74 mm	33	74	5	424	154.3	302
2	>74 mm	14	3	2	19	6.2	12
3	>74 mm	6	2	0	20	21.0	41
4	>74 mm	16	14	3	63	25.5	50
5	>74 mm	10	4	0	54	55.0	108
6	>74 mm	9	2	0	29	30.0	59
7	>74 mm	9	8	0	89	90.0	176
PNG EXTENSION	>74 mm	1	0	0	1	0.0	0
TOTAL	**>74 mm**	**97**	**107**	**10**	**961**	**261.6**	**513**

Table 4. Juvenile Coho Population Estimates in Km 1011 Ponds, May 1993 to 1999.

Year	Juvenile Coho Estimates		
	>74 mm (95% CI)	**<75 mm**	**Combined**
1993	222 (179-263)	964	1186
1994	2304 (1777-2832)	336	2640
1995	1549 (1223-1875)	296	1845
1996	2820 (2163-3477)	1484	4304
1997	1124 (845-1403)	271	1395
1998	1806 (1452-2160)	107	1913
1999	961 (448-1474)	0	961

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[5] M refers to the number of coho initially marked.
[6] C refers to the total number of coho recaptured.
[7] R refers to the number of recaptured coho with marks.
[8] N refers to the estimates population.
[9] C.I. refers to confidence intervals.
[10] Note: no coho with fork lengths less than 75 mm were caught during the 1999 mark-and-recapture.

Table 5. Mean Fork Lengths of Coho Sampled During Mark-and-Recapture Population Estimates in the Km 1011 Ponds May 1993 to 1999.

	<75 mm		>74 mm (pre-smolts)	
	fl (mm)	**n**	**fl (mm)**	**n**
1993	Pre-construction			
1994	66.3	63	100.6	648
1995	70.2	47	99.6	533
1996	65.9	472	89.9	752
1997	68.6	91	93.8	411
1998	68.4	40	100.9	692
1999	na	0	116.3	205

any past year. We noted in the 1998 studies that many of the larger coho that we assumed were going to leave as smolts in 1998 remained in the pond, leading to a discrepancy between the mark-and-recapture estimates and the smolt migration numbers in the downstream trap. This may account for the much larger fish present in the ponds in 1999 compared to past years.

3.2.1.2 Km 1010 Population Estimates

A mark-and-recapture estimate was not conducted in Km 1010 Pond in 1999 due to the lack of fish captured during two trials in early May to determine whether sufficient coho were present to warrant a population estimate.

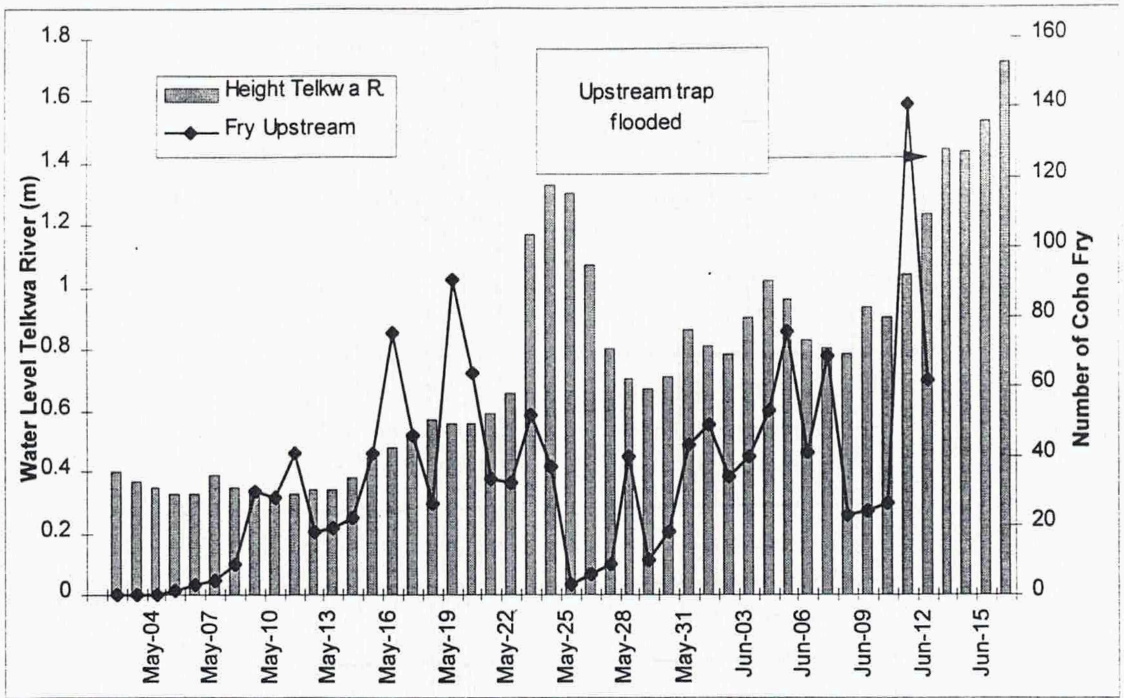
3.2.2. Fish Upstream Movements

3.2.2.1 Km 1011 Upstream Migrants

In total, 1487 fish moved upstream in Km 1011 Ponds during the May to mid-June period (Table 6). Newly-emerged coho fry comprised 97% of the fish moving upstream. A small number of coho yearlings (43) and rainbow trout (7) were also passed upstream into the ponds. The detailed results outlining daily movements are summarized in Appendix 3 Table 1.

The number of age 0+ coho moving upstream in May (799) was the highest recorded to date. The fry migration was continuing through June until the traps were washed out mid-month. The number of coho yearling upstream migrants (30) was well down from earlier years (Table 6).

Figure 4. Coho Fry Upstream Movements in Km 1011 Ponds Versus Telkwa River Levels, May to Mid-June 1999.



Coho fry were first captured in the upstream trap on May 5 (Figure 4 and Appendix 3 Table 1). This is very close to the first fry recorded in 1998 and approximately a week earlier than 1996 and 1997. Steady numbers of fry moved upstream on a daily basis from approximately May 9 onward, with a drop during a high-flow period in late May when the upstream trap was submerged. In the past, most coho fry upstream migration into the ponds occurred during June and July. The 1437 coho fry passed upstream prior to June 16th exceeds the next highest fry migration year (1996) when 978 fry were passed upstream by that date. The small number of coho yearlings entered the ponds throughout the period of trap operation.

The high recruitment of coho fry into Km 1011 during the period of trap operation is indicative of improved spawner recruitment into the Telkwa River during the fall of 1998 compared to the previous two years. The very low yearling numbers recorded moving into the ponds is further evidence of poor coho recruitment in the Telkwa in 1997. Coho fry recruitment in 1997 was the lowest to date (Table 6).

Similar to the previous two years, increased fry migration into the ponds was not directly related to rising flows in the Telkwa River. However, the highest daily migration occurred during a period of increasing streamflows just prior to the traps flooding out.

Table 6. Summary of Km 1011 Upstream and Downstream Fish Movements by Month and Year (1996 to 1999).

UPSTREAM MOVEMENTS

Month	Coho 0+				Coho 1+				Rainbow				Whitefish				Dolly Varden				CT
	1996	1997	1998	1999	1996	1997	1998	1999	1996	1997	1998	1999	1996	1997	1998	1999	1996	1997	1998	1999	1997
May	553	170	112	799	233	253	119	30	0	8	2	6	1	1	1	0	0	0	2	0	0
June	980	351	158	638	440	349	121	13	2	2	1	1	7	4	0	0	0	0	0	0	1
July	861	308	105	na	76	136	23	na	0	2	1	na	0	0	0	na	0	0	0	na	1
Aug (1-9)	37	dry	dry	na	9	dry	dry	na	0	dry	dry	na	0	dry	dry	na	0	dry	dry	na	dry
Total	2431	829	375	1437	758	738	263	43	2	12	4	7	8	5	1	0	0	0	2	0	2

DOWNSTREAM MOVEMENTS

Month	Coho Smolts				Coho Pre-smolts*				Coho Fry				Rainbow				Whitefish				DV	Chub	BT
	1996	1997	1998	1999**	1996	1997	1998	1999	1996	1997	1998	1999	1996	1997	1998	1999	1996	1997	1998	1999	1998	1999	1999
May	21	730	539	204	1	2	2	2	2	0	1	6	7	2	3	2	2	1	0	0	2	0	1
June	205	650	282	87	9	18	0	0	51	4	0	16	18	8	6	1	1	1	0	1	0	1	0
July	9	2	1	na	9	14	2	na	238	8	0	na	0	0	0	na	1	0	0	na	0	na	na
Aug (1-9)	0	dry	dry	na	2	dry	dry	na	4	dry	dry	na	0	dry	dry	na	0	dry	dry	na	dry	na	na
Total	235	1382	822	291	21	34	4	2	295	12	1	22	25	10	9	3	4	2	0	1	2	1	1

*These fish were larger juveniles not exhibiting smolt characteristics (loss of parr marks, silver colouration and black tip on caudal fin).
**Evidence of a mink interfering with the d/s trap box on May 23 and 24, 1999, a peak period of migration.
No data was collected after June 16th in 1999 due to high Telkwa River flows flooding the outlet of the ponds.

A summary of upstream coho migrant fish length is presented in Appendix 3 Table 3 and Appendix 3 Figure 1. Coho fry sizes in 1999 are comparable to those measured in previous years. As in past years, most yearlings entering the pond complex were less than 80 mm fork length (Appendix 3 Figure 1).

3.2.2.2 Km 1010 Upstream Migrants

A total of 194 fish migrated upstream into the Km 1010 Pond during the May to mid-June period (Table 7). Newly-emerged coho fry comprised 96% of the total. A small number of coho yearlings, rainbow trout and a single Dolly Varden comprised the remainder of the total. After June 15, the Telkwa River overflowed into channels entering the top end of the Km 1010 Pond, and we assume coho fry entered the complex area above the trap box during this flooding. The culvert at the outlet of the Km 1010 Pond is presently a barrier to juvenile fish upstream migration at all flows.

Table 7. Summary of Coho Migrants at Km 1010 from May 8 to June 15, 1999.

UPSTREAM MOVEMENTS					
Month	**Coho 0+**	**Coho 1+**	**Rainbow**	**Whitefish**	**Dolly Varden**
May	6	2	1	0	0
June	180	3	1	0	1
Total	186	5	2	0	1
DOWNSTREAM MOVEMENTS					
Month	**Coho Smolts**	**Coho Fry**	**Rainbow**	**Whitefish**	**Dolly Varden**
May	35	0	1	0	4
June	42	0	4	0	3
Total	77	0	5	0	7

The first coho fry migrants appeared in the outlet stream during late May coinciding with high flow conditions in the Telkwa River and increasing water temperatures in the outlet creek. Only six coho fry moved up into Km 1010 Pond during May (Table 7). A steady upstream migration of coho fry really didn't start until the first week of June in Km 1010, approximately one month later than in Km 1011. In total, 180 coho fry moved into Km 1010 Pond, mainly during the middle of June just prior to the high-flow period that ended the trapping. Daily summaries of fish movements are presented in Appendix 3 Table 2.

3.2.3 Fish Downstream Movements

3.2.3.1 Km 1011 Downstream Migrants

A total of 321 fish were captured in the downstream traps during the study period (Table 6). This included 291 coho smolts, two coho pre-smolts, 22 coho fry, three rainbow parr, one mountain whitefish, one bull trout juvenile, and one peamouth chub.

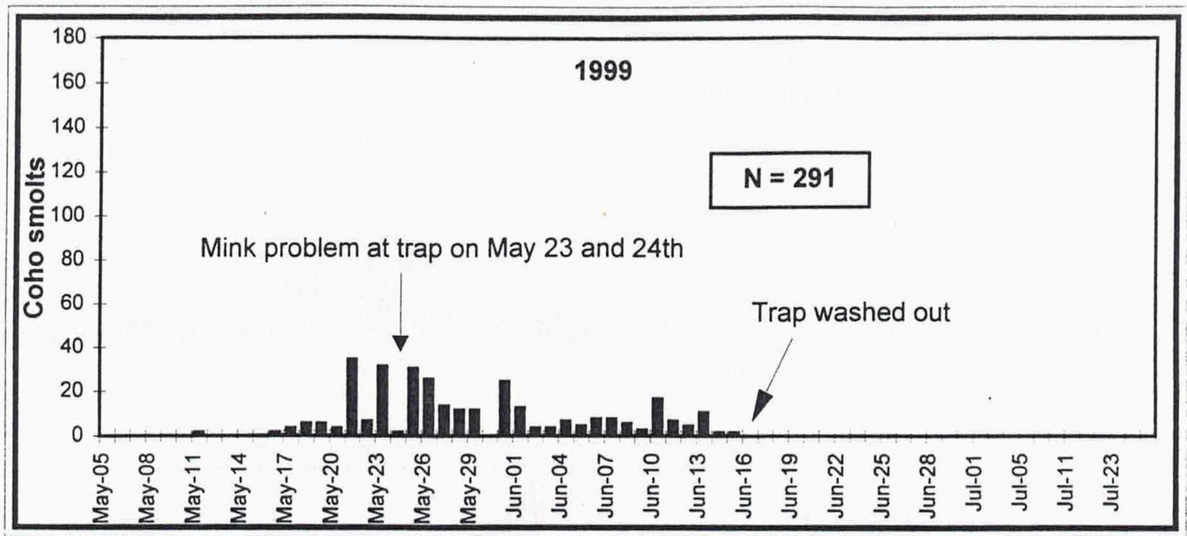
By the time the downstream trap box was flooded out, 291 coho smolts had left Km 1011 Pond (Figure 5). Timing data from other years suggests that the smolt migration from Km 1011 is typically declining by mid-June. In the previous two years, over 95% of the smolt movement occurred prior to June 18th with the peak of movements occurring during the last week of May and into the first week of June (Figure 5).

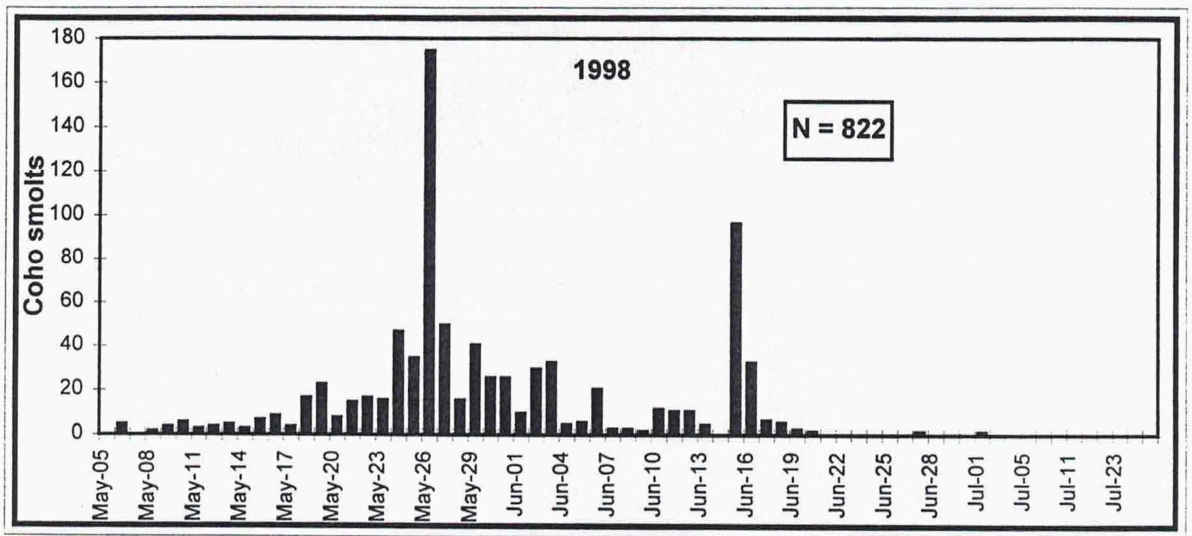
A number of factors compromised the coho smolt data in 1999. The late snowmelt freshet ending with the traps washing out prior to the expected end of the smolt migration, as well as mink problems at the traps for two days during what is normally the peak period for smolt movements resulted in unreliable smolt numbers.

However, we conclude that the smolt outmigration in 1999 was going to be relatively low compared to past years based on the generally low smolt numbers leaving on a daily basis when the traps were functioning well compared to similar periods in other years. Whether the total number of smolts actually leaving the ponds falls within the estimated range based on the mark-and-recapture estimates (between 448 and 1474 based on 95% confidence intervals) is unknown.

Coho smolts leaving Km 1011 in 1999 averaged 123 mm fork length. These smolts were between 13 and 24 mm larger than the mean size measured in past years (Figure 6 and Table 8). Since 1996, the mean size of smolts leaving Km 1011 Ponds has been increasing. Presumably this reflects a higher proportion of older age class smolts in the migration.

Figure 5. Timing of Coho Smolt Downstream Migration at Km 1011 from 1997 to 1999.





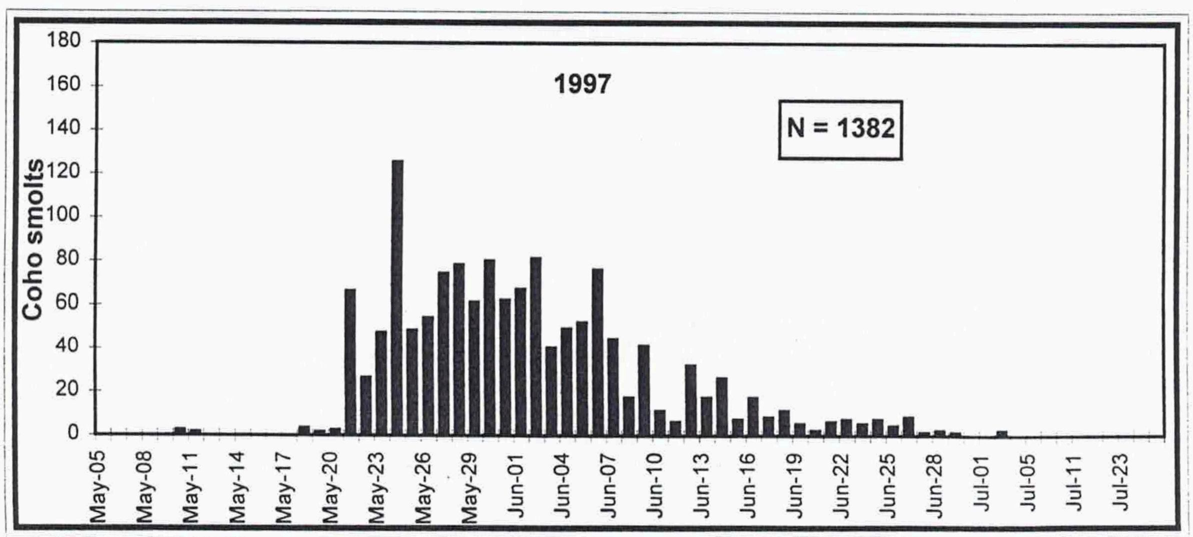


Figure 6. Length-Frequency of Coho Smolts Leaving Km 1011 Ponds from 1996 to 1999.

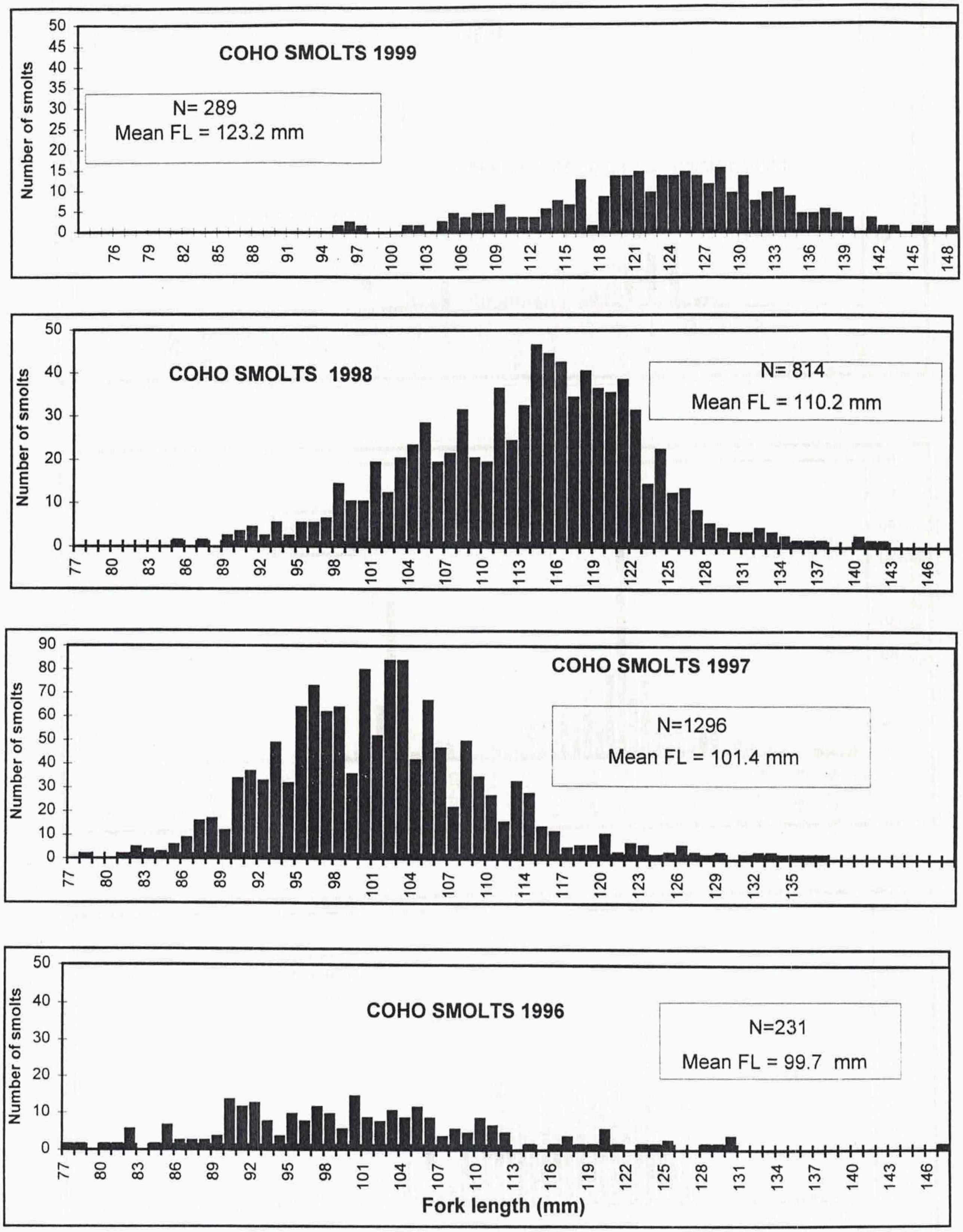


Table 8. Summary of Mean Length and Weight of Coho Smolts at Km 1011 Ponds for the Period 1996 to 1999.

	Length (mm)				Weight (g)			
	1996	1997	1998	1999	1996	1997	1998	1999
Mean	99.7	101.4	110.2	123.2	10.0	10.8	13.4	19.1
Number	144	1296	814	289	144	127	415	162
Range	77-147	78-150	82-151	95-148	4.7-35.2	5.3-24.5	5.9-24.9	9.4-28.4
Std	11.5	8.5	9.0	9.5	3.9	2.9	3.2	3.9

Age information derived from scales for coho smolts sampled at the downstream trap in 1999 is not available at the time of this report preparation. However aging data for smolts collected in 1997 and 1998 indicates that there is a wide overlap in the age structure of coho smolts captured during the May-June period mainly ranging from age 1+ to age 3+ (Appendix 4 Table 1). This presumably reflects the range of life history strategies evident in coho using the ponds, including immigration at both the fry and yearling stages. A single age 4+ coho smolt was reported in the 1998 sample.

Although the age information collected from coho smolts suggests that smolt size tends to increase with age, there is so much overlap in the sizes, particularly in the 1998 sample, that size is not a reliable predictor of age for the Km 1011 coho smolts (Appendix 4 Table 1).

Table 9 summarizes the frequency of occurrence of the different age classes in the smolt samples for 1997 and 1998. This summary suggests that a higher proportion of the smolts leaving Km 1011 Ponds in 1998 were age 2+ and age 3+ fish. The high percentage of large smolts in 1999 may reflect the strong fry recruitment into Km 1011 Ponds during 1996 and the strong yearling recruitment the following year. At the same time, the poor fry recruitment observed in the ponds in 1998 has probably led to a lower proportion of age 1+ smolts in the 1999 migration. It should be emphasized that the results presented in Table 9 are not from a randomly collected sample of smolts. Instead, samples were collected to represent a range of size classes of smolts moving through the downstream traps.

3.2.3.2 Km 1010 Downstream Migrants

Table 7 summarizes the number of fish moving downstream from Km 1010 Pond during the May and June period of operation. A total of 76 coho smolts, five rainbow and seven Dolly Varden moved downstream from May 11th to June 16th. The daily summaries are presented in Figure 7 and Appendix 3 Table 2. The summaries indicate that smolt movements occurred throughout the period of trap operation in small numbers.

Table 9. Percentage of Smolts by Different Age Classes from 1997 to 1999.

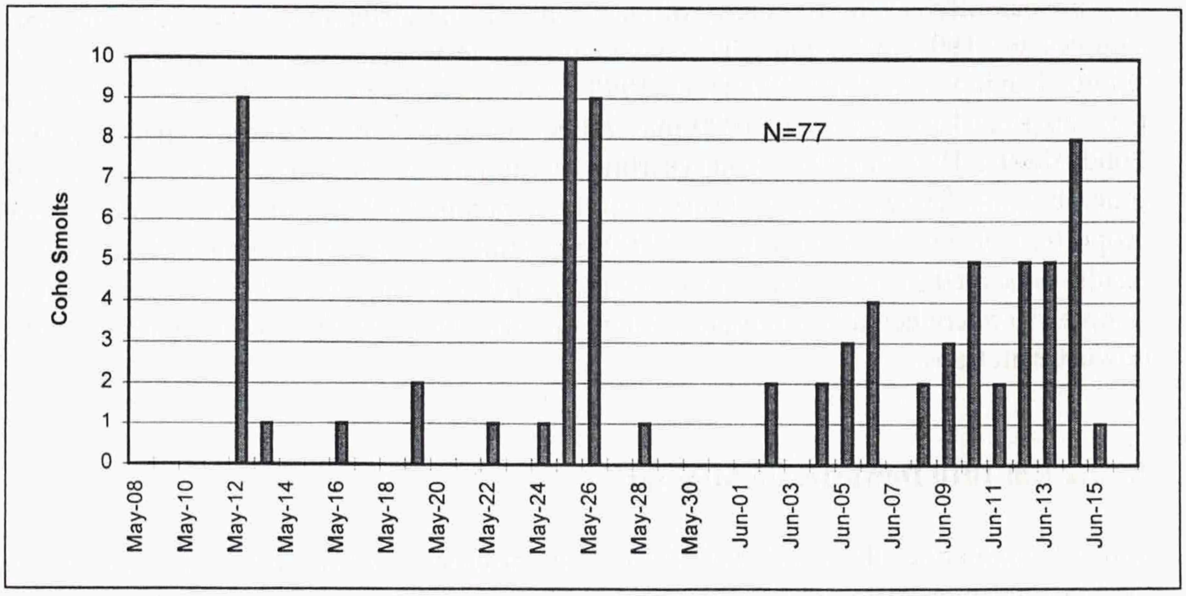
	N	Age 1	Age 2	Age 3	Age 4
1997	113	51.3	46.0	1.8	0
1998	53	37.7	41.5	18.9	1.9
1999	46	na[11]	na	na	na

Coho smolts leaving Km 1010 Pond ranged from 84 to 148 mm fork length, with a mean length of 112 mm (Figure 8).

A summary of fork lengths of the rainbow trout and Dolly Varden leaving Km 1010 pond is presented in Appendix 3 Table 4. Rainbow trout migrants were parr ranging from 50 to 111 mm fork length while Dolly Varden up to 196 mm were captured in the downstream trap. Dolly Varden may spawn in the small inlet tributary draining near the old Pacific Northern Gas right-of-way.

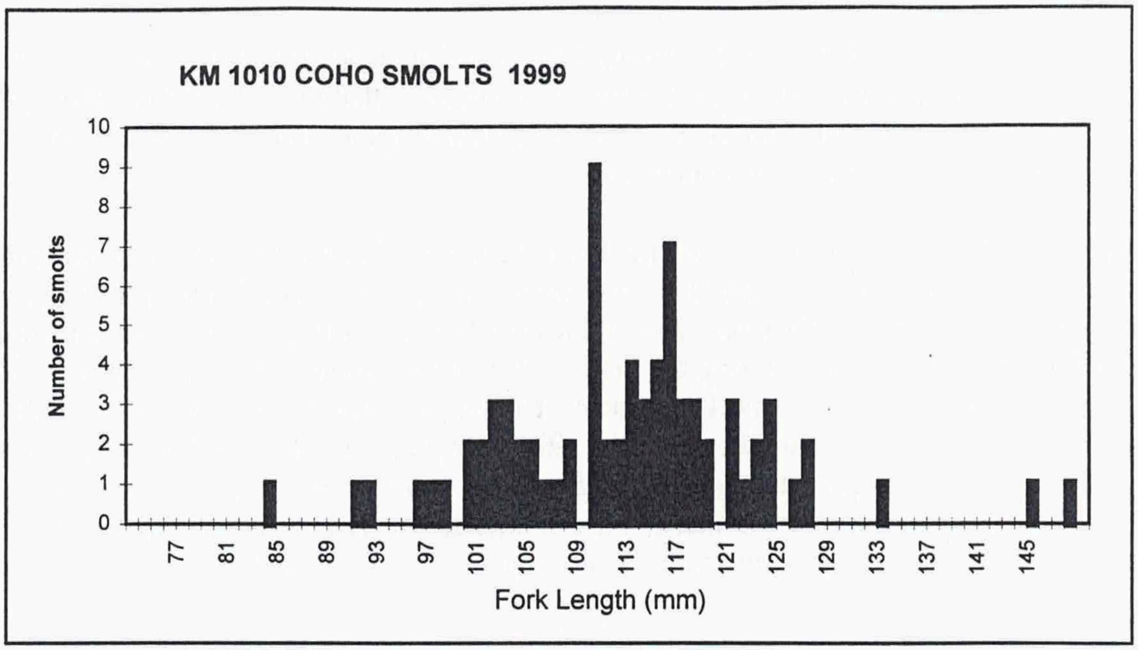
We did not expect to capture 76 coho smolts from the Km 1010 Pond given that no fish were captured in the two minnow trap trials to determine whether there were enough fish to conduct a mark-and-recapture estimate.

Figure 7. Timing of Coho Smolt Downstream Migration in Km 1010 Pond, 1999.



[11] Scale information for 1999 samples in not yet available.

Figure 8. Length-Frequency of Coho Smolts Captured in Km 1010 Pond in 1999.



4.0 DISCUSSION AND RECOMMENDATIONS

4.1 Population Estimate and Coho Smolt Migration

The mark-and-recapture population estimate conducted in Km 1011 Ponds in May 1999 resulted in an estimate of 961 coho pre-smolts in the ponds prior to the smolt outmigration (Table 3). This is the lowest number for all years since the first estimate was made in 1993 (Table 4). The total absence of coho smaller than 75 mm in the sample was very unusual and presumably reflects the exceptionally low fry recruitment into the ponds during the summer of 1998.

A total of 291 coho smolts were captured in the downstream traps prior to high-flow conditions in mid-June bringing the study to an end. The high flow conditions flooded over the traps, and along with mink problems at the trap for two days during the peak period of migration, resulted in an incomplete coho smolt count for 1999. Despite the trap problems, it is apparent that the 1999 smolt migration was going to be low compared to the previous two years.

The 1999 coho smolts were large, with the mean smolt size more than 20 mm larger than smolts captured in 1996 and 1997 (Table 8). The high proportion of large smolts leaving the ponds in 1999 may reflect the strong fry recruitment into Km 1011 during 1996 and the strong yearling recruitment the following year. Although there is a wide overlap in smolt sizes at different ages, we suspect that the very large average smolt size in the

1999 sample relfects a high proportion of older smolts (typically age 2+ and 3+) reflecting the very poor coho fry recruitment into Km 1011 in 1998.

Only 19 of the 291 coho smolts leaving Km 1011 Ponds had caudal clip marks from the mark-and-recapture estimates (Table 10). This suggests that just over 19% of the marked pre-smolts were actually captured in the downstream traps, similar to 1998 results, and significantly lower than 1997 estimates.

In the past, we have suggested that the low percentage of marked fish actually leaving the ponds may have been a result of more coho remaining in the ponds for an extra year to achieve a larger size. This explanation does not fit the situation in 1999, since the mean size of the pre-smolt fish during the mark-and-recapture in early May was already a very large 116 mm, and we suspect that most of these pre-smolts would leave the ponds in 1999. The incomplete smolts counts in 1999 may partly account for the low proportion of marked pre-smolts actually leaving the ponds. However, since 1997 we have had between 20 and 56% of the marked pre-smolts recaptured at the trap box. The low proportion of marked fish recaptured is puzzling.

Table 10. Ratio of Marked to Unmarked Coho in the Km 1011 Pond Studies.

	Number of Smolts	Number of Marked Pre-smolts[12]	Number of Smolts With Marks	% of Smolts With Marks	% of Marked Pre-smolts Leaving Ponds	% of Recaptured Fish Marked[13]
1996	233	402	27	11.6	6.7	14.1
1997	1382	301	168	12.2	55.8	26.4
1998	822	287	61	7.4	21.2	15.9
1999	291	98	19	6.5	19.4	9.4

Table 10 also shows that the proportion of marked fish recaptured during the mark-and-recapture estimates was the lowest to date (9.4%). The generally low numbers of coho captured during the population estimate, along with the low recapture rate suggests that the very cool conditions prevalent during the early May period may have not been conducive for effective minnow trapping. The low numbers of fish recaptured resulted in a wide confidence interval range associated with the population estimate in 1999.

[12] Marked during population estimate in early May.

[13] Recaptured during mark-and-recapture estimates.

It is interesting to note that only nine coho smolts with right ventral clips were captured in 1999 from a total of 250 coho yearlings clipped in 1998 resulting in a return of 3.1%. However, we observed that some injury to fish had resulted from these clips. There may have been some mortality of the yearlings clipped last year, so no further pelvic clips will be conducted on coho migrants.

The 77 coho smolts leaving Km 1010 Pond during 1999 was a higher number than expected since the culvert at the outlet of the pond has presented a barrier to coho fry moving upstream for most of the previous year. However, efforts to elevate the outlet pool to assist fry passage at the culvert during the summer of 1998 may have assisted some coho migration into the pond. As well, some fry may have moved in from the top end during high water conditions in the previous two years.

4.2 Upstream Coho Migrants

The trapping studies indicated that coho migrant upstream movements into the Km 1011 Pond reflected an overall stronger fry recruitment in the Telkwa River in 1999. This presumably resulted from improved coho spawner escapements into the Telkwa River in 1998 compared to the two previous years. The 1437 coho fry passed upstream by mid-June was the highest number recorded by this date since the traps were first installed in 1996. We suspect that upstream fry movements continued through much of the early summer of 1999. Newly-emerged coho fry appeared in the outlet to Km 1011 Pond in early May within one week of previous first fry observations at this site.

The upstream trapping results from Km 1010 yielded some interesting comparisons to those obtained in Km 1011. Coho fry movements into the Km 1010 Pond started approximately one month later than in Km 1011. The later migration of coho fry into Km 1010 Pond compared to Km 1011 may reflect several factors. Firstly, water temperatures in this pond were cool through May, and were similar to the mainstem Telkwa River water temperatures (Figure 2). Warm water temperature is probably an important factor drawing mainstem Telkwa River coho fry migrants into off-channel habitats such as Km 1010.

Secondly, during lower flow conditions in the Telkwa River, there is little slow water habitat at the confluence of the inflows from Km 1010 Pond. We suspect that coho fry move right past this small tributary without recognizing that it is present. As flows increase, the Telkwa backs up into the lower section of the outlet stream from Km 1010 Pond, providing a slack water area for fry to hold.

It is interesting to note that during a site visit on October 15 to Km 1011, large numbers of coho fry were noted in the stream channel below the impassable pond outlet culvert. We suspect that coho migrants might continue to move into Km 1010 Pond if it was accessible through the late summer and fall, since streamflows remain suitable through this period. Km 1011 outlet flows tend to disappear in late July or early August in most years and we suspect this is the end of the fry upstream migration during most years.

4.3 Productivity Estimates

Based on the mark-and-recapture estimates, the Km 1011 Ponds have produced between 961 and 2820 coho pre-smolts annually (Table 11). The pre-smolt estimates correspond to production ranging from 11 to 32 smolts/100 m^2 during the past six years (Table 11).

A comparison of actual smolt output in 1999 to other years is not very meaningful since the study was ended early due to flooding, and we had predation problems during the peak of migration.

Although pre-smolt numbers were lower in 1999, the average size of coho smolts was larger than in the past. The mean smolt weight of 19 grams is almost twice the mean weight of the 1996 and 1997 coho smolts (Table 8). The very large difference in smolt size may be the result of a higher proportion of older age class fish due to poor recruitment of fry in the past two years. As well, the low numbers of fish present in the ponds in 1998 may have resulted in less competition for food and faster growth rates for those fish present. The large variation in mean smolt size has important survival implications, as larger smolts typically have higher survival rates than their smaller counterparts.

Bustard (1998) compared Km 1011 Pond coho smolt production estimates to those obtained in other studies. For example, a relationship derived by Koning and Keeley (1997), suggests a potential capability of the 0.87 ha of ponded habitat at Km 1011 to produce 2750 smolts.

Smolt yields measured at Km 1011 Ponds to date of approximately 10 smolts/100 m^2 (Table 11) are lower than estimates for coastal systems ranging from 14 to 51 smolts/100 m^2 (Foy and Decker, 1997; Picard et al. 1998; and Marshall and Britton 1990). These other studies were conducted on coastal watersheds with longer growing seasons and a high proportion of age 1+ smolts[14]. The Km 1011 Pond data suggest that 50% or more of the Km 1011 coho are remaining two and three years in the pond prior to smolting. One large coho smolt captured in 1998 was four years old.

[14] Typically up to 95% of smolts in coastal ponds leave as age 1+ fish (Matt Foy, DFO, pers. comm).

Table 11. Coho Production Estimates in Km 1011 Ponds from 1993 to 1999.

Year	>74 mm	All Coho Combined	Pre-smolts/ 100 m^2	Total Coho/ 100 m^2	Smolts/ 100 m^2	Kgs/100 m^2 All Coho[15]
1993	222	1186	na			
1994	2304	2640	26.4	30.2		0.28
1995	1549	1845	17.7	21.1		0.19
1996	2820	4304	32.3	49.3		0.30
1997	1124	1395	12.9	16.0	15.9	0.12
1998	1806	1913	20.7	21.9	9.4	0.22
1999	971	971	11.1	11.1	3.3[16]	0.17
Mean (94-99)	1762	2178	20.2	24.9	9.6	0.22

Based on these observations, potential production benefits from off-channel pond developments in northern interior populations of coho such as in the Telkwa Watershed should take into account that potential productivity may be lower than reported in the literature where information has been largely derived from studies in coastal systems.

Marshall and Britton (1990) suggest that biomass may be superior to fish numbers as an expression of coho carrying capacity. Coho biomass has ranged from 0.12 to 0.30 kgs/100 m^2 in the Km 1011 Ponds since 1994. This is at the lower end of biomass estimates reported for coastal overwintering ponds in the Marshall and Britton (1990) review.

It should be stressed that adult coho escapements to the Telkwa Watershed, as well as other Bulkley River tributaries, has been severely depressed during most years in the past several decades (DFO 1998). We suspect that the ponds have been underseeded by coho fry and yearlings during the past several years, and that smolt production from the ponds has been limited by this poor recruitment. The 1999 coho escapement to the Telkwa River appears excellent, and this combined with good fry recruitment from the 1998 escapement should help to better test the capability of Telkwa 1011 Ponds to produce coho smolts.

[15] Based on mark-recapture population estimates. See Appendix 4 Table 2 for detailed summary.
[16] This represents a minimum estimate due to predation and trap flooding problems in 1999.

4.4 Recommendations

Specific recommendations are mainly directed at improvements to the Km 1010 Pond. Planning for some of this work is presently underway with the modifications scheduled for next season. Recommendations include the following:

- We recommend that the outlet channel to Km 1010 Pond be modified to result in no drop at the outlet culvert to ensure that coho fry are able to move into the pond.
- Improvements to the actual confluence site of the Km 1010 outlet stream and the Telkwa River to create more slow water habitat, especially during lower flow conditions should be considered.
- We also suggest excavating the channel along the old PNG right-of-way at Km 1010 in an effort to collect more subsurface flows from the Telkwa River floodplain. This would probably add a greater groundwater component to this system that tends to be dominated by surface flows. Km 1010 Pond water temperatures were much colder than at the Km 1011 Ponds.
- Consideration should be given to constructing a deflection berm at the top end of the pond/inlet creek complex to re-direct overflows from the Telkwa River back into the river rather than the ponds. Otherwise, we suspect that the culvert outlet or berm will be washed out due to too much water entering the pond during extreme flow events.
- The total area of pond and stream habitat contributing to coho production at Km 1010 needs to be calculated to assess smolt production on a unit area basis.
- The PNG extension channels in Km 1011 should be carefully monitored in the next year to determine whether they are utilized during a year of good coho fry recruitment. If poor utilization of these channels continues, some consideration should be given to re-establishing flows into Channel 1.
- Coho smolt aging should be done randomly with the objective of providing frequency of occurrence of age classes. To date sampling has been conducted to spread sampling uniformly amongst all size classes.

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Appendix 1 Table 1. Summary of Water Temperature and Streamflow Information 1999. in Km 1011 Ponds.

Date	Lower Pond @ 0.5 m			Outlet @	Telkwa R.	Outlet Q	Q	Fry	Telkwa
	Min	Max	Mean	Trap		(litres/sec)	cfs	Upstream	gauge ht
May 2	8.5	10.5	9.5	11.5	6	10.0	0.35	0	0.4
May 3	7.8	8.7	8.3	8	4	13.0	0.46	0	0.37
May 4	6.8	7.8	7.3	9.5	4	5.2	0.18	0	0.35
May 5	7.4	7.8	7.6	7.5	3	3.3	0.11	1	0.33
May 6	7.3	7.8	7.6	10.5	4.5	4.3	0.15	3	0.33
7	7.8	9.0	8.4	8.0	3.5	4.7	0.17	4	0.39
8	8.2	10.0	9.1	10.5	5.0	3.4	0.12	9	0.35
9	8.9	9.9	9.4	10.5	4.5	3.3	0.11	30	0.33
10	8.5	9.3	8.9	10.0	5.0	2.7	0.10	28	0.32
11	9.0	9.4	9.2	9.0	5.0	1.6	0.06	41	0.33
12	8.7	9.8	9.3	10.5	5.0	2.0	0.07	18	0.34
13	9.0	9.8	9.4	9.0	4.0	1.8	0.06	19	0.34
14	9.5	10.2	9.9	12.0	6.0	4.3	0.15	22	0.38
15	10.1	10.5	10.3	11.5	5.5	2.2	0.08	41	0.45
16	10.2	10.7	10.5	13.0	6.0	3.5	0.12	76	0.48
17	10.7	11.0	10.9	10.5	4.5	3.4	0.12	46	0.51
18	10.7	11.1	10.9	10.5	4.5	2.5	0.09	26	0.57
19	10.0	10.8	10.4	11.0	5.0	3.1	0.11	91	0.56
20	10.1	10.6	10.4	11.0	5.0	3.1	0.11	64	0.56
21	10.0	10.6	10.3	11.0	5.0	3.2	0.11	33	0.59
22	9.8	10.6	10.2	12.0	4.0	6.5	0.23	32	0.66
23	9.1	10.2	9.7	15.0	6.5	9.0	0.32	52	1.17
24	10.2	10.8	10.5	13.0	4.0			37	1.33
25	10.0	11.0	10.5	11.0	5.0			3	1.30
26	10.0	10.9	10.5	9.5	3.5	8.7	0.31	6	1.07
27	9.5	10.1	9.8	12.0	5.0	6.3	0.22	9	0.80
28	9.5	10.6	10.1	12.0	6.0	5.3	0.19	40	0.70
29	10.0	10.9	10.5	10.0	5.0	3.7	0.13	10	0.67
30	10.9	11.5	11.2	13.0	6.0	4.0	0.14	18	0.71
31	11.0	12.5	11.8	12.5	5.0	7.4	0.26	43	0.86
Avg			9.7	10.8	4.8				
Jun-01	11.5	12.4	12.0	12.0	5.0	5.7	0.20	49	0.81
2	11.9	12.8	12.4	14.0	6.0	4.1	0.14	34	0.78
3	12.9	14.1	13.5	14.0	5.5	6.8	0.24	40	0.90
4	14.1	13.1	13.6	14.0	5.0	6.2	0.22	53	1.02
5	12.0	13.2	12.6	12.5	5.0	6.3	0.00	76	0.96
6	11.9	12.7	12.3	14.0	6.0	4.5	0.16	41	0.83
7	12.1	12.4	12.3	12.5	5.0	3.8	0.13	69	0.80
8	11.6	12.3	12.0	12.0	5.0	3.4	0.12	23	0.78
9	12.3	12.4	12.4	12.0	5.0	4.4	0.16	24	0.93
10	12.0	13.0	12.5	13.0	6.0	3.8	0.13	26	0.90
11	13.0	14.5	13.8	16.0	7.0	5.3	0.19	141	1.04
12	14.3	15.4	14.9	17.0	8.0	6.7	0.24	62	1.23
13	15.1	15.9	15.5	16.0	6.0			0	1.44
14	15.5	16.0	15.8	14.0	9.0			0	1.43
15	15.4	16.6	16.0	14.0	7.0			0	1.53
16	10.1	16.4	13.3	17.0	5.0			0	1.72
17	10.1	10.2	10.2						
18	10.1	10.7	10.4						
19	9.6	11.6	10.6						
20	11.2	12.0	11.6						
21	11.4	12.0	11.7						
22	11.2	12.0	11.6						
23	11.8	12.4	12.1						
24	12.0	13.1	12.6						
25	13.0	13.9	13.5						

Appendix 1 Table 1. Summary of Water Temperature and Streamflow Information 1999. in Km 1011 Ponds.									
Date	Lower Pond @ 0.5 m			Outlet @	Telkwa R.	Outlet Q	Q	Fry	Telkwa
	Min	Max	Mean	Trap		(litres/sec)	cfs	Upstream	gauge ht
26	13.5	13.9	13.7						
27	13.0	13.8	13.4						
28	12.5	13.3	12.9						
29	12.8	13.0	12.9						
30	12.8	13.0	12.9						
Avg			12.8	14.0	6.0				
Jul-01	12.8	13.0	12.9						
2	12.5	13.4	13.0						
3	13.0	14.3	13.7						
4	14.0	14.5	14.3						
5	14.2	15.6	14.9						
6	15.0	16.0	15.5						
7	15.7	16.0	15.9						
8	15.5	16.7	16.1						
9	16.0	16.8	16.4						
10	16.2	16.6	16.4						
11	16.1	16.8	16.5						
12	16.0	17.0	16.5						
13	16.0	17.0	16.5						
14	15.2	16.1	15.7						
15	15.2	15.9	15.6						
16	15.0	15.9	15.5						
17	15.9	16.1	16.0						
18	15.8	16.9	16.4						
19	16.9	17.7	17.3						
20	17.4	18.1	17.8						
21	17.5	18.1	17.8						
22	17.0	17.9	17.5						
23	15.9	17.0	16.5						
24	15.5	16.5	16.0						
25	15.5	16.0	15.8						
26	15.0	15.8	15.4						
27	15.5	15.8	15.7						
28	15.4	15.8	15.6						
29	14.4	15.5	15.0						
30	13.3	14.5	13.9						
31	13.8	14.5	14.2						
Avg			15.7						
Aug-01	14.2	15.0	14.6					-	
2	15.0	15.7	15.4						
3	15.5	16.2	15.9						
4	16.2	16.8	16.5						
5	16.8	17.8	17.3						
6	17.6	18.0	17.8						
7	17.8	18.5	18.2						
8	18.0	18.5	18.3						
9	17.2	18.0	17.6						
10	16.1	17.2	16.7						
11	15.5	16.2	15.9						
12	14.3	15.5	14.9						
13	14.5	15.0	14.8						
14	14.8	15.0	14.9						
15	14.4	14.7	14.6						
16	14.6	14.8	14.7						
17	14.6	14.8	14.7						
18	14.8	14.9	14.9						

Appendix 1 Table 1. Summary of Water Temperature and Streamflow Information 1999. in Km 1011 Ponds.

Date	Lower Pond @ 0.5 m			Outlet @ Trap	Telkwa R.	Outlet Q (litres/sec)	Q cfs	Fry Upstream	Telkwa gauge ht
	Min	Max	Mean						
19	14.8	15.1	15.0						
20	14.8	15.2	15.0						
21	14.8	15.0	14.9						
22	14.8	15.0	14.9						
23	14.6	15.0	14.8						
24	14.3	14.8	14.6						
25	13.2	14.3	13.8						
26	12.9	13.6	13.3						
27	11.9	12.9	12.4						
28	11.9	12.0	12.0						
29	11.8	12.0	11.9						
30	11.0	11.8	11.4						
31	10.8	11.2	11.0						
Avg			14.9						
Sep-01	10.8	11.0	10.9						
2	10.8	11.0	10.9						
3	10.8	11.0	10.9						
4	10.9	11.3	11.1						
5	11.3	11.9	11.6						
6	11.5	11.9	11.7						
7	11.0	11.8	11.4						
8	11.1	11.1	11.1						
9	11.0	11.1	11.1						
10	11.0	11.1	11.1						
11	10.9	11.1	11.0						
12	10.7	11.0	10.9						
13	10.5	10.9	10.7						
14	10.8	10.9	10.9						
15	10.8	10.9	10.9						
16	10.5	10.9	10.7						
17	10.3	10.6	10.5						
18	10.3	10.6	10.5						
19	10.6	11.0	10.8						
20	10.8	11.0	10.9						
21	10.8	11.1	11.0						
22	11.0	11.1	11.1						
23	10.8	11.0	10.9						
24	10.1	11.0	10.6						
25	9.4	10.0	9.7						
26	8.3	9.3	8.8						
27	7.5	8.3	7.9						
28	6.7	7.8	7.3						
29	6.5	6.8	6.7						
30	6.6	6.9	6.8						
Avg			10.3						
Oct-01	6.1	6.8	6.5						
2	5.8	6.1	6.0						
3	6.0	6.0	6.0						
4	5.9	6.0	6.0						
5	5.8	6.0	5.9						
6	5.9	6.1	6.0						
7	6.0	6.1	6.1						
8	6.1	6.2	6.2						
9	6.0	6.2	6.1						

Appendix 1 Table 1. Summary of Water Temperature and Streamflow Information 1999. in Km 1011 Ponds.

Date	Lower Pond @ 0.5 m			Outlet @ Trap	Telkwa R.	Outlet Q (litres/sec)	Q cfs	Fry Upstream	Telkwa gauge ht
	Min	Max	Mean						
10	5.5	6.0	5.8						
11	5.0	5.5	5.3						
12	4.6	5.0	4.8						
13	4.6	4.8	4.7						
14	4.5	4.9	4.7						
15	4.6	4.6	4.6			dry			dry
Avg			5.6						

Appendix 1 Table 2. Summary of Water Temperature and Streamflow Information in Km 1010 Ponds 1999.

Date	Lower Pond @ 0.5 m Min	Max	Mean	Outlet @ Trap	Telkwa R.	Fry Upstream	Telkwa gauge ht
May-04	2.0	2.2	2.1				0.35
May-05	1.1	2.1	1.6				0.33
May-06	1.3	2.1	1.7				0.33
May-07	1.7	2.8	2.3				0.39
May-08	2.8	3.1	3.0	5.0	5.0	0	0.35
May-09	3.0	3.1	3.1				0.33
May-10	3.0	3.1	3.1				0.32
11	2.8	3.5	3.2				0.33
12	3.1	3.8	3.5	3.5	5.0	0	0.34
13	3.2	3.8	3.5	3.5	4.0	0	0.34
14	3.0	4.0	3.5	4.5	6.0	0	0.38
15	3.2	3.9	3.6	6.0	5.0	0	0.45
16	3.2	4.0	3.6	5.5	6.0	0	0.48
17	3.2	4.1	3.7	6.5	4.5	0	0.51
18	3.2	4.1	3.7	6.5	4.5	0	0.57
19	3.2	4.0	3.6	6.0	5.0	0	0.56
20	3.3	4.1	3.7	6.5	5.0	0	0.56
21	3.3	4.1	3.7	6.0	5.0	0	0.59
22	3.1	4.1	3.6	5.5	4.0	0	0.66
23	3.4	5.2	4.3	10.0	6.5	0	1.17
24	4.0	5.2	4.6	nr	4.0	2	1.33
25	3.2	5.1	4.2	7.0	5.0	0	1.30
26	3.0	4.6	3.8	6.0	3.5	2	1.07
27	3.1	4.6	3.9	9.5	5.0	0	0.80
28	3.4	4.8	4.1	10.0	6.0	0	0.70
29	4.0	4.8	4.4	8.0	5.0	0	0.67
30	4.2	4.6	4.4	8.0	6.0	0	0.71
31	4.2	5.7	5.0	9.0	5.0	2	0.86
Avg			3.5	6.6	5.0		
Jun-01	4.2	5.7	5.0	9.0	5.0	4	0.81
2	4.7	5.5	5.1	10.5	6.0	1	0.78
3	5.2	6.6	5.9	10.0	5.5	0	0.90
4	5.3	6.5	5.9	10.0	5.0	11	1.02
5	5.0	5.8	5.4	10.5	5.0	2	0.96
6	5.0	5.8	5.4	11.5	6.0	5	0.83
7	5.0	5.2	5.1	9.0	5.0	9	0.80
8	5.2	5.9	5.6	8.5	5.0	3	0.78
9	5.2	6.0	5.6	10.0	5.0	9	0.93
10	5.5	6.1	5.8	11.0	6.0	9	0.90
11	6.1	7.1	6.6	12.0	7.0	0	1.04
12	7.1	7.9	7.5	16.0	8.0	26	1.23
13	6.4	7.9	7.2	11.0	6.0	27	1.44
14	5.9	7.5	6.7	14.0	9.0	18	1.43
15	6.0	7.6	6.8	13.5	7.0	44	1.53
16	5.8	7.2	6.5	10.0	5.0	12	1.72
17	4.8	5.8	5.3				
18	5.1	6.5	5.8				
19	5.5	6.5	6.0				
20	5.4	6.5	6.0				
21	5.2	6.1	5.7				
22	5.1	7.0	6.1				
23	6.0	7.4	6.7				
24	6.2	7.7	7.0				
25	6.8	8.0	7.4				
26	6.8	8.0	7.4				

Appendix 1 Table 2. Summary of Water Temperature and Streamflow Information in Km 1010 Ponds 1999.

Date	Lower Pond @ 0.5 m			Outlet @ Trap	Telkwa R.	Fry Upstream	Telkwa gauge ht
	Min	Max	Mean				
27	6.4	7.6	7.0				
28	6.1	7.0	6.6				
29	6.2	6.9	6.6				
30	6.5	7.3	6.9				
Avg			**6.2**	**11.0**	**6.0**		
Jul-01	6.5	7.3	6.9				
2	6.0	8.2	7.1				
3	7.0	8.7	7.9				
4	7.1	8.7	7.9				
5	7.2	9.1	8.2				
6	7.8	9.1	8.5				
7	8.0	9.0	8.5				
8	8.2	9.5	8.9				
9	8.2	9.5	8.9				
10	8.3	9.0	8.7				
11	8.4	9.1	8.8				
12	8.2	9.2	8.7				
13	7.6	9.1	8.4				
14	7.8	8.2	8.0				
15	7.8	8.8	8.3				
16	7.8	8.8	8.3				
17	8.1	9.0	8.6				
18	8.8	9.9	9.4				
19	9.5	10.2	9.9				
20	9.5	10.2	9.9				
21	9.4	10.2	9.8				
22	8.9	10.0	9.5				
23	7.8	8.9	8.4				
24	8.1	8.9	8.5				
25	7.8	8.4	8.1				
26	8.0	9.1	8.6				
27	8.6	9.1	8.9				
28	8.0	8.8	8.4				
29	7.5	8.5	8.0				
30	7.0	7.9	7.5				
31	7.6	8.2	7.9				
Avg			**8.5**				
Aug-01	8.3	9.0	8.7				
2	8.5	9.0	8.8				
3	9.0	9.5	9.3	14.0			
4	9.5	10.0	9.8				
5	10.0	11.0	10.5				
6	10.4	11.0	10.7				
7	10.6	11.8	11.2				
8	10.2	11.8	11.0				
9	9.9	10.2	10.1				
10	9.4	10.0	9.7				
11	8.1	9.4	8.8				
12	7.9	9.0	8.5				
13	8.6	9.0	8.8				
14	8.3	9.0	8.7				
15	8.0	9.0	8.5				
16	8.4	9.0	8.7				
17	8.2	8.9	8.6				
18	8.8	9.0	8.9				
19	8.8	9.2	9.0				

Appendix 1 Table 2. Summary of Water Temperature and Streamflow Information in Km 1010 Ponds 1999.							
Date	Lower Pond @ 0.5 m			Outlet @ Trap	Telkwa R.	Fry Upstream	Telkwa gauge ht
	Min	Max	Mean				
20	8.9	9.2	9.1				
21	8.9	9.1	9.0				
22	8.5	9.0	8.8				
23	8.3	8.6	8.5				
24	8.0	8.6	8.3				
25	7.7	8.2	8.0				
26	6.5	8.1	7.3				
27	6.0	6.6	6.3				
28	6.3	7.5	6.9				
29	6.8	7.5	7.2				
30	6.0	6.8	6.4				
31	5.5	6.3	5.9				
Avg			8.7				
Sep-01	5.5	6.4	6.0				
2	6.0	6.5	6.3				
3	6.0	6.2	6.1				
4	6.0	7.1	6.6				
5	7.0	7.1	7.1				
6	6.9	7.3	7.1				
7	5.5	7.3	6.4				
8	5.6	6.2	5.9				
9	6.2	7.0	6.6				
10	6.0	6.9	6.5				
11	5.4	6.0	5.7				
12	4.8	5.1	5.0				
13	4.6	5.0	4.8				
14	4.7	5.1	4.9				
15	5.0	5.4	5.2				
16	5.0	5.4	5.2				
17	4.9	5.0	5.0				
18	5.0	6.1	5.6				
19	6.1	7.0	6.6				
20	5.9	6.9	6.4				
21	5.9	6.5	6.2				
22	6.2	6.5	6.4				
23	6.1	6.5	6.3				
24	5.1	6.0	5.6				
25	4.7	5.1	4.9				
26	4.0	4.7	4.4				
27	4.0	4.4	4.2				
28	3.8	4.2	4.0				
29	3.2	4.0	3.6				
30	3.8	4.1	4.0				
Avg			5.6				
Oct-01	3.5	4.0	3.8				
2	3.0	3.9	3.5				
3	3.8	4.0	3.9				
4	3.8	4.1	4.0				
5	3.5	3.9	3.7				
6	3.5	4.0	3.8				
7	4.0	4.3	4.2				
8	3.8	4.1	4.0				
9	3.8	4.0	3.9				
10	3.7	3.9	3.8				

Appendix 1 Table 2. Summary of Water Temperature and Streamflow Information in Km 1010 Ponds 1999.

Date	Lower Pond @ 0.5 m			Outlet @	Telkwa R.	Fry	Telkwa
	Min	Max	Mean	Trap		Upstream	gauge ht
11	3.2	3.7	3.5				
12	2.8	3.2	3.0				
13	2.5	2.8	2.7				
14	2.8	2.8	2.8				
15	2.5	2.5	2.5	1 cm of ice on pond			
Avg			**3.5**				

Appendix 2 Table 1. **Summary of Dissolved Oxygen and Temperature Measurements Taken in the Telkwa River Km 1011 Ponds on March 2, 1997, March 5, 1998, and May 5, 1999.**

Pond Section	Depth (m)	Dissolved Oxygen (ppm)			Temperature (C)			Snow Depth (m)			Ice Depth (m)		
		1997	1998	1999	1997	1998	1999	1997	1998	1999	1997	1998	1999
Lower Pond	0.0	7.5	7.5	9.8	0.9	0.8	6.9	0.3-0.9	0.3	open	0.5	0.3	open
	0.5	7.3	6.8	9.9	1.2	1.0	6.1						
	1.0	7.2	6.8	9.8	1.5	1.0	6.1						
	1.1	7.2		9.5	1.6		6.1						
Upper Pond	0.0	9.6	6.3	10.9	1.2	1.0	5.0	<0.1	0.2	open	0.2-0.5	0.2	open
	0.5	8.4	6.2	10.8	3.2	2.0	5.1						
	1.0	7.9	2.2	10.8	3.5	2.1	5.1						
	1.2	7.7	0.8	10.5	3.5	3.0	5.2						
Channel 1	0.0	9.8	7.2	8.5	1.0	2.0	3.0	none	<0.1	open	*	0.2	open
	0.5	8.0	4.4	7.1	4.0	3.0	5.0						
Channel 2	0.0	2.2	8.0	11.2	2.0	0.8	6.5	0.0-0.6	0.3	open	0.4	0.2	open
	0.5	1.9	2.0	11.2	3.5	2.0	6.5						
	1.0	1.8	0.3	12.4	3.8	4.2	7.3						
Channel 3	0.0	0.5	1.5	10.5	1.4	0.0	5.0	0.3-1.0	0.4	open	0.5	0.7	open
	0.5	0.2	0.9	10.2	1.5	0.3	4.0						
	0.9	0.2	1.3	10.0	1.5	0.9	4.0						
PNG extension	0.0	11.7	7.8	9.9	4.5	3.0	5.1	open	0.3	open		0.8	open
	0.5	10.3	4.1	9.9	4.5	4.0	6.0						
Sidechannel	0.0	10.9	7.5	7.4	4.0	3.0	4.0	none	none	open	<0.1	**	open
	0.5	10.2	4.7	6.8	4.0	3.0	5.2						

* 50% open with some slush ice.

** 80% open - some slush.

Note: A beaver dam was still present in the sidechannel. The PNG extension channel has been re-routed and now enters the upper portion of Channel 2.

The new channel is shallow and ice-free for 30 m.

Appendix 2 Table 2. Summary of Dissolved Oxygen and Temperature Measurements Taken in the Telkwa River Km 1010 Ponds on March 14, 1996, March 5, 1998, and May 10, 1999.

Pond Section	Depth (m)	Dissolved Oxygen (ppm)			Temperature (C)			Snow Depth (m)			Ice Depth (m)		
		1996	1998	1999	1996	1998	1999	1996	1998	1999	1996	1998	1999
Site 1	0.0	ice	6.1	10.9	0.0	0.1	4.0	0.6	*	none	0.4		clear
Outlet channel	0.5	2.1	6.1		0.1	0.1							
Site 2	0.0	ns	ice	11.5	ns	0.0	4.0		0.6	none		0.6	clear
Lower pond-	0.5		4.8	11.5		0.1	3.5						
near outlet	0.8		4.8			0.1							
	1.0			11.0			3.5						
	1.5		4.8	9.6		0.1	4.0						
Site 3	0.0	ns	ice	7.2	ns	0.0	1.8		0.6	none		0.4	**
Lower pond-	0.4		0.8	7.7		0.1	3.8						
left corner													
Site 4	0.0	ice	5.2	10.1	0.0	0.1	3.0	0.2	0.3	none	0.7	0.4	**
Lower pond-	0.5	ice	5.2	8.3	0.0	0.1	3.0						
mid section	1.0	11.9		7.4	0.9		3.9						
Site 5	0.0	ns	5.9	7.2	ns	0.1	2.5		0.3	***		0.3	clear
Lower pond-	0.5		5.3	7.1		0.1	3.5						
at inlet creek													

ns = No sample taken

* Short section of open water at shallow riffle with a trickle discharge.

** Pockets of ice covering pond.

*** Trickle flow in inlet creek. Snow still present in the forest.

Appendix 3 Table 1. Summary of Upstream and Downstream Trapping Results at the Outlet to the Telkwa Ponds at Km 1011, 1999.

DATE	UPSTREAM				DOWNSTREAM					
	COHO				COHO	PRE	COHO	RBT	R VENT	MARKS
	AGE O	AGE 1+	RBT	MW	SMOLTS	SMOLTS	FRY			
May-02										
May-03	0									
May-04	0	1								
5	1									
6	3									
7	4									
8	9									
9	30									
10	28	1								
11	41				1					
12	18	4								
13	19	1						RBT-58		
14	22	1								
15	41	3	RBT-57							
16	76	1			1					
17	46				3				1	
18	26	0			5					
19	91				5					
20	64				3					
21	33	0			34				2	2
22	32				6				1	
23	52	4			31	1	2	BT-85		1
24	37	1	RBT-62		1	1				
25	0	3			30					
26	6	3			25				1	1
27	9	4	RBT-4		13				1	1
28	40				11					2
29	10				11		1			2
30	18	3			0		3			
31	43				24			RBT-1	2	2
Jun-01	49	1			12		1	CHUB-1		
2	34				3		4	RBT-1		
3	40	1			3		2			
4	53	1			6		3			1
5	76	4			4		3			1
6	41				7					1
7	69		RBT-1		7		2	MW-65		1
8	23	1			5					1
9	24				2		1			
10	26				16				1	
11	141	4			6					1
12	62	1			4					1
13	0				10					1
14	washed out				1					
15					1					
16	WASHED OUT		WASHED OUT			WASHED OUT			WASHED OUT	
17										
TOTAL	1437	43	4	1	291	2	22	9	9	19
									3.1	6.5

Appendix 3 Table 2. Summary of Upstream and Downstream Trapping Results at the Outlet to the Telkwa Ponds at Km 1010 in 1999.

DATE	UPSTREAM				DOWNSTREAM				
	COHO				COHO	PRE	COHO	RBT	OTHER
	AGE 0+	AGE 1+	RBT	MW	SMOLTS	SMOLTS	FRY		
8									
9									
10									
11	Traps fully operational as of this date								
12	0				9				DV-2
13	0				1				DV-1
14	0				0				
15	0				0				
16	0				1				
17	0				0				
18	0				0				
19	0				2				
20	0				0				
21	0				0				
22	0				1				
23	0				0				
24	2				1				
25	0				10				
26	2				9				
27	0				0				
28	0	1	RBT -1		1				
29	0				0				
30	0	1			0				DV-1
31	2				0			RBT-1	
Jun-01	4		RBT-1		0				
2	1				2			RBT-2	
3	0				0				
4	11				2				
5	2				3				
6	5				4				DV-1
7	9				0			RBT-1	
8	3				2				DV-1
9	9				3				
10	9				5		1		
11	0	1	DV-1		2				
12	26				5				
13	27				5			RBT-1	
14	18	1			8				DV-1
15	44	1			1				
16	12				Washed out due to Telkwa R inflows at top end				
17									
18									
TOTAL	**186**	**5**	**4**	**1**	**77**	**0**	**1**		

Appendix 3 Table 3. Summary of Fork Length Measurements of Upstream Coho Migrants in Km 1011 Ponds from 1996 to 1999.

Age 0+

	May				June				July			
	1996	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**
Number	343	151	108	598	542	325	161	343	416	303	104	end of
Size Range (mm)	30-43	29-42	29-43	30-45	30-47	28-50	28-51	30-45	30-49	28-57	29-55	study
Mean Fork Length	35.1	32.8	33.2	35.4	35.9	37.6	36.0	34.7	38.4	44.4	41.3	washed
Std	2.4	2.2	1.7	2.5	2.9	4.8	4.5	2.3	4.3	7.6	6.8	out

Age 1+

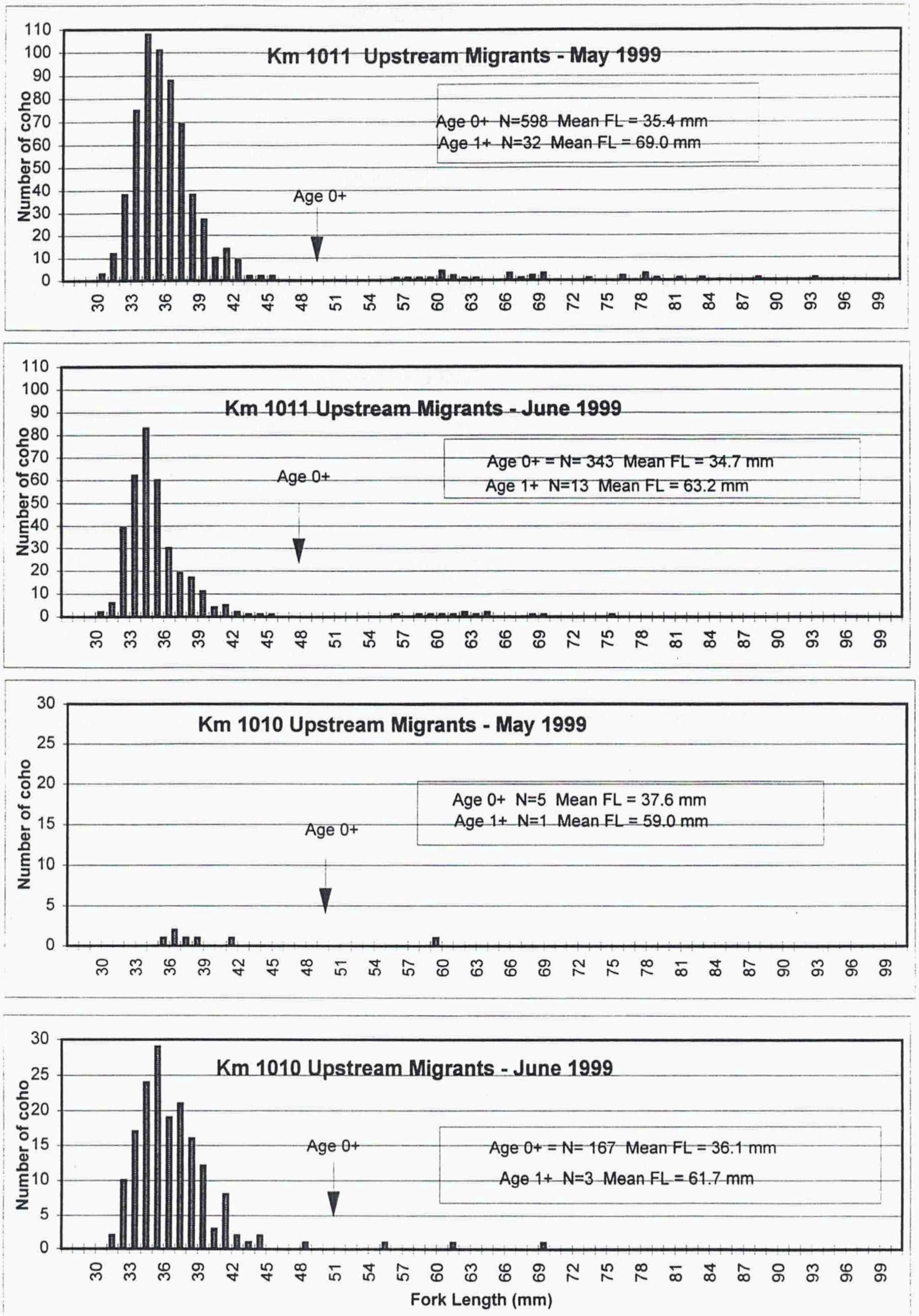
	May				June				July			
	1996	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**
Number	192	256	119	32	347	350	119	13	95	132	24	end of
Size Range (mm)	44-81	45-108	50-82	56-90	48-96	51-100	55-88	56-75	50-72	58-92	58-80	study
Mean Fork Length	56.1	64.1	64.1	69.0	61.8	69.2	69.4	63.2	59.0	73.9	77.2	washed
Std	7.2	10.4	7.3	9.6	6.8	8.8	7.3	5.1	5.4	8.6	8.5	out

Appendix 3 Table 4. Summary of Fork Lengths of Fish Species Other than Coho in Km 1011 and Km 1010 Pond Outlets, 1999.

Km 1011								
Species	Rainbow Trout		Mountain Whitefish		Bull Trout		Peamouth chub	
	Outlet traps							
	Up	Down	Up	Down	Up	Down	Down	Mark-recapture
	33	58		65		85	73	92
	50	61						
	52	65						
	52	82						
	56							
	57							
	62							
count	7	4		1		1	1	1
max	62	82		65		85	73	92
min	33	58		65		85	73	92
avg	51.7	66.5		65.0		85.0	73.0	92.0
std	9.2	10.7						

Km 1010				
	Rainbow Trout		Dolly Varden	
	Up	Down	Up	Down
	53	50	77	91
	51	61		94
		92		98
		101		99
		111		100
				155
				196
count	2	5	1	7
max	53	111	77	196
min	51	50	77	91
avg	52.0	83.0	77.0	119.0
std	1.4	26.3		40.5

Appendix 3 Figure 1. Summary of Fork Lengths of Upstream Coho Migrants in Km 1011 and Km 1010 Ponds, 1999.



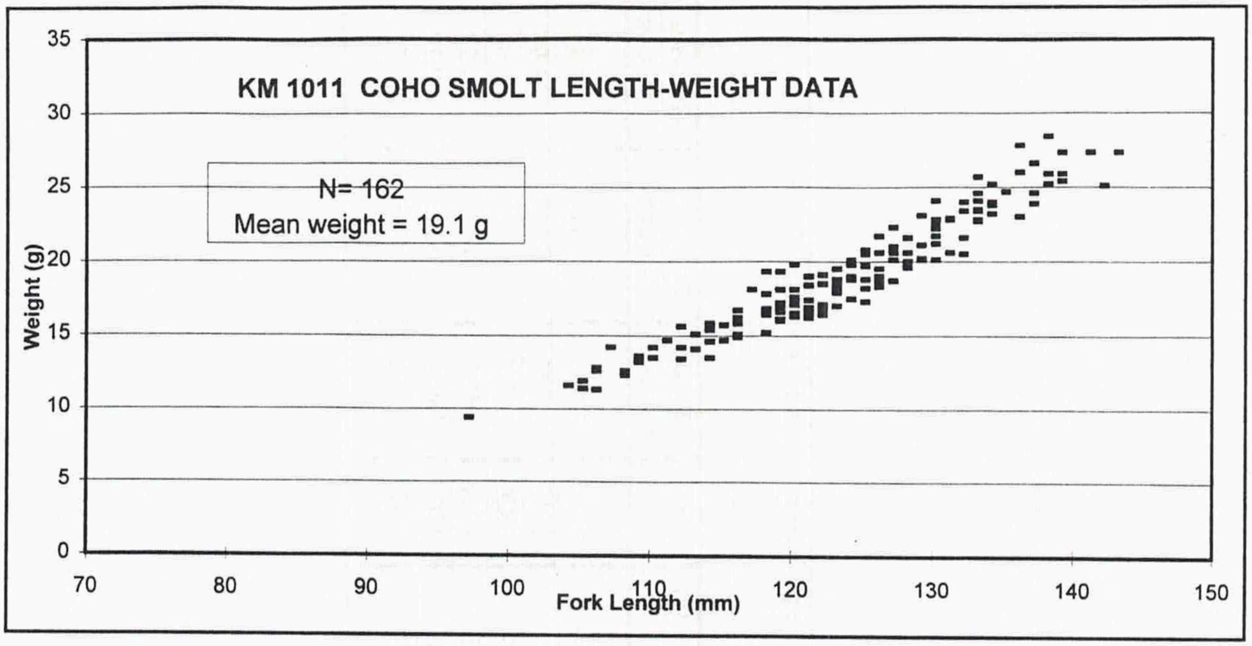
Appendix 4 Table 1. Summary of Age-Length Determinations for Coho Captured in Mark-Recapture and Downstream Smolt Trap, 1995 to 1998.

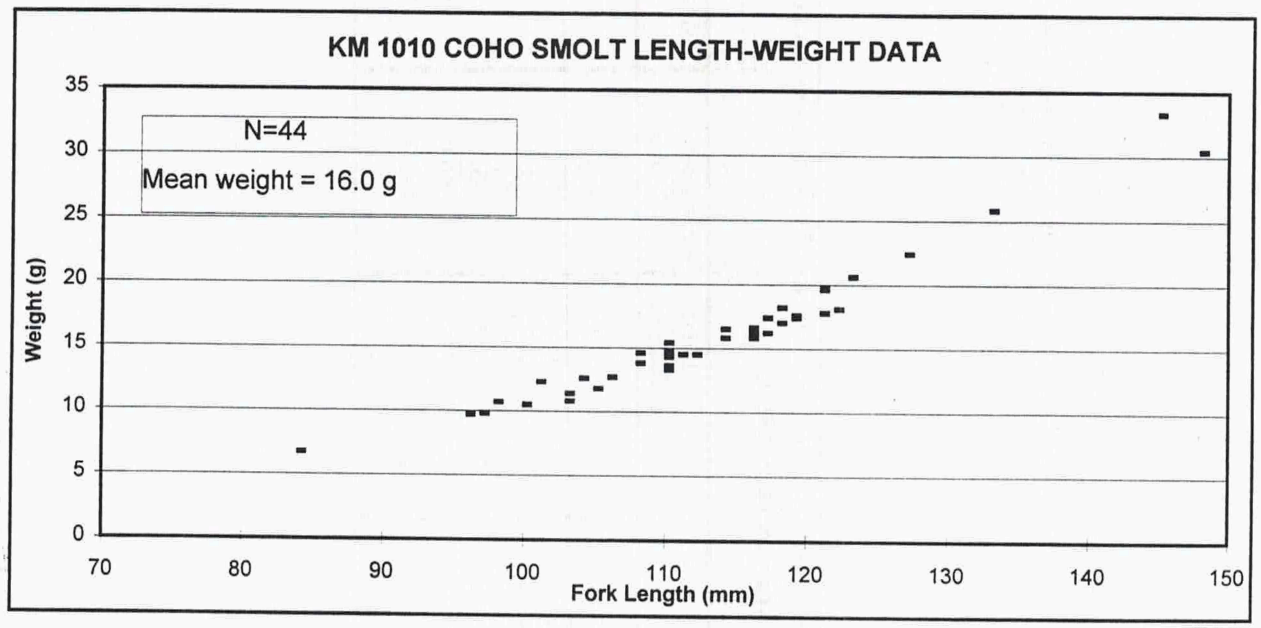
	1998 smolts			
Age	**1+**	**2+**	**3+**	**4+**
FL Range (mm)	78-138	87-134	82-137	151
FL Average	105.1	109.4	116.6	151
n	20	22	10	1
	1997 smolts			
Age	**1+**	**2+**	**3+**	
FL Range (mm)	82-132	87-150	121-129	
FL Average	98.1	114.9	125.0	
n	20	26	2	
	1997 mark-recapture			
Age	**1+**	**2+**	**3+**	
FL Range (mm)	51-120	68-131	na	
FL Average	81.6	105.6	na	
n	38	26	0	
	1995 mark-recapture			
Age	**1+**	**2+**	**3+**	
FL Range (mm)	77-111	92-118	115-124	
FL Average	88.3	106.3	119.8	
n	24	16	9	

Appendix 4 Table 2. Coho Biomass Estimates Based on Mark-and-Recapture Population Estimates in Km 1011 Ponds in Early May 1994 to 1999.

Year	Mean length <75 mm	Mean wt (g)	n	Total Biomass	Mean length >75 mm	Mean wt (g)	n	Total Biomass	Combined All Coho	Grams/m^2 All Coho
1994	66.3	3.24	336	1087	100.6	10.40	2304	23955	25042	2.88
1995	70.2	3.80	296	1124	99.6	10.11	1549	15661	16785	1.93
1996	65.9	3.18	1484	4720	89.9	7.59	2820	21400	26120	3.00
1997	68.6	3.56	271	965	93.8	8.55	1124	9607	10571	1.22
1998	68.4	3.53	107	378	100.9	10.48	1806	18934	19312	2.22
1999	0.0		0	0	116.3	15.60	961	14996	14996	1.72

Appendix 4 Figure 1. Coho Smolt Length-Weight Information for Km 1011 and Km 1010 Ponds, 1999.





Appendix 5 Table 1. Wildlife Observations in the Vicinity of Km 1011 Pond 1999.			
Date	**Birds**	**Amphibians**	**Other**
May-02	kingfisher, 2 uid ducks	1 w, toad - upper pool	
May-03	1 male mallard - upper pond		
	bufflehead duck - lower pond		
May-04	2 kingfishers		
May-05	1 male mallard		
May-07	5 uid ducks, 1 kingfisher	2 w. toads in d/s trap	
May-08		1 w. toad in d/s trap	
May-09	kingfisher		
	6 yellow-rumped warblers		
May-10	4 uid ducks		
May-15	2 uid ducks		
May-16		1 w. toad	
May-17	kingfisher	1 w. toad in d/s trap	
	red-winged blackbird		
May-18	kingfisher, uid duck	2 w. toads in d/s trap	
May-19	2 uid ducks		
May-22	kingfisher		
	male merganser on river @ trap		
May-23	kingfisher		mink interfering with d/s trap
May-24			mink interfering with d/s trap
May-27	kingfisher, Stellar jay	1 w. toad in d/s trap	deer mouse caught in mink trap
May-29			deer mouse caught in mink trap
May-30	kingfisher	1 w toad in d/s trap	deer mouse caught in mink trap
May-31	1 male mallard		
	yellow-rumped warblers in brush near pond outlet		deer mouse caught in mink trap
Jun-01		2 w. toads in d/s trap	deer mouse caught in mink trap
Jun-02	kingfisher		
Jun-03	goldeneye duck - lower pond		deer mouse caught in mink trap
Jun-06		2 w. toads in d/s trap	
Jun-07	kingfisher	1 w. toad in d/s trap	weasel caught in mink trap
Jun-08	goldeneye duck - lower pond		
Jun-09		3 w. toads in d/s trap	
Jun-11		1 w toad in d/s trap	
Jun-12		3 w. toads in d/s trap	
Jun-13		1 w. toad	
Jun-14		1 w. spotted frog	
		several toads in outlet pond	
Jun-15		1 w. spotted frog	
		several toads in outlet pond	
Jun-18	kibgfisher	major hatch of tadpoles below	abundance of monarch butterflies
		lower pond.	in groups for the past week.

Appendix 5 Table 1. Wildlife Observations in the Vicinity of Km 1010 Pond 1999.

Date	Birds	Amphibians	Other
May-08	kingfisher		
May-12	kingfisher		
	goldeneye duck		
May-13	kingfisher		
May-14	kingfisher		
May-16		1 w. toads in d/s trap	
May-18	kingfisher	2 w. toads in d/s trap	
May-20	kingfisher		
May-24	kingfisher	long-toed salamander	
	dipper at mouth		
May-25	1 male goldeneye		
May-27	woodpecker heard		
May-29	2 gray jays & 1 stellar jay obs. on the way in		
Jun-08			porcupine chewing on wood of trap boxes
Jun-13		2 w. toads in d/s trap	