Biophysical inventory of tributaries to Owikeno Lake – 1984-85

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BIOPHYSICAL INVENTORY OF TRIBUTARIES TO OWIKENO LAKE - 1984-85

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MARCH 1988

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ABSTRACT

This report summarizes the results of a biophysical stream inventory and fish habitat evaluation conducted during fall 1984 and spring 1985 on the tributaries to Owikeno Lake at the head of Rivers Inlet, British Columbia. The report includes a summary of known fish utilization and physical habitat descriptions on a reach by reach basis for the major tributaries to Owikeno Lake.

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1.0 INTRODUCTION

The Owikeno Lake drainage has a basin area of approximately 3940 km2 which includes some of the highest portions of the Coast Mountains. It empties into the head of Rivers Inlet via the Wannock River approximately 100 km north of Port Hardy.

The drainage supports all 5 Pacific salmon species including the third largest sockeye run on the B.C. coast as well as very valuable chinook and coho populations.

Owikeno Lake has 10 major tributaries ranging in size from second to fourth order which provide spawning and rearing habitat for anadromous species (Figure 1).

1.1 OBJECTIVES

Large scale logging activity began in the Owikeno Basin in the mid 1970's with operations based in the Sheemahant and Machmell Rivers. Recent prospects of logging development expanding into several previously unlogged drainages (Neechanz, Tzeo, Washwash, Inziana) and the possibility of new access to Owikeno Lake via South Bentinck Arm, generated a need for additional fish habitat information.

Although the major sockeye spawning areas in the basin have long been well known, there was little previous documentation of the physical characteristics of this habitat. In addition, in many areas the upstream limits of anadromous fish distribution and the habitat utilization of the upper portions of the tributaries was not clearly understood.

The objectives of this project were to:

1) Provide physical habitat descriptions at a 1:50000 scale for the major tributaries to Owikeno Lake;
2) Determine the upstream limits of anadromous fish distribution;
3) Assess salmonid habitat in the basin - particularly in those areas not usually accessed by Department of Fisheries and Oceans personnel;
4) Assess the sensitivity of fish habitat to potential timber harvesting development.

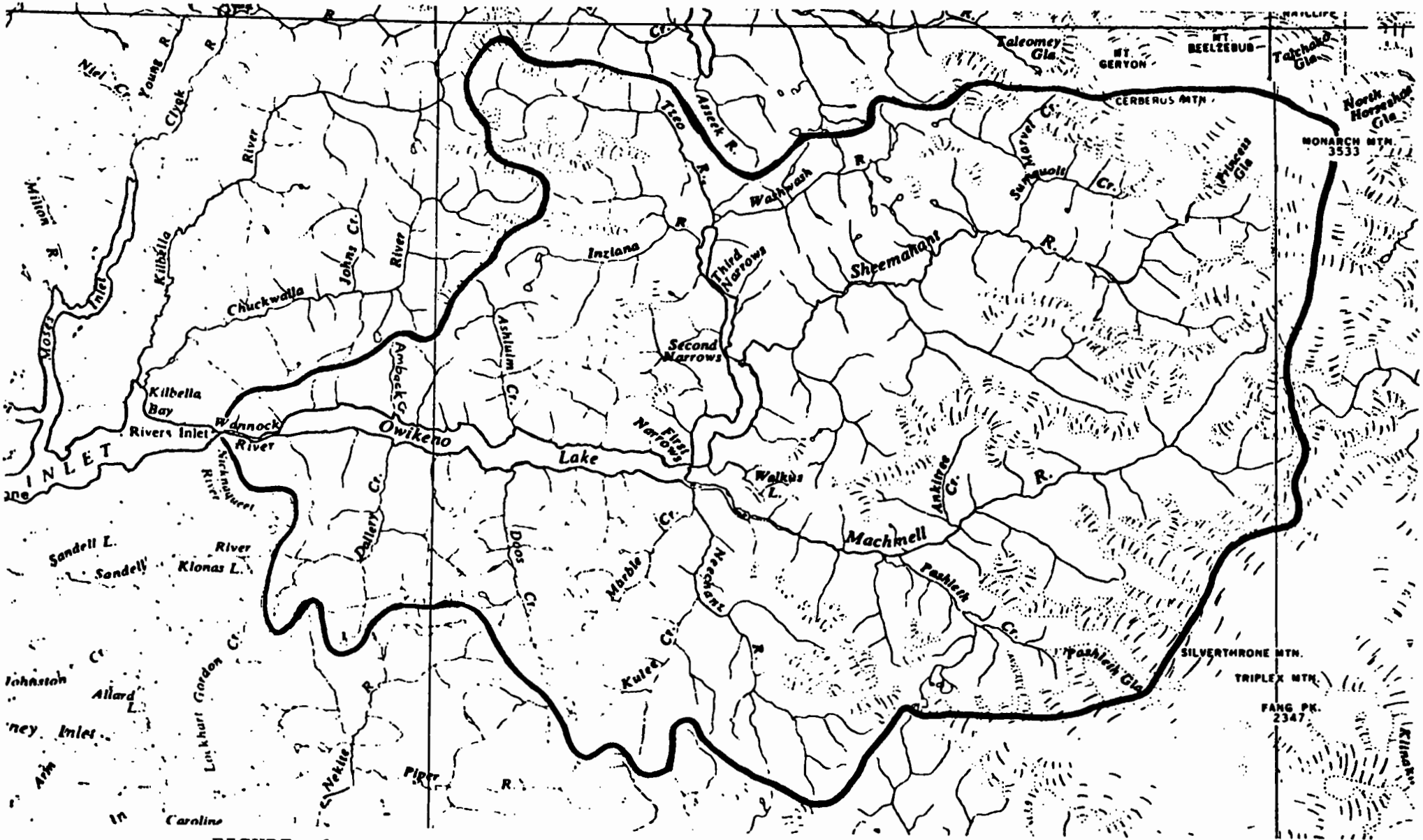

FIGURE 1. KEY MAP OF OWIKENO LAKE DRAINAGE (approx. 1:400,000)

1.2 METHODS

The Owikeno inventory generally followed B.C. Ministry of Environment, Resource Analysis Branch (RAB) methodology (Chamberlin, 1980). The physical reach descriptions using RAB format were completed by air photo interpretation and helicopter overflights, backed up by ground observations. Presence/absence fish sampling was done by electrofisher at 27 sites using helicopter and boat access.

Fish sampling and ground assessments of the lower Neechanz, Tzeo, Washwash, and Inziana Rivers were carried out on September 7 and 8, 1984. An aerial survey of the Tzeo and Sheemahant Rivers including fish sampling of the upper portions was done on October 28, 1984. Aerial surveys and fish sampling of the Machmell, Neechanz, Ashlulm, Dallery, and Amback systems were carried out on May 16 and 17, 1985.

In some areas (eg. smaller tributaries known to be inaccessible to anadromous fish) detailed reach descriptions were not completed and assessment consisted of air photo and map interpretation only. These areas were assessed primarily to determine whether potential exists for headwater utilization. Reach gradients and reach lengths were obtained from 1:50000 topographic maps using a map wheel. Rough estimates of the amount of `off-channel' rearing habitat were made by measuring side channel lengths from maps and air photos.

1.3 STUDY AREA

The Owikeno Lake drainage consists of typical coastal high relief terrain with steep sided, glacially-carved, u-shaped valleys. Elevations surrounding the lake rise sharply from lake level (less than 15 m) to ridges of 1500-1800 m. Maximum elevations in the drainage occur at the eastern boundary with elevations up to 3500 m (Mt. Monarch / Monarch Icefield). There is evidence of old volcanic activity in the eastern portion of the drainage, with large areas of basaltic formations occurring in the Upper Machmell and Sheemahant/Sumquolt valleys.

Owikeno Lake, itself, consists of 4 basins separated by narrows. The lake has a general `L'-shaped orientation, with the large lower basin (approximately 33 km long) oriented east-west and the 3 smaller upper basins (about 20 km) oriented north-south.

Historical streamflow records exist only for the Wannock River at the lake outlet (see Table 1), however the general hydrology of the major tributaries can be deduced from their drainage basin characteristics and observed runoff patterns (see Table 2).

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WANNOCK RIVER AT OUTLET OF OWIKENO LAKE - STATION NO. 08FA002

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1927	---	---	---	---	---	---	---	---	---	626	148	163	---	1927
1928	367	106	146	116	436	624	729	634	388	284	208	127	348	1928
1929	---	---	---	---	---	---	552	627	388	460	163	125	---	1929
1930	102	209	107	210	219	667	598	558	474	352	347	252	341	1930
1931	141	139	127	145	329	577	526	461	413	280	389	78.9	298	1931
1932	112	117	137	153	293	540	567	632	481	499	509	176	352	1932
1933	106	60.3	71.4	140	307	432	724	701	520	558	523	163	361	1933
1934	174	218	173	363	398	542	606	567	515	---	---	---	---	1934
1961	---	---	106	153	317	637	647	527	479	440	285	100	---	1961
1962	281	361	47.5	187	282	530	600	730	278	692	418	397	401	1962
1963	177	266	110	101	258	510	543	508	581	578	246	267	346	1963
1964	195	167	80.6	137	213	795	827	500	427	582	261	---	---	1964
1965	---	---	---	---	---	---	647	583	289	874	250	191	---	1965
1966	96.5	91.2	152	289	353	554	648	560	410	570	281	227	358	1966
1967	159	146	82.3	81.1	413	896	756	597	776	727	388	248	440	1967
1968	575	176	192	124	361	515	688	481	519	537	338	132	384	1968
1969	65.5	54.8	75.6	113	803	877	522	623	393	326	376	169	334	1969
1970	78.9	119	82.5	118	395	585	528	474	359	215	103	61.6	280	1970
1971	178	381	79.0	113	359	538	634	815	548	404	335	99.3	369	1971
1972	60.3	70.0	270	166	540	799	831	550	283	233	168	189	385	1972
1973	148	87.2	85.3	136	331	458	550	432	527	379	129	138	284	1973
1974	85.9	84.9	86.9	184	322	582	669	570	463	602	180	215	336	1974
1975	131	62.0	60.0	92.2	276	621	764	535	281	257	484	196	315	1975
1976	228	121	81.0	114	399	578	789	750	554	362	355	460	401	1976
1977	160	172	107	171	228	474	687	675	261	357	247	130	290	1977
1978	55.2	94.5	129	131	229	497	597	563	361	417	376	105	297	1978
1979	52.5	56.3	170	139	426	500	536	480	419	274*	99.0	220	283	1979
1980	114	103	90.4	142	347	467	474	420	582	312	305	590	326	1980
1981	234	152	93.1	151	334	385	518	488	358	320	400	109	296	1981
1982	94.0	85.0	65.4	78.7	313	772	578	410	588	327	171	108	299	1982
MEAN	160	141	111	150	336	591	625	567	482	443	289	192	336	MEAN

LOCATION - LAT 51 40 80 N DRAINAGE AREA, 3 940 km²
LONG 127 10 30 W NATURAL FLOW

WANNOCK RIVER AT OUTLET OF OWIKENO LAKE - STATION NO. 08FA002

ANNUAL EXTREMES OF DISCHARGE AND ANNUAL TOTAL DISCHARGE FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE (m^3/s)	MAXIMUM DAILY DISCHARGE (m^3/s)	MINIMUM DAILY DISCHARGE (m^3/s)	TOTAL DISCHARGE (dam^3)	YEAR
1927	---	---	---	---	1927
1928	---	1 520 ON JAN 10	73.1 ON JAN 2	11 000 000	1928
1929	---	---	---	---	1929
1930	---	1 540 ON JUN 10	69.9 ON JAN 30	10 800 000	1930
1931	---	1 080 ON NOV 2	67.4 ON DEC 16	9 400 000	1931
1932	---	2 130 ON NOV 19	51.8 ON FEB 18	11 100 000	1932
1933	---	1 810 ON OCT 27	52.4 ON FEB 14	11 400 000	1933
1934	---	1 080 ON SEP 16	99.7 ON JAN 2	---	1934
1961	1 350 AT 10:00 PST ON SEP 5	1 310 ON SEP 5	---	---	1961
1962	1 620 AT 06:30 PST ON OCT 3	1 530 ON OCT 3	42.2 ON MAR 16	12 600 000	1962
1963	1 340 AT 20:30 PST ON OCT 2	1 260 ON OCT 2	58.4 ON FEB 1	10 900 000	1963
1964	1 310 AT 17:00 PST ON OCT 13	1 260 ON OCT 14	58.6 ON MAR 29	---	1964
1965	2 110 AT 04:00 PST ON OCT 22	2 000 ON OCT 22	---	---	1965
1966	1 560 AT 15:00 PST ON OCT 26	1 510 ON OCT 26	66.3 ON JAN 6	11 200 000	1966
1967	2 090 AT 01:50 PST ON OCT 11	1 990 ON OCT 11	66.3 ON MAR 20	13 900 000	1967
1968	2 920 AT 04:00 PST ON JAN 24 *	2 720 ON JAN 24 *	57.8 ON DEC 31	12 100 000	1968
1969	1 230 AT 14:45 PST ON AUG 15	1 190 ON JUN 13	46.4 ON JAN 30	10 500 000	1969
1970	1 160 AT 02:12 PST ON MAY 17	1 110 ON MAY 17	51.5 ON DEC 25	8 200 000	1970
1971	1 530 AT 01:00 PST ON AUG 22	1 330 ON AUG 22	50.7 ON JAN 6	11 600 000	1971
1972	1 170 AT 13:42 PST ON JUN 29	1 150 ON JUN 29	41.1 ON FEB 5 *	10 900 000	1972
1973	1 630 AT 04:39 PST ON SEP 29	1 580 ON SEP 29	56.9 ON FEB 18	8 970 000	1973
1974	1 650 AT 01:44 PST ON OCT 18	1 590 ON OCT 17	50.7 ON JAN 12	10 600 000	1974
1975	1 200 AT 03:26 PST ON JUL 10	1 190 ON JUL 11	45.9 ON FEB 19	9 930 000	1975
1976	1 710 AT 04:00 PST ON DEC 17	1 710A ON DEC 17	73.6E ON MAR 14	12 700 000	1976
1977	1 230 AT 18:10 PST ON OCT 23	1 140 ON OCT 23	60.9 ON DEC 31	9 140 000	1977
1978	1 320 AT 21:02 PST ON NOV 7	1 190 ON NOV 8	48.2 ON JAN 18	9 390 000	1978
1979	877 AT 03:08 PST ON MAY 27	833 ON MAY 27	42.4 ON JAN 15	8 930 000	1979
1980	1 820 ON DEC 16	1 670E ON DEC 16	66.3 ON JAN 21	10 300 000	1980
1981	1 280 ON NOV 3	1 210E ON NOV 3	68.7 ON FEB 12	9 330 000	1981
1982	---	1 530E ON SEP 9	55.1 ON MAR 21	9 430 000	1982
		* - EXTREME RECORDED FOR THE PERIOD OF RECORD		10 600 000	MEAN

A - MANUAL GAUGE (SEE REFERENCE INDEX) E - ESTIMATED

TABLE 1. HISTORICAL STREAMFLOW SUMMARY FOR WANNOCK RIVER AT THE OUTLET OF OWIKENO LAKE (FROM WATER SURVEY OF CANADA, 1983)

The majority of the tributaries - Amback, Dallery, Ashlulm, Neechanz, Genesee, Inziana, Tzeo, and Washwash - have hydrological regimes which are mainly controlled by rainfall and spring snowmelt. Weather records from the Namu station indicate that appoximately 70% of the total annual precipitation for the area falls from October through April. Generally, the higher the median elevation of the drainage, the greater the winter snow accumulation, and the greater the proportion of the annual runoff which will occur as spring/early summer snowmelt. Higher elevation systems such as the Neechanz and Tzeo, can therefore be expected to have more prolonged spring/summer high flow periods than lower elevation systems such as the Amback and Ashlulm. In general, however, all these systems will normally have a low flow period in late summer/early fall.

The Machmell and Sheemahant Rivers, on the other hand, are very large, glacially-regulated systems originating in the icefields of the eastern portion of the Owikeno drainage. These systems have typical glacial flow patterns with high flows continuing throughout the summer months. These two systems have the greatest overall influence on the hydrology of Owikeno Lake.

Owikeno Lake outlet flows (see Table 1) have monthly maxima in the June/July/August period, with a secondary monthly peak in October. Maximum instanteous flows are usually associated with fall rain-on-snow events. Minimum monthly flows for all systems occur in late winter, with daily minimums at the outlet occuring between December and March.

TABLE 2. SUMMARY OF DRAINAGE BASIN CHARACTERISTICS FOR THE MAJOR TRIBUTARIES TO OWIKENO LAKE.

STREAM	LAKE BASIN	WATERSHED AREA (KM2)	MAXIMUM ELEVATION (M)	PREVAILING ASPECT	RUNOFF CHARACTERISTICS
AMBACK C	LOWER	41	1585	S	RAIN / SPRING SNOWMELT
DALLERY C	LOWER	179	1920	N	RAIN / SPRING SNOWMELT
ASHLULM C	LOWER	98	1950	S	RAIN / SPRING SNOWMELT
NEECHANZ R	LOWER	414	2075	N	RAIN / SPRING SNOWMELT (SOME GLACIAL)
MACHMELL R	LOWER	1000+	2870	W	GLACIALLY CONTROLLED
GENESEE C	2ND	18	1950	W	RAIN / SPRING SNOWMELT
SHEEMAHANT R	2ND	1000+	3533	W	GLACIALLY CONTROLLED
INZIANA R	UPPER	171	2075	E	RAIN / SPRING SNOWMELT (SOME GLACIAL)
TZEO R	UPPER	166	2195	E/S	RAIN / SPRING SNOWMELT (SOME GLACIAL)
WASHWASH R	UPPER	130	2286	W	RAIN / SPRING SNOWMELT (SOME GLACIAL)

2.0 SUMMARY OF FISH DISTRIBUTION AND PHYSICAL STREAM CHARACTERISTICS

All 5 Pacific salmon species (chinook, chum, coho, pink, and sockeye) as well as steelhead, cutthroat trout, and Dolly Varden char are present in the Owikeno Lake drainage. Table 3 displays average and target escapements for the salmon species present in each tributary. Other species present in the lake include three-spine stickleback, sculpins, and lamprey.

Of the species present in the drainage, sockeye salmon have received the most management effort and therefore have the most clearly defined spawning distribution. Sockeye utilize the Wannock River and also spawn in numerous parts of the lake itself. Beach spawning areas are located primarily near river mouths and in the narrows. The locations of major beach spawning areas are indicated on the accompanying maps (see Appendix II). In the tributaries, sockeye tend to be concentrated in the lower reaches. Smaller numbers may ascend sections of difficult passage to utilize upstream reaches in the Dallery, Neechanz, Sheemahant, and Tzeo Rivers. Table 4 contains a ranking of the Owikeno Lake tributaries in terms of average sockeye spawning density (ie. average number of spawners/wetted area) for the main spawning areas.

Chinook salmon spawn mainly in the Wannock River, with small numbers also utilizing most of the lake tributaries. The most important of the tributary populations is the Neechanz River/Marble Creek population. In the tributaries, chinook are generally distributed further upstream than the main concentrations of sockeye and are known to utilize some of the upper reaches (eg. Neechanz River).

Coho salmon appear to be fairly evenly distributed throughout all of the accessible stream reaches. They tend to utilize accessible portions of the smaller `feeder' tributaries and the upper reaches of the major stream systems. Coho were found in the upper reaches of the Neechanz, Sheemahant, and Tzeo Rivers. Juvenile coho can be expected to utilize any accessible back-channel and pond habitat throughout their distribution.

Pink and chum salmon are found in small numbers in the lower reaches of most of the 10 major tributaries.

Small numbers of steelhead are known to be present in the Dallery, Machmell, and Neechanz Rivers, and are suspected to be present in most other tributaries. Steelhead were found in the extreme upper reaches of the Neechanz River, above the normal distribution of chinook and coho. Where present, steelhead undoubtedly have the widest distribution (ie. the farthest upstream) of the anadromous species.

TABLE 3. SUMMARY OF RECORDED SALMON ESCAPEMENTS AND ESCAPEMENT TARGETS FOR OWIKENO LAKE AND TRIBUTARIES (FROM THOMSON, ET AL, 1987).

STREAM		SOCKEYE	COHO	PINK (EVEN)	PINK (ODD)	CHUM	CHINOOK
AMBACK C	Ave.1980-86	73929	275	1625	168	73	50
	Ave.1970-79	49250	770	2440	33	25	
	Target	100000	3500	1000	1000	100	50
ASHLULM C	Ave.1980-86	23314		583	717	96	34
	Ave.1970-79	8205	42	450	242	39	18
	Target	40000	200	750	750	50	150
DALLERY C	Ave.1980-86	35929	338	5375	1783	26	27
	Ave.1970-79	19400	200	2463	367	38	68
	Target	90000	5000	4000	4000	50	500
GENESEE C	Ave.1980-86	19543	138	400	733	17	
	Ave.1970-79	17760	63	435	1017		
	Target	25000	300	3000	3000		
INZIANA R	Ave.1980-86	28346	50				
	Ave.1970-79	32500					
	Target	75000	50				
MACHMELL R	Ave.1980-86	24929					
	Ave.1970-79	11438	200				
	Target	80000	1000				
NEECHANZ R	Ave.1980-86	39114	617	2	450	6	51
	Ave.1970-79	25550	288	483			52
	Target	50000	3500	1000	1000	100	1000
OWIKENO LAKE	Ave.1980-86	11943					
	Ave.1970-79	21000					
	Target	30000					
SHEEMAHANT R	Ave.1980-86	145857	1957				
	Ave.1970-79	73250	1293				69
	Target	200000	5000				1000
TZEO R	Ave.1980-86	12857	83				118
	Ave.1970-79	13060	25				38
	Target	50000	500				500
WASHWASH R	Ave.1980-86	51929	94	100	63		84
	Ave.1970-79	48850	285	300	25		48
	Target	100000	1000	500	500		3000

TABLE 4. COMPARISON OF AVERAGE SOCKEYE SPAWNING DENSITIES IN MAJOR SPAWNING AREAS OF OWIKENO LAKE TRIBUTARIES.

STREAM SECTION		AV.WETTED WIDTH (M)	LENGTH (KM)	WETTED AREA (M2)	% GRAVEL	AVE.SOCKEYE ESCAPEMENT (1970-86)	EST. SPAWNING DENSITY (#/M2)
GENESEE C	(R1)	6	1300	7800	N/A	18650	2.39
AMBACK C	(R1)	8	4400	35200	50	61500	1.75
WASHWASH R	(R1)	15	1200	18000	50	50000	1.52
	(R2)	25	600	15000	30		
INZIANA R	(R1)	35	1100	38500	70	30400	0.79
DALLERY C	(R2)	20	2600	52000	50	27670	0.53
NEECHANZ R	(R1)	30	3000	90000	60	32330	0.34
+ MARBLE C	(R1)	10	500	5000	70		
ASHLULM C	(R1)	12	6400	76800	50	15750	0.21
TZEO R	(R1)	20	1400	28000	50	13000	0.16
	(R2)	20	700	14000	20		
	(R3)	20	2000	40000	40		
SHEEMAHANT R	(R1)	40	19500	780000	50	109550	0.14
MACHMELL R	(R1)	50	8300	415000	40	18180	0.03
	(R2)	40	4000	160000	40		

Dolly Varden char were found throughout most systems, including headwater areas of the Machmell and Sheemahant Rivers, which are inaccessible to anadromous species. There appear to be two populations of Dolly Varden in these systems - one associated with the lake and lower reaches and the other an isolated headwater population. These headwater populations may also be present in other smaller tributaries which were not sampled during the survey.

Cutthroat trout were generally found in all of the lake tributaries, although usually only in the lower reaches, with the exception of the Sheemahant River. Most of the cutthroat are likely either lake or anadromous populations.

For all the major tributaries, fish species present and stream channel characteristics (channel width, valley:channel ratio, gradient, and substrate composition) are displayed on a reach by reach basis on the accompanying 1:50000 topographic maps (Appendix II). This information is also summarized in tabular form along with a verbal reach description, an assessment of relative fisheries values, and comments on reach sensitivity in Appendix I.

2.1 AMBACK CREEK

Amback Creek is a small system which flows into the north shore of the lower lake basin. All 5 salmon species have been observed. It is accessible to all species for approximately 4.4 km before the gradient rises sharply at the head of the valley. This accessible reach is relatively homogeneous and is identified as Reach 1. Amback Creek has no significant tributaries

Reach 1 has an average wetted width (at normal late summer flows) of approximately 8 m. and therefore has a total main-channel wetted area of about 35200 m2. There is also a substantial amount of rearing habitat available in secondary channels and side channels.

Coho, cutthroat trout, and Dolly Varden were captured during fish sampling in mid-May. Water temperatures were slightly warmer (7C) than other systems at this time, likely due to its southern aspect.

2.2 DALLERY CREEK

Dallery Creek enters the lower basin from the south. It has a `stepped' gradient profile, with an alternating sequence of steep gradient and low gradient reaches. All 5 salmon species and steelhead are present in the lower 2 reaches. It is accessible to all species for approximately 3.8 km where a steep gradient reach impedes further access. Small numbers of sockeye have been reported present in the reach above (Reach 4) (S. Bachen, pers. comm.), so other species (chinook, coho, steelhead) are likely also present above 3.8 km. Unfortunately, we were not able to confirm fish presence/absence upstream from this point during the 1985 sampling.

Reach 1 is approximately 1.2 km long with large pools in the lower section, adjacent to the lake, and rapids throughout the upper portion.

Virtually all the known spawning occurs in Reach 2, which is a low gradient reach (0.4%) approximately 2.6 km long. There is a short rapids within this reach, but sockeye have been observed above this section of difficult passage. This reach has an average wetted width of 20 m and a total wetted area of 52000 m2. There is also extensive rearing habitat available in approximately 500 m of side channels and one large wetland area.

Reach 3 is a short, steep gradient reach which is probably impassable to pink, chum, and most sockeye. Steelhead, coho, and chinook are likely able to ascend this reach.

Above this reach, there is excellent low gradient (0.8%) spawning and rearing habitat in Reach 4 extending for approximately 4.5 km. Reach 4 has an average wetted width of 15 m and a total wetted area of about 67500 m2. Additional habitat also exists in approximately 500 m of side channels, the lower reach of an unnamed tributary (1000 m), and several adjacent wetlands.

Reach 5 is another steep gradient section which may be impassable to all species. Reach 6 (2.5 km long) is low gradient once again, and has extensive wetlands which would provide excellent rearing and some spawning habitat. There is very little useable habitat above Reach 6.

As mentioned above, fish sampling conducted during the survey was inconclusive in determining the extent of fish utilization above Reach 2. During fish sampling in May 1985, no fish were captured in samples in Reach 6 or in Reach 4. However, sampling in Reach 2 - a zone known to have heavy spawning - produced only 1 juvenile trout. Water temperatures in Dallery Creek were very cold at this time (3.5-4.0 C) and it is possible that juveniles were still in the gravel. Further sampling is required to determine the extent of fish utilization of Reach 4 and the presence or absence of fish in Reach 6.

In general, Dallery Creek would be fairly sensitive to timber harvesting development due to the steep valley walls. The extensive wetlands in the valley bottom provide valuable rearing habitat, but may also help reduce any impacts to the main channel. Access via Owikeno Lake would require log handling and camp facilities to be sited in a sensitive area near the creek mouth.

2.3 DOOS CREEK

Doos Creek enters the lower basin from the south. It has a 15 m falls near the mouth which blocks all fish access. Doos Creek was examined briefly from the air and reach gradients were estimated in order to determine whether potential habitat exists above the barrier. No fish sampling was carried out, so it is possible that resident Dolly Varden and/or cutthroat populations may be present.

The steep gradient section at the mouth (Reach 1) extends for appoximately 2.1 km and has additional small falls and chutes above the main barrier. Reach 2 is about 9.8 km long and has a gradient of approximately 2.0%. It is generally swift-flowing with boulder substrate. This habitat appears marginal for spawning and rearing of Oncorhynchus species, but may have limited value for steelhead. Above Reach 2, the gradient increases further and the habitat is likely unsuitable for anadromous fish.

2.4 ASHLULM CREEK

Ashlulm Creek is another fairly small system which enters the lower basin from the north. The creek is accessible to all 5 salmon species at least as far as the upper boundary of Reach 1 - a distance of 6.4 km. There are no significant tributaries.

Reach 1 has a gradient of 1.5% and is fairly fast-flowing with several small rapids. The average wetted width is approximately 12 m and the total wetted area is 76800 m2. There are very few side channels, and rearing habitat is not extensive.

Reach 2 is a steep gradient reach (4.6%) of about 3.0 km with rapids throughout. There are no barriers present, however, so it is possible that coho, chinook, or steelhead may ascend this reach.

Above this steep gradient section, there is about 2.5 km of lower gradient habitat (2.4%) before the stream rises sharply at the head of the valley. This reach does have some suitable spawning and rearing habitat including some side channels and wetlands.

During fish sampling in May 1985, chinook, coho, and sockeye fry were captured near the upper boundary of Reach 1, indicating that these species are distributed at least to 6.4 km. Only Dolly Varden were captured upstream in Reach 3. It is likely that the anadromous species rarely, if ever, ascend beyond Reach 1 or the lower part of Reach 2.

2.5 MACHMELL RIVER

The Machmell River is a large, glacially-fed system which enters the lake at the First Narrows. The lower 2 reaches (approximately 12.3 km) of the Machmell are fairly open, low gradient, braided sections while the next 3 reaches (about 21.6 km) are confined by near-vertical canyon walls. Above the canyon, there is another open, braided reach about 15 km long.

All 5 salmon species, steelhead, cutthroat, and Dolly Varden enter the Machmell, although only coho and sockeye have been positively confirmed as spawning in the Machmell itself. Fisheries assessment tends to be very difficult in the mainstem Machmell due to the very high turbidity. It is likely that small numbers of chinook, chum, and pinks also utilize the river. The lower 4 reaches of the Machmell are accessible to anadromous fish, with a possible barrier occurring in the canyon, near the mouth of Pashleth Creek, approximately 22 km from the mouth. Anadromous fisheries values, however, are concentrated mainly in Reaches 1 and 2.

Only Dolly Varden were captured in fish sampling carried out above the canyon in Reach 6.

Reach 1 is a low gradient (0.5%), braided reach with a very unstable, dynamic channel and floodplain. The channel shifts regularly due to the large amount of bedload deposition and the great fluctuation between minimum and maximum flows. The substrate is mainly large gravel and cobble. The total wetted area is very large (50 m wetted width x 8.3 km length = 415000 m2) although much of this is undoubtedly unuseable due to the large amount of bedload movement. The most important areas for fish utilization are likely the numerous side and secondary channels, as these tend to be slightly more stable.

Reach 2 is similar to Reach 1, although slightly higher gradient (0.9%) and more confined. This reach is approximately 4.0 km long and has an average wetted width of about 40 m. Side channels are less numerous and fish utilization is likely lower than in Reach 1.

The canyon section of the Machmell has near-vertical basalt walls - the material being deposited by old lava flows in the area. Reach 3 has a gradient of 0.9% and is mainly fast-flowing with boulder substrate. The extent of fish utilization is unknown, but is likely quite low. The reach length is approximately 4.9 km.

Reach 4 is a fairly steep gradient canyon section (2.5%) with rapids and chutes throughout its length (5.1 km). A series of chutes and small falls become increasingly severe toward the upper end of the reach from the mouth of Pashleth Creek upstream to the reach boundary. The largest of the falls is approximately 4m high. This section likely forms a barrier to all anadromous fish.

Above Reach 4 there is a long canyon section (11.6 km) with slightly lower gradient (2.0%). This reach is fast-flowing with mainly boulder substrate.

Reach 6 is a lower gradient (1.4%), less confined reach with extensive braiding similar to Reach 1. This reach lies between about 1600 and 2300 feet elevation, however, and would be expected to have a very harsh climate and limited productivity.

Additional low gradient habitat exists above Reach 6, but this was not surveyed, because the elevation was considered to be too high to be useable. It is possible (but unlikely) that Dolly Varden may be present above Reach 6.

Apart from the Neechanz River (see Section 2.6), the Machmell has virtually no tributaries which provide significant amounts of fish habitat. All tributaries have steep gradient sections and are not accessible to anadromous fish. The only exceptions are 2 small, unnamed tributaries (one locally known as Clear Creek) which flow into Reaches 1 and 2. These tributaries currently enter side channels of the Machmell and enhance these side channels by providing an inflow of clear (and warmer) water.

The Machmell River is generally not very sensitive to timber harvesting development. The hydrology of the system as a whole is governed mainly by glacial melt and is not likely to be sensitive to minor changes in low-elevation runoff. Much of the system also has clearly-defined terraces which form a topographic break and keep timber harvesting activity well away from the river itself. Within the lower 2 reaches, however, the side channels - which likely provide the majority of the useable habitat - are quite sensitive, as they can be easily destabilized in such a dynamic floodplain environment.

2.6 NEECHANZ RIVER

The Neechanz River is a tributary of the Machmell and enters approximately 1 km upstream from Owikeno Lake.

All 5 salmon species, as well as steelhead, cutthroat, and Dolly Varden are present. Anadromous fisheries values are concentrated in the lower 10.8 km of the Neechanz River mainstem (Reaches 1 - 4) and the lower 0.5 km of Marble Creek (Reach 1). Of this area, the lower 3 km of the mainstem (Reach 1) and Marble Creek are the most important, providing spawning habitat for the bulk of the sockeye population. During the survey, salmon species were not captured or observed above Reach 4 (10.8 km), although steelhead juveniles were captured in Reach 6 (17.5 km) and may be present to Reach 8 (21.4 km). There are no distinct barriers to adult migration below Reach 9, however, so small numbers of chinook and/or coho may reach these upper reaches under some conditions.

Reach 1 is a low gradient fluvial fan area with mainly gravel substrate. In addition to the valuable spawning areas in the main channel, there are a number of side channels providing rearing habitat, particularly around the mouth of Marble Creek. The average total wetted area in the main channel is approximately 90000 m2, and there is approximately 1800 m of side channel habitat.

Reach 2 is a much more confined and steeper gradient reach (1.0%). There are 2 bedrock constrictions present, which form short rapids. The spawning utilization of this reach is much lower than in Reach 1, but there is undoubtedly scattered spawning by chinook, coho, sockeye, and steelhead

wherever the substrate is suitable. There is very little off-channel rearing habitat.

Reach 3 is very similar to Reach 2, although somewhat less confined.

In Reach 4, the valley broadens somewhat, and the channel is much less confined. There is extensive braiding and numerous side channels present. Although this reach is rarely assessed during spawning, it is likely an important chinook, coho, and steelhead spawning area. Large numbers of chinook fry were present during fish sampling carried out in May 1985. This reach is about 4.0 km long, and has approximately 4200 m of off-channel habitat including sidechannels and the lower ends of small tributaries.

Reach 5 is a steep gradient reach (4.0%), with rapids and cascades throughout its length (2.9 km). Although there are no definite barriers to adult migration, it is doubtful that any species except steelhead would regularly ascend this reach.

In the upper section of the river, Reaches 6 and 8 contain some low gradient spawning and rearing habitat, although the elevation may become limiting toward the upper end. Juvenile steelhead and Dolly Varden were captured in Reach 6 during the survey. Steelhead undoubtedly utilize Reach 6 and possibly also Reach 8 for spawning.

Reach 9 has a gradient of 10% and forms a barrier to all anadromous fish. There is some lower gradient habitat above the barrier in Reach 10, but the high elevation makes it unsuitable.

Marble Creek and one small tributary adjacent to Marble Creek are the only tributaries to the Neechanz with significant amounts of habitat accessible to anadromous species. Reach 2 of Marble Creek has a canyon and 15 m falls which block further access. Other tributaries in the lower 10.8 km (including Kulee Creek) are likely utilized only in the lower few meters where they enter the Neechanz River floodplain. The upper sections of tributaries such as Marble, Kulee, and Cheetwoot were not sampled, so it is possible that resident Dolly Varden populations may be present.

The Neechanz watershed, generally, is fairly sensitive to road and timber harvesting development due to the steep valley walls. Valley wall failures (slides) are already evident Reaches 4 and 6. In addition, reaches with extensive side channels and wetlands can be sensitive to destabilization through road encroachment and bank disruption. Areas with high sensitivity include Reach 1 of the Neechanz River (particularly in the area of the Marble Creek confluence), Reach 1 of Marble Creek, and Reach 4 of the Neechanz. The upper part of the watershed also has a very high incidence of avalanches.

2.7 GENESEE CREEK

Genesee Creek flows into the second basin of Owikeno Lake at the north edge of the Machmell River fan. It was not surveyed during the 1984/85 survey. The accessible portion of the creek is just that part which lies on the Machmell fan itself - a section approximately 1.3 km long. Above this, the creek flows directly off the steep valley wall.

The Genesee is a very important sockeye producer. Chum, coho, and pink are also present.

2.8 SHEEMAHANT RIVER

The Sheemahant River is a large, glacially-fed system which flows west into the second basin. The river has an extensive fan which forms the Second Narrows. The mainstem Sheemahant River occupies a fairly broad, low gradient valley which extends almost to the glaciers at the headwaters.

Fisheries assessments in the Sheemahant are difficult due to the very high turbidity which is common during the summer and early fall. Chinook, coho, pink, sockeye, cutthroat and Dolly Varden are known to be present, while small numbers of chum and steelhead may also utilize the river. A series of small falls at approximately 19.5 km impedes fish passage and may be a barrier (particularly to sockeye) under some (or most) flow conditions. The section below 19.5 km (Reach 1) is therefore the most heavily utilized by anadromous fish. Coho were found to be present to at least 47.8 km (Reach 3), however, so it is likely that other species (chinook, sockeye, and steelhead) also manage to gain access to the upper river. In the mainstem Sheemahant, there are no other definite barriers to adult migration below the headwaters (55.6 km), although the habitat is marginal above Reach 3 (47.8 km). Dolly Varden are present literally right to the toe of the glaciers.

The entire section from the mouth to 34.0 km is fairly uniform, but the section below the falls at 19.5 km has been broken out as a separate reach for the purposes of this survey. This section has an overall gradient of about 0.2 %. It has a high percentage of bars and some braided, multiple channel sections. Gravel quality varies considerably, with some areas being heavily compacted with sandy material. Reach 2 is very similar to Reach 1, but is slightly more confined. There is good rearing in side and secondary channels, the lower parts of small tributaries, and in several adjacent wetlands in both lower reaches. Reaches 1 and 2 combined have roughly 12500 m of available off-channel habitat.

Reach 3, which lies upstream from the mouth of Sumquolt Creek, is a 13.8 km section which has a broad floodplain with

very extensive sidechannels and wetlands. The substrate is composed mainly of gravel (approximately 50 %). This reach appears to have excellent spawning and rearing habitat. There is approximately 14000 m of off-channel habitat available in side channels and the lower ends of small tributaries. This reach is not normally assessed during the spawning season, so the current extent of spawner utilization is not known. Relatively small numbers of coho juveniles were captured during fish sampling in October, 1984.

Reach 4 is a short, confined, steep gradient reach with rapids throughout. The gradient averages 2.7%, but is likely greater in places. There are no definite barriers present, but passage is difficult. Only Dolly Varden were captured above this reach.

Reach 5 is an open, braided reach with moderate gradient (1.5%). This reach appears fairly unstable due to the influence of the glacier immediately upstream. Dolly Varden were present during sampling in October, 1984.

The larger, named tributaries of the Sheemahant River include Kull Creek, Lemolo Creek, and Sumquolt Creek. The lower portion of Sumquolt Creek was surveyed from the air, while the assessment of Kull and Lemolo was limited to gradient analysis. Although no fish sampling was done in these tributaries, anadromous fish are undoubtedly present in Reach 1 of each stream. From the gradient analysis and other observations, it appears that anadromous fish would utilize only the extreme lower portions of these tributaries.

The Sheemahant Valley, as a whole, is only moderately sensitive to timber harvesting development. The flow regime is governed in large part by the glaciers in the headwaters and would not likely be greatly influenced by minor changes in low elevation run-off. The presence of a defined `valley flat' also tends to protect the mainstem from impacts of roads and timber harvesting located at the valley walls. Within the valley, however, the mainstem channel is fairly unstable, and road locations or timber harvesting within this `valley flat' may increase the instability. The presence of large debris in the form of logjams may also be important in stabilizing the main channel and side channels, so that removing streamside timber (ie. the source of the large debris) may reduce channel stability in the long term.

2.9 INZIANA RIVER

The Inziana River flows into the northwest end of the upper basin of Owikeno Lake. Only the lower 1.1 km are accessible to anadromous fish. Above this point, a series of large falls in a steep canyon section block all access. Coho, sockeye, cutthroat, and Dolly Varden are known to be present below the falls. There may also be small numbers of chinook, pink, and steelhead present. No fish sampling was done above the falls and this upper section is likely barren.

Reach 1 - the only accessible reach - is a low gradient (approx. 0.6%) fan area with excellent spawning gravel throughout most of the reach. The lower section near the lake, however, tends to be sandy. This reach is very heavily utilized by sockeye salmon (up to 100K escapement). A `breakthrough' has occurred approximately 350 m from the `old' mouth of the river which has cut off flow to some good spawning gravel. The useable channel is now approximately 750 m long. The wetted width is appoximately 35 m, giving a total wetted area of 26250 m2. Apart from the `breakthrough' at the lower end, this reach is currently quite stable. There is only one small side channel present, affording about 200m of `off-channel' rearing habitat.

There are at least 2 major falls in Reach 2 - a steep canyon reach about 500 m long with an overall gradient of approximately 16 %. The two falls at the lower end of the reach are about 8m and 12m high.

The upper portion of the watershed is likely barren of fish. The mainstem Inziana River and its main tributary Keet Creek have a combined channel length of about 30 km, but most is moderate to steep gradient, with little potential for outplanting or other utilization. There is one low gradient (0.7%) section approximately 3 km long in the middle section of the upper river which does have good spawning and rearing habitat.

The lower fan area would be quite sensitive to timber harvesting, as the harvesting and related developments could reduce channel stability. Harvesting in the upper watershed would likely not have significant impacts, providing that sediment input was controlled and there were no significant changes in the runoff pattern.

2.10 TZEO RIVER

The Tzeo River flows into the head of the upper basin of Owikeno Lake. The stream flows east in a narrow valley originating from high elevation snow and icefields before spilling out into a wider, lower gradient valley and flowing south into the head of the lake. In its lower reach, the Tzeo flows along the edge of the fluvial fan formed by the Washwash River, which also flows into the head of the lake.

Coho and sockeye are the most numerous salmon species in the Tzeo, with chinook, pinks, cutthroat and Dolly Varden present in much smaller numbers. Small numbers of chum and steelhead may also be present. The river is accessible to all anadromous fish for at least 4 km, where a small cascade hinders further access. The bulk of the sockeye spawn below this point. This cascade is definitely passable, however, to coho, sockeye, and trout (either cutthroat or steelhead) which have all been observed in the reaches above. The limit of anadromous access is approximately 9 km (Reach 5), where the gradient increases significantly. There is very little useable habitat above this point. In general, the limiting factor to sockeye production in the Tzeo River appears to be gravel quality, which tends to be quite poor due to a fairly high sand component.

The lower 5 reaches of the Tzeo River alternate between low gradient sections with little confinement and slightly steeper more confined sections. Reach 1 is approximately 1.4 km long with a gradient of 0.3 %. The reach is fairly heavily utilized by sockeye spawners, although the substrate has a large percentage of sand which limits the amount of suitable spawning habitat. Most of the flow from the Washwash River now enters the upper part of this reach through the `breakthrough' across the Washwash fan. This extra flow has probably helped flush some of the sand out of the system and increased the utilization of this reach. There are approximately 300 m of sidechannel habitat in the reach.

Reach 2 is a confined reach about 0.7 km long with moderate gradient (0.9 %) and some rapids. The substrate is mainly boulders and the spawning utilization is fairly limited.

Reach 3, approximately 2 km long, is a low gradient reach (0.4 %) with a wide floodplain which has extensive wetland areas The reach is fairly heavily utilized by sockeye spawners although, once again, a high percentage of sand limits the amount of spawning habitat. There is approximately 1750 m of sidechannel and wetland habitat.

Reach 4 is a confined reach similar to Reach 2. It is about 1.1 km long with a gradient of 1.0 %. A cascade at the lower reach boundary hinders fish passage.

Reach 5 is approximately 4 km long and is another low gradient reach (0.6 %) with an extensive floodplain. There is approximately 3750 m of sidechannel and wetland habitat suitable for rearing (including the lower ends of several small tributaries). The current extent of utilization is somewhat unclear because spawning enumerations are not generally conducted in this reach. The spawning and rearing habitat appear very good, however, and coho adults and juveniles were sampled during the survey. Sockeye are likely also present in small numbers, along with chinook and steelhead.

Above Reach 5, the channel becomes much steeper and more confined. Reach 6 has an average gradient of 5.3 % with numerous cascades and small falls which, in combination, are probably impassable. Coho and chinook may be present in the lower section of the reach, although the habitat is marginal at best. No fish were captured in a sample done in the upper portion of the reach.

In terms of timber harvesting, the most sensitive area in the Tzeo is the lower reach along the Tzeo-Washwash fan. This area could be destabilized by harvesting and related access development. Reaches 2 - 5 are moderately sensitive to development. Habitat protection measures in this area should stress protection of mainstem stream banks and the sidechannel/wetland areas. Access and timber harvesting conditions would be more difficult in the upper part of the watershed, but timber quality may be insufficient to warrant development.

2.11 WASHWASH RIVER

The Washwash River flows southwest in a steep, narrow valley, before spilling out into a broad fluvial fan near the head of Owikeno Lake. The fan area is very active due to the large amount of bedload movement and the lower Washwash channel has shifted and divided several times over the last 50 years. During these years, the flow has been divided into two main channels - one channel flowing along the east valley wall and into Owikeno Lake and the other, shorter channel cutting across the fan and flowing into the Tzeo River. Since the early 1960's, the shorter `breakthrough' channel has carried most of the flow.

The Washwash River has the same species composition as the Tzeo - dominated by sockeye, with a good coho population, and smaller numbers of chinook, chum, pinks, Dolly Varden, cutthroat, and probably steelhead. Only the lower two reaches (approximately 1.8 km) are accessible to anadromous fish due to the presence of an impassable falls and steep canyon section in Reach 3. The upper Washwash River was not surveyed, but the gradient appears to be too steep to provide any valuable fish habitat. This area is likely barren of

fish.

Reach 1 of the Washwash consists of many channels including the 2 main channels mentioned above. The `old' channel, which now carries very little flow, is approximately 1200 m long and has a fairly low gradient. There are numerous smaller side channels connected to this channel and these provide excellent rearing habitat for coho. The `breakthrough' channel has a steeper gradient (nearly 2 %) and is approximately 700 m long. Both channels are utilized extensively by sockeye spawners, although low flows in the `old' channel have limited utilization in recent years. There have been attempts made to artificially stabilize the fan and return the majority of the flow to the longer `old' channel, although these have been unsuccessful to date.

Reach 2 of the system is a confined, fairly steep gradient reach (approximately 4 %) with only limited spawning habitat.

Reach 3 is a 1.9 km canyon reach with a gradient of over 10 %. A large falls is present at the lower end. The system may be barren above this point, although no fish sampling was done above Reach 2.

The Washwash River fan is very sensitive to timber harvesting and associated development due to the natural instability of the area and the many valuable sidechannels which are present. The upper valley is less sensitive, although steep terrain and avalanche potential may make access difficult. Any extra additions of sediment or increases in peak flows as a result of harvesting in the upper valley may also increase the instability of the fan area.

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APPENDIX I. SUMMARY TABLE OF FISH DISTRIBUTION AND REACH CHARACTERISTICS

Stream (Watershed #)	Reach No. & Length	Av. Channel Width (wetted)	Species Present	Reach Description	Fisheries Values	Sensitivity Comments
Amback C. 91-1282-150	1 4.4 Km.	10 m. (8 m.)	CH, CM, CO, PK, SK, CT, DV, (ST)	Moderate gradient (1.8%). Many multiple-channel areas. High % of gravels (50%). Some sections with steeper gradient.	High. Good spawning throughout reach. Good rearing in multi-channel areas.	Multi-channel areas are fairly unstable.
	2 0.5 Km.		(0)	Very steep gradient (12.8%).	Low. Impassible to anadromous fish.	
Dallery C. 91-1282-160	1 1.2 Km.	18 m. (15 m.)	CH, CM, CO, PK, SK, ST, (CT, DV)	Gradient 0.9% for reach. Confined with bedrock banks and boulder substrate. Rapids with steeper gradient (estimate 1 - 2%) throughout upper portion.	Moderate. Mainly a migration reach. Limited spawning.	Steep valley walls may make development access difficult.
	2 2.6 Km.	30 m. (20 m.)	CH, CM, CO, PK, SK, ST, (CT, DV)	Low gradient (0.6%). Less confined reach with some side channels and one wetland area. High % of gravels (50%).	High. Main spawning area for all species. Good rearing in off-channel areas.	Steep valley walls with with wetlands present on the flood plain.
	3 0.9 Km.	10 m. (10 m.)	? (CH, CO, SK, ST, DV)	Short, steep gradient reach - 1.7% average - with rapids and chutes throughout.	Low. Very difficult passage. Reportedly passable to some SK - probably also CH, CO, and ST	Steep valley walls may make access difficult.
	4 4.3 Km.	25 m. (15 m.)	? (CH, CO, SK, ST, DV)	Low gradient (0.8%). Less confined reach with extensive side channels and wetlands. High % of gravels (50%).	?. Excellent spawning and rearing habitat. SK reported present - CH,CO,ST probable. No fish captured in May 1985 sample.	Extensive wetlands in valley bottom.
	5 1.0 Km.	8 m. (8 m.)	?	Steep gradient reach - 2.3% average with rapids and chutes throughout. Some sections 4 - 5% gradient.	Low. Very difficult passage. Probably impassable to all.	
	6 2.5 Km.		?	Low gradient reach (0.6%) with extensive wetlands. Upper section has a high % of gravel.	?. Good spawning and excellent coho rearing habitat. No fish captured May, 1985.	Extensive wetlands in valley bottom.
	7 1.4 Km.		(0)	Steep gradient (5.4%) with impassable falls.	Low.	
Unnamed C. (tributary to Dallery C.) 91-1282-160-040	1 1.0 Km.	8 m. (6 m.)	? (CH, CO, SK, ST, DV)	Gradient 2.3%. Multiple-channel flow. 40% gravel.	Moderate. May provide spawning and rearing habitat.	
	2 2.5 Km.		(0)	Steep gradient (8.3%). Impassable.	Low.	

Stream (Watershed #)	Reach No. & Length	Av. Channel Width (wetted)	Species Present	Reach Description	Fisheries Values	Sensitivity Comments
Doos C. 91-1282-300	1 2.1 Km.	15 m. (15 m.)	? (DV)	Steep gradient (6.1%). Impassable falls at mouth. Several other small falls and chutes.	Low. May be some spawning at mouth below falls.	
	2 9.6 Km.	20 m. (15 m.)	? (DV)	Moderate gradient (2.0%). Mainly fast-flowing with boulder substrate.	Low. Appears to have very little good rearing or spawning habitat.	
Ashlulm C. 91-1282-320	1 6.4 Km.	15 m. (12 m.)	CH, CM, CO, PK, SK, CT, DV, (ST)	Moderate gradient (1.5%). Mainly swift flowing with some small rapids. 50% gravel. Very few side channels.	High. Good spawning throughout the reach. Rearing habitat is only average due to lack of off-channel habitat.	Mainly stable. Very few sensitive side channels.
	2 3.0 Km.	10 m. (10 m.)	DV	Steep gradient (4.6%). Rapids with boulder substrate throughout.	Low. CH, CO, ST may ascend this reach. Only DV captured May, 1985.	
	3 2.5 Km.	15 m. (10 m.)	DV	Moderate gradient (2.4%). Less confined, with moderate side channels. 40% gravel.	Moderate. Some good spawning and rearing habitat. Only DV captured May, 1985.	Narrow valley bottom with side channels and wetlands.
Machmell R. 91-1282-550	1 8.3 Km.	200 m. (50 m.)	CO, SK, ST, CT, DV (CH, CM, PK)	Fairly low gradient (0.5%). Large, glacial river flowing in braided channel. Very unstable reach. Substrate mainly large gravel (40%) and cobble (40%).	Moderate. Some good spawning gravel but very unstable. Most important areas are side channels, especially those with clear water.	Very active channel makes road location difficult. Important side channel areas are sensitive.
	2 4.0 Km.	120 m. (40 m.)	CO, SK, ST, CT, DV (CH, CM, PK)	Gradient 0.8%. Similar to Reach 1, but slightly more confined. Channel is braided and unstable.	Moderate. Same as above.	Same as above.
	3 4.9 Km.	50 m. (30 m.)	(CH, CO, SK, ST, CT, DV)	Gradient 0.9%. Entrenched canyon with vertical walls. Fast flowing with mainly boulder substrate.	Moderate - low. May be utilized to some extent for spawning.	Low sensitivity.
	4 5.1 Km.	20 m. (20 m.)	(CH, CO, ST, DV)	Fairly steep gradient (2.5%) canyon with chutes and small falls throughout. Boulder and bedrock substrate.	Low. Chutes and falls are probably impassable upstream from Pashleth Creek.	Low sensitivity.
	5 11.6 Km.	25 m. (20 m.)	DV	Canyon with slightly lower gradient (2.0%). Fast flowing with mainly boulder substrate.	Low. Probably only DV present.	Low sensitivity.

Stream (Watershed #)	Reach No. & Length	Av. Channel Width (wetted)	Species Present	Reach Description	Fisheries Values	Sensitivity Comments
Machmell R. 91-1282-550	6 15.0 Km.	60 m. (20 m.)	DV	Lower gradient (1.4%). Less confined with open, braided sections. 40% gravel.	Low. Probably only DV present.	
	7 1.1 Km.	15 m. (15 m.)	(0)	Steep (7.3%) canyon reach	Low. Probably no fish present beyond this point. Altitude and climate are limiting.	
Neechanz R. 91-1282-550-010	1 3.0 Km.	50 m. (30 m.)	CH, CM, CO, PK, SK, ST, CT, DV, + (Lamprey, sculpins).	Low gradient (0.5%) fluvial fan area. Large % of gravel (60%). Active side channels near mouth of Marble Ck. otherwise mainly stable.	Extremely high. Up to 50,000 SK spawners. Also CH, CM, CO, PK & ST spawning. Good rearing areas in side channels.	High sensitivity, especially active side/ flood channel area near Marble Ck.
	2 1.8 Km.	35 m. (25 m.)	CH, CO, SK, ST, DV	Confined reach with 2 bedrock constrictions. Mainly cobble/boulder substrate (60%). Stable channel.	Moderate. Scattered CH, CO, SK, and ST spawning. Some rearing. CM and PK likely present in small numbers.	Channel is stable, virtually no side channels present.
	3 2.0 Km.	40 m. (30 m.)	CH, CO, SK, ST, DV	Moderate gradient (1.5%). Slightly less confined than R2. Mainly cobble/ boulder substrate (60%). Stable channel.	Moderate. Scattered CH, CO, SK, and ST spawning. Some rearing.	Channel is stable, few side channels present.
	4 4.0 Km.	75 m. (30 m.)	CH, CO, SK, ST, DV	Moderate gradient (1.5%). Channel less confined and more unstable. Extensive braiding and side channels. 40% gravel.	High. Suspected important CH, CO, and ST spawning area. Good rearing in side channels and wetlands.	Channel already fairly unstable. Some wetland areas. Potential valley wall instability.
	5 2.9 Km.	15 m. (10 m.)	ST, DV	Steep gradient (4.0%). Rapids and cascades throughout. 100% large boulder substrate.	Low. Migration reach for ST. Possibly limited ST rearing. CH and CO may ascend this reach under some conditions.	Channel is very stable. Valley walls are steep, however.
	6 3.9 Km.	30 m. (15 m.)	ST, DV	Moderate gradient (2.1%). Less confined. Some suitable spawning gravel (40%).	Moderate. Suspect spawning of ST. Also some good rearing areas in side channels.	Steep valley walls with some instability evident.
	7 2.4 Km.	15 m. (10 m.)	(ST, DV)	Moderate - steep gradient (2.5%) with extensive rapids. 80% boulder substrate. Avalanche tracks on valley walls.	Low. Suspect ST and DV may be present. Little or no spawning or rearing habitat.	Avalanche potential.
	8 1.5 Km.	40 m. (12 m.)	(ST, DV)	Less confined reach with 50% gravel. Several side channels.	Moderate. ST,DV may be present. Habitat suitable for spawning and rearing.	Avalanche potential. Also some valley wall instability.

Stream (Watershed #)	Reach No. & Length	Av. Channel Width (wetted)	Species Present	Reach Description	Fisheries Values	Sensitivity Comments
Neechanz R. 91-1282-550-010	9 1.9 Km.	15 m. (10 m.)	(O)	Very steep gradient (9.9%). Cascades and falls throughout.	Low. Poor habitat.	Avalanche potential.
	10 5.5 Km.	30 m. (10 m.)	(O)	Lower gradient (2.7%). Less confined. 50% gravel Moderate side channels.	Low. Habitat probably not useable due to high elevation.	Avalanche potential.
Marble C. 91-1282-550-010-010	1 0.8 Km.	12 m. (10 m.)	CH, CM, CO, PK, SK, ST, DV, CT	Active fluvial fan area with multiple channels. 70% gravel.	Extremely high. Important SK and CH spawning area. Good rearing in multiple channel area near mouth.	Active multiple channel area is easily affected by development.
	2 1.4 Km.	10 m. (10 m.)	CH, CO, ST	Bedrock canyon with chutes and falls throughout. Impassable.	Low, except for extreme lower end of canyon which is used for spawning by CH, CO and ST.	
Kulee C. 92-1282-550-010-100	1 2.5 Km.	12 m. (10 m.)	(CH, CO, ST, DV)	Steep gradient (6.0%) with bedrock canyon and impassable falls.	Low. May be very limited utilization of extreme lower portion. Rest is inaccessible.	
Genesee C. 91-1282-560	1 1.3 Km.		CM, CO, PK, SK (CH, CT, DV)	Not surveyed.	Very high.	
Sheemahant 91-1282-650	1 19.5 Km.	75 m. (40 m.)	CH, CO, PK, SK, CT, DV (CM, ST)	Low gradient (0.2%). Fairly large, glacial river. High % of bars with some braiding. Channel is mainly stable. 50% gravel.	High. Excellent spawning gravel in places - although some areas are compacted with sand. Some good rearing in side channels.	If stream banks and side channels are disturbed - the channel could be easily destabilized. Roads should be located near valley walls.
	2 14.5 Km.	50 m. (30 m.)	CH, CO, SK, CT, DV (ST)	Low gradient (0.3%). Very similar to Reach 1. Slightly fewer bars and more confined. Several wetland areas adjacent to the channel.	High. Small falls impedes access to this reach, but potentially as valuable as Reach 1.	Same as above.
	3 13.8 Km.	35 m. (20 m.)	CO, CT, DV (CH, SK, ST)	Low gradient (0.7%). Fairly broad flood plain with extensive side channels and wetlands. 50% gravel.	High. Appears to provide excellent spawning and rearing habitat.	Extensive wetlands throughout the flood plain.
	4 1.2 Km.	12 m. (10 m.)	DV (CO, ST)	Fairly steep gradient (2.7%). Confined reach with rapids throughout.	Low. Poor habitat. Rapids appear to be passable.	
	5 6.7 Km.	30 m. (10 m.)	DV	Moderate gradient (1.5%). Open, braided reach immediately below the toe of a glacier. Mainly cobble substrate.	Low. DV present. Habitat is marginal due to elevation and proximity to the glacier.	

Stream (Watershed #)	Reach No. & Length	Av. Channel Width (wetted)	Species Present	Reach Description	Fisheries Values	Sensitivity Comments
Sumquolt C. 91-1282-650-300	1 1.5 Km.	20 m. (10 m.)	(CH, CO, SK, ST, CT, DV)	Gradient 1.1%. Open fan area with some braiding. Mainly cobble substrate.	Low - moderate. May be limited utilization of this reach for spawning.	This is a fairly active fan area.
	2 2.1 Km.	6 m. (6 m.)	(0)	Steep gradient (5%) bedrock canyon with impassable falls.	Low. Suspect no fish present above this reach.	Low sensitivity.
Inziana R. 91-1282-750	1 1.1 Km.	40 m. (35 m.)	CO, SK, CT, DV (CH, PK)	Gradient 0.6%. Fan area. Fairly stable except in lower portion where channel has shifted. 70% gravel.	Extremely high. Excellent spawning gravel. Up to 100,000 SK spawners.	Very high sensitivity. Fan area could be easily destabilized.
	2 0.5 Km.		(0)	Very steep gradient (16%) canyon reach with impassable falls.	Low. No anadromous species above this reach.	
Washwash R. 91-1282-780 New Chan. Old Chan.	1 0.7 Km. 1.2 Km.		CH, CM,CO, PK, SK, CT, DV, sculpin, lamprey, stickleback, (ST)	Active fan area. "New" channel which enters the Tzeo is shorter with moderate gradient (2.0%). Old channel carries some flow, has many side channels and lower gradient (1.1%)	Extremely high. Both channels have good spawning. Old channel has excellent rearing in side channels.	Very high sensitivity. Many small channels present. Fan could be easily destabilized.
	2 0.6 Km.	35 m. (25 m.)	CH, CO, SK, DV (CM, PK, ST, CT)	Confined reach with fairly steep gradient (4.4%). Mainly cobble and boulder substrate.	High. Utilized by CH, CO, SK for spawning.	Some valley wall instability at upper end of reach.
	3 1.9 Km.		(0)	Steep gradient (10.6%) canyon reach with impassable falls.	Low. No anadromous fish above falls at lower end.	Steep valley walls may make access difficult.
	4 7.4 Km.		(0)	Gradient 4.4%. Not surveyed in field.	Low.	Some avalanche potential.
Tzeo R. 91-1282-800	1 1.4 Km.	35 m. (20 m.)	CH, CO, PK, SK, CT, DV, sculpin, lamprey, stickleback, (CM, ST)	Low gradient (0.3%) reach at edge of Washwash fan. Substrate is mainly sand (30%) and gravel (50%).	High. Good spawning and rearing area.	Very high sensitivity. Washwash-Tzeo fan area could be easily destabilized.
	2 0.7 Km.	30 m. (20 m.)	CH, CO, PK, SK, CT, DV, sculpin, lamprey, (CM, ST)	Moderate gradient (0.9%) with some rapids. Confined with mainly boulder substrate.	Moderate. Some spawning. Mainly a migration reach.	Confined channel mainly protected by terraces. Some instability noted in right valley wall.
	3 2.0 Km.	40 m. (20 m.)	CH, CO, PK, SK, CT, DV, OS, (CM, ST)	Low gradient reach (0.4%). Wide floodplain with extensive wetlands on left bank. Sand (50%) and gravel (40%) substrate.	High. Utilized for spawning and rearing.	Extensive wetlands present.

Stream (Watershed #)	Reach No. & Length	Av. Channel Width (wetted)	Species Present	Reach Description	Fisheries Values	Sensitivity Comments
Tzeo R. 91-1282-800	4 1.1 Km.	25 m. (15 m.)	CH, CO, SK, CT, (DV, ST)	Confined reach with moderate gradient (1.0%). Cascades present at lower end. Mainly boulder substrate.	Moderate. Cascades at lower end probably hinders distribution. Some spawning of SK and CO.	Confined channel, mainly protected by terraces.
	5 4.0 Km.	40 m. (15 m.)	CH, CO, SK, CT, (DV, ST)	Fairly low gradient (0.6%). Wide floodplain with extensive side channels and wetlands. 40% gravel.	High. Good spawning and rearing.	Extensive wetlands utilized by fish.
	6 7.0 Km.	15 m. (10 m.)	(DV)	Confined reach with steep gradient (5.3%). Impassable chutes and falls present.	Low. CO and CH may be present in lower 1 Km. only. Poor habitat.	Steep valley walls may make access difficult. Also avalanche potential.

APPENDIX II. AQUATIC BIOPHYSICAL MAPS

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TZEO RIVER
BRITISH COLUMBIA

AQUATIC BIOPHYSICAL

1. Explanatory Notes

2. Example (Reach Symbol)

3. Fish Species

4. Channel Components

5. Bed (Substrate) Materials

6. Streams with Limited Information

7. Watershed Codes

8. Site Specific Information

9. References

10. Credits

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92 M/11

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RIVERS INLET

COAST LAND DISTRICT RANGE 2

BRITISH COLUMBIA

AQUATIC BIOPHYSICAL

1. Explanatory Notes

2. Examples (Result Symbol)

3. Fish Species

4. Channel Components

5. Bed Substantial Materials

6. Streams with Limited Information

7. Watershed Codes

8. Site Specific Information

9. References

10. Credits

CANADA

EDITION 1

92 M/9

MACHMELL RIVER

COAST LAND DISTRICT RANGE 5

BRITISH COLUMBIA

1:50,000

PACIFIC RANGES

COAST MOUNTAINS

AQUATIC BIOPHYSICAL

1. Explanatory Notes

2. Example (Reach Symbol)

3. Fish Species

4. Channel Components

5. Bed Substantial Materials

6. Streams with Limited Information

7. Watershed Codes

8. Site Specific Information

9. References

10. Credits

92 M-7

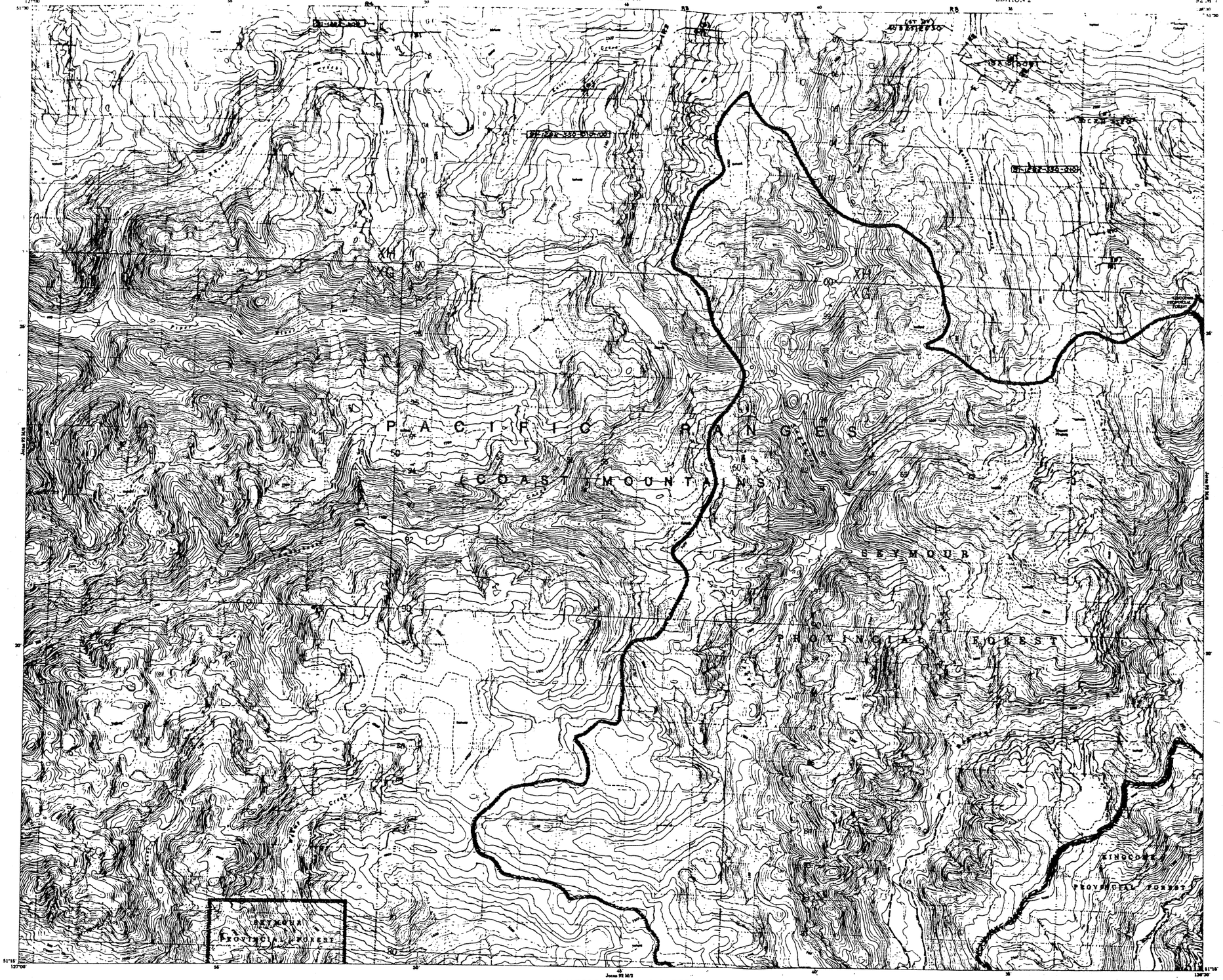
1:50 000

CANADA

Joins 92 M-10

EDITION 2

92 M-7



Joins 92 M/2

MOUNT PHILLEY

COAST LAND DISTRICT RANGE 2

BRITISH COLUMBIA

Scale 1:50 000 Échelle

AQUATIC BIOPHYSICAL

1. Explanatory Notes

2. Example (Mosaic Symbol)

3. Fish Species

4. Channel Components

5. Bed Mineralized Materials

6. Streams with Limited Information

7. Watershed Codes

8. Site Specific Information

9. References

10. Credits

92 M/16

CANADA

1:50 000

EDITION 2

92 M/16

SHEEMAHANT RIVER

COAST LAND DISTRICT RANGE 2

BRITISH COLUMBIA

Scale 1:50 000 Échelle

AQUATIC BIOPHYSICAL

1. Explanatory Notes

2. Example (Watch Symbol)

3. Fish Species

4. Channel Components

5. Bed Stabilizing Materials

6. Streams with Limited Information

7. Watershed Codes

8. Site Specific Information

9. References

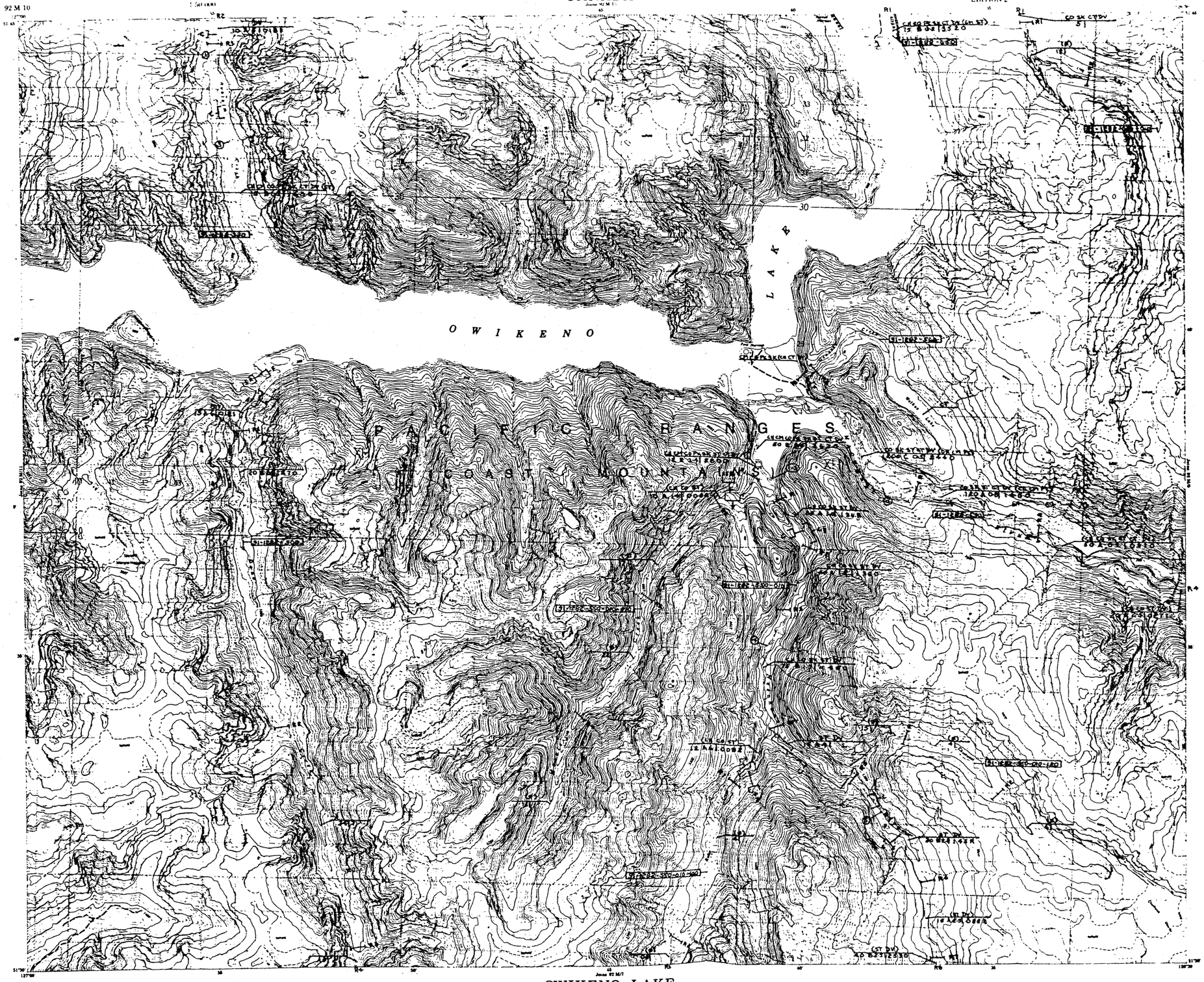
10. Credits

CANADA

92 M 10

EDITION 2

92 M 16



Joins 92 M/7

OWIKENO LAKE

COAST LAND DISTRICT RANGE 2

BRITISH COLUMBIA

Scale 1:50 000 Échelle

AQUATIC BIOPHYSICAL

1. Explanatory Notes

2. Example (Reach Symbol)

3. Fish Species

4. Channel Components

5. Bed Sedimental Materials

6. Streams with Limited Information

7. Watershed Codes

8. Site Specific Information

9. References

10. Credits