BEAR LAKE SOCKEYE SALMON SMOLT ENUMERATION PROJECT SEASON REPORT, 2001

By

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ABSTRACT

Bear Lake supports the largest sockeye salmon *Oncorhynchus nerka* run along the North Alaska Peninsula. A smolt enumeration project was implemented at Bear Lake in 2000 to assess sockeye salmon smolt production by estimating the population size, age structure, and physical size of the sockeye salmon smolt emigrating from Bear Lake. The limnological conditions of Bear Lake were also assessed by collecting nutrient level, zooplankton, temperature, and dissolved oxygen data. A total of 3,335,375 (+/- 2,248,560; 95% C.I) sockeye salmon smolt were estimated to have emigrated from Bear Lake in 2001. The majority (60.7 %) of the outmigrating smolt were age 2. The mean lengths (mm) and weights (g) of the smolt sampled, by age, were 73.1 and 3.8 (age 0.), 117.3 and 16.3 (age 1.), 121.1 and 17.5 (age 2.) and 131.1 and 22.1 (age 3.), indicating that the smolt that emigrated from Bear Lake in 2001 were large and healthy.

INTRODUCTION

Bear Lake is located on the north side of the Alaska Peninsula, approximately 25 km east of Port Moller (Figure 1). The lake has a surface area of 25.6 km^2, a mean depth of 32 m and a maximum depth of 104 m (Honnold et al. 1996; Figure 2). Bear River is roughly 30 km in length and drains northwesterly into the Bering Sea. The Bear Lake watershed supports the largest sockeye salmon *Oncorhynchus nerka* runs in the Northern District of the Alaska Peninsula Management Area (Bouwens et al. 2001). Over the last 10 years, sockeye salmon escapements have ranged from about 305,000 in 1995 to about 606,000 sockeye salmon in 1991 (McCullough 2000). It is generally accepted that there is both an early and late sockeye salmon run to Bear Lake. Ramstad (1998) examined the morphology, life history, and genetic traits of the early and late runs of sockeye salmon at Bear Lake and concluded the two runs were indeed distinct and separate. Total run and return size data to Bear Lake are unavailable because, during the early run, several stocks are harvested concurrently. Late run harvest data are available, and over the last 10 years have ranged from 297,000 in 1998 to 1.15 million in 1995 (Murphy et al. 2000).

There has been relatively little limnology research on Bear Lake or fishery research on its sockeye salmon stocks. Honnold et al. (1996) evaluated the potential sockeye salmon production of Bear Lake and concluded that it was most likely limited by spawning area. Bear Lake was found to be relatively rich in zooplankton biomass and the smolt produced were robust, indicating the forage base for sockeye salmon was probably underutilized.

There are multiple methods available to determine escapement goals for a particular system (Honnold and Sagalkin 2001). The escapement goal of 200,000 - 250,000 sockeye salmon to Bear Lake, developed in the late 1960s and early 1970s by area management biologists, was based primarily upon historic escapement data (Bob Murphy, Alaska Department of Fish and Game, Kodiak, personal communication). Typical return/spawner (R/S) calculations are helpful and have been calculated for Bear Lake (Honnold et al. 1996). Unfortunately, total return data are only available for the late run to Bear Lake (Bouwens et al. 2001). Euphotic volume (EV) has been used as an indicator of potential sockeye salmon production in many Alaskan sockeye salmon lakes, and probably is an appropriate estimator of sockeye salmon production in deep, oligotrophic lakes such as Bear Lake (Honnold et al. 1996; Koenings and Kyle 1997). Zooplankton biomass may also be an indicator of sockeye salmon production, but the relationship between zooplankton biomass and smolt biomass production becomes less clear when the lake is not rearing-limited (Koenings and Kyle 1997).

A smolt and limnology project was implemented to further assess the potential for sockeye salmon production at Bear Lake. Specifically, data on smolt production and health (length and weight) provide a measure of the rearing capabilities of the system. This goal was to be achieved by addressing the following objectives:

1) Estimate the population size of emigrating sockeye salmon smolt from Bear Lake.
2) Estimate the mean weight and length, by age, of sockeye salmon smolt emigrating from Bear Lake.
3) Measure water temperature and dissolved oxygen profiles, zooplankton abundance and species composition, and the water chemistry of Bear Lake.

The purpose of this document is to report the preliminary results of the 2001 field season. Therefore, conclusions and recommendations are limited.

METHODS

Trap Description

In 2000, a rotary screw trap was used to capture smolt emigrating from Bear Lake with little success due to the flow conditions of Bear River paired with the relatively large size of Bear Lake smolt (Bouwens 2001). The large, strong smolt were able to avoid the screw trap and swim against the sow current of the upper Bear River. In 2001, an incline plane trap was designed and fabricated after Todd (1994) to capture sockeye salmon smolt at Bear River. The trap was 122 cm wide and 152 cm high at the trap entrance. The trap was 280 cm long and tapered to an exit opening that was 91 cm wide and 30 cm high. A 0.89 m^3 live box was attached to the downstream end of the trap. The trap bed consisted of 0.63 cm diameter perforated plate that was bent into four "V" shaped baffles, each of which was approximately 10 cm high and 10 cm wide. The entire inside of the trap was painted black. The sides of the trap were covered with 0.95 cm black plastic mesh.

A support structure made of 244 cm long by 10 cm high by 10 cm wide wooden timbers was used to attach a winch which allowed the vertical adjustment of the downstream end of the trap bed. This structure consisted of four legs arranged in an angled configuration that supported a cross member that spanned the width of the trap. A pulley was attached to the cross member and a cable was threaded from a winch attached to one of the legs through the pulley on the cross member and attached to the aft end of the trap.

Two wings were configured upstream of the trap to direct fish into the trap. The wings were supported by 5 cm diameter schedule 80 piping configured into bipods supporting a cross member. The legs of the bipods were 1.2 m in length and the cross members were 2.4 m in length. Wooden stringers were attached to the upstream legs of the bipods approximately 30 cm from the bottom and 30 cm from the top of the legs. Perforated aluminum plating (122 cm by 244 cm; 1.5 cm diameter holes) was laid on the wooden stringers. Plastic mesh (0.95 cm) was laid on the aluminum in a manner that allowed the placement of sandbags along the bottom to seal any holes between the bottom of the aluminum and the substrate.

Trap Placement

The trap was placed approximately 1 km downstream of the lake outlet on May 23, as recommended in Bouwens (2001). The center of the trap was located approximately 3 m off the northern bank. The mouth of the trap was placed in approximately 60 cm deep water. The offshore lead was 3.65 m long and the inshore lead was 3.04 m in length, and were placed at approximately a 60° angle to the trap mouth.

The initial trap configuration was modified several times to accommodate changing flow conditions. On June 6, the trap was slightly modified by widening the wings to about a 45° angle to increase flows. On June 21, the trap and wings were moved towards shore approximately 1 m because of rising water and scouring issues on the outside wing. On July 2, the trap was again moved about 1 m inshore and upriver approximately 4 m because of high water. On July 4, the trap was moved downriver approximately 10 m because of dropping water conditions. The lead configuration was changed at this trapping location. The offshore wing was approximately 3.5 m in length and was configured almost 90° to the current. The inshore lead was about 4 m in length and was positioned about 45° to the current. On July 5, the trap was relocated to the original location and the wings were placed in their original configuration. On July 9, the trap was moved up stream about 2 m and offshore about 2 m to increase flows due to dropping water conditions. On July 13, the trap was again moved up stream about 2 m and offshore about 2 m to increase flows due to dropping water conditions. On July 16, water levels increased and the trap was moved downstream approximately 1.5 m to prevent scouring. On July 17, a smolt diversion device was installed on the offshore panel. This device consisted of a 10.9 m long gillnet cork line with 12 each 6.3 cm by 20.3 cm wooden flashers evenly spaced along the line. This line connected an anchor located upstream of the offshore lead, to the upstream most point on the offshore lead. The line was held at a 70° angle to the current. On July 18, standard weir panels were placed under the leads to prevent scouring. On July 25, the trap was again moved offshore approximately 3 m due to dropping water levels. After being moved, the wings and flasher line were placed in the same configuration as before. On August 3 the trap was again moved offshore into the main channel. The flasher line was not reinstalled. The traps were pulled for the season on August 10.

Fish Enumeration

As sockeye salmon smolt emigrate primarily at night, a smolt day was defined as a period from noon to noon, with the date corresponding to the day of the first 12-hour period. All data were recorded in this format. All fish captured were netted out of the trap's catch box, identified, and counted by species. Salmon smolt were defined as juvenile salmon >45 mm fork length (FL). Salmon < 45 mm FL were considered fry. Fry and smolt numbers were recorded separately, and catches were tallied individually.

Age, Weight, and Length Sampling

When available, sockeye salmon smolt were sampled for age, weight, and length (AWL) information five days/week. On nights when less than 40 sockeye salmon smolt were captured, all captured smolt were sampled for AWL information. On nights when greater than 40 smolt were captured, a random sample of 40 smolt were collected and sampled for AWL information.

Tricaine methanesulfonate (MS-222) was used to anesthetize smolt prior to sampling. Fork length (FL) was measured to the nearest 1 mm, and fish were weighed to the nearest 0.1 g. A sample of 5-10 scales were removed from the preferred area (INPFC 1963) and mounted on a microscope slide for age determination. After sampling, fish were held in aerated water until they recovered from the anesthetic, and were subsequently released downstream from the trap. Age

was estimated from scales using a microfiche reader under 36X or 60X magnification. All data were recorded in European notation (Koo 1962).

Condition factor (Bagenal and Tesch 1978) for each smolt sampled was determined using:

$$K = \frac{W}{L^3} 10^5 \quad , \qquad (1)$$

where K is smolt condition factor, W is weight in g, and L = FL in mm.

Mark Recapture Experiments

A weekly sample (goal = 1,000) of sockeye salmon smolt were marked using Bismark brown dye and released upstream of the traps to estimate the proportion of the total smolt emigration that was being captured in the trap.

Fish to be marked were transferred from the in-stream live box to a transport/marking tote (113.6 l). The tote was then covered and a water pump was used to slowly exchange the water in the tote for 30 minutes. The circulation pumps were then turned off and 3.8 g of Bismark Brown-Y dye was dissolved in the tote. After 20 minutes in the dye, the pump was started and the tote was flushed with fresh water for 90 minutes.

Smolt showing normal behavior were transported upstream to the release site. At the release site, the smolt were dip netted from the containers, counted, transferred to 18.9 l buckets, and released across the stream. The Bear River smolt population was estimated by using methods described in Carlson et al. (1998).

Limnology Sampling

Limnology samples were taken from Bear Lake on May 25, June 29, July 27, and August 11. Four limnology sampling stations were established in Bear Lake (Figure 2) and marked with a buoy. The coordinates of the stations are listed in Table 1. Zooplankton samples, Secchi disk readings along with temperature, dissolved oxygen (DO), and light intensity profiles were taken from all four stations. Water samples were taken from stations 2 and 3. More complete sampling methods and equipment descriptions can be found in Bouwens and Schrof (2000).

Climate Data

Air and water temperature, wind direction and velocity, and cloud cover and elevation were measured twice daily (1200 and 2400 hours) throughout the field season. Hand held mercury thermometers were used to measure the temperatures. Wind direction and velocity, cloud cover, and cloud elevation was visually estimated by field personnel.

RESULTS

Trap Catches

A total of 33,852 sockeye salmon smolt were captured in the trap in 2001 (Table 2; Appendix A). In addition to sockeye salmon smolt, a total of 13,498 sockeye salmon fry, 7,089 juvenile coho salmon *O. kisutch*, 1,172 pink salmon *O. gorbuscha* fry, 148 Dolly Varden char *Salvelinus malma*, 2,104 sculpin *Cottus spp.*, 8 stickleback (family Gasterosteidae), and 1 Alaska blackfish *Dallia pectoralis* were captured (Appendix A).

Age, Weight and Length Sampling

A total of 1,919 sockeye salmon smolt were sampled for AWL data in 2001; ages were discernable from 1,917 of these (Table 3). The majority (54.1%) of the sockeye salmon smolt sampled were age 2., followed by age 1. smolt (40.5%). There were few age 0. and age 3. sockeye salmon smolt sampled (Table 3). The age compositions of smolt sampled from 1993 to 2001 are listed in Table 4. The mean length, weight, and condition factor of sockeye salmon smolt sampled in 2001, by age, are listed in Table 5, and these data are listed with historic data in Table 6. The smolt at Bear Lake in 2001 were large and robust, with condition factors over 0.95 for the major age classes.

Trap Efficiency Estimates

Mark-recapture experiments were conducted on eight occasions beginning on June 11 and ending on August 9. Trap efficiencies ranged from a low of 0.14 % to a high of 4.55 % (Table 2).

Sockeye Salmon Smolt Emigration and Timing

The estimated number of sockeye salmon smolt that emigrated in 2001 was 3,337,375 (±2,248,560; 95% C.I.; Table 7). The 2001 emigration consisted of 3,414 age 0., 1,132,508 age 1., 2,022,820 age 2., and 176,633 age 3. sockeye salmon smolt (Table 7). There was little migratory activity until early June, when emigration rates increased substantially, peaking on June 16 (Figure 3). Emigration rates subsequently dropped off, and peaked again about a month later on July 14 (Figure 3). The earlier peak was composed of proportionately more age 2. smolt than the later peak (Figure 4).

Limnology Sampling

Bear Lake showed a marked thermocline in 2001, and surface water temperatures at the surface ranged between 5° C in May to 12° C in August (Figure 5). Temperature profiles indicated the lake was mixed in May and was stratified in June and July. The temperature profile in August indicated the thermocline was breaking down. Hypolimnetic temperatures ranged from 3° to 6° over the summer. DO levels ranged from 7 to 10 ug/L over the summer (Figure 5). There were

no distinct DO discontinuities with depth. DO was not measured in August due to equipment failure.

Light intensity and penetration was measured at all stations. Averaged over stations, the depth to which 1% of the subsurface light penetrated, or EZD, was 26.9 m in May, 29.8 m in June, 17.9 m in July, and 20.7 m in August. Overall, the average EZD for 2001 was 20.1 m. This equated to an EV of 515 X 10^6 m^3. Based upon the EV model of Koenings and Burkett (1987), the modeled production of threshold sized smolt (2.5 g) is approximately 12 million fish annually. When the actual mean size of Bear Lake smolt (11.6 g; age 1. and 2. from 1993 - 2001) was substituted in the equation, the 2001 modeled smolt production was approximately 3.5 million smolt. Based upon these production levels, the total expected sockeye salmon production of Bear Lake was about 1.3 million adult sockeye salmon. These data are listed in comparison to 2000 data in Table 8.

Cyclops and *Bosmina* were the predominant macrozooplankton genera found in Bear Lake. A large number of rotifers were also noticed but they are not considered significant sockeye salmon forage (Tables 9-11; Koenings et al. 1987). *Cyclops* were more abundant than *Bosmina* earlier in the summer, and *Bosmina* became more abundant later in the season. Koenings and Kyle (1997) developed a model to relate sockeye salmon smolt production to zooplankton abundance. The expected sockeye salmon smolt production of Bear Lake based on this model in 2001 was approximately 2.5 million 11.6 g smolt.

Surface water samples were taken from stations 2 and 3 (1 m depth). These samples were analyzed for the following parameters: pH, alkalinity, total phosphorus (TP), total filterable phosphorus (TFP), filterable reactive phosphorus (FRP), ammonia, nitrate + nitrite, chlorophyll *a*, and phaeophytin *a*. Averaged between stations, phosphorus, chlorophyll *a*, and nitrate+nitrite levels decreased over the season, while ammonia levels increased (Table 12). FRP increased substantially at Station 2 over the summer while it remained relatively constant at Station 3. Similarly, there was a steady decline in nitrate+nitrite at Station 2 over the summer while the nitrate+nitrite levels at Station 3 were more variable (Table 13).

Climate Data

Air temperatures ranged from 2.5 °C on June 9 to 18.0 °C on July 5. Water temperatures ranged from 3.5 °C on May 20 to 11.0 °C on July 15. Air and water temperatures, wind direction and velocity, cloud cover and elevation, and stream height and velocity data are listed in Appendix B.

DISCUSSION

The inclined plane trap used in 2001 performed much better than the screw trap used in 2000 (Bouwens 2001), and smolt catches were significantly higher. The trap did, however, require to be relocated on numerous occasions in response to changing water conditions. The trap reqired relocation when the water level increased or decreased more than about 30 cm. Part of the problem was due to the erosion of the substrate under the wings. The substrate in Bear River is lightly compacted and well sorted. This problem was solved by laying weir panels under the

wings to provide support for the wings. It is recommended that the inclined plane trap be used again in 2002 with the weir panel modifications.

Trap efficiencies were low and, more importantly, there were few recaptures from each mark-recapture test. An additional inclined plane trap would increase the overall trap efficiency. Low trap efficiencies would be acceptable if enough fish were marked and subsequently recaptured to provide statistical confidence with the low trap efficiency. The large size of the Bear Lake smolt precluded marking as many smolt as preferred, due to crowding problems in the marking container. Additional marking containers and dye will be available for the 2002 field season.

The total smolt population estimate for 2001 was reasonable despite the low trap efficiencies and low confidence in the estimates. The estimated smolt production based on the EV model of Koenings and Burkett (1987) and the estimated smolt production based on the zooplankton model of Koenings and Kyle (1997) were similar to the actual smolt estimate from this study after adjustments were made for the actual size of the smolt that leave Bear Lake. Both of these models were developed to estimate the production of small (2 to 5 g) sockeye salmon smolt. These models then estimated the smolt production of Bear Lake to be over 10 million smolt. When the actual size of Bear Lake smolt was substituted in the equation, however, the modeled production and the number of smolt estimated out of Bear Lake were similar to the actual estimate of 3.34 million smolt. It is important to note that these models were developed using systems in which production was limited by available rearing habitat, not by spawning habitat, which is considered the case at Bear Lake (Honnold et al. 1996).

Both the EV and zooplankton model predicted adult sockeye salmon production of approximately 1.3 to 1.5 million fish. These production numbers are based on producing the more numerous, but smaller, smolt. It is not possible to provide a true estimate of the total run to Bear Lake because of the mixed stock nature of the early-run fishery. These numbers are, however, similar to the estimated production potential of 1.2 million sockeye salmon as reported in Murphy et al. (2000), which was calculated by average return per spawner methods, using data from the late-run. It is likely, then, that these total production estimates are reasonable.

The traditional EV and zooplankton models assume a marine survival of approximately 11%. These models were modified, though, to reflect the production of the size of smolt that are actually produced from Bear Lake. The question is, then, is it reasonable to continue to assume 11% marine survival to predict future run strength? Sockeye salmon smolt marine survival is known to be size dependent, with larger fish exhibiting higher survival rates (Ricker 1962; Burgner 1991). The size of the smolt produced from Bear Lake are much larger than the threshold sized smolt, and would then likely have higher marine survival. Based on the estimated smolt and adult production of Bear Lake sockeye salmon, the marine survival is likely to be about 35 – 40%. This is within the range of observed survival rates compiled in Burgner (1991).

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Table 1. Coordinates and types of samples taken from the four limnology stations located in Bear Lake, 2001.

Station	Latitide	Longitude	Sample taken[a]
1	55° 58.574' N	160° 12.092' W	Z, L, T
2	55° 59.092' N	160° 12.092' W	Z, L, T, H_20
3	55° 59.935' N	160° 13.666' W	Z, L, T, H_20
4	56° 00.901' N	160° 14.310' W	Z, L, T

[a] Z = zooplankton, L = light intensity profiles, T = temperature, DO, and Sechi profiles, H_2O = water quality samples.

Table 2. Daily and cumulative sockeye salmon trap catches and corresponding mark-recapture data for the Bear Lake smolt project, by smolt day, 2001.

Smolt date	Catch		Mark-recapture			
	Daily	Cumulative	No. released	Daily recaptures	Cumulative recaptures	%[a]
5/23	2	2				
5/24	1	3				
5/25	0	3				
5/26	4	7				
5/27	4	11				
5/28	6	17				
5/29	2	19				
5/30	4	23				
5/31	2	25				
6/1	4	29				
6/2	2	31				
6/3	5	36				
6/4	9	45				
6/5	11	56				
6/6	34	90				
6/7	252	342				
6/8	161	503				
6/9	76	579				
6/10	226	805				
6/11	436	1,241	395	16	16	4.29%
6/12	35	1,276		1	17	4.55%
6/13	414	1,690		0	17	4.55%
6/14	138	1,828		0	17	4.55%
6/15	89	1,917		0	17	4.55%
6/16	8,575	10,492		0	17	4.55%
6/17	3,135	13,627		0	17	4.55%
6/18	2,355	15,982	643	11	11	1.86%
6/19	45	16,027		0	11	1.86%
6/20	54	16,081		0	11	1.86%
6/21	4,412	20,493		0	11	1.86%
6/22	1,319	21,812	730	0	0	0.14%
6/23	313	22,125		0	0	0.14%
6/24	141	22,266		0	0	0.14%
6/25	105	22,371		0	0	0.14%
6/26	139	22,510		0	0	0.14%
6/27	158	22,668	215	2	2	1.39%
6/28	194	22,862		1	3	1.85%
6/29	85	22,947		0	3	1.85%
6/30	400	23,347		0	3	1.85%
7/1	257	23,604		0	3	1.85%
7/2	26	23,630		0	3	1.85%
7/3	3	23,633		0	3	1.85%
7/4	5	23,638		0	3	1.85%
7/5	0	23,638		0	3	1.85%

-Continued-

Table 2. (page 2 of 2)

Smolt date	Catch		Mark-recapture			
	Daily	Cumulative	No. released	Daily recaptures	Cumulative recaptures	%
7/6	9	23,647		0	3	1.85%
7/7	40	23,687		0	3	1.85%
7/8	12	23,699		0	3	1.85%
7/9	29	23,728		0	3	1.85%
7/10	30	23,758		0	3	1.85%
7/11	36	23,794		0	3	1.85%
7/12	25	23,819		0	3	1.85%
7/13	310	24,129		0	3	1.85%
7/14	3,612	27,741		0	3	1.85%
7/15	1,380	29,121		0	3	1.85%
7/16	11	29,132	564	1	1	0.35%
7/17	56	29,188		0	1	0.35%
7/18	639	29,827		0	1	0.35%
7/19	1,955	31,782		0	1	0.35%
7/20	142	31,924	480	15	15	3.33%
7/21	190	32,114		0	15	3.33%
7/22	124	32,238		0	15	3.33%
7/23	41	32,279		0	15	3.33%
7/24	7	32,286		0	15	3.33%
7/25	242	32,528		0	15	3.33%
7/26	495	33,023		0	15	3.33%
7/27	175	33,198	150	1	1	1.32%
7/28	74	33,272		0	1	1.32%
7/29	184	33,456	152	2	2	1.96%
7/30	58	33,514		0	2	1.96%
7/31	13	33,527		0	2	1.96%
8/1	9	33,536		0	2	1.96%
8/2	4	33,540		0	2	1.96%
8/3	22	33,562		0	2	1.96%
8/4	13	33,575		0	2	1.96%
8/5	78	33,653		0	2	1.96%
8/6	29	33,682		0	2	1.96%
8/7	107	33,789		0	2	1.96%
8/8	48	33,837		0	2	1.96%
8/9	15	33,852		0	2	1.96%

[a] Calculated by: % = {(M+1)/(R+1)]*100;
where: M = number of marked fish, and;
R = number of marked fish recaptured (Carlson et al. 1998).

Table 3. Age composition of Bear Lake sockeye salmon smolt samples by week, 2001.

Week	Week Ending	Sample Size		Ages 0	1	2	3	Total
21	23-May	2	Percent	0	0	50	50	100
			Numbers	0	0	1	1	2
22	30-May	21	Percent	0	4.8	90.5	4.8	100
			Numbers	0	1	19	1	21
23	6-Jun	58	Percent	0	6.9	75.9	17.2	100
			Numbers	0	4	44	10	58
24	13-Jun	195	Percent	0	3.6	88.7	7.7	100
			Numbers	0	7	173	15	195
25	20-Jun	200	Percent	0	6.5	82	11.5	100
			Numbers	0	13	164	23	200
26	27-Jun	199	Percent	0	26.6	68.3	5	100
			Numbers	0	53	136	10	199
27	4-Jul	98	Percent	0	28.6	66.3	5.1	100
			Numbers	0	28	65	5	98
28	11-Jul	156	Percent	0	54.5	44.2	1.3	100
			Numbers	0	85	69	2	156
29	18-Jul	356	Percent	0.6	48	46.9	4.5	100
			Numbers	2	171	167	16	356
30	25-Jul	207	Percent	0	61.4	35.7	2.9	100
			Numbers	0	127	74	6	207
31	1-Aug	222	Percent	0	64	34.2	1.8	100
			Numbers	0	142	76	4	222
32	8-Aug	188	Percent	3.2	72.3	23.9	0.5	100
			Numbers	6	136	45	1	188
33	15-Aug	15	Percent	0	66.7	33.3	0	100
			Numbers	0	10	5	0	15
Total		1,917	Percent	0.4	40.5	54.1	4.9	100
			Numbers	8	777	1,038	94	1,917

Table 4. Age composition of Bear Lake sockeye salmon smolt samples from 1993 to 2001.

Year	Dates		Ages 0	1	2	3	4	Total
1993	06/01-08/02	Percent	0.0	7.6	92.3	0.1	0.0	100
		Numbers	0	121	1,465	1	0	1,587
1994	06/08-07/20	Percent	0.0	9.7	87.3	3.0	0.0	100
		Numbers	0	125	1,120	38	0	1,283
1995	06/15-07/23	Percent	0.1	12.0	87.8	0.1	0.0	100
		Numbers	1	123	896	1	0	1,021
1996	06/12-07/17	Percent	0.3	7.6	91.9	0.2	0.0	100
		Numbers	2	46	554	1	0	603
1997	06/23-08/15	Percent	0.1	43.7	56.1	0.1	0.0	100
		Numbers	1	542	696	1	0	1,240
1998	06/20-08/21	Percent	0.0	55.3	44.7	0.1	0.0	100
		Numbers	0	787	636	1	0	1,424
1999	06/13-08/24	Percent	0.0	1.6	97.9	0.5	0.0	100
		Numbers	1	33	2,013	10	0	2,057
2000	05/18-08/15	Percent	0.6	31.9	66.9	0.6	0.0	100
		Numbers	12	682	1,428	12	1	2,135
2001	05/18-08/15	Percent	0.4	40.5	54.1	4.9	0	100
		Numbers	8	777	1,038	94	0	1,917
Total		Percent	0.2	24.4	74.2	1.2	0.0	100.0
		Numbers	25	3,236	9,846	159	1	13,267

Table 5. Mean length, weight, and condition factor of Bear Lake sockeye salmon smolt samples by age and week, 2001.

		Length (mm)			Weight (g)			Condition		
Age	Week	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error
0	29	2	74.5	3.50	2	4.1	0.75	2	0.99	0.041
0	32	6	72.7	2.88	6	3.7	0.41	6	0.95	0.056
Totals		8	73.1	2.23	8	3.8	0.34	8	0.96	0.042
1	22	1	84.0	NA	1	4.5	NA	1	0.76	NA
1	23	4	98.3	15.85	4	10.6	5.61	4	0.88	0.065
1	24	7	103.9	8.14	7	11.6	3.33	7	0.94	0.068
1	25	13	109.8	2.68	13	11.9	0.78	13	0.90	0.032
1	26	53	112.3	0.97	53	13.7	0.32	53	0.96	0.009
1	27	28	110.6	1.57	28	13.1	0.55	28	0.95	0.014
1	28	85	115.1	0.62	85	15.2	0.27	85	0.99	0.006
1	29	171	116.4	0.57	171	15.7	0.24	171	0.98	0.005
1	30	127	116.8	0.57	127	16.0	0.24	127	1.00	0.006
1	31	142	118.9	0.47	142	17.3	0.23	142	1.02	0.005
1	32	136	123.7	0.52	136	19.6	0.26	136	1.03	0.005
1	33	10	123.8	1.66	10	19.6	0.87	10	1.03	0.013
Totals		777	117.3	0.30	777	16.3	0.13	777	1.00	0.003
2	21	1	78.0	NA	1	3.4	NA	1	0.72	NA
2	22	19	99.9	4.88	19	10.0	1.27	19	0.94	0.071
2	23	44	122.1	1.69	44	16.0	0.87	44	0.84	0.016
2	24	173	126.5	0.56	173	19.8	0.28	173	0.97	0.006
2	25	164	122.2	0.70	164	17.4	0.32	164	0.94	0.006
2	26	136	117.5	0.60	136	15.5	0.23	136	0.95	0.005
2	27	65	117.2	0.99	65	15.6	0.38	65	0.96	0.009
2	28	69	121.2	0.93	69	17.3	0.44	69	0.96	0.011
2	29	167	120.1	0.82	167	17.2	0.42	167	0.97	0.005
2	30	74	119.9	1.09	74	17.7	0.44	74	1.01	0.007
2	31	76	122.9	0.87	76	19.2	0.42	76	1.02	0.008
2	32	45	124.4	0.97	45	20.6	0.47	45	1.06	0.009
2	33	5	120.8	4.09	5	16.9	2.24	5	0.93	0.054
Totals		1038	121.1	0.31	1038	17.5	0.14	1038	0.96	0.003
3	21	1	115.0	NA	1	11.0	NA	1	0.72	NA
3	22	1	121.0	NA	1	18.1	NA	1	1.02	NA
3	23	10	141.0	3.75	10	25.9	2.12	10	0.89	0.030
3	24	15	130.9	2.10	15	22.0	1.12	15	0.97	0.024
3	25	23	131.7	2.89	23	22.3	1.52	23	0.95	0.021
3	26	10	125.2	3.92	10	18.9	1.99	10	0.94	0.020
3	27	5	134.4	4.58	5	23.2	2.37	5	0.94	0.017
3	28	2	116.5	10.50	2	15.8	4.05	2	0.97	0.008
3	29	16	128.4	4.28	16	21.0	2.37	16	0.93	0.022
3	30	6	129.5	8.23	6	22.7	4.91	6	0.99	0.027
3	31	4	134.3	5.02	4	23.5	2.63	4	0.96	0.017
3	32	1	161.0	NA	1	41.3	NA	1	0.99	NA
Totals		94	131.1	1.45	94	22.1	0.78	94	0.94	0.009

Table 6. Mean length, weight, and condition factor of sockeye salmon smolt samples taken from Bear River, by age and year, 1993-2001.

		Length			Weight			Condition		
Age	Year	n	Mean	SE	n	Mean	SE	n	Mean	SE
0	1996	2	75.0	6.00	2	3.2	0.15	2	0.77	0.146
0	1997	1	96.0	NA	1	8.2	NA	1	0.93	NA
0	1999	1	67.0	NA	1	2.4	NA	1	0.80	NA
0	2000	12	71.4	3.42	12	3.6	0.45	12	0.95	0.056
0	2001	8	73.1	2.23	8	3.8	0.34	8	0.96	0.042
1	1993	121	90.2	0.65	119	7.2	0.15	119	0.97	0.012
1	1994	125	98.7	0.89	125	9.5	0.22	125	0.97	0.007
1	1995	123	105.1	0.87	123	11.5	0.30	123	0.97	0.008
1	1996	46	101.5	1.74	46	10.0	0.43	46	0.93	0.017
1	1997	539	105.7	0.37	539	12.0	0.12	539	1.00	0.003
1	1998	786	105.2	0.30	787	10.8	0.09	786	0.91	0.002
1	1999	33	93.6	1.61	33	7.2	0.38	33	0.84	0.013
1	2000	682	106.3	0.36	682	12.7	0.13	682	1.03	0.005
1	2001	777	117.3	0.30	777	16.3	0.13	777	1.00	0.003
2	1993	1,464	98.2	0.19	1,458	9.1	0.05	1,457	0.96	0.003
2	1994	1,114	107.5	0.26	1,118	12.0	0.08	1,112	0.95	0.002
2	1995	895	112.3	0.25	893	13.7	0.09	892	0.96	0.003
2	1996	554	113.3	0.40	550	13.6	0.12	550	0.92	0.004
2	1997	695	114.6	0.23	695	14.3	0.08	695	0.94	0.003
2	1998	636	113.5	0.46	635	13.6	0.14	635	0.91	0.002
2	1999	2,013	102.6	0.18	2,013	9.4	0.05	2,013	0.86	0.001
2	2000	1,428	110.4	0.22	1,428	13.9	0.08	1,428	1.02	0.003
2	2001	1,038	121.1	0.31	1,038	17.5	0.14	1,038	0.96	0.003
3	1993	1	118.0	NA	1	14.1	NA	1	0.86	NA
3	1994	38	113.3	1.49	38	13.8	0.48	38	0.93	0.009
3	1995	1	135.0	NA	1	21.3	NA	1	0.87	NA
3	1996	1	115.0	NA	1	14.8	NA	1	0.97	NA
3	1997	1	125.0	NA	1	18.0	NA	1	0.92	NA
3	1998	1	130.0	NA	1	18.0	NA	1	0.82	NA
3	1999	10	139.3	4.50	10	24.7	2.45	10	0.89	0.011
3	2000	12	132.7	3.37	12	23.3	1.90	12	0.98	0.031
3	2001	94	131.1	1.45	94	22.1	0.78	94	0.94	0.009
4	2000	1	161.0	NA	1	42.9	NA	1	1.03	NA

Table 7. Bear River sockeye salmon smolt population estimates, by age, 2000 and 2001.

Year		Number of Smolt					S.E.	95% C.I	
		Age 0.	Age 1.	Age 2.	Age 3.	Total		Lower	Upper
2000	Numbers	Estimate Not Possible							
	Percent								
2001	Numbers	3,414	1,132,508	2,022,820	176,633	3,335,375	1,146,339	1,090,285	5,583,935
	Percent	0.10	33.95	60.65	5.30	100.00			

Table 8. Modeled optimal sockeye salmon escapement, smolt production, and adult production based on euphotic volume (EV) calculations from Bear Lake, 2000 and 2001.

			Optimal Escapement		Smolt Production		
Year	EZD (m)	EV (x 10^6 m^3)	Lower	Upper	Threshold Sized	Bear Average[a]	Adult Production
2000	22.7	581	465,000	523,000	13,400,000	4,000,000	1,450,000
2001	20.1	515	412,000	463,000	11,800,000	3,500,000	1,290,000

Calculations based on Koenings and Burkett (1987).

[a] Assuming the 1993 to 2001 average age 1. and 2. smolt weight of 11.9 g and 81 kg smolt production per EV unit.

Table 9. Average number of zooplanktors per m^3 and m^2 from Bear Lake, over all stations, 2001.

	Mean Macrozooplankton Density									
	(no./m^3)					(no./m^2)				
Taxon	5/25	6/29	7/27	8/11	Average	5/25	6/29	7/27	8/11	Average
Copepods:										
Ergasilis	0	0	0	0	0	0	0	0	0	0
Epischura	0	23	21	0	11	0	1,393	995	0	597
Ovig. *Epischura*	0	0	0	0	0	0	0	0	0	0
Diaptomus	0	0	0	0	0	0	0	0	0	0
Ovig *Diaptomus*	0	0	0	0	0	0	0	0	0	0
Cyclops	3,339	3,589	2,519	2,358	2,951	189,092	196,523	146,066	129,777	165,365
Ovig. *Cyclops*	44	18	60	130	63	2,588	995	3,516	6,602	3,425
Harpaticus	0	0	0	0	0	0	0	0	0	0
Nauplii	522	0	189	146	214	28,729	0	11,180	7,398	11,827
Total Copepods	3,906	3,630	2,790	2,634	3,240	220,409	198,912	161,757	143,777	181,214
Cladocerans:										
Bosmina	0	42	333	1,869	561	0	2,455	18,909	104,598	7,121
Ovig. *Bosmina*	0	0	71	96	42	0	0	3,848	5,772	1,283
Daphnia l.	0	0	0	0	0	0	0	0	0	0
Ovig. *Daphnia l.*	0	0	0	0	0	0	0	0	0	0
Daphnia g.	0	0	0	0	0	0	0	0	0	0
Holopedium	0	0	0	0	0	0	0	0	0	0
Ovig. *Holopedium*	0	0	0	0	0	0	0	0	0	0
Chydorinae	44	0	0	0	11	2,654	0	0	0	885
Polyphemus	0	0	0	0	0	0	0	0	0	0
Immature Cladocera	0	0	44	128	43	0	0	2,389	7,663	796
Total Cladocerans	44	42	448	2,093	657	2,654	2,455	25,146	118,033	10,085
Total Cope.+Clad.	3,950	3,672	3,238	4,727	3,897	223,063	201,367	186,903	261,810	191,298
Rotifers:										
Kellicottia	313	2,561	8,903	9,370	5,287	18,312	139,928	520,170	544,486	305,724
Asplanchna	26	0	0	0	7	1,526	0	0	0	382
Keratella	13	264	589	356	305	796	14,928	34,534	21,032	17,823
Conochilus	9	0	0	0	2	464	0	0	0	116
Other Rotifers	4	0	87	0	23	199	0	5,009	0	1,302
Total Rotifers	366	2,825	9,579	9,726	5,624	21,298	154,857	559,713	565,519	325,347

Table 10. Biomass estimates (mg dry weight/m^3) of the major zooplankton species, by sample date, for Bear Lake, 2001.

Taxon	Sample Date 5/25	6/29	7/27	8/11	Average
Copepods:					
Epischura	0.00	0.00	0.00	0.00	0.00
Cyclops	4.37	11.58	7.77	7.85	7.89
Ovig. Cyclops	0.15	0.06	0.17	0.73	0.28
Total copepods	4.52	11.65	7.94	8.57	8.17
Cladocerans:					
Bosmina	0.00	0.09	0.57	5.33	1.50
Ovig. *Bosmina*	0.00	0.00	0.12	0.06	0.04
Total cladocerans	0.00	0.09	0.68	5.39	1.54
Copepods:Cladocerans	NA	129.65	11.59	1.59	5.30
Total Biomass	4.52	11.74	8.62	13.97	9.71

Table 11. Biomass estimates (mg dry weight/m^2) of the major zooplankton species, by sample date, for Bear Lake, 2001.

Taxon	Sample Date 5/25	6/29	7/27	8/11	Average
Copepods:					
Epischura	0.00	0.22	0.06	0.00	0.07
Cyclops	247.61	634.32	451.50	418.87	438.08
Ovig. Cyclops	8.78	3.32	3.81	38.28	13.55
Total copepods	256.39	637.86	455.38	457.15	451.69
Cladocerans:					
Bosmina	0.00	5.22	33.67	274.25	78.28
Ovig. *Bosmina*	0.00	0.00	7.75	7.67	3.86
Total cladocerans	0.00	5.22	41.41	281.92	82.14
Copepods:Cladocerans	NA	122.22	11.00	1.62	5.50
Total Biomass	256.39	643.08	496.79	739.07	533.83

Table 12. Surface (1 m) water quality data taken from stations 2 and 3 from Bear Lake, 2001.

Date	Sta	Water Sample Depth	Secchi	pH	Alkalinity (mg/L)	Total P (ug/L P)	TFP (ug/L P)	FRP (ug/L P)	Ammonia (ug/L N)	Nitrate + Nitrite (ug/L N)	Chloro-phyll a (ug/L)	Phaeo-phytin a (ug/L)
5/25/01	2	1 m	9.0	7.3	14.0	14.7	2.9	0.5	2.7	125.9	1.60	0.04
6/29/01	2	1 m	9.0	7.4	18.0	9.6	5.9	8.5	2.9	122.3	1.60	0.04
7/27/01	2	1 m	7.5	7.0	17.0	14.6	6.5	13.5	2.5	66.7	0.96	0.16
8/11/01	2	1 m	6.5	7.2	23	12.8	3.1	40.4	5.1	62.7	0.96	0.38
Mean			8.0	7.2	18.0	12.9	4.6	15.7	3.3	94.4	1.28	0.16
STDV			1.2	0.2	3.7	2.4	1.9	17.3	1.2	34.4	0.37	0.16
5/25/01	3	1 m	8.8	7.3	17.0	16.6	15.4	11.1	3.1	76.4	2.56	0.04
6/29/01	3	1 m	5.8	7.2	19.0	10.4	5.9	9.1	2.4	108.2	1.28	0.29
7/27/01	3	1 m	5.8	7.2	12.0	12.5	8.6	8.5	2.4	75.2	0.96	0.04
8/11/01	3	1 m	6.8	7.2	20.0	8.3	7.1	9.9	4.9	85.3	0.64	0.48
Mean			6.8	7.2	17.0	12.0	9.3	9.7	3.2	86.3	1.36	0.21
STDV			1.4	0.0	3.6	3.5	4.2	1.1	1.2	15.3	0.84	0.21
Mean over stations 2,3												
5/25/01	2,3	1 m	8.9	7.3	15.5	15.7	9.2	5.8	2.9	101.2	2.08	0.04
6/29/01	2,3	1 m	7.4	7.3	18.5	10.0	5.9	8.8	2.7	115.3	1.44	0.17
7/27/01	2,3	1 m	6.6	7.1	14.5	13.6	7.6	11.0	2.5	71.0	0.96	0.10
8/11/01	2,3	1 m	6.7	7.2	21.5	10.6	5.1	25.2	5.0	74.0	0.80	0.43
Mean			7.4	7.2	17.5	12.4	6.9	12.7	3.3	90.3	1.32	0.18
STDV			1.1	0.1	3.2	2.6	1.8	8.6	1.2	21.5	0.58	0.17

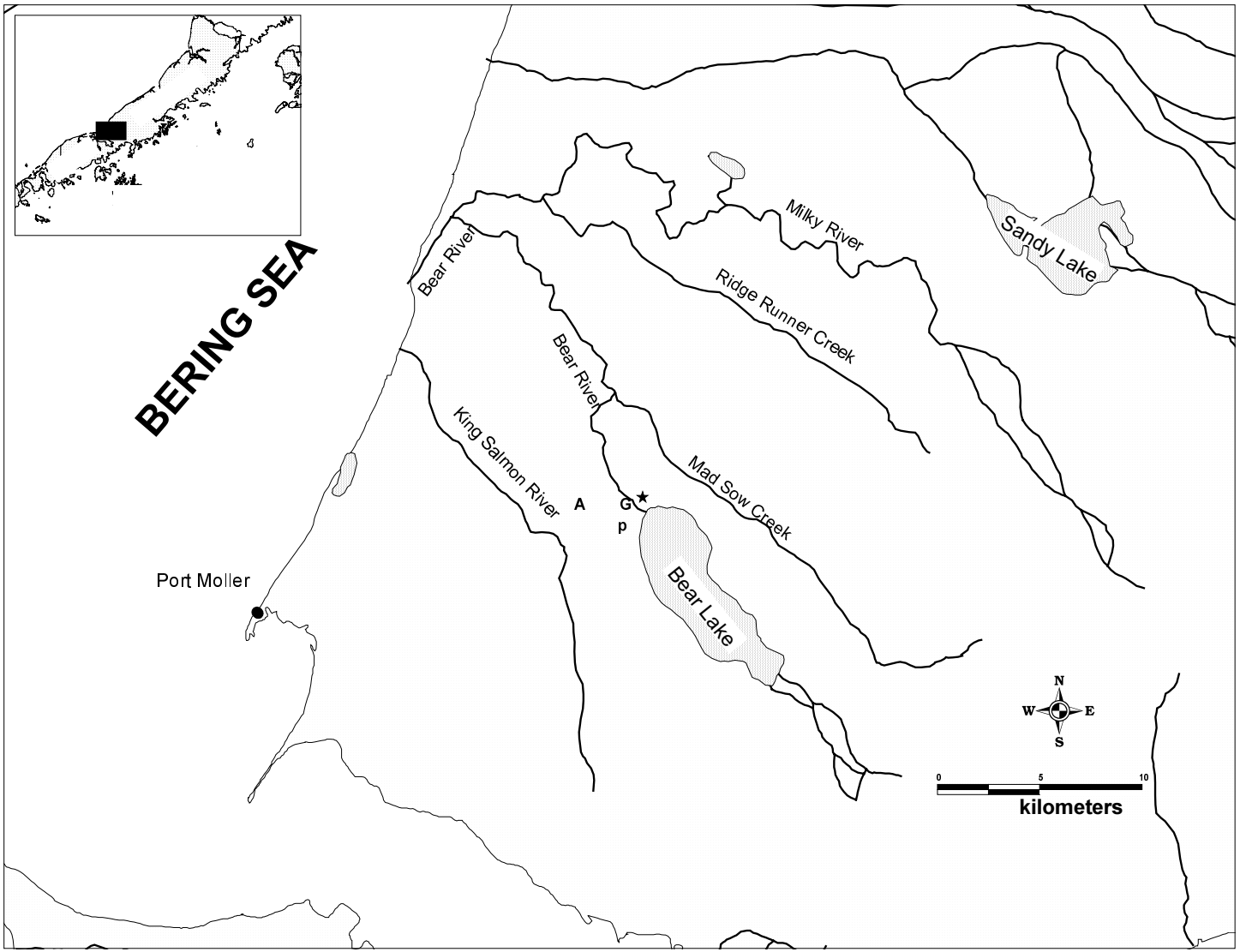

Figure 1. Map of the Bear Lake area on the Alaska Peninsula.

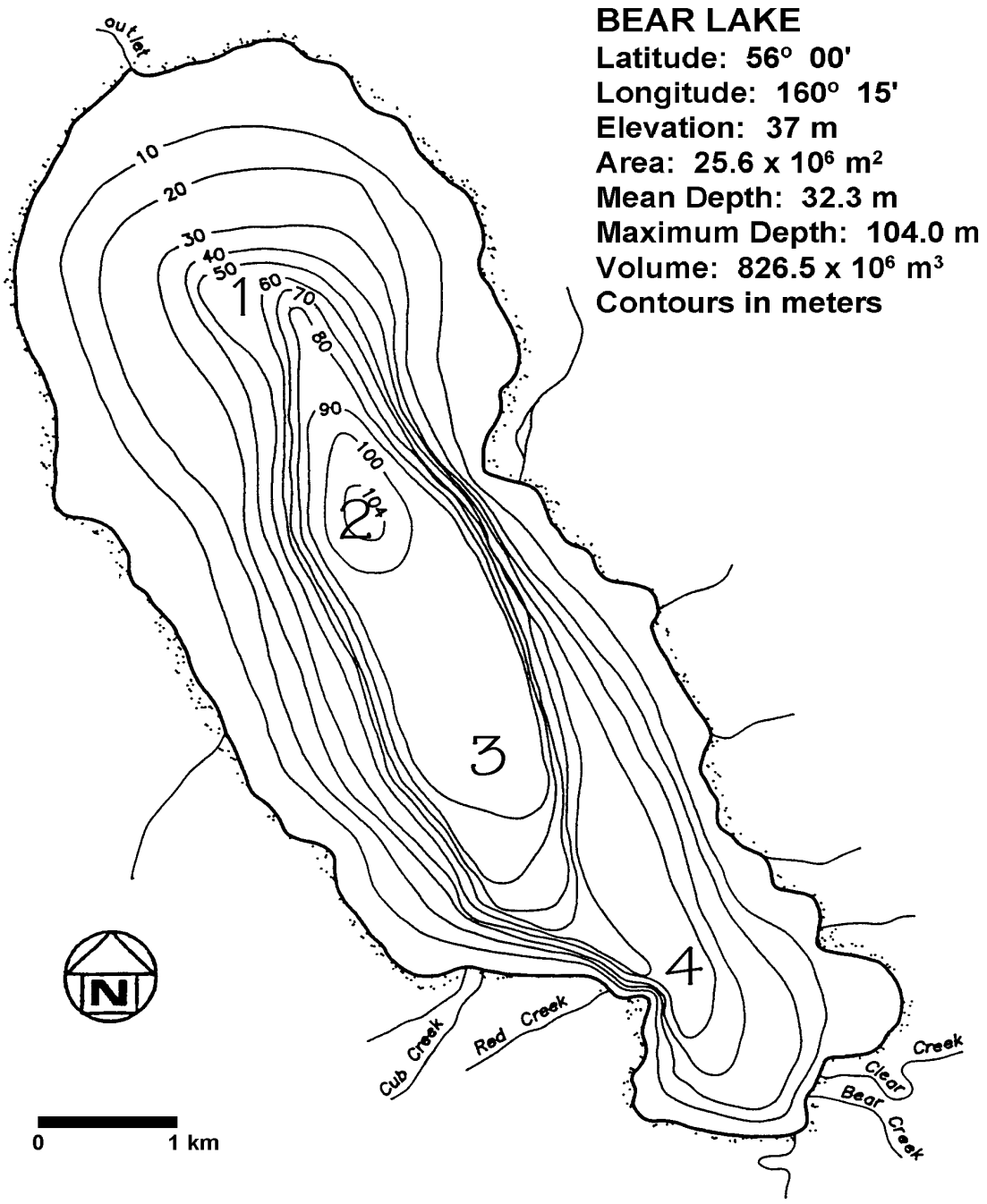

Figure 2. Bathymetric map of Bear Lake showing the locations of the limnology stations (1-4).

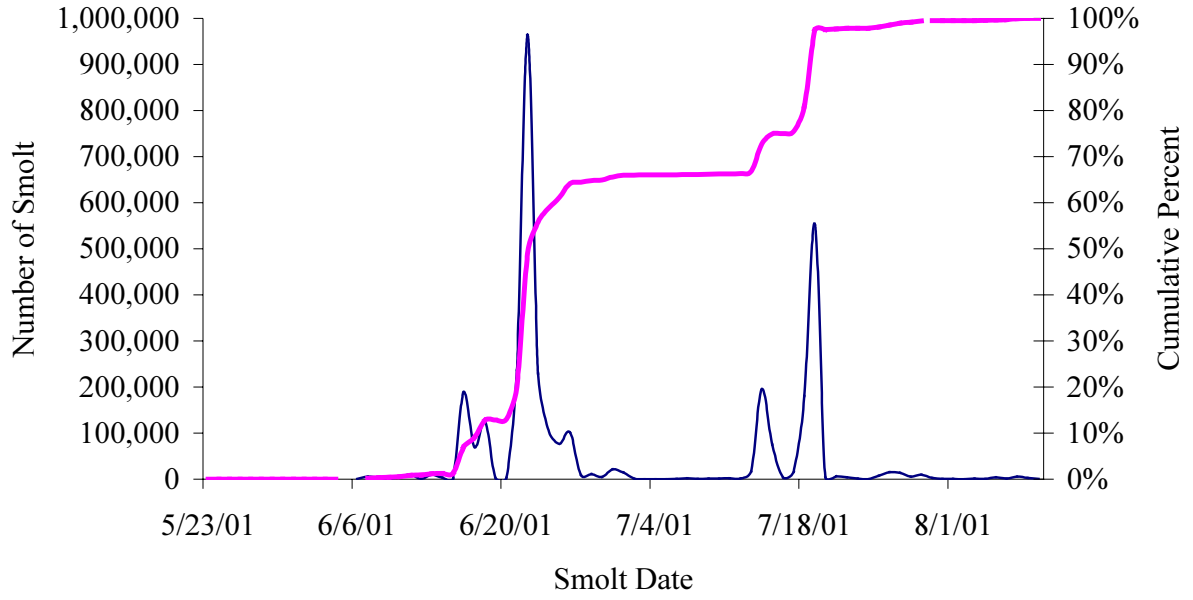

Figure 3. Estimated daily sockeye salmon smolt emigration and cumulative percentage, by day, for Bear Lake, 2001.

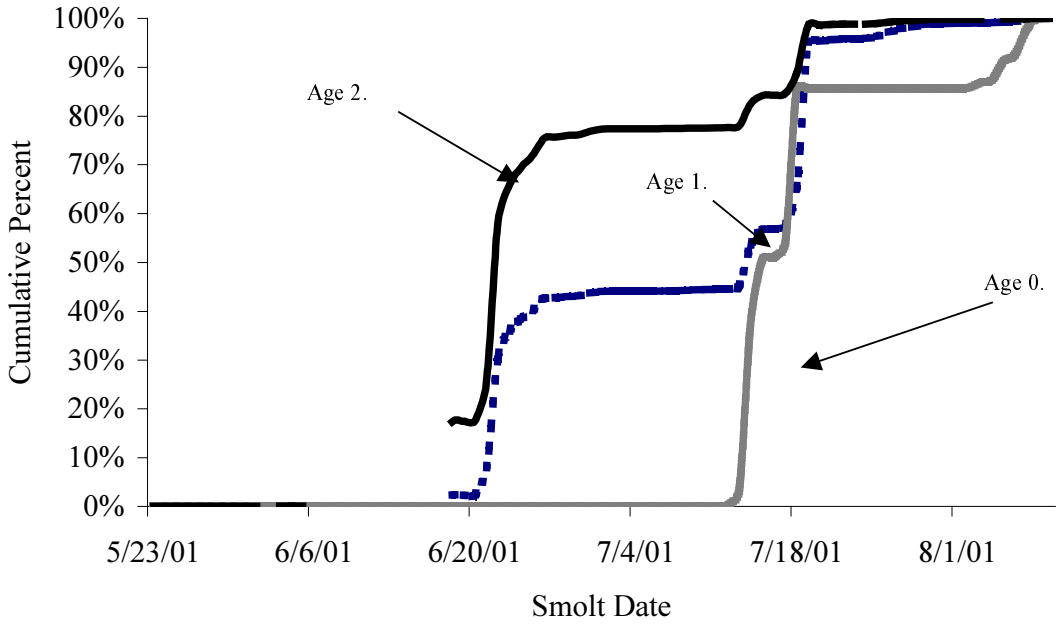

Figure 4. Cumulative percentage of the estimated number of sockeye salmon smolt emigrating from Bear Lake, by age and day, 2001.

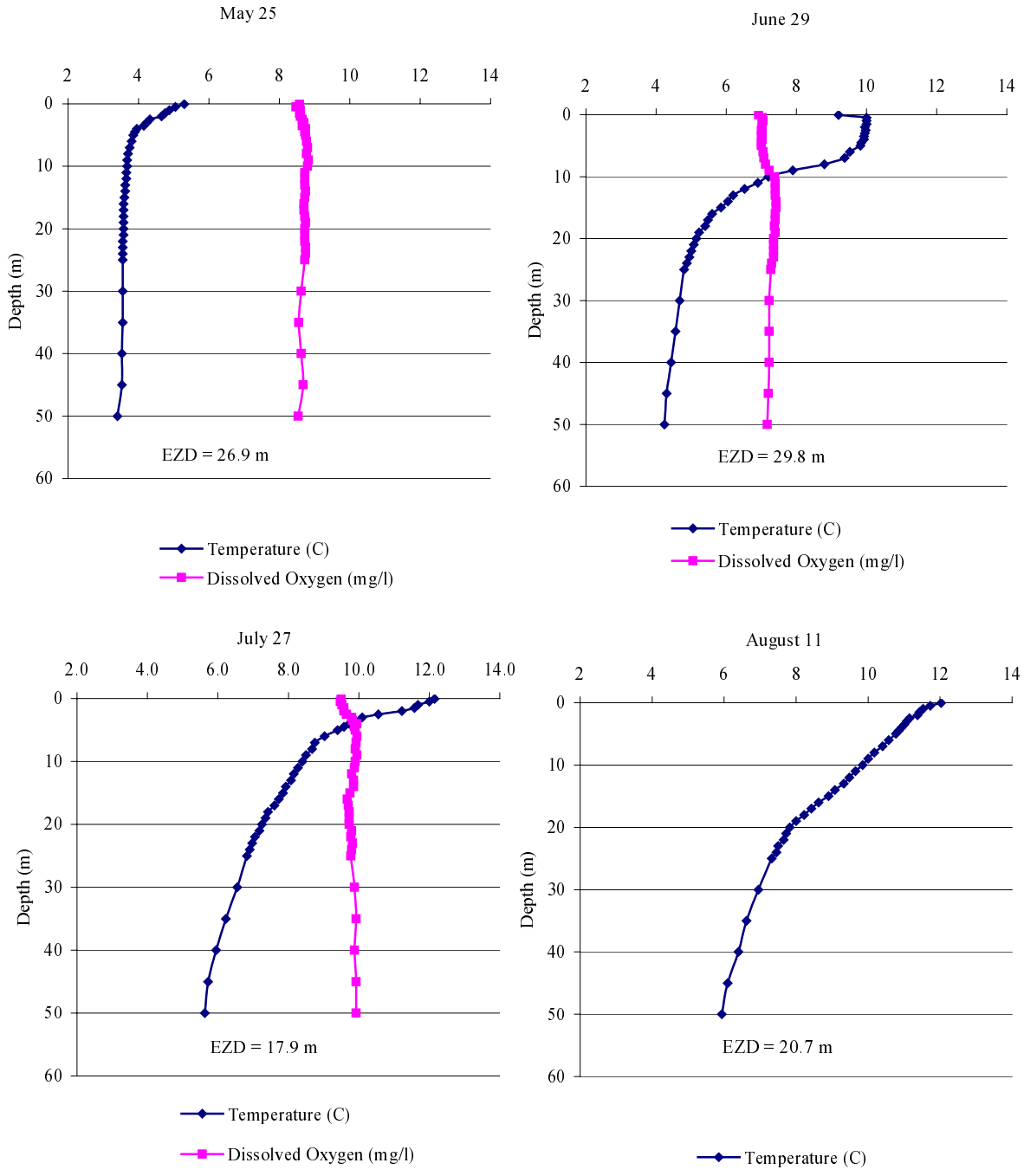

Figure 5. Mean temperature and dissolved oxygen profiles measured in Bear Lake, May through August, 2001.

APPENDIX

Appendix A. Daily trap catches of the Bear Lake sockeye salmon smolt enumeration project, 2001.

	Catch						
Smolt Date	Sockeye smolt	Sockeye fry	Coho	Pink	Dolly Varden	Sculpin	Other
5/23/01	2	50	90	86	0	27	
5/24/01	1	109	38	142	4	49	
5/25/01	0	87	50	50	3	65	
5/26/01	4	123	125	103	1	50	
5/27/01	4	120	83	57	1	61	
5/28/01	6	57	45	67	0	20	
5/29/01	2	38	28	54	0	10	
5/30/01	4	100	160	85	0	25	
5/31/01	2	50	45	50	0	16	
6/1/01	4	99	70	88	3	32	
6/2/01	2	50	30	30	2	16	
6/3/01	5	60	122	25	1	11	
6/4/01	9	125	130	28	2	24	
6/5/01	11	115	145	20	0	24	
6/6/01	34	105	90	5	2	10	1 stickleback
6/7/01	252	57	24	5	7	7	
6/8/01	161	165	20	5	9	32	
6/9/01	76	157	235	44	2	6	
6/10/01	226	117	98	29	3	22	
6/11/01	436	185	255	45	0	98	2 stickleback
6/12/01	35	44	54	0	7	44	
6/13/01	414	57	43	0	5	70	
6/14/01	138	112	138	18	0	36	
6/15/01	89	165	105	25	2	70	
6/16/01	8,575	115	107	76	9	19	1 stickleback
6/17/01	3,135	40	55	20	4	4	
6/18/01	2,355	388	36	15	17	19	1 stickleback
6/19/01	45	380	182	0	8	27	
6/20/01	54	397	96	0	2	33	
6/21/01	4,412	255	70	0	0	30	
6/22/01	1,319	2,680	1,130	0	3	73	
6/23/01	313	2,180	575	0	1	17	
6/24/01	141	960	350	0	0	18	
6/25/01	105	244	134	0	1	10	
6/26/01	139	165	110	0	0	2	
6/27/01	158	365	130	0	0	13	
6/28/01	194	560	175	0	1	35	
6/29/01	85	150	125	0	3	40	
6/30/01	400	710	200	0	0	13	
7/1/01	257	183	92	0	0	2	
7/2/01	26	215	206	0	0	5	
7/3/01	3	255	115	0	0	7	
7/4/01	5	0	0	0	0	0	
7/5/01	0	27	23	0	0	7	
7/6/01	9	3	3	0	0	4	
7/7/01	40	95	73	0	0	9	

-Continued-

Appendix A. (page 2 of 2)

	Catch						
Smolt Date	Sockeye smolt	Sockeye fry	Coho	Pink	Dolly Varden	Sculpin	Other
7/8/01	12	15	30	0	0	12	
7/9/01	29	22	20	0	0	17	
7/10/01	30	50	50	0	0	10	
7/11/01	36	87	37	0	0	2	
7/12/01	25	32	15	0	0	2	
7/13/01	310	85	85	0	0	18	
7/14/01	3,612	50	75	0	0	10	
7/15/01	1,380	0	0	0	0	5	1 AK blackfish
7/16/01	11	10	0	0	0	0	
7/17/01	56	35	5	0	0	10	
7/18/01	639	10	10	0	0	7	
7/19/01	1,955	5	7	0	0	0	
7/20/01	142	25	2	0	4	20	
7/21/01	190	15	3	0	0	12	1 stickleback
7/22/01	124	14	4	0	0	6	
7/23/01	41	10	24	0	0	4	
7/24/01	7	4	9	0	0	5	
7/25/01	242	42	28	0	1	45	
7/26/01	495	40	20	0	1	48	
7/27/01	175	50	27	0	4	33	
7/28/01	74	67	84	0	3	37	1 stickleback
7/29/01	184	38	56	0	3	47	
7/30/01	58	28	68	0	0	54	
7/31/01	13	14	19	0	2	19	
8/1/01	9	15	11	0	2	37	
8/2/01	4	0	5	0	2	31	
8/3/01	22	2	33	0	2	92	
8/4/01	13	5	35	0	1	60	
8/5/01	78	2	18	0	4	64	
8/6/01	29	1	17	0	4	40	
8/7/01	107	6	22	0	5	72	
8/8/01	48	0	40	0	5	53	1 stickleback
8/9/01	15	5	20	0	2	20	
Total	33,852	13,498	7,089	1,172	148	2,104	

Appendix B. Daily weather and stream observations at Bear Lake, 2001.

Date	Time	Temperature (C) Air	Temperature (C) Water	Cloud Cover (%)	Wind Direction	Wind Vel. (mph)	Gauge Height (cm)	Velocity (Cts./sec)
5/23	0001	5.0	5.0	80	NW	5		
	1200	6.8	4.8	100	NW	5		
5/24	0001	5.0	5.0	100	NW	5		
	1200	11.0	5.0	75	NW	5		
5/25	0001	6.0	5.5	100	NW	10		
	1200	7.0	5.5	100	NW	5		
5/26	0001	5.0	5.5	80	NW	10		
	1200	8.0	5.5	100	NW	25		
5/27	0001	1.0	3.5	100	N	10		
	1200	3.0	4.1	100	0	10		
5/28	0001	3.8	4.0	100	NW	0		
	1200	9.0	4.5	35	NW	5		
5/29	0001	4.0	5.0	30	NW	5		
	1200	5.5	5.0	70	NW	10	24	26
5/30	0001	4.5	5.0	100	NW	5	24	25
	1200	9.2	5.2	85	0	0	24	24
5/31	0001	4.5	5.0	80	NW	5	24	25
	1200	11.5	7.5	40	0	0	25	25
6/1	0001	3.5	5.5	100	NW	5	26	26
	1200	14.5	7.5	10	NW	5	27	25
6/2	0001	6.0	5.0	80	N	5	27	26
	1200	8.0	5.3	100	NW	3	31	27
6/3	0001	6.5	5.5	100	0.0	0	32	27
	1200	8.0	6.0	40	NW	5	33	28
6/4	0001	6.0	5.5	100	W	10	34	29
	1200	8.0	6.0	75	N	10	37	29
6/5	0001	5.5	5.0	90	SE	5	37	29
	1200	5.2	5.0	100	NW	3	40	31
6/6	0001	5.0	5.2	100	NW	5	39	30
	1200	6.0	5.0	100	SE	5	40	31
6/7	0001	5.0	4.0	60	0.0	0	40	31
	1200	5.0	5.0	70	NW	5	39	32
6/8	0001	6.0	6.0	55	0.0	0	41	32
	1200	9.0	6.0	70	NW	5	41	34
6/9	0001	6.0	6.0	50	0	0	41	35
	1200	10.0	8.0	50	NW	5	41	34
6/10	0001	4.2	6.0	4	0	0	42	33
	1200	8.0	6.2	100	0	0	42	33
6/11	0001	6.0	6.0	100	0	0	42	34
	1200	7.0	5.0	100	0	0	42	33
6/12	0001	5.0	5.0	100	NW	10	42	33
	1200	6.0	5.0	100	NW	10	42	34
6/13	0001	5.5	5.0	100	NW	0	42	34
	1200	7.0	6.5	100	NW	5	42	33
6/14	0001	6.0	5.0	100	0	0	41	34
	1200	7.0	5.5	100	NW	5	41	33
6/15	0001	6.0	5.5	100	0	0	40	33
	1200	7.5	5.5	100	0	0	40	31

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Appendix B. (page 2 of 4)

Date	Time	Temperature (C) Air	Water	Cloud Cover (%)	Wind Direction	Vel. (mph)	Gauge Height (cm)	Velocity (Cts./sec)
6/16	0001	6.5	5.5	100	0	0	40	30
	1200	14.0	6.5	20	NW	5	40	33
6/17	0001	6.0	5.8	1	NW	2	40	34
	1200	15.0	9.5	15	NE	10	41	35
6/18	0001	7.0	6.5	15	0	0	42	32
	1200	9.0	9.0	15	SE	5	44	34
6/19	0001	8.2	8.0	20	NE	1	44	35
	1200	10.0	8.0	10	NW	5	45	34
6/20	0001	8.5	8.0	100	SW	3	47	35
	1200	7.5	7.5	100	NW	5	46	34
6/21	0001	5.5	5.0	100	0	0	48	33
	1200	12.0	8.5	0	SE	5	49	34
6/22	0001	13.5	8.5	0	SE	10	47	35
	1200	13.5	11.5	40	SE	25	49	35
6/23	0001	10.5	10.0	80	SE	30	54	34
	1200	10.2	9.8	100	0	0	52	36
6/24	0001	9.0	10.0	100	SE	5	50	35
	1200	13.5	10.0	100	SE	5	54	35
6/25	0001	7.5	7.5	100	0	0	54	35
	1200	8.5	8.5	100	NW	5	55	36
6/26	0001	7.2	8.0	100	0	0	54	35
	1200	9.0	9.0	100	NW	3	55	36
6/27	0001	6.5	6.5	100	NW	5	54	36
	1200	10.0	10.0	100	0	0	54	36
6/28	0001	8.0	9.0	100	NW	0	54	36
	1200	11.0	11.0	30	0	5	54	37
6/29	0001	11.0	11.0	80	0	0	54	36
	1200	10.0	10.0	100	0	0	59	37
6/30	0001	8.5	9.0	100	0	0	60	38
	1200	11.0	10.5	100	SE	0	57	36
7/1	0001	11.0	10.5	75	SE	5	63	38
	1200	11.0	11.0	100	SE	15	65	38
7/2	0001	10.0	10.0	100	SE	10	65	38
	1200	11.0	11.0	20	SE	20	68	38
7/3	0001	13.0	10.0	40	SE	45	66	36
	1200	14.0	11.0	100	SE	5	68	35
7/4	0001	10.0	10.2	100	NW	5	70	44
	1200	11.0	9.0	100	NW	5	70	44
7/5	0001	8.0	8.0	100	NW	5	69	48
	1200	8.0	6.0	100	NW	10	71	49
7/6	0001	6.0	6.0	100	NW	5	70	40
	1200	10.0	7.0	75	NW	5	70	
7/7	0001	8.0	6.0	100	0	5	69	
	1200	8.5	7.5	25	0	0	68	
7/8	0001	7.0	8.0	100	NW	0	67	
	1200	10.5	8.5	80	NW	5	66	
7/9	0001	7.5	8.5	100	NW	0	64	
	1200	13.0	9.0	100	SW	5	63	

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Appendix B. (page 3 of 4)

Date	Time	Temperature (C) Air	Water	Cloud Cover (%)	Wind Direction	Vel. (mph)	Gauge Height (cm)	Velocity (Cts./sec)
7/10	0001	9.7	10.0	100	NW	5	62	
	1200	15.0	10.0	100	0	0	61	
7/11	0001	11.0	9.5	100	0	0	59	
	1200	9.5	9.0	100	W	5	60	
7/12	0001	8.0	7.0	100	0	0	59	
	1200	9.5	8.5	100	0	0	59	
7/13	0001	9.4	9.5	100	0	0	58	
	1200	12.0	10.0	90	0	0	57	
7/14	0001	9.0	9.5	80	0	0	56	
	1200	14.0	9.5	90	SE	10	57	
7/15	0001	11.0	11.0	75	SE	50	62	
	1200	10.0	10.0	90	SW	15	65	
7/16	0001	10.0	10.0	100	SE	15	69	
	1200	11.0	10.0	40	SW	5	72	
7/17	0001	12.0	10.0	75	NW	5	72	
	1200	11.0	10.0	100	0	0	72	
7/18	0001	11.0	11.0	100	0	0	70	
	1200	14.0	10.0	100	SE	15	72	
7/19	0001	11.0	10.0	75	SE	10	81	
	1200	11.0	10.0	85	SE	20	83	
7/20	0001	9.0	9.0	90	SE	25	88	
	1200	12.0	9.0	100	0	0	85	
7/21	0001	9.0	9.0	100	0	0	86	
	1200	10.0	9.0	100	0	0	86	
7/22	0001	10.0	10.0	100	0	0	82	
	1200	10.0	10.0	100	0	0	81	
7/23	0001	10.0	10.0	100	0	0	79	
	1200	12.0	10.0	100	0	0	76	
7/24	0001	10.0	10.0	100	0	0	75	
	1200	13.0	10.5	100	0	0	72	
7/25	0001	10.0	10.0	100	0	0	71	
	1200	12.0	10.5	100	0	0	69	
7/26	0001	10.5	10.5	100	0	0	68	
	1200	15.0	11.0	100	0	0	68	
7/27	0001	10.5	10.0	30	0	0	67	
	1200	15.5	12.0	20	0	0	65	
7/28	0001	14.0	13.0	90	SE	15	65	
	1200	15.5	12.0	95	0	0	68	
7/29	0001	15.0	11.0	100	0	0	58	
	1200	14.0	11.0	100	SW	5	68	
7/30	0001	14.5	11.0	100	W	5	68	
	1200	13.0	11.0	100	NW	5	68	
7/31	0001	11.0	10.0	70	0	0	67	
	1200	11.0	10.5	100	NW	10	66	
8/1	0001	9.0	10.0	100	NW	5	65	
	1200	13.0	10.5	85	0	0	65	

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Appendix B. (page 4 of 4)

Date	Time	Temperature (C) Air	Water	Cloud Cover (%)	Wind Direction	Vel. (mph)	Gauge Height (cm)	Velocity (Cts./sec)
8/2	0001	11.0	10.0	85	0	0	64	
	1200	12.0	11.0	100	NW	5	64	
8/3	0001	10.0	11.0	100	NW	5	63	
	1200	11.0	11.0	100	NW	5	63	
8/4	0001	11.0	8.5	80	NW	5	63	
	1200	11.0	8.0	90	NW	10	63	
8/5	0001	9.5	7.5	100	NW	5	63	
	1200	9.0	10.0	100	NW	5	63	
8/6	0001	14.0	10.0	100	SE	5	62	
	1200	11.0	10.0	100	NW	5	62	
8/7	0001	12.0	10.0	100	SE	5	59	
	1200	12.0	11.0	60	SE	5	59	
8/8	0001	9.0	11.0	50	0	0	58	
	1200	15.0	12.0	15	SE	20	56	
8/9	0001	11.0	11.0	30	SE	15	55	
	1200	12.0	11.0	15	SE	5	56	
8/10	0001	9.0	11.0	35	SE	5	56	
	1200	15.0	12.0	100	NW	5	56	

Appendix C. Distribution list.

Individual	Organization	Address	# of copies
Hazel Nelson	Lake and Peninsula Borough	1577 C St. Suite 330 Anchorage AK 99501	1
Pat Martin	CAMF Member	2771 Deer Creek Rd Boseman MT 59715	1
Patti Nelson	ADF&G	Kodiak ADF&G Office	1
Ken Bouwens	ADF&G	Kodiak ADF&G Office	5
Bob Murphy	ADF&G	Kodiak ADF&G Office	1
Steve Honnold	ADF&G	Kodiak ADF&G Office	1
Mark Witteveen	ADF&G	Kodiak ADF&G Office	1
Nick Sagalkin	ADF&G	Kodiak ADF&G Office	1
Eric Newland	ADF&G	Kodiak ADF&G Office	1
Drew Crawford	ADF&G	Anchorage ADF&G Office	1
Keith Weiland	ADF&G	Anchorage ADF&G Office	1
Warren Johnson	Bear Lake Lodge	Bear Lake	1
Chris Boatright	FRI	UW-SAFS Box 355020 Seattle WA 98195	1