DOCUMENTATION OF NEARSHORE SOCKEYE SPAWNING HABITAT IN BABINE LAKE

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1.0 INTRODUCTION

Babine Lake stocks of sockeye salmon (*Oncorynchus nerka*) account for 95% of sockeye spawning in the Skeena River system (West and Mason, 1987). About half of these fish spawn in the Fulton River and Pinkut Creek spawning channels, constructed by the Department of Fisheries and Oceans from 1965 to 1971. In some years the number of sockeye returning to these channels is greater than the channel capacity and "surplus" fish are forced to spawn below the counting fences. At Fulton River these surplus fish spawn in a half kilometre length of the river downstream of the counting fence and also, possibly, along the nearshore margins of Babine Lake near Fulton River. At Pinkut Creek the counting fence is situated only about 100 metres upstream of the river outlet, and it is thought that surplus sockeye may spawn along the lake margin. In addition, anecdotal records of sockeye salmon spawning in Babine Lake exist from the mid-1960's, prior to the completion of the Pinkut and Fulton spawning channels. These records consist mostly of gill net catches of ripe sockeye in shallow, nearshore waters of the lake during late fall, after most spawners had moved into the lake tributaries. H.D. Smith's journal entries for 1962 indicate that divers observed redds at Red Bluff Point (C. Wood, pers. comm.). These redds were presumed to be sockeye redds as sockeye were observed, but many lake char (*Salvelinus namaycush*) were also seen in the area. Apparently no eggs could be collected from these redds.

In order to make decisions regarding the potential for harvesting surplus sockeye the Department of Fisheries and Oceans (DFO) has initiated an investigation of sockeye spawning in Babine Lake. The goals of this investigation are:

1. To document the quantity and quality of suitable lake spawning habitat;
2. To determine if and where surplus sockeye spawn along the lake margins;
3. To assess whether the anecdotal records of lake spawning by non-surplus sockeye are plausible.

In 1991 field investigations took place near Fulton River, however in that year the number of sockeye spawners did not exceed the capacity of the spawning channel. The general objectives of the 1991 program were:

1. To characterize and map the shallow water nearshore habitat of Babine Lake in the vicinity of Fulton River and assess the value of this habitat for spawning sockeye, particularly with respect to egg survival;

2. To assess egg-to-alevin survival of eyed sockeye eggs from fish taken from the Fulton River when incubated in a range of substrate habitats at two sites in Babine Lake. To compare these survival rates with those of eyed eggs incubated in the Fulton River spawning channels;

3. Identify important physicochemical parameters (eg. substrate composition and dissolved oxygen levels within substrate) which could affect egg-to-alevin survival;

4. Monitor water temperature on a continuous basis over the winter at the sites of egg incubation.

The results of these field investigations are summarized by Emmett and Convey (1992). In general it was determined that egg survival was good only when the eggs were incubated in substrate which was relatively free of fines and the interstitial dissolved oxygen levels were greater than 9.0 ppm (designated as habitat A). Very little nearshore habitat in the Fulton River area or along the eastern shore of the lake between Fulton River and Twain Creek met these criteria.

In the fall of 1992 large surpluses of sockeye were expected for both the Fulton River and Pinkut creek spawning channels and DFO wished to take this opportunity to further investigate whether surplus spawners used the margin of Babine Lake. The survey team revisited Babine Lake in October 1992 with the following objectives:

1. Document nearshore habitat at the south end of Babine Lake;

2. Survey nearshore areas in the vicinity of Pinkut Creek and Fulton River for spawning sockeye;

3. Provide an estimate of the number of sockeye observed spawning in lake habitat;

4. Characterize the habitat used by lake spawning sockeye with respect to substrate, interstitial O_2 levels, water depth and distance from shore.

Priority was given to the lakeshore near Pinkut Creek as this part of the lake was not surveyed in 1991, and there is only about 100 metres of creek bed downstream of the counting fence available to surplus sockeye.

2.0 METHODS

2.1 SURVEY AREA

The habitat surveys covered the southern section of Babine Lake from Twain Creek in the northwest to the Sutherland River in the east (Figure 1). Most of the survey effort focused on areas within 10 kilometres of the spawning channel at Pinkut Creek. The two largest areas of lake spawning were located just east of Boling Point and around Pinkut Point (Figures 1 and 2). The characterization of lake spawning habitat was conducted primarily in these two areas.

Near the Fulton River, surveys for sockeye spawners concentrated on the shoreline from Red Bluff to Port Arthur as well as the opposite shore of the lake, where suitable spawning substrate had been identified in 1991 (Figure 3).

2.1 HABITAT TRANSECTS

The purpose of the habitat surveys was to assess the suitability of nearshore substrate as spawning and egg incubation habitat for sockeye. Divers swam transects perpendicular to shore recording the dominant substrate, width and depth of various habitat zones. These habitat types were classified according to the following criteria:

Habitat A. Several layers of gravel or cobble substrate over sand or silt substrate. Very little sand or silt within the interstitial spaces of the cobble or gravel.

Habitat B. Gravel and/or cobble substrate mixed with sand or silt. Most interstitial space between the larger substrate filled with sand or silt.

Habitat C. Sand or silt with little, if any, larger substrate.

These are the same classification criteria used in the previous year's surveys (Emmett & Convey, 1992). Dissolved oxygen samples from each of these zones were taken (see Section 2.3 for a description of the sampling method) and video recordings were made of some of the habitat transects (see Appendix Table A for the video index).

2.3 MEASURING SPAWNING HABITAT CHARACTERISTICS

Spawning sockeye were identified visually from a boat running along the lake shoreline. Spawning sockeye were readily identified by their behaviour; they were observed in small groups of both

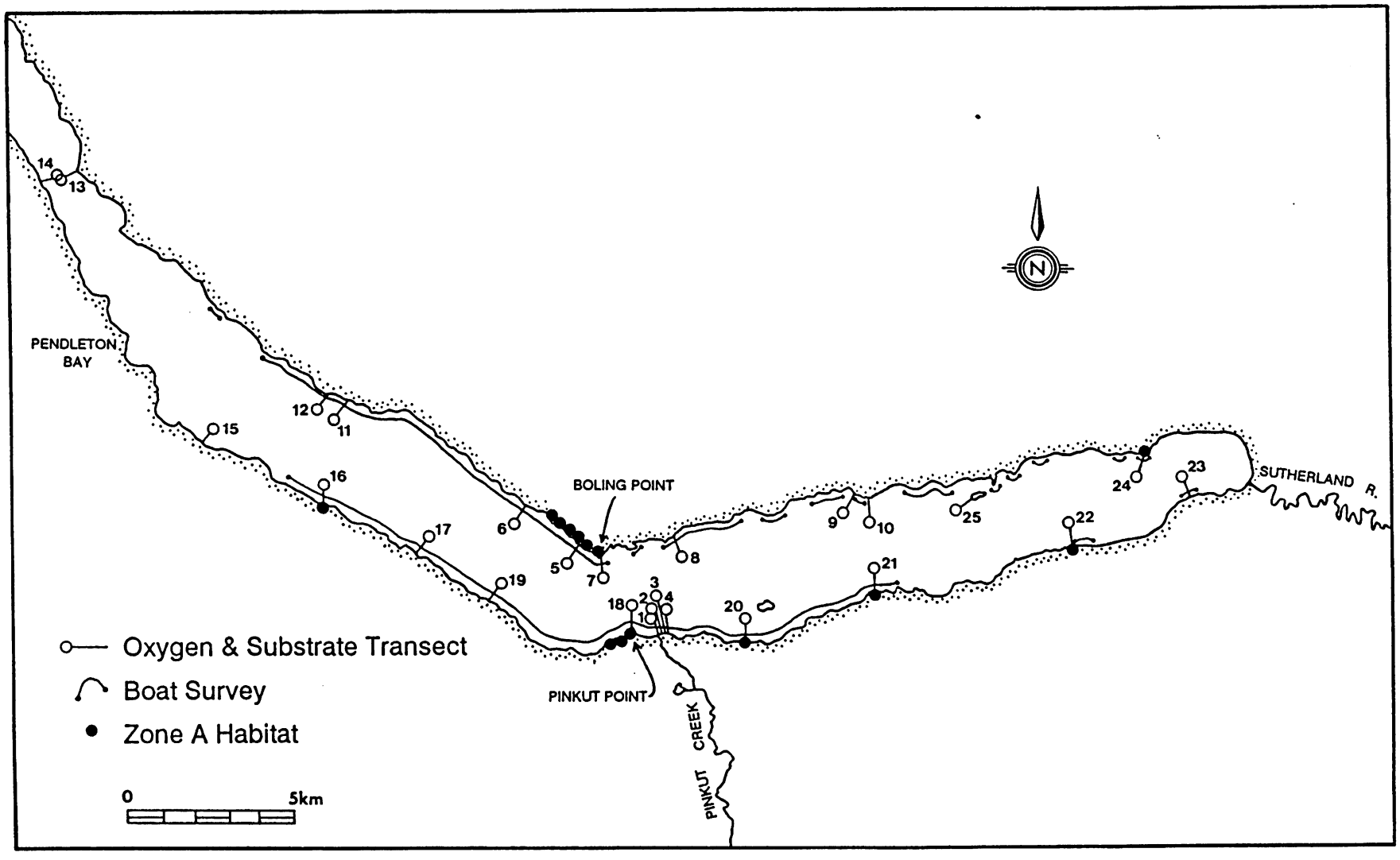

Figure 1. **Map of south end of Babine Lake showing habitat transects and shoreline surveyed by boat for sockeye spawners.**

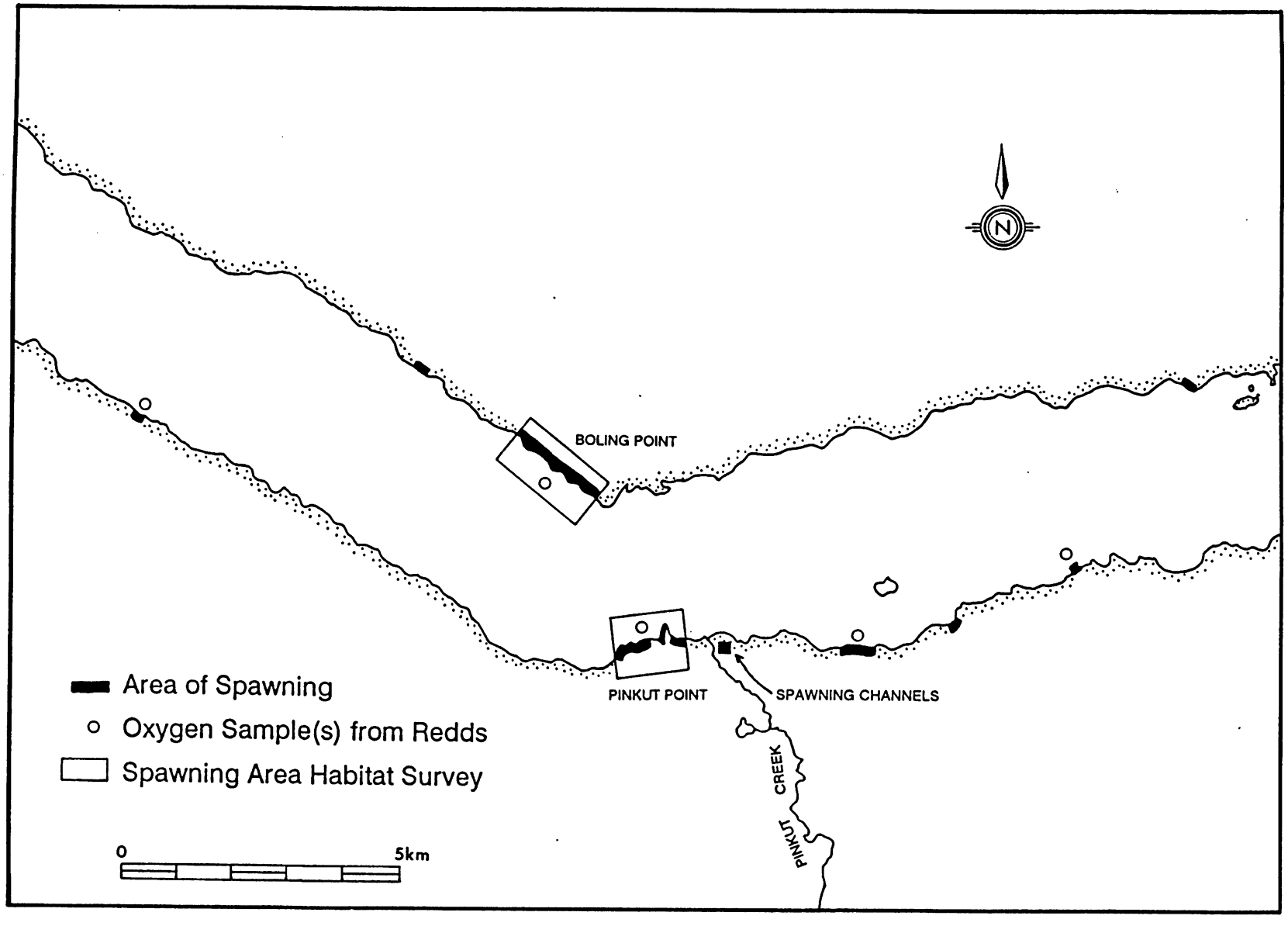

Figure 2. **Map showing nearshore areas of Babine Lake near Pinkut Creek where sockeye spawning was documented.**

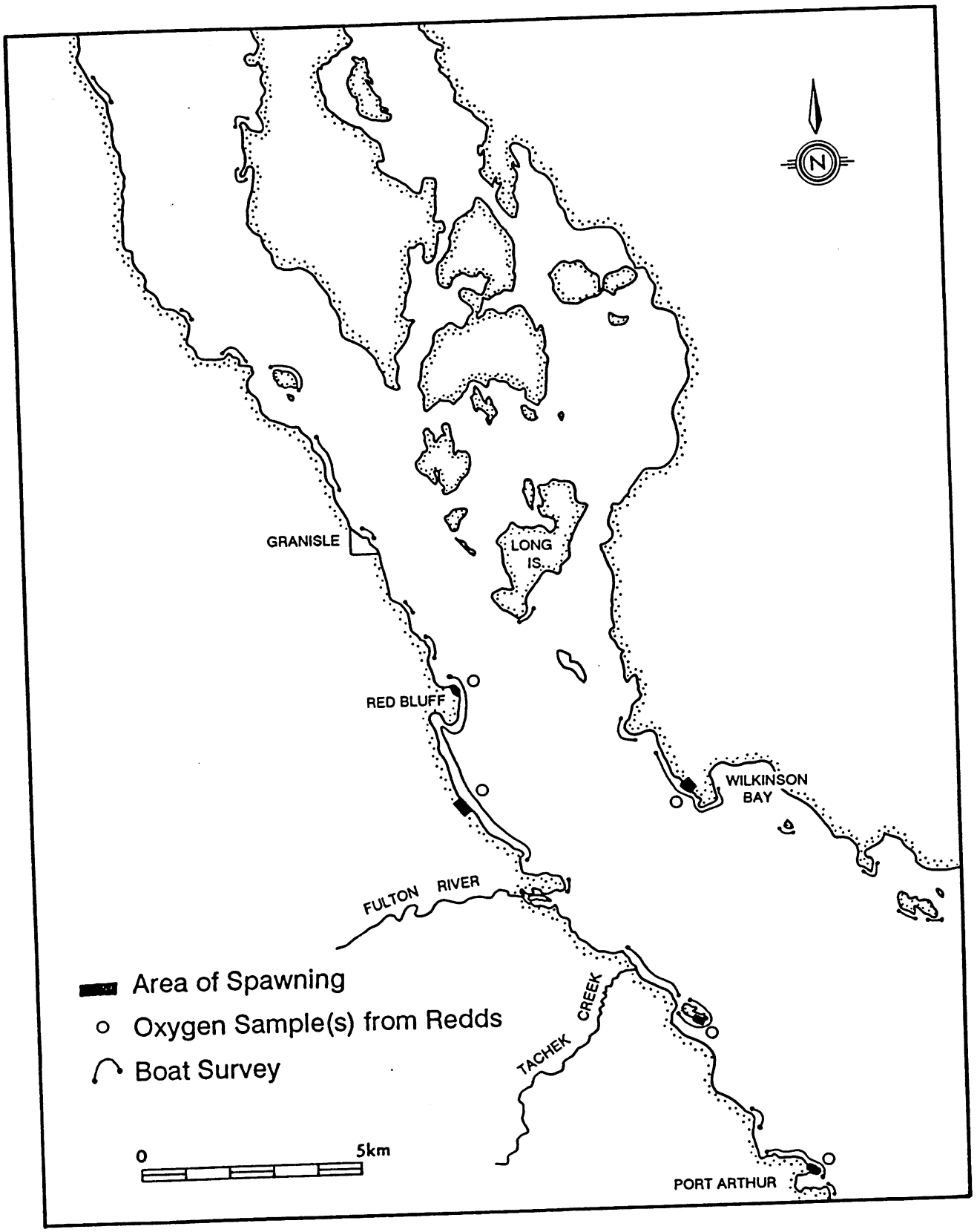

Figure 3. Map showing nearshore areas of Babine Lake near Fulton River where sockeye spawning was documented.

males and females, which tended to remain in stationary positions along the shoreline. Tail fanning of substrate was often observed but actual spawning not documented. In most cases, spawning was confirmed by diver observations of sockeye eggs within the bottom substrate. The areas of spawning were mapped on 1:50,000 topographical maps and a visual estimate of the shoreline length was made.

In two areas near Pinkut Creek (Boling Point and Pinkut Point) the spawning habitat was further characterised by divers measuring the distance from shore, width, and depth of the spawning zone every 100 metres along the spawn length. Video recordings were made of selected sampling points. Five substrate samples from bottom substrate with sockeye eggs were taken from each of these two spawning areas. The substrate samples were dried at 110°C overnight then screened through a sieve series (100, 50, 25.4, 12.7, 9.5, 4.8, 3.4 and 1.2 mm) and the fractions weighed ($\pm$ 0.1 g). In each of these two spawning areas ten pairs of interstitial water samples were taken from redds and from substrate adjacent to the redds for the measurement of dissolved oxygen. Interstitial water samples were also taken from redds in some of the smaller areas of spawning observed around Pinkut Creek and Fulton River.

2.4 Sampling Dissolved Oxygen from Bottom Substrate

Interstitial water from the bottom substrate was sampled using a 60cc syringe coupled to a 25cm stainless steel hollow rod. The rod was closed at the bottom with a metal tip but perforated with several holes (1-2 mm) approximately 3cm above the tip. The hollow rod was driven 5 to 15cm into the substrate and the sample drawn slowly into the syringe. To avoid sample contamination with lake water the first 10 cc of sample was flushed from the syringe by disconnecting the syringe/rod coupling and ejecting the water from the syringe. The syringe was then recoupled and a full sample drawn. Using several syringes, five to six samples could be taken before surfacing to measure oxygen content. Concurrent water temperature measurements ($\pm$ 0.5°C) were taken with a hand-held thermometer placed in the substrate beside the site of the oxygen sample.

Oxygen was measured by placing a probe (Oxyguard Handy Oxygen Probe, Point Four Systems Inc; accuracy $\pm$2% at 0-50 ppm) into the syringe casing after the plunger was removed.

2.5 Estimates of the Lake Spawning Population

At Boling and Pinkut Points the spawning population was estimated by divers snorkelling selected 100 metre sections of shoreline and counting spawners. Two divers made independent counts of sockeye and the boat operator provided a third count from the water surface. Twenty to thirty percent of the total

length of spawning shoreline in each of the two areas was enumerated using this method. A qualitative assessment of spawner abundance (low, medium, high) was made for all 100m sections of the shoreline by reviewing observations made while carrying out the habitat measurements (Section 2.3). The spawner estimate for the sections not enumerated by divers was made by assigning a fish count based on the actual counts made in sections with the same abundance rating. The abundance estimate calculation is given in Appendix Table B.

In other smaller spawning areas, sockeye were counted from the boat moving slowly along the shoreline.

2.6 Marking Spawning Area and Redds at Pinkut Point

At Pinkut Point three shoreline markers were placed approximately 30 metres apart at the eastern end of the spawning area. In order to assess shoreline ice scour, three groups of fluorescent painted cobbles were placed at varying distances from shore (7.0 - 15.0 metres) and depths (0.6 - 3.0 metres) along each transect. In addition ten redds in this area were marked with painted cobbles and numbered survey tape to facilitate the assessment of egg survival during a possible second field trip in March 1993. Temperature probes were placed in four different redds in the transect area. The probes were connected to a data logger (Starlog Model 6003B) housed in an underwater case which was placed on the lake bottom at a depth of 4 metres. The data logger will monitor water temperature at five second intervals and record the average temperature over a 12 hour period.

2.7 Enumerating Sockeye in Selected Babine Lake Tributaries

During the field survey sockeye were observed in several tributaries of Babine Lake, and counts of live sockeye were made in Twain, Tachek and Pierre Creeks. Independent counts were made by two persons walking the creek. In addition eggs were taken from a number of female carcasses and egg counts conducted to estimate egg retention in dead females.

3.0 RESULTS

3.1 GENERAL

The field work was carried out over 11 days from September 25 to October 5th, 1992. The first eight days were spent in the southern end of Babine Lake, in the area of Pinkut Creek. The last three days were spent at Fulton River, in the same general area where field work was conducted in 1991/92. The weather over the field period was quite moderate, with no days of heavy winds. Daytime temperatures were above the freezing mark. The lake level was 710.455 metres above sea level on October 1st (S. Barnetson, pers. comm.). The lake level tends to fluctuate about one meter over a year, with the lowest levels being recorded in spring, prior to the snowpack runoff.

A surplus of spawning sockeye was experienced at both the Pinkut and Fulton spawning channels in 1992. Preliminary estimates of surplus spawners were 200,000 for Pinkut and 250,000 for Fulton (S. Barnetson, pers. comm.). In late September large numbers of sockeye (>50,000) were observed in the Fulton River below the counting fence; however, at Pinkut, the surplus spawners had dispersed and only a few thousand were observed in the short stretch of creek below the counting fence.

3.2 HABITAT TRANSECTS

A total of 25 habitat transects were conducted in the south end of Babine Lake, from Twain Creek to the Sutherland River (Figure 1). The habitat assessment data for these transects are given in Appendix ??, Table A. Four transects were made along the beach in front of the Pinkut spawning channels. The substrate in this area is primarily gravel and cobble mixed with sand (classified as habitat C). At depths greater than about three metres the substrate changed to sand/silt (Habitat C) and the bottom slope was more pronounced. No sockeye eggs were found in this area, although several small areas of disturbed substrate were observed.

The remaining 21 transects were conducted at 2-10 kilometre spacing along the lake shoreline, the transects being more closely spaced in the area of the lake near Pinkut Creek. The transects were conducted at sites most likely suitable for egg incubation; exposed points with nearshore boulder, cobble, or gravel substrate. The most common nearshore substrate at the transect sites was habitat B (cobble and/or gravel mixed with sand). Habitat A substrate was observed on seven of the 25 transects, most often directly along the shoreline. The transects with habitat classified as habitat A are shown in Figure 1. At depths below 3-5 metres, habitat C (sand and/or silt) was most commonly observed. This is

similar to the nearshore habitat observed in the Fulton River region of Babine Lake (Emmett and Convey, 1992), except that habitat A (considered the only habitat suitable for egg incubation) was more frequently observed in the southern end of the lake. Habitat A was usually observed on steep, rocky shoreline with bottom substrate formed of sharp, angular cobble or boulder which may have slumped off the steep shore. At certain sites (Transects 5, 8, 18, 20, 21) the rocky slope continued underwater to depths of up to 10 metres.

Seventy one oxygen samples from substrate were taken on the 25 transects, a minimum of two samples per transect. The oxygen data is given in Appendix Table D and is summarized by habitat type in Figure 4. Dissolved oxygen levels in habitat A ranged between 6.2 and 10.2 ppm (five of 17 samples were less than 9 ppm). In habitat B oxygen levels ranged between 0.8 and 10.2 ppm, with 38 of 43 samples less than 9 ppm. In habitat C oxygen ranged between 0.8 and 2.8 ppm. This confirms results obtained in 1991 (Emmett and Convey, 1992); that only in habitat A were dissolved oxygen levels suitable for the incubation of sockeye eggs.

3.3 Sockeye Spawning Habitat Characteristics

Figure 1 shows the shoreline in the southern end of Babine Lake surveyed by boat for sockeye spawners. Figure 3 shows the nearshore areas where spawning activity was observed and confirmed by divers. Approximately 45 kilometres of shoreline were surveyed and sockeye spawning was recorded along 3.4 kilometres (7.5%) of this shoreline. Most of the spawning activity was observed in two shoreline sections within five kilometres of Pinkut Creek, a 1.9 kilometre section just west of Boling Point and a 1.2 kilometre section around Pinkut Point, just west of Pinkut Creek (Figure 3). A total of 2000 sockeye spawners were estimated from boat and diver counts in the southern area of the lake; 650 fish near Boling Point, 900 fish near Pinkut Point and 400 fish in the six minor areas of spawning shown in Figure 3. Methods used to identify spawning and estimate the number of spawners at Boling and Pinkut Points are given in Section 2.5, the abundance calculation is summarized in Appendix Table B. Note that boat counts ranged between 25 and 76% of diver counts made along the same section of shoreline. The accuracy of the boat counts were strongly effected by adverse weather conditions.

Figure 3 shows the area of Babine Lake near Fulton River. A total of 21 kilometres of shoreline was surveyed by boat and less than 0.5 kilometres of sockeye spawning (approximately 2% of the surveyed shoreline) was observed. Sockeye were observed spawning in four locations between Red Bluff and Port Arthur and at one location on the opposite side of the lake, on the rocky point west of Wilkinson Bay. These spawning areas were less than 150 metres in length and the number of spawners

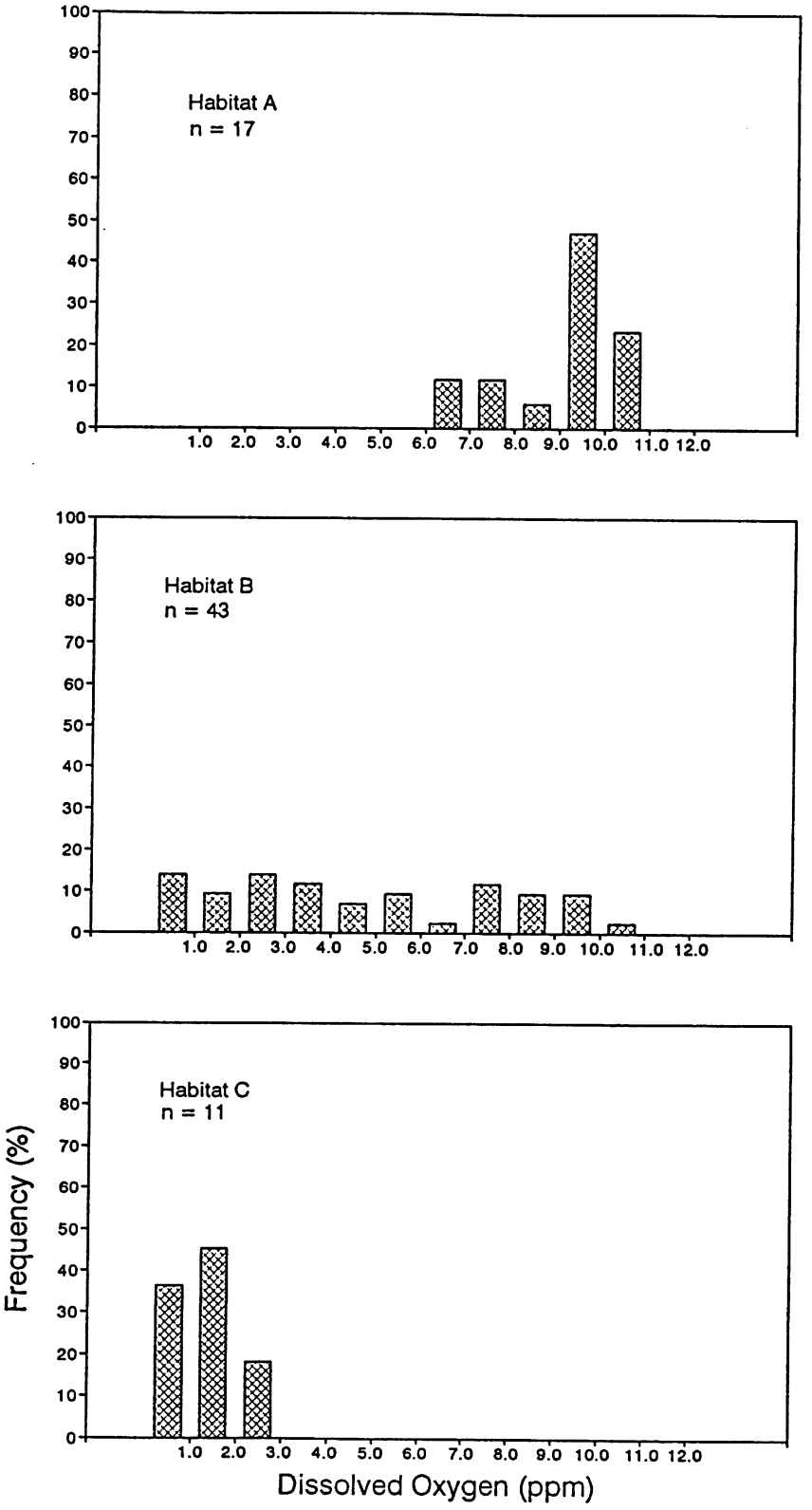

Figure 4. **Interstitial dissolved oxygen (ppm) in substrate from the three habitat types. Samples taken from the 25 habitat transects conducted at the south end of Babine Lake.**

was not great; boat counts ranged from 10 fish at Tachek Island to 165 fish in an area of spawning located halfway between Red Bluff and Fulton River. In total, approximately 300 sockeye were observed spawning in the Fulton River region of the lake. Divers inspected the type A habitat off Wilkinson Beach, which was used for sockeye egg incubation in 1991/92, but there was no evidence of sockeye spawning.

In almost all cases sockeye were observed spawning in type A habitat. Usually the fish spawned very near shore in shallow water. Many of the areas were located on steeply sloped rocky shoreline and the sockeye spawned on narrow nearshore ledges of loose rock. At Boling and Pinkut Points spawners were most abundant where this rock material also formed a steep underwater slope to depths of up to 10 metres. The shoreline at several of the minor spawning areas (Wilkinson Point, Tachek Island, Port Arthur) was also formed of similar exposed, steep rocky shoreline. The substrate in these areas was relatively free of fines and areas of spawning could be readily distinguished as disturbed rocky substrate cleaned of silt and algal growth. Individual redds were not always identifiable, particularly in the shallow areas were overspawning may have occurred.

In the spawning areas sockeye tended to hold positions right over the area where eggs were deposited. The fish actively defended these areas, particularly against rainbow trout (*Oncorhynchus mykiss*). Spawning pairs could often be identified, although actual spawning was seldom observed and probably had occurred before the dive surveys were made. Typical nearshore spawning habitat is shown photographically in Figure 5 as well as in the accompanying video (see the video index, Appendix Table A).

Spawning in habitat B was only observed in the Fulton River area of Babine Lake, specifically between Red Bluff and Fulton River. As in other spawning areas, shallow, nearshore habitat was used (Figure 5).

Samples of interstitial water from substrate containing sockeye eggs were taken from 31 sites in the southern area of Babine Lake and 11 sites in the Fulton River area. Levels of dissolved oxygen and the associated substrate type are given in Appendix Table E. The levels of dissolved oxygen are summarized as a histogram in Figure 6. In the southern end of Babine Lake oxygen levels in spawning substrate were greater than 9 ppm in 25 of 31 samples (80%). In the Fulton River area oxygen levels in spawning substrate exceeded 9 ppm in seven of eleven samples (64%). Three of the four samples with oxygen levels less that 9 ppm were from habitat B.

In Figure 7 dissolved oxygen levels from substrate with eggs ("redds") are compared to samples taken immediately adjacent to the "redds". At both Boling and Pinkut Points the mean value of dissolved

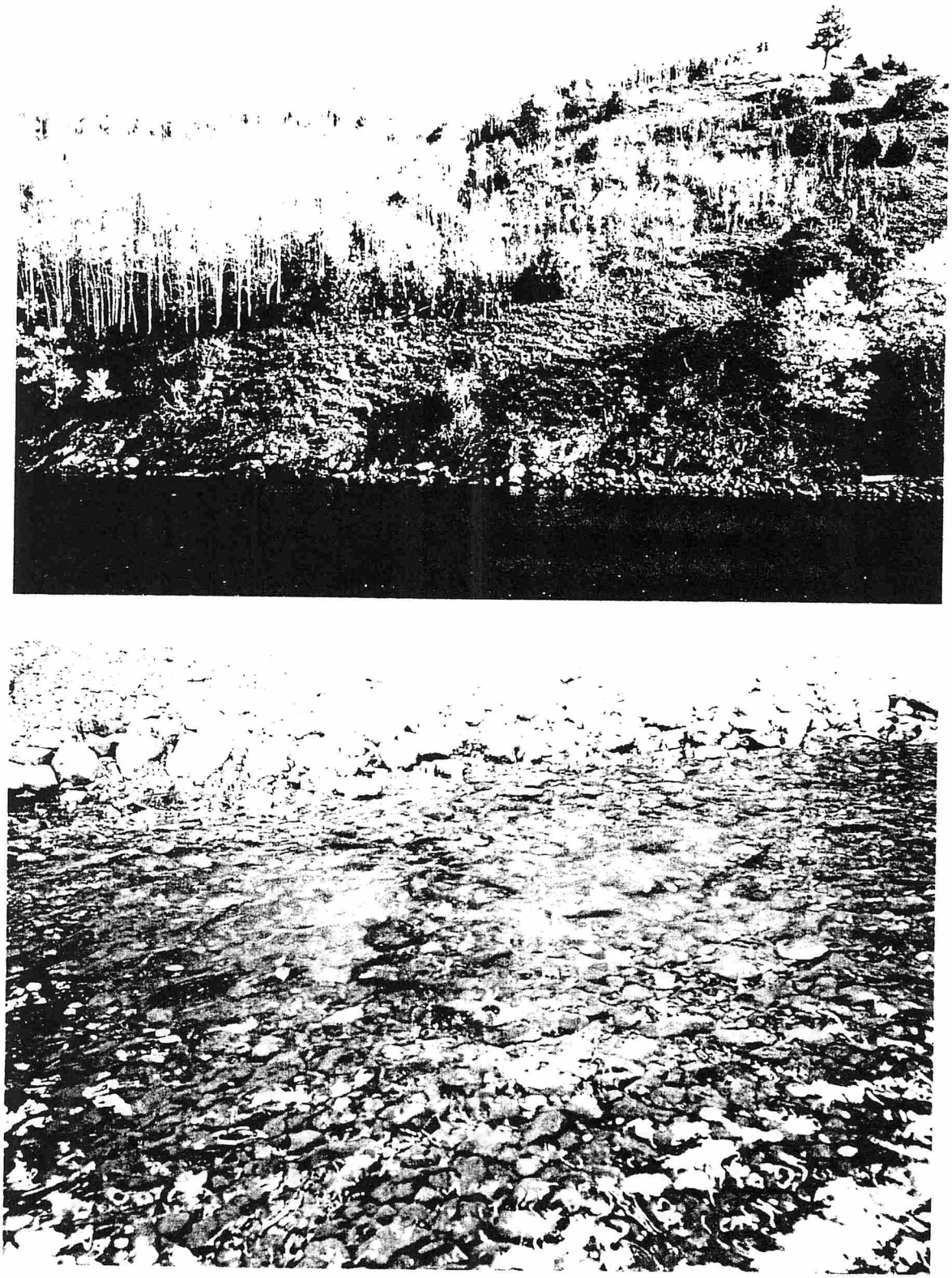

Figure 5. (Top) Typical steep sided rocky shoreline in the Boling Point spawning habitat.

(Bottom) Sockeye spawning in nearshore substrate (Habitat B) south of Red Bluff.

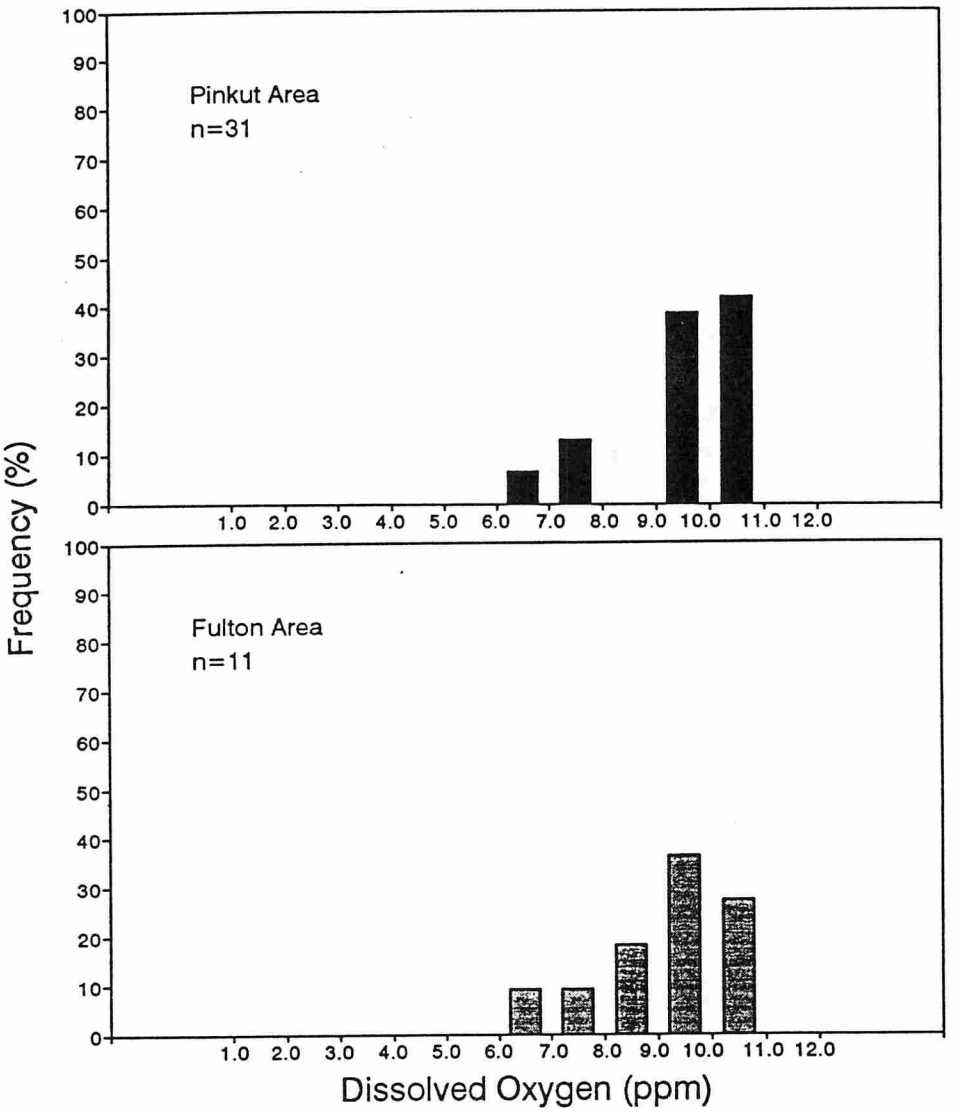

Figure 6. **Interstitial dissolved oxygen (ppm) in substrate from sockeye spawning habitat.**

oxygen is similar in both sets of samples, indicating that sockeye do not substantially modify the bottom substrate in the lake spawning areas. Figure 7 also compares the level of dissolved oxygen in the lake spawning areas with samples taken from both Pinkut Creek and the Pinkut spawning channels. There is no substantial differences between the mean level of oxygen in samples from the lake spawning habitat and Pinkut Creek. Dissolved oxygen in the spawning channel is slightly higher than the other areas. Data for all samples are given in Appendix Table F.

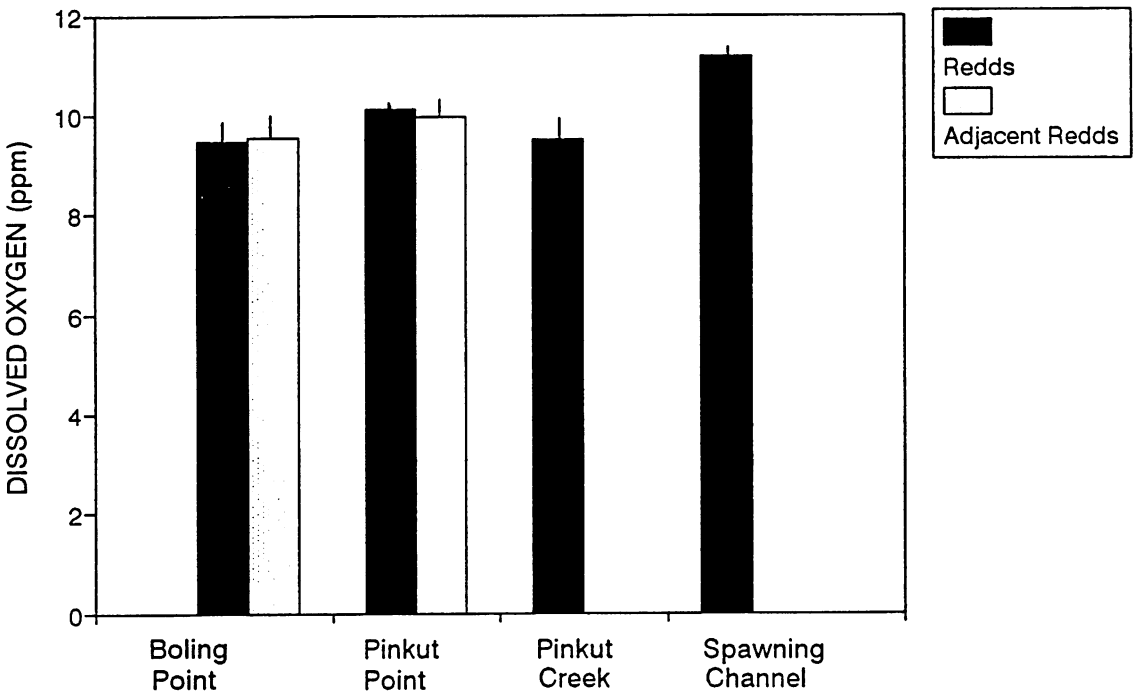

Figure 7. **Mean level of dissolved oxygen in substrate interstitial water from (1) redds and substrate adjacent to these redds (Boling and Pinkut Points) , (2) Pinkut Creek substrate below the counting fence and (3) spawning channel #1 at Pinkut Creek. N=10 for all means, error bars indicate standard error of mean.**

Five substrate samples from redds were taken from both the Pinkut and Boling Point spawning areas. The proportion of various size factions in these samples is shown in Figure 8, the fraction weight data are given in Appendix Table G. At both areas the majority of the spawning substrate was greater than 12 mm in size and the mean proportion of fines (<3.4 mm) was less than 1%. This corresponds with habitat A substrate samples taken the previous year at Wilkinson Bay and Long Island (Emmett and Convey, 1992), except the proportion of substrate greater than 100 mm in size was larger in the Boling and Pinkut Point spawning areas.

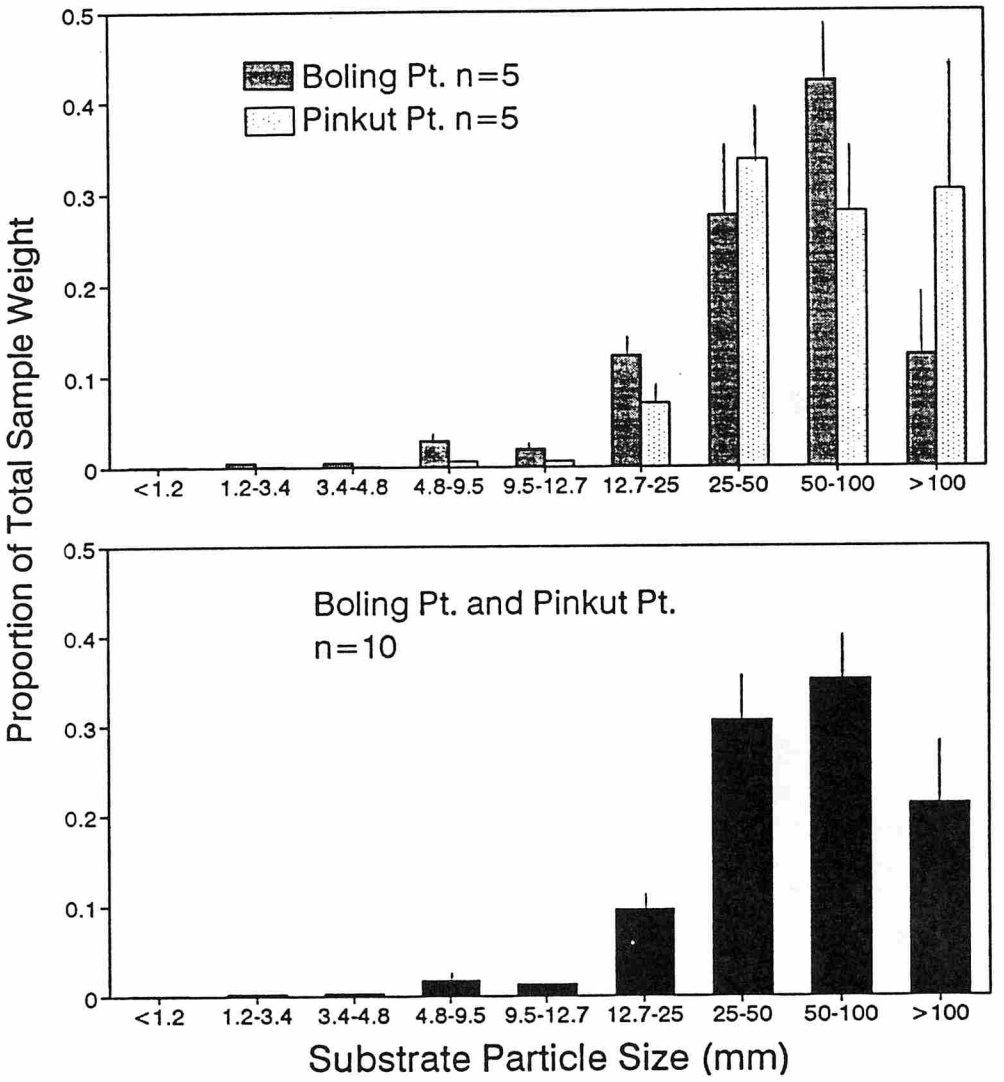

Figure 8. **Summary of substrate particle size by size fraction for samples taken from the Boling and Pinkut Points spawning habitat.**

The depth of the spawning habitat was measured at 29 locations in the south end of Babine Lake and at 11 locations in the Fulton River region of the lake. A frequency distribution of these depth measurements is given in Figure 9. Most (74%) of these depths were less than 1 metre, and at only 5 locations (12% of the total sample) were eggs found at depths greater that 2 metres. The deepest location was at 6.1 meters. Most of these deeper locations were on rocky slopes just below shallow rock ledges where sockeye had also spawned.

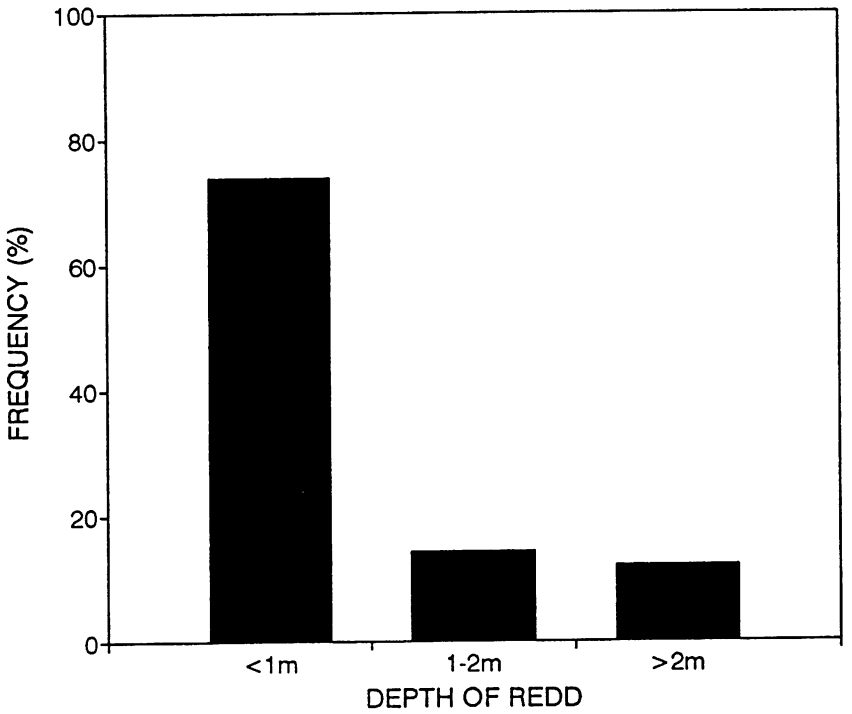

Figure 9. Frequency distribution of the depth of spawning habitat measured at 29 locations in the south end of Babine Lake and 11 locations near Fulton River. Lake level was 710.455 metres above sea level at the time of sampling.

At the two larger spawning areas near Pinkut and Boling Points the minimum and maximum depth, distance from shore and width of the spawning zone was measured at 100 metre intervals along the shoreline. These measurements are summarized in Table 1, data for each interval is given in Appendix Table H. The nearshore characteristics of the spawning habitat was similar in both areas. The spawning habitat ranged from 0.3 to 4 metres in depth and from 0.4 to 25 metres from shore. In both areas the spawning habitat was mostly within 10 metres of shore and less than 10 metres in width. These observations are typical of the other, more minor spawning areas identified in the lake.

Table 1. Nearshore characteristics of sockeye lake spawning habitat near Boling and Pinkut Points, October 1992.

LOCATION	N	DEPTH (M)				DISTANCE FROM SHORE (M)			
		Minimum		Maximum		Minimum		Maximum	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Boling Point	9	0.6	0.3-0.9	2.0	0.5-3.5	1.8	1-4	8.5	1-12
Pinkut Point	7	0.8	0.5-2.0	1.7	0.7-3.5	6.0	1-21	12.0	5-25

3.4 TRIBUTARY SPAWNING

On October 5th counts of live sockeye in Twain, Pierre and Tachek Creeks were made. The average count of the two surveyors is given in Table 2. Differences between the individual counts was less than 5%. A large number of sockeye (1275) were counted in Tachek Creek. Spaghetti tags (applied at the Babine River fence) were observed on eleven of these fish; three of the tags were recovered. At Tachek Creek most (41 of 45) female carcasses examined still contained a considerable number of eggs. Eight female carcasses from the creek were sampled for egg retention; the number of retained eggs ranged from 1355 - 3363 (data summarized in Appendix Table I).

In Pierre Creek and Twain Creek sockeye counts were much smaller (125 fish and 245 fish respectively). Only two of 35 female carcasses examined in these two creeks contained a significant number of unspawned eggs.

It is likely that the sockeye observed in Tachek Creek were surplus spawners from Fulton River, and many of the fish may have died without spawning or, at best, only partially spawning. In Twain and Pierre Creeks the sockeye observed in these surveys may represent part of a later run of fish which would not be enumerated by the tributary counts which take place earlier in the year.

Table 2. **Summary of sockeye counts in selected tributaries of Babine Lake conducted October 5, 1992.**

Creek	Distance Surveyed	Sockeye Live Count	# Tags Observed
Twain	1.0 km	245	0
Pierre	0.5 km	125	0
Tachek	1.0 km	1275	11

3.5 LAKE CHAR SPAWNING

In the fall of 1991 lake char (*Salvelinus namaycush*) were observed by divers at Wilkinson Beach, and several lake char eggs were recovered from the habitat A in this area (Emmett and Convey, 1992). During this year's field work lake char were observed in the same location as spawning sockeye on the rocky point just west of Wilkinson Beach (Figure 3). In this area the sockeye spawned mainly on the shallow rocky ledge just off the shoreline. Lake char eggs were found at the deeper margin of this ledge and down the subsequent rocky slope to depths of about 4 metres. Single char eggs were often found in the interstices of the rocky substrate; the eggs were less buoyant than sockeye and appeared to be slightly adhesive. When disturbed, they did not float as freely as sockeye eggs. Unlike sockeye, adult lake char did not remain directly over the spawning habitat, rather they were seen moving back and forth, midway in the water column, just off the rocky slope. The spawning habitat of these lake char is shown in the accompanying video (see Appendix Table A for the video index).

4.0 DISCUSSION

A total of 450,000 surplus sockeye were estimated for the Fulton and Pinkut spawning channels in 1992 (S. Barnetson, pers. comm.). Our nearshore surveys estimated about 2000 lake spawning sockeye in the area of Pinkut Creek and 300 lake spawners near the Fulton River. These numbers probably underestimate the total lake spawning population in these areas as spawning activity appeared to have peaked prior to the time of the survey. However, it is clear that only a very small proportion of the surplus sockeye from the spawning channels are accounted for as lake spawners.

Documentation of lake spawning habitat in Babine Lake show that sockeye actively select good egg incubation habitat; angular rocky substrate relatively free of fines, with interstitial oxygen levels suitable for egg development. The lake spawners do not appear to modify marginal habitat to create better spawning substrate. There is very little suitable spawning habitat available to sockeye in the areas of Babine Lake which were surveyed. That which was observed usually occurred in the shallow nearshore zone, often along steep, rocky shoreline. Our observations indicate that this type of habitat is more common near Pinkut Creek than near the Fulton River. For this reason, as well as the lack of streambed downstream of the counting fence at Pinkut, it is understandable that more lake spawning was observed in the southern area of the lake.

Over the two field seasons at Babine Lake (1991 & 1992) a total of 84 nearshore habitat transects were conducted, 55 along shoreline from Granisle to Twain Creek and 29 south of Twain Creek to the Sutherland River. No suitable sockeye spawning habitat was observed at depths below 6 metres on any of these transects. It is unlikely that sockeye spawn in areas of Babine Lake other than in the immediate nearshore margin. Therefore, if there are any major natural spawning populations of sockeye in Babine Lake, they should be readily observable from the air or by nearshore boat surveys. We consider the lake spawners observed in 1992 to be surplus spawners from the Pinkut and Fulton Channels for the following reasons:

1. Most were located within five kilometres of the spawning channels;

2. Many female carcasses recovered along the lake shore margins were unspawned or partially spawned, These were likely surplus fish that have moved back into the lake and died without finding suitable spawning habitat;

3. Very few lake spawners were observed in the Fulton River area, presumably due to the lack of suitable lake spawning habitat and the availability of river habitat below the counting fence in the Fulton River. The large number of sockeye in Tachek Creek and the high proportion of unspawned female carcasses indicate that these fish do not likely spawn in the creek and probably came from the Fulton River.

5.0 REFERENCES

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6.0 PERSONAL COMMUNICATIONS

Barnetson, S., Fulton River Enhancement Facility, Topley Landing, B.C..

Wood, C., Pacific Biological Station, Nanaimo, B.C..

APPENDIX

TABLE A. Index to video; methods used in 1991-92 field work, documentation of sockeye spawning habitat.

Time (hr:min:sec)	Footage (ft)	Description
0:00:09	1.03	SOCKEYE EGG SURVIVAL IN BABINE LAKE (Nov 91-March 92)
0:00:18	2.06	Methods
0:00:25	2.86	Dissolved Oxygen Sampling
0:01:20	9.17	Habitat A
0:02:36	17.87	Habitat B
0:03:56	27.04	Habitat C
0:05:14	35.98	Outplanting of sockeye eggs
0:05:51	40.22	Habitat A
0:07:25	50.99	Habitat B
0:08:28	58.21	Habitat C
0:10:28	71.96	Retrieval at Long Island
0:12:34	86.39	Lake Char Redds
0:15:42	107.93	SOCKEYE SPAWNING IN BABINE LAKE (SEP-OCT 92)
0:16:09	111.03	Boling Point
0:19:50	136.35	Pinkut Point
0:27:55	191.92	SPAWNING IN PINKUT CREEK
0:30:25	209.11	LAKE TROUT SPAWNING HABITAT IN BABINE LAKE
0:34:49	239.36	END

TABLE B. Data used to estimate sockeye spawners at Boling and Pinkut Points
L=low, M=medium, H=high abundance

SECTION	ABUNDANCE CODE	ASSIGNED COUNT	ACTUAL COUNT DIVER 1	ACTUAL COUNT DIVER 2	BOAT
BOLING POINT					
0-100	L	10			
100-200	L	10			
200-300	L	10			
300-400	L	10			
400-500	L	10	9	6	2
500-600	M	40			
600-700	L	10			
700-800	H	120			
800-900	H	120	122	107	57
900-1000	M	40			
1000-1100	M	40	38	30	17
1100-1200	M	40			
1200-1300	L	10			
1300-1400	L	10			
1400-1500	L	10			
1500-1600	M	40			
1600-1700	M	40			
1700-1800	M	40			
1800-1900	M	40	37	ND	28
TOTAL		650			
PINKUT POINT					
-50 - 0	H	100			
0-100	H	200	203	228	63
100-200	M	55			
200-300	0	0			
300-400	L	20			
400-500	L	20	20	14	5
500-600	M	55			
600-700	H	200			
700-800	M	55			
800-900	M	55	45	48	14
900-1000	L	20			
1000-1100	M	55			
1100-1200	M	55	70	67	26
TOTAL		890			

TABLE C. Data summaries for the habitat transects. Depth (in metres) given for shallow end of each habitat zone. SI=Silt, SD=Sand, GR=Gravel, CB=Cobble, BD=Boulder.

TRANSECT	DATE	HABITAT 1 TYPE	HABITAT 1 DEPTH	HABITAT 1 SUBSTRATE	HABITAT 2 TYPE	HABITAT 2 DEPTH	HABITAT 2 SUBSTRATE	HABITAT 3 TYPE	HABITAT 3 DEPTH	HABITAT 3 SUBSTRATE	COMMENTS
1	SEPT. 25	B	<3	CB/SA/GR	C	>3	SA/SI				
2	SEPT. 25	B	<1.2	CB/GR/SA	B	1.2-4	GR/SA	C	>2.4	SA/SI	drop off at 3m
3	SEPT. 25	B	<1.5	CB/SA	C	1.5-3	SA/GR	C	>3	SA/SI	drop off at 3m
4	SEPT. 25	B	to 18+	GR/SA							drop off at 3m
5	SEPT. 26	A	<6	CB/GR	C	>6	SA/SI				drop off at 3m; gravel bank
6	SEPT. 26	B	<3.7	CB/GR/SA	C	>3.7	SA/SI				Redds, drop off at 1.5m; cb/gr wall
7	SEPT. 26	B	<1	CB/GR	A	1-4.6	CB	B	>4.6	SA/BR/CB/BL	drop off at 1.5m; cb/gr wall
8	SEPT. 26	B	to 6+	CB/GR/SA							drop off at 1m, cliff at 6m
9	SEPT. 26	B	<4.6	CB/GR/SA	C	>4.6	SA/SI				drop off at 3m
10	SEPT. 26	B	<1.5	GR/CB	B	>1.5	GR				drop off at 1.5m
11	SEPT. 27	B	<4.6	CB/GR/SA	C	>4.6	SA/SI				drop off at 1.5m; gravel bank
12	SEPT. 27	B	to 6+	BL/GR/SA/BR							
13	SEPT. 27	B	<1.2	GR/SA	C	1.2-3	SA/GR	C	>3	SA/SI	drop off at 2.5m
14	SEPT. 27	B	<1	CB/GR	B	>1	CB/SI				
15	SEPT. 27	B	<3	CB/GR/SA/SI	C	>3	SA/SI				
16	SEPT. 27	B	<1	CB/GR	B	1-2.4	CB/SA	C	>2.4	SA/SI	
17	SEPT. 27	B	to 6+	GR/CB/SA							Redds
18	SEPT. 28	A	<1.2	CB/BL	B	1.2-9	BL/CB/GR				
19	SEPT. 28	B	<4	CB/GR/SA	C	>4	SA/SI				Redds, cliff to 10+m
20	SEPT. 28	A	<1	GR/CB/BL	B	1-8	CB/GR/SA/BL	C	>8	SA/SI	
21	SEPT. 28	A	<1	GR/CB	A	1-6	BL/CB				Redds
22	SEPT. 28	A	<2	CB/GR	B	2-4.6	CB/SA/SI	C	>4.6	SA/SI	Redds, C habitat silty
23	SEPT. 28	B	<1.5	CB/SA	C	>1.5	SA/SI				
24	SEPT. 28	B	<1.2	BR	A	1.2-3	CB/GR	B	3-6	CB/GR/SA	
25	SEPT. 28	B	<1.2	BL/GR/SA	B	1.2-3	BL	B	3-7	SA/BL	

TABLE D. Substrate dissolved oxygen data from nearshore habitat transects.

TRANSECT	DEPTH (m)	HABITAT TYPE	SUBSTRATE	TEMPERATURE (C) DIVER	TEMPERATURE (C) BOAT	OXYGEN PPM	OXYGEN % SAT	PENTN (cm)	COMMENTS
1	0.9	B	CB/SA	11.5	11.3	7.2	67	4	
1	1.8	C	SA/GR	12	11.3	2.2	20	8	
1	1.8	B	CB/GR	12	11.5	4.4	41	6	"HOLES" AT REF PT A
1	7.6	C	SA/SI	12	11.3	1	9	5	
2	0.9	B	CB/GR/SA	12	11.2	2	19	4	
2	3.0	B	GR/SA	12	11.1	2.2	21	4	
2	3.0	B	GR/SA	12	11.2	0.9	9	20	
2	7.6	C	SA/SI	12	11.2	0.8	7	20	
3	0.9	B	CB/SA	10.5	11.6	5.8	55	5	
3	2.4	B	SA/GR	11	11.8	1.2	12	5	
3	7.6	C	SA/SI	11	11.7	0.7	7	6	
4	0.6	A	CB/GR/SA	12	12.3	10.1	97	5	
4	0.6	B	GR/SA	12	12.3	9.7	92	10	
4	3.0	B	GR/SA	12	13.2	0.8	8	6	
4	3.0	B	GR/SA	12	13.7	0.9	9	4	
5	0.9	A	CB/GR	11	11.3	9.9	92	10	REDD
5	1.8	A	CB/GR	10.5	11.3	10.2	95	6	REDD
5	6.1	A	CB/GR	11	11.2	10.2	95	10	
6	0.6	B	CB/GR	11	10.9	7.8	71	6	
6	2.4	B	CB/GR/SA	11.5	10.8	9.8	88	6	
6	6.1	C	SA/SI	11	10.9	1.3	11	8	
7	0.6	B	CB/GR	11	11	9.2	86	4	
7	3.0	A	CB	11	10.9	10	92	10	
7	6.1	B	SA/BR	11	10.9	2.5	23	4	
8	0.9	B	CB/GR	11.5	12	8.8	82	4	
8	3.0	B	CB/GR/SA	11.5	11.4	0.8	7	10	
8	6.1	B	CB/GR	11.5	12.1	2	18	10	
9	0.6	B	CB/GR/SA	11.5	12.3	6.1	58	6	
9	1.8	B	GR/SA	11.5		4.2	42	6	
9	6.1	C	SA/SI	11.5	11.1	0.7	6	10	
10	0.9	B	CB/GR	12	11.8	5.3	50	4	
10	3.0	B	GR	12	12.1	1.1	11	10	
10	6.1	B	GR	12	12	7	66	10	
11	0.6	B	CB/GR/SA	11.5	11.1	7.5	70	4	
11	1.8	B	GR/SA	11	10.8	4.2	38	5	
11	6.1	C	SA/SI	11	10.9	0.6	6	10	
12	1.2	B	BL/GR/SA	10	11	8.4	78	4	
12	3.0	B	BL/GR/SA	10	11.1	3.6	33	4	
12	6.1	B	BL/GR/SA	10	11	5.3	50	6	
13	0.6	B	GR/SA	10.5	10	3.1	28	4	
13	1.5	C	GR/SA	10.5					NO SAMPLE; SILT TOO HARD TO PULL
14	0.9	B	CB/GR/SA	10	10.7	10.4	94	3	DEEPER SAMPLES PLUGGED WITH SIL
15	0.9	B	CB/GR/SA	10.5	11	5.3	46	3	
15	1.8	B	CB/SA/SI	11	10.9	2.3	19	4	
15	4.6	C	SA/SI	11	10.8	2.8	25	4	
16	0.6	A	CB/GR	10	11	8	73	4	
16	1.8	B	CB/SA	10	11.1	0.9	9	4	
16	3.0	C	SA	10.5	11	1.2	11	6	
17	1.2	B	CB/GR/SA		11	3.7	35	4	
17	3.0	B	CB/GR/SA		11.1	3.8	34	6	
17	6.1	B	GR/SA		11.1	0.8	9	5	
18	0.6	A	CB	10		9.6	90	6	REDDS TO 4'
18	1.2	A	CB/BL	10.5		9.4	88	5	
18	4.6	A	BL/CB/GR	10		6.6	61	5	
19	0.9	B	CB/GR/SA	10		8.6	82	3	
19	1.5	B	CB/GR/SA	10		8.5	83	4	
19	4.6	C	SA/SI	10		1.1	11	6	
20	0.9	A	CB/GR	11		6.5	61	6	REDD
20	3.0	B	CB/GR/SA/B	11		7.8	74	6	
20	6.1	B	CB/GR/SA/B	11					TOO DIFFICULT TO PULL
21	0.9	A	GR/CB	11		9.1	90	4	HOLE w NO EGGS
21	0.9	A	CB/GR	11		9.7	92	4	REDD w EGGS
21	3.0	A	BL/CB	11		9.7	91	10	NO EGGS DEEPER
22	0.6	A	CB/GR	11		7.6	72	4	SCUMMY
22	1.5	A	CB	11.5		7.6	73	10	SCUMMY
22	3.7	B	CB/SA/SI	11.5		1.3	14	6	
23	0.9	B	CBSA	12		9.5	92	5	
23	3.0	C	SA/SI	12		1.5	13	10	
24	1.2	A	CB/GR	12		9.2	90	6	LEAF DEBRIS
24	3.0	B	CB/GR	12		1.2	10	8	LEAF DEBRIS
24	6.1	B	CB/GR/SA	12		2.1	21	8	
25	3.0	A	BL	12		9.3	92	10	CAN'T INSERT SPIKE AT SHALLOW DEP
25	7.3	B	SA/BL	12		3.6	34	4	

TABLE E. Substrate dissolved oxygen data collected from sockeye spawning substrate in Babine Lake.

LOCATION	DEPTH (m)	HABITAT TYPE	SUBSTRATE	TEMPERATURE DIVER	TEMPERATURE BOAT	OXYGEN PPM	OXYGEN % SAT	PENTN (cm)	COMMENTS
TRANSECT 5	0.9	A	CB/GR	11	11.3	9.9	92	10	EGGS UNDER ROCK
TRANSECT 5	1.8	A	CB/GR	10.5	11.3	10	95	6	EGGS UNDER ROCKS
TRANSECT 16	0.6	A	CB/GR		11	6.8	63	7	CLOSE TO TRANS 16
TRANSECT 16	0.6	A	CB/GR		11.1	7.5	68	7	CLOSE TO TRANS 16
TRANSECT 16	0.6	A	CB/GR		11.1	7.4	69	7	CLOSE TO TRANS 16
TRANSECT 18	0.6	A	CB/GR	11	11.3	9.7	91	8	
TRANSECT 18	0.6	A	CB	10		9.6	90	6	REDDS TO 4'
TRANSECT 18	0.6	A	CB/GR	11	11.2	9.9	91	8	
TRANSECT 18	0.6	A	CB/GR	11	11.3	9.8	90	8	
TRANSECT 20	0.9	A	CB/GR	11		6.5	61	6	
TRANSECT 21	0.9	A	CB/GR	11		9.7	92	4	REDD w EGGS
BOLING 100	0.6	A		11.5		9.8	101	8	
BOLING 1100	0.7	A		11.5		10	99	10	
BOLING 1200	0.9	A		12		10	101	10	
BOLING 1400	1.9	A		11.5		9.9	96	8	
BOLING 1400	0.8	A		11		10	100	8	
BOLING 500	0.55	A		11.5		10	100	8	
BOLING 600	0.5	A		11.5		7.7	79	8	
BOLING 800	0.6	A		11.5		7.7	79	8	
BOLING 800	4	A		11		9.8	97	8	
BOLING 900	3.5	A		11.5		9.3	95	8	
PINKUT 0	3.5	A		11		9.9	93	10	
PINKUT 0	1.1	A		11		9.9	92	10	
PINKUT 100	1.6	A		11		9.9	93	10	
PINKUT 100	0.8	A		11		10	94	10	
PINKUT 1075	0.7	A		11.5		10	99	10	
PINKUT 1100	0.7	A		11.5		10	97	10	
PINKUT 1100	0.7	A		11.5		10	95	10	
PINKUT 500	0.55	A		11		10	98	10	
PINKUT 600	0.7	A		11		10	9.8	10	
PINKUT 800	0.7	A		11.5		10	96	10	
RED BLUFF A	0.9	B	CB/GR/SA	10	9.8	6.1	55	8	
WILKINSON N	1.5	A	CB/GR	10	10.9	7	64	8	
RED BLUFF E	0.3	B	CB/GR/SA	9	9.8	8.4	77	8	
RED BLUFF E	0.25	B	CB/GR/SA	9	9.7	8.6	77	8	
PT ARTHUR	0.65	A	GR	10	10.5	9.4	88	8	BL IN AREA; WOOD FIBRES BTN GR
TACHEK	1.1	A	GR/CB	10	10.3	9.5	87	5	BL IN AREA; WOOD FIBRES BTN GR
WILKINSON N	0.7	A	GR/CB		10	9.6	90	8	
PT ARTHUR	0.55	A	CB/GR	10.5	10.3	9.9	93	8	
WILKINSON N	3	A	CB/GR	10	10.7	10	94	8	
WILKINSON N	0.75	A	GR/CB		10	10	93	8	
RED BLUFF E	0.4	B	CB/SA/GR	9	9.6	10	94	8	

TABLE F. Dissolved oxygen data collected from (1) Redds and substrate adjacent to Redds at Pinkut and Boling Points, (2) Redds in the Pinkut spawning channel and (3) Redds in Pinkut Creek below the counting fence.

LOCATION	DEPTH (m)	HABITAT TYPE	TEMPERATURE DIVER	TEMPERATURE BOAT	OXYGEN PPM	OXYGEN % SAT	PENTN (cm)
BOLING 100	0.7	A ADJ	11.5		10.1	103	
BOLING 100	0.6	A REDD	11.5		9.8	101	
BOLING 500	0.55	A REDD	11.5		10	100	
BOLING 500	0.6	A ADJ	11.5		10.4	102	
BOLING 600	0.5	A REDD	11.5		7.7	79	
BOLING 600	0.6	A ADJ	11.5		9.9	98	
BOLING 800	4	A ADJ	11		9.8	98	
BOLING 800	0.6	A REDD	11.5		7.7	79	
BOLING 800	4	A REDD	11		9.8	97	
BOLING 800	0.65	A ADJ	11.5		7	71	
BOLING 900	3.5	A REDD	11.5		9.3	95	
BOLING 900	3.5	A ADJ	11.5		9.9	97	
BOLING 1100	0.6	A ADJ	11.5		10.3	100	
BOLING 1100	0.7	A REDD	11.5		10.2	99	
BOLING 1200	0.9	A REDD	12		10.2	101	
BOLING 1200	1	A ADJ	11.5		9.8	98	
BOLING 1400	1.9	A REDD	11.5		9.9	96	
BOLING 1400	0.7	A ADJ	11		10	100	
BOLING 1400	2	A ADJ	11.5		8.3	81	
BOLING 1400	0.8	A REDD	11		10	100	
PINKUT 0	1.1	A REDD	11		9.9	92	10
PINKUT 0	1.2	A ADJ	11		7.3	69	10
PINKUT 0	3.5	A REDD	11		9.9	93	10
PINKUT 0	3.5	A ADJ	11.5		10	94	10
PINKUT 100	1.4	A ADJ	11		10.1	96	10
PINKUT 100	0.8	A REDD	11		10	94	10
PINKUT 100	0.8	A ADJ	11		10	95	10
PINKUT 100	1.6	A REDD	11		9.9	93	10
PINKUT 500	0.6	A ADJ	11		10.3	98	10
PINKUT 500	0.55	A REDD	11		10.3	98	10
PINKUT 600	0.7	A REDD	11		10.4	9.8	10
PINKUT 600	0.7	A ADJ	11		10.5	99	10
PINKUT 800	0.7	A REDD	11.5		10.2	96	10
PINKUT 800	0.7	A ADJ	11.5		10.4	99	10
PINKUT 1075	0.7	A ADJ	11.5		10.3	99	10
PINKUT 1075	0.7	A REDD	11.5		10.3	99	10
PINKUT 1100	0.7	A REDD	11.5		10.2	97	10
PINKUT 1100	0.65	A ADJ	11		10.4	99	10
PINKUT 1100	0.7	A ADJ	11.5		10.3	98	10
PINKUT 1100	0.7	A REDD	11.5		10.1	95	10
PINKUT CREEK	0.3	A REDD		8.3	10.4	90	10
PINKUT CREEK	0.3	A REDD		8.3	10.2	91	10
PINKUT CREEK	0.3	A REDD		8.4	10.2	91	10
PINKUT CREEK	0.3	A REDD		8.4	10.4	91	10
PINKUT CREEK	0.3	A REDD		8.5	8.5	74	10
PINKUT CREEK	0.3	A REDD		9.9	6.5	60	10
PINKUT CREEK	0.3	A REDD		10	8.2	75	8
PINKUT CREEK	0.3	A REDD		8.4	10.6	91	10
PINKUT CREEK	0.3	A REDD		8.6	9.4	81	10
PINKUT CREEK	0.3	A REDD		8.3	10.6	92	10
RIVER SURFACE	0.0	WATER			11	100	0
SPAWNING CHANNEL	0.5	A REDD			11.4	99	
SPAWNING CHANNEL	0.5	A REDD		8.7	11.2	97	
SPAWNING CHANNEL	0.5	A REDD		8.2	11.2	97	
SPAWNING CHANNEL	0.5	A REDD			11.4	99	
SPAWNING CHANNEL	0.5	A REDD			11.4	98	
SPAWNING CHANNEL	0.5	A REDD			11.3	98	
SPAWNING CHANNEL	0.5	A REDD		8.4	10.6	93	
SPAWNING CHANNEL	0.5	A REDD		8.3	11.1	97	
SPAWNING CHANNEL	0.5	A REDD			11.3	98	
SPAWNING CHANNEL	0.5	A REDD			10.9	95	

TABLE G. Proportion of size classes in substrate samples taken from Pinkut and Boling Point spawning areas.

	LOCATION	DEPTH (m)	OXYGEN (ppm)	FRACTION SIZE CLASSES (mm) WITH WEIGHTS (g) >100	50-100	25-50	12.7-25	9.5-12.7	4.8-9.5	3.4-4.8	1.2-3.4	<1.2	TOTAL
BOLING POINT:	500	0.55	10		2086	2764	649	8.4					5507.4
	800	0.6	7.7	2361	1420	603	527	203	428	130.4	124.8	19.6	5816.8
	900	3.5	9.3	1720	3532	2249	508	101.5	145	6.5	2	0.7	8264.7
	1200	0.9	10.2		3402	2714	616	32.3	12	0.6	0.5	0.5	6777.9
	1400	0.8	10		2700	478	1202	195.6	232.6	6.9	1		4816.1
PINKUT POINT:													0
	0	1.1	9.9	1776	676	2008	945	111.4	101	9.3	4.6	2.4	5633.7
	0	3.5	9.9	9567	1537	2279	156.7				0.05	0.05	13539.8
	100	0.8	10		2173	2954	720	4.1	0.5				5851.6
	600	0.7	10.4	4158	1963	1877	297	75.7	67.3	4.1	0.8		8442.9
	1100	0.7	10.2		3426	2609	63.8		0.8			0.1	6099.7

TABLE H. Habitat characteristics of sockeye spawning areas at Boling and Pinkut Points.
Habitat measurements were made at 100m intervals along the shoreline length of spawn.

BOLING POINT

INTERVAL (m)	MINIMUM DEPTH	MINIMUM DISTANCE	MAXIMUM DEPTH	MAXIMUM DISTANCE	WIDTH	% DISTURBED	O2 SAMPLE	SUBSTRATE SAMPLE	COMMENTS
0	0.3	0.4	0.5	4	3.6	10	NO	NO	NO EGGS SEEN,
1	0.6	2	1.4	9	7	70	YES	NO	
2	0.4	1	0.6	4	3	25	NO	NO	NO EGGS SEEN
3	0.6	2	0.8	6.5	4.5	10	NO	NO	NO EGGS SEEN
4					0		NO	NO	NO DISTURBED ARES NOTED
5	0.5	1	1.1	6	5	50	YES	YES	
6	0.5	1.5	1	4.5	3	20	YES	NO	
7					0		NO	NO	NO DISTURBED AREAS SEEN
8	0.5	1	4	11	10	70	YES(2)	YES	MAJOR SPAWNING AREA
9	0.7	1	3.5	12	11	80	YES	YES	MAJOR SPAWNING AREA
10	0.7	1	1.4	7	6	5	NO	NO	
11	0.7	3	2	10	7	80	YES	NO	SOME DISTURBED SUBSTRATE TO 6m BUT NO EGGS
12	0.9	1.5	1.2	6	4.5	40	YES	YES	
13	0.6	1	0.6	1	0	5	NO	NO	NO EGGS SEEN
14	0.7	4	2.5	11	7	30	YES(2)	YES	
15	0.4	2	0.6	3	1	5	NO	NO	NO EGGS SEEN
16					0		NO	NO	<1% DISTURBANCE, ROCKS COVERED WITH GREEN ALGAE
17					0		NO	NO	<1% DISTURBANCE,GREEN ALGAE ON ROCKS
18	0.6	2	0.7	6	4	40	NO	NO	NO EGGS SEEN, FISH IN AREA
19	0.6	3	0.7	5	2	50	NO	NO	NO EGGS SEEN, NO FISH SEEN
MEAN	0.64	1.78	2.01	8.50	6.72				

PINKUT POINT

INTERVAL (m)	MINIMUM DEPTH	MINIMUM DISTANCE	MAXIMUM DEPTH	MAXIMUM DISTANCE	WIDTH	% DISTURBED	O2 SAMPLE	SUBSTRATE SAMPLE	COMMENTS
0	0.9	1	4	20	19	90	YES(2)	YES(2)	NO DEEPER THAN 1.5m TO E OF MARKER
1	0.5	1	1.5	10	9	90	YES(2)	YES	BASICALLY 100% OF MOVEABLE NONBOULDER SUBSTRATE
2	BEACH-NOT SURVEYED				0		NO	NO	
3	BEACH-NOT SURVEYED				0		NO	NO	
4	0.6	2	0.9	5	3	25	NO	NO	NO EGGS
5	0.5	7	0.8	9	2	30	YES	NO	
6	0.7	5	0.8	7	2	75	YES	YES	A COUPLE OF DIGS AT 2m DEPTH
7	2	21	3.5	25	4	40	NO	NO	LOTS OF FISH, SEE DIVE NOTES
8	0.5	2	0.7	6	4	60	YES	NO	
9					0		NO	NO	NO FISH NO EGGS NO DISTURBANCE
10					0		NO	NO	MINOR DITURBANCES ONLY AT 3m DEPTH WHICH IS SILTY
11	0.5	5	0.7	7	2	80	YES(3)	YES	
MEAN	0.80	6.00	1.71	12.00	6.00				

TABLE I. Egg retention in female sockeye carcasses (% retention assumes a fecundity of 3000 eggs per female).

Stream	Total Egg Weight	Subsample Weight	Subsample No. of eggs	Total Egg Number	% Retention
Twain	320.01	30.06	233	2480	83
Twain	356.53	34.31	302	3138	105
Tachet	181.45	18.75	140	1355	45
Tachet	240.3	26.43	254	2309	77
Tachet	217.8	23.59	193	1782	59
Tachet	512.77	58.55	384	3363	112
Tachet	305.94	30.97	245	2420	81
Tachet	314.23	30.72	251	2567	86
Tachet	258.99	27.22	198	1884	63
Tachet	257.88	26.29	245	2403	80