FRED Reports

LARSON LAKE SOCKEYE AND COHO SALMON SMOLT ENUMERATION AND SAMPLING, 1982

BY

Robert C. Lebida

Number 35

Alaska Department of Fish & Game
Division of Fisheries Rehabilitation,
Enhancement and Development

LARSON LAKE SOCKEYE AND COHO SALMON SMOLT ENUMERATION AND SAMPLING, 1982

By
Robert C. Lebida
Number 35

Alaska Department of Fish and Game
Division of Fisheries Rehabilitation,
Enhancement and Development

Don W. Collinsworth
Commissioner

Stanley A. Moberly
Director

P.O. Box 3-2000
Juneau, Alaska 99802

May 1984

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The population characteristics of sockeye salmon (Oncorhynchus nerka) and coho salmon (O. kisutch) smolts were investigated as part of a pre-fertilization assessment of Larson Lake. An estimated 644,000 sockeye and 1,400 coho salmon smolts emigrated from the lake between 28 May and 24 June 1982. Forty-four percent of the sockeye and 43% of the coho salmon emigrated before disappearance of the lake ice on 6 June. Greater than 95% of the smolts of both species emigrated during the darkest part of the day between 1800-0600 h. All the sockeye salmon smolts sampled were age 1.0 and had a mean length of 77 mm and a mean weight of 3.7 g; 9.6% of the coho salmon smolts in the subsample were age 1.0, 86.4% were age 2.0, and 4.0% were age 3.0. The mean lengths and weights for each age class were 99 mm and 9.4 g, 129 mm and 20.1 g, and 164 mm and 46.8 g, respectively. Five species of resident fish were captured in Larson Lake, with rainbow trout (Salmo gairdneri) and slimy sculpin (Cottus cognatus) dominating the catch. Basic physical and climatological parameters were also recorded. Additional juvenile and adult salmon data will be required to evaluate the possibility of a lake fertilization project at Larson Lake.

KEY WORDS: Larson Lake, salmon, smolts, sockeye, Oncorhynchus nerka, coho, O. kisutch, rearing, population characteristics, lake fertilization.

INTRODUCTION

This project was undertaken as the fisheries phase of the pre-fertilization assessment of Larson Lake. The primary objectives were to determine the abundance, size, age, and migration timing of sockeye salmon (Oncorhynchus nerka) and coho salmon (O. kisutch) smolts. Other objectives were to determine the relative abundance and condition of rearing juvenile salmon and to characterize the resident fish species as to their relative abundance and interaction with sockeye and coho salmon fry. However, because of budget constraints, only the primary project objectives were adequately accomplished.

Minimal fishery and other biological data exist for the Larson Lake system. However, sporadic anadromous fish surveys have been conducted on this system since 1949. Prior historical escapements were based on index area estimates, with the largest escapement of 3,000 sockeye salmon recorded in 1976. However, an escapement of 8,000 sockeye adults was estimated by aerial survey during 1981. In contrast, no coho salmon escapements have been estimated for Larson Lake, but the species of anadromous and resident fish species that are indigenous to Larson Lake have been reported (Lebida 1977) (Table 1).

Description of Study Area

Larson Lake is located in the western slope foothills of the Talkeetna Mountains: approximately 10.5 km (by air) east of the city of Talkeetna (map reference: Talkeetna Mountains B-6, T26N, R3W, S8, S.M.) (Figure 1). In relation to most lakes in the upper Cook Inlet area, the lake is comparatively large and deep (surface area 176.9 ha - mean depth 16.4 m) (Lebida 1977). The water is clear and comprises a volume of 29.1×10^6 m^3. The lakeshore consists primarily of rock and sand beaches, but the extreme south end is predominantly marshland.

The system drains a watershed of 34.2 km^2, which is heavily forested with spruce (Picea glauca & P. mariana), alder (Alnus spp), paper birch (Beutla

Table 1. List of common and scientific names of fish species found in the Larson lake drainage.[1/]

Common Name	Scientific name
Sockeye salmon	Oncorhynchus nerka (Walbaum)
Coho salmon	Oncorhynchus kisutch (Walbaum)
Chum salmon	Oncorhynchus keta (Walbaum)
Pink salmon	Oncorhynchus gorbuscha (Walbaum)
Rainbow trout	Salmo gairdneri Richardson
Dolly Varden	Salvelinus malma (Walbaum)
Lake trout	Salvelinus namaycush (Walbaum)
Round whitefish	Prosopium cylindraceum (Pallas)
Longnose sucker	Catostomus catostomus (Forster)
Slimy sculpin	Cottus cognatus Richardson
Threespine stickleback	Gasterosteus aculeatus Linnaeus
Burbot	Lota lota (Linnaeus)

[1/] Taken from Lebida (1977).

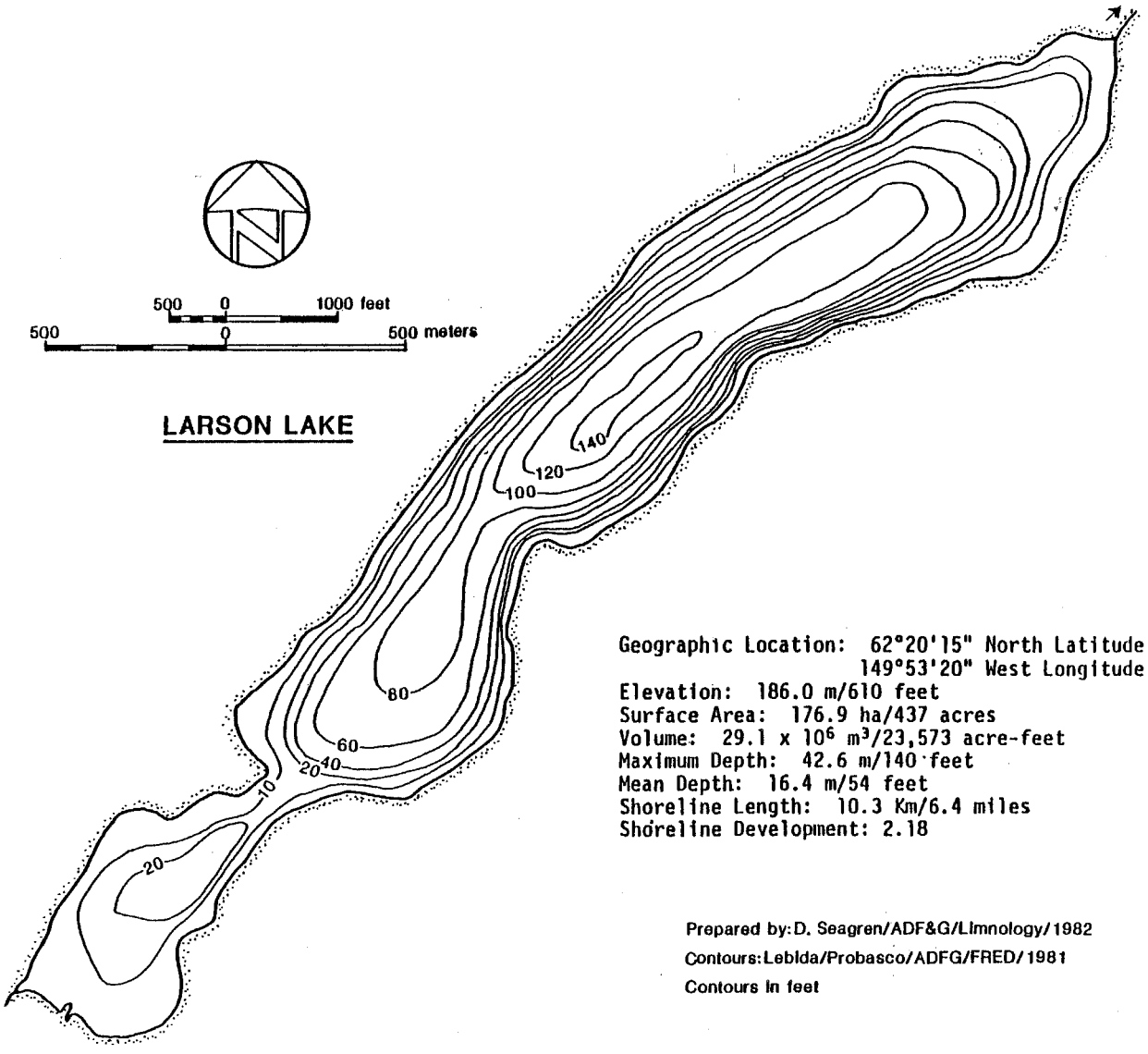

Figure 1. Bathymetric map of Larson Lake.

papyrifera), and willow (Salix spp). The inlet creek at the south end of the lake drains two small ponds. The outlet creek is fairly swift and shallow, flowing 2.0 km into the Talkeetna River. Bedrock is evident in limited reaches of the outlet creek. The majority of sockeye salmon spawning occurs in the lake shallows, and, thus, the Larson Lake salmon production appears to be limited by spawning area.

MATERIALS AND METHODS

Emigrating salmon smolts were captured with a fyke net in Larson Creek, 16 m downstream from the lake outlet. The net body measured 1.2 m x 1.2 m at the mouth and was 4-m long, tapering to a 50.8-cm diameter at the cod end. The wings were 1.2 m deep x 4.6 m long. All netting was constructed of 0.64-cm square measure knotless nylon (Delta extra heavy) dyed green with no net coat. A 0.9-m x 2.4-m x 0.8-m aluminum mesh (9.4-mm diameter) live-box was attached to the cod end. The net fished the entire discharge of the creek.

Preliminary smolt sampling in Larson Creek was conducted 28 - 29 May 1982. Sampling on a daily basis began on 2 June and the live-box was emptied every 3 h until 24 June. Because of the break-up and movement of ice down the creek on 6 June, the net was periodically removed between 2100-2400 h. Complete net removal occurred 19-20 June, between 2130-1700 h, and 22 June, between 1800-2400 h because of high winds and waves.

At the end of each sampling period, the total number of smolts were determined either by counting individual smolts or by a biomass/counting technique. If less than approximately 1,000 smolts were in the live-box (by visual observation), all the smolts were hand tallied and identified by species. If more smolts were in the live-box, the biomass/counting technique was used. For this technique a tared, 19.0-liter bucket, which was filled with approximately 5 liters of water and suspended from a calibrated 17.8-cm diameter dial scale (20 kg x 50g capacity), was used to weigh all of the smolts. A wooden frame (0.9 m x 1.0 m) covered with burlap material was used to crowd smolts to one end of the live-box so

that they could be netted. All smolts were removed from the live-box in small numbers with a dip net, allowed to drain for 15 sec, placed into the tared bucket, weighed, and released. Only 0.5 kg of smolts were weighed and individually counted for each subsample. Three replicate subsamples were taken to calculate the average number of smolts per kg. The percent representation of each species in the subsamples was used to determine total species number. The sum of emigrating smolts captured during a subsampled 3-h period was determined by:

$$N = Tw \left(\frac{n}{Sw}\right)$$

Where Tw is the total weight (kg) of smolts captured: n is the average number of individuals in the subsample count: Sw is the average subsample weight (kg); and N is the estimated total number of emigrating smolts. Daily individual counts and biomass totals were summed to obtain total weekly and seasonal estimates.

Each day, a subsample of 20 sockeye salmon smolts and up to 20 coho salmon smolts were anesthetized with MS 222, measured to the nearest mm (fork length) and weighed to the nearest 0.1 g. A scale smear was taken from the primary scale growth area, mounted between glass slides, and analyzed for age using a microfiche projector.

Physical parameters,including mean water and air temperature in degrees Celsius, creek stage height in centimeters, and general climatological observations were recorded daily. Air and water temperatures were measured with a calibrated maximum-minimum thermometer. The creek water temperatures were taken at mid-depth. Stage heights were measured using a fixed meter stick that was located upstream from the smolt sampling site.

RESULTS

Sockeye Salmon Smolt Sampling

An estimated total of 644,000 sockeye salmon smolts emigrated from Larson Lake between 28 May and 24 June 1982 (Figure 2). Two distinct migration peaks occurred. The first peak accounted for 44% of the total outmigration and occurred between 29 May and 5 June before the melting of the lake ice on 6 June. The second peak accounted for 56% of the total and occurred between 7 and 14 June, following ice out.

The estimate of 644,000 fish does not include the number of smolts migrating between 0600 h, 29 May to 1800 h, 2 June, since the collection gear was not fishing continuously. From the preliminary sampling, however, it appeared that some sockeye smolts had migrated from Larson Lake prior to the initiation of preliminary sampling on 28 May.

Ninety-seven percent of the sockeye salmon smolts emigrated during the darkest part of the day, between 1800-0600 h, and 3% during the brightest, between 0600-1800 h (Figure 3). Of these, the majority (61%) emigrated between 0000-0600 h. During the 25 days of smolt sampling, 23 days were overcast.

Scale samples, weights, and lengths were collected from 444 sockeye salmon smolts (Table 2). All sampled smolts were age 1.0 with a mean length of 77 mm and a mean weight of 3.7 g. The majority (74.2%) were 71-80 mm in length (Figure 4). The average size remained similar throughout the sampling period; however, slightly smaller smolts were caught as the sampling period progressed (Figure 5).

Longer smolts (>76 mm) represented 76% of those captured during the first sampling period but decreased to 42% for the last period (Table 3). The longer smolts (>76 mm) accounted for 60% of the total sample.

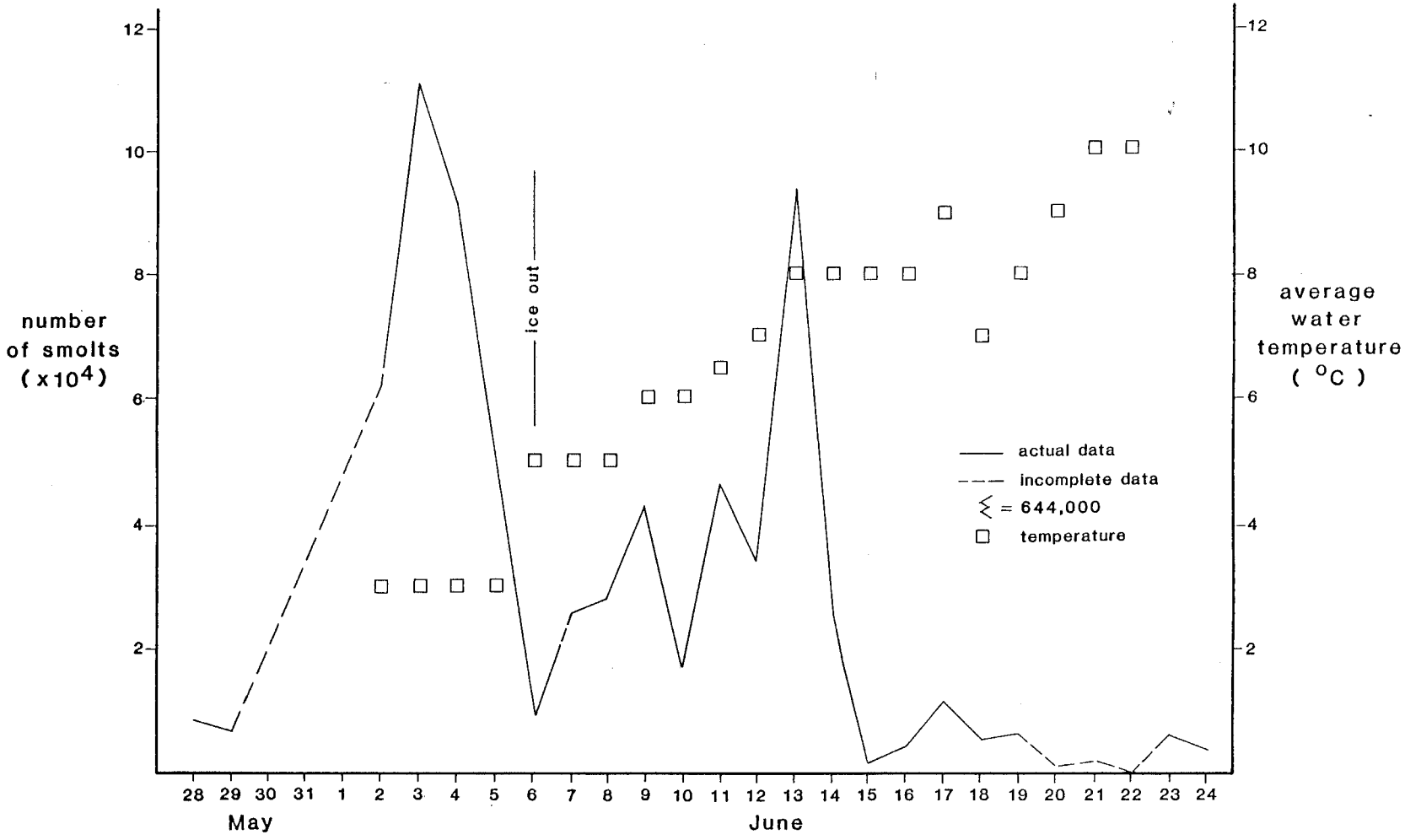

Figure 2. Total daily emigration of Larson Lake sockeye salmon smolts and average daily water temperatures, 28 May - 24 June 1982.

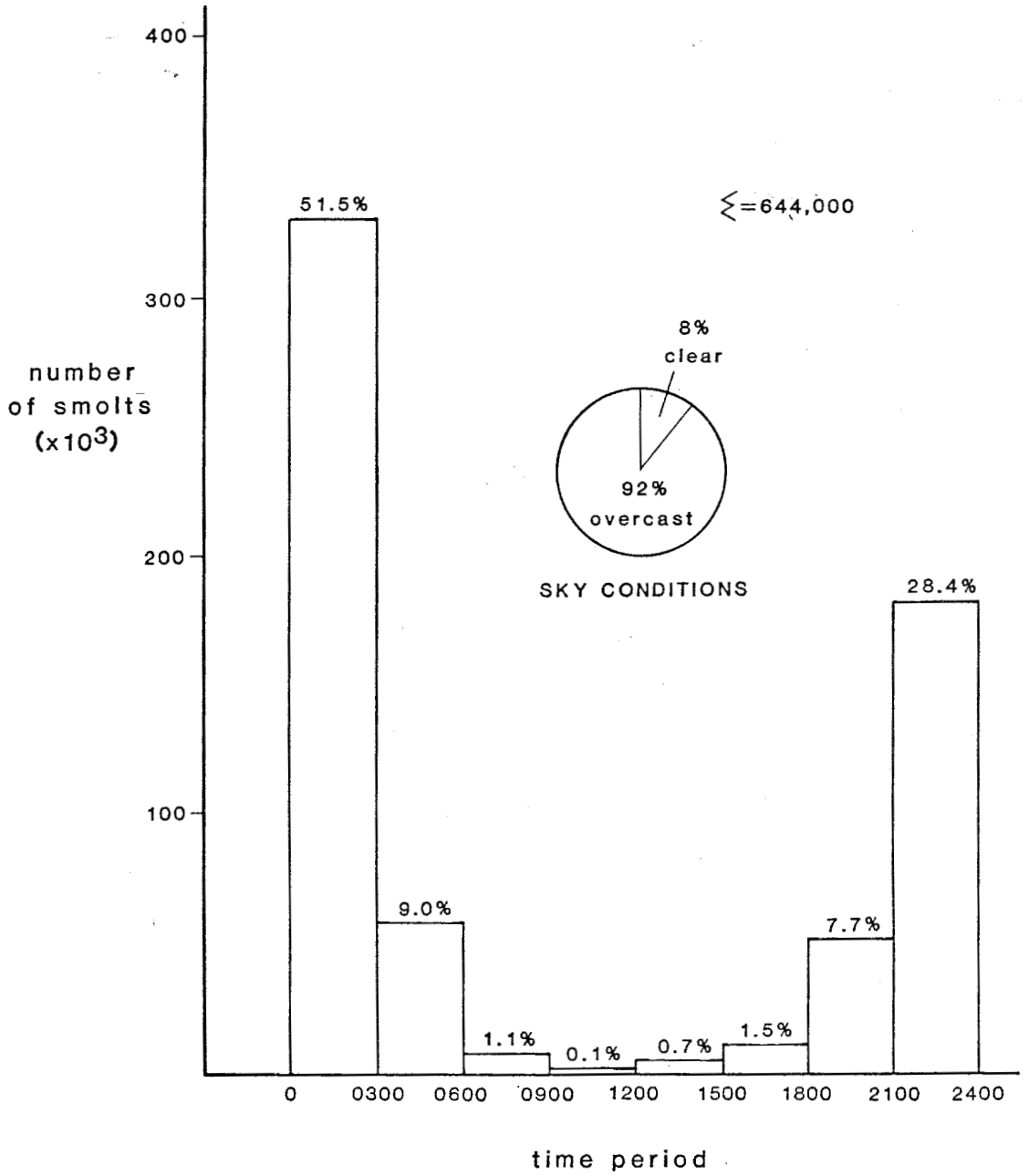

Figure 3. Diel emigration pattern of Larson Lake sockeye salmon smolts, 28 May - 24 June 1982.

Table 2. Ages, weights and lengths of sockeye and coho salmon smolts sampled from Larson Lake, 1982.

Age Class	Number Sampled	Age Class Composition (%)	Length (mm)			Weight (g)		
			Mean	S.D.	Range	Mean	S.D.	Range
		Sockeye						
1.0	444	100.0	77	4.2	63-88	3.7	0.6	2.1-5.4
		Coho						
1.0	17	9.6	99	5.4	89-108	9.4	1.6	6.7-12.1
2.0	152	86.4	129	11.0	103-157	20.1	5.5	10.0-32.7
3.0	7	4.0	164	22.6	146-204	46.8	18.6	29.6-79.1

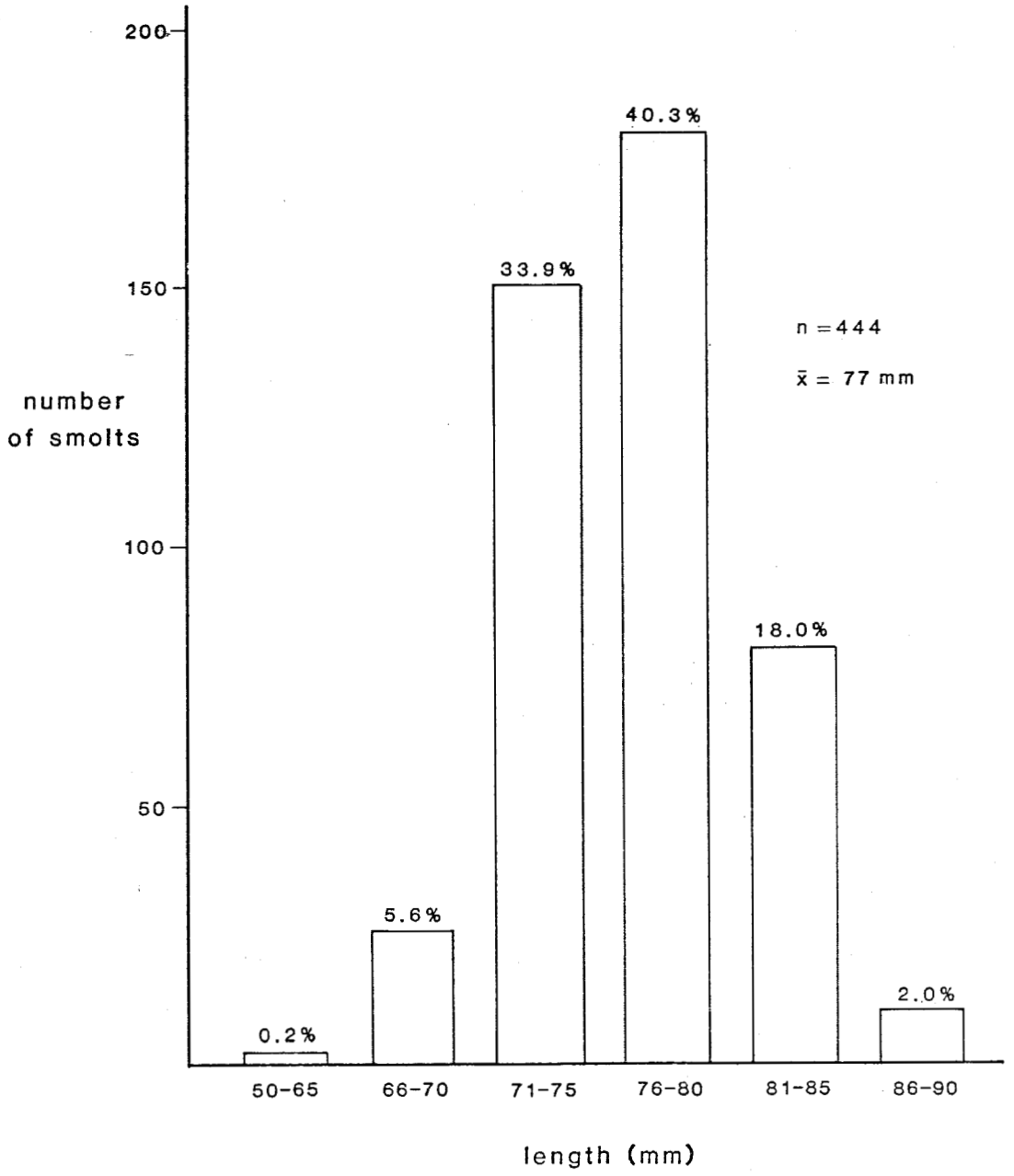

Figure 4. Length frequency distribution of age 1.0 sockeye salmon smolts sampled from Larson Creek, 3 - 22 June 1982.

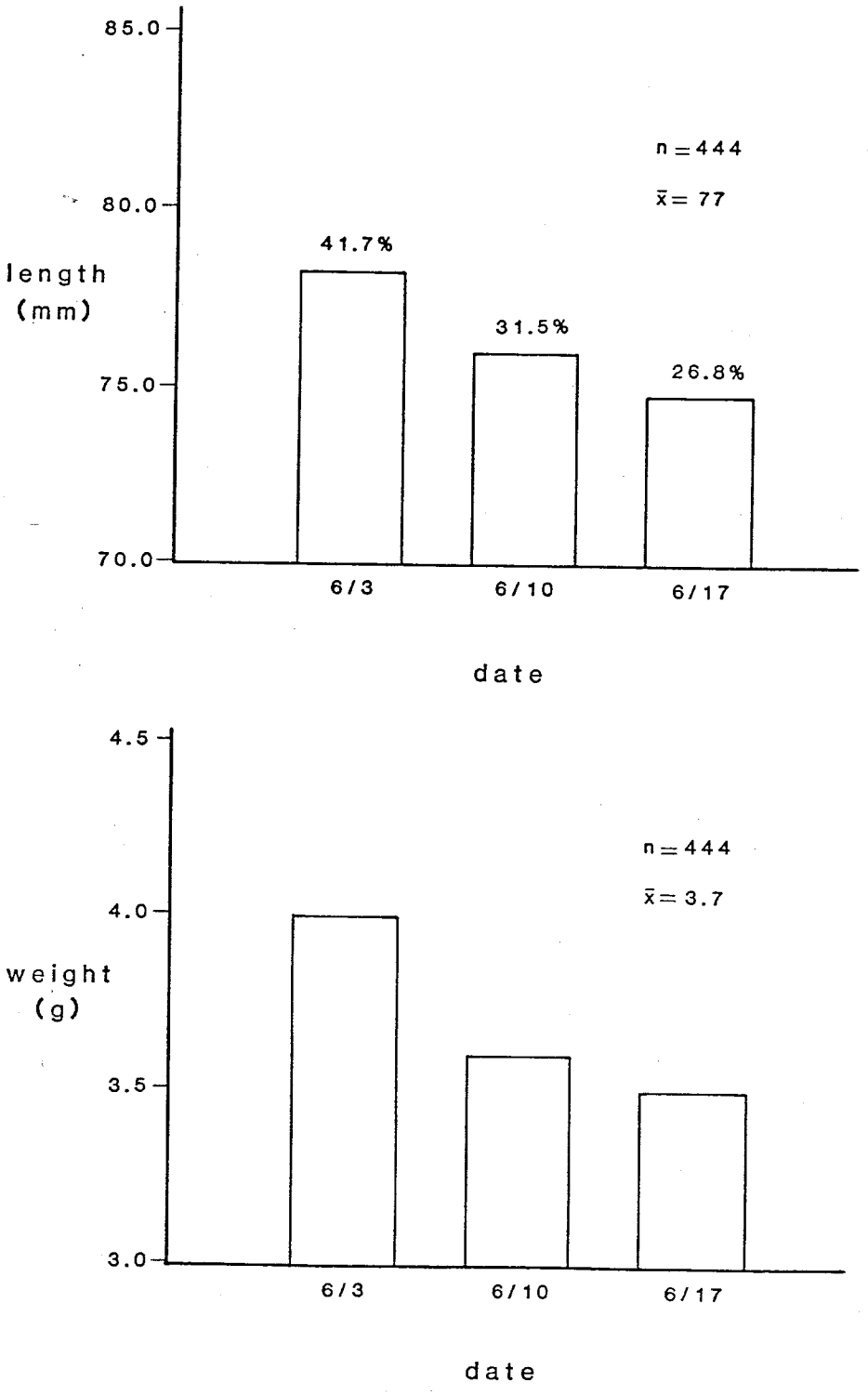

Figure 5. Weekly mean lengths and weights of age 1.0 sockeye salmon smolts from Larson Creek, 3 - 22 June 1982.

Table 3. Weekly distribution by length of age 1.0 sockeye salmon smolts and the percentage of smolts shorter and longer than 75 mm sampled from Larson Lake, 1982.

Length (mm)	6/3 - 6/9		6/10 - 6/16		6/17 - 6/23		Total	
	Number	%	Number	%	Number	%	Number	%
60-65	0		1		0		1	
66-70	1		14		10		25	
71 - 75	41		50		59		150	
	45	24	65	46	69	58	176	40
76 - 80	81		53		46		180	
81 - 85	55		18		4		77	
86 - 90	7		4		0		11	
	143	76	75	54	50	42	268	60
Total sampled	185	100	140	100	119	100	444	100

Coho Salmon Smolt Sampling

An estimated total of 1,400 coho salmon smolts emigrated from Larson Lake between 28 May and 24 June 1982 (Figure 6). Sporadic migration peaks occurred throughout the sampling period. Forty-three percent of the smolts outmigrated prior to the complete disappearance of lake ice on 6 June. This estimate does not include the number of smolts migrating from Larson Lake prior to initiation of sampling on 28 May.

Ninety-five percent of the coho salmon smolts emigrated during the darkest part of the day, between 1800-0600 h, and 5% during the brightest, between 0600-1800 h (Figure 7). Of these, the majority (91%) emigrated between 2100-0300 h. Again, during the 25 days of smolt sampling, 23 days were overcast.

Scales, weights and lengths were collected from 176 coho salmon smolts. Of these, 9.6% were age 1.0, 86.4% were age 2.0, and 4.0% were age 3.0 (Table 2). Mean lengths and weights for each age class were 99 mm and 9.4 g (age 1.0), 129 mm and 20.1 g (age 2.0), and 164 mm and 46.8 g (age 3.0), respectively. The total sample mean length was 127 mm and the mean weight was 20.2 g. Weekly age compositions and sizes of coho smolts are presented in Table 4.

Most (88.1%) of the coho salmon smolts sampled were 106-155 mm in length (Figure 8) and most (86.9%) were age 2.0 fish (Table 5). Average size of age 1.0 smolts remained fairly constant throughout the sampling period, with age 1.0 fish fluctuating slightly in size and age 3.0 smolts decreasing in size as the sampling period progressed (Figures 9 & 10).

Resident Fish Sampling

Captured between 2 and 24 June were 91 rainbow trout (*Salmo gairdneri*), 133 slimy sculpin (*Cottus cognatus*), 5 Dolly Varden (*Salvelinus malma*), 8 three-spine stickleback (*Gasterosteous aculeatus*) and 1 longnose sucker (*Catostomus catostomus*). Daily emigration patterns of these

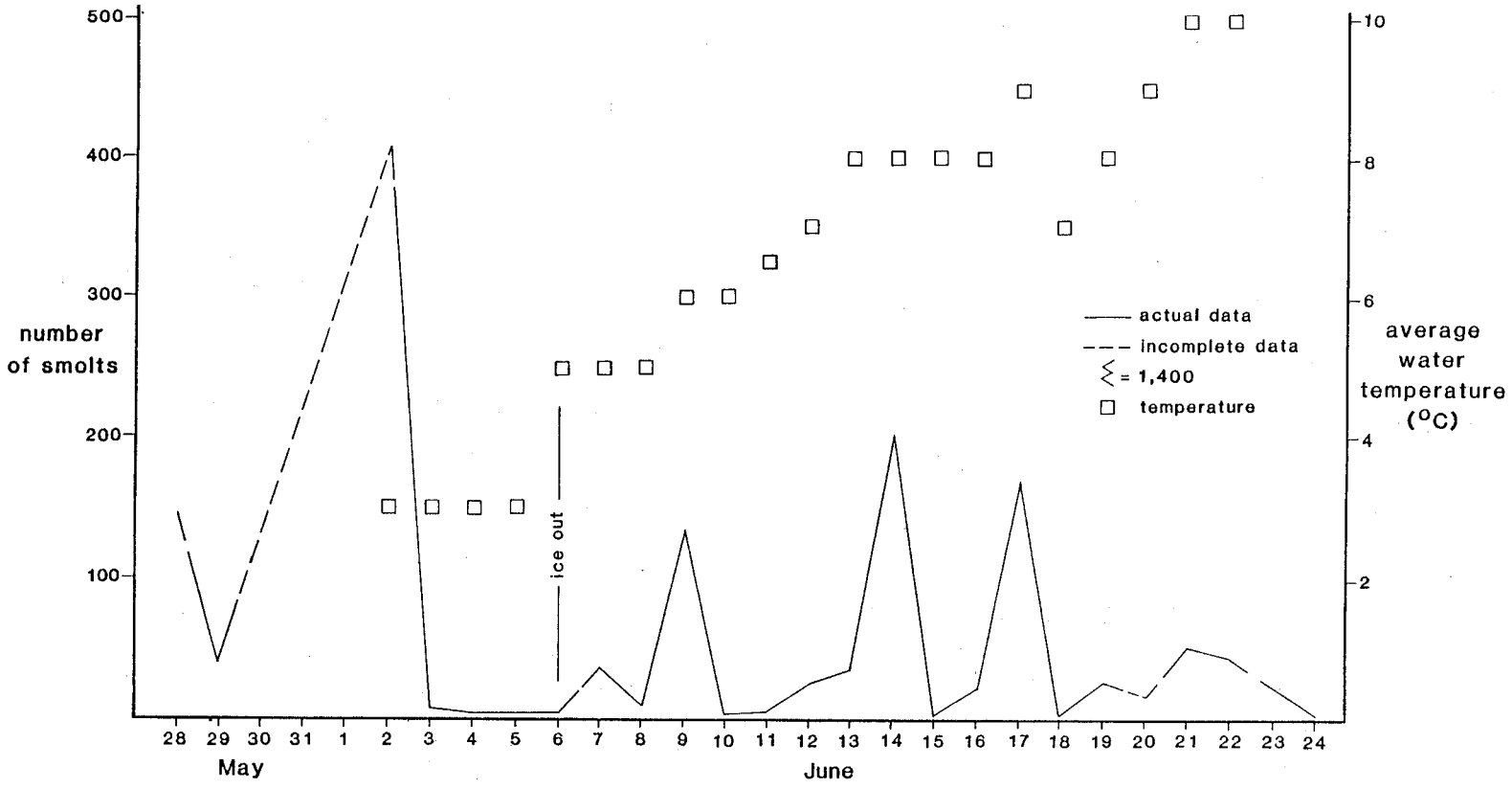

Figure 6. Daily emigration totals of Larson Lake coho salmon smolts and average daily water temperatures, 28 May - 24 June 1982.

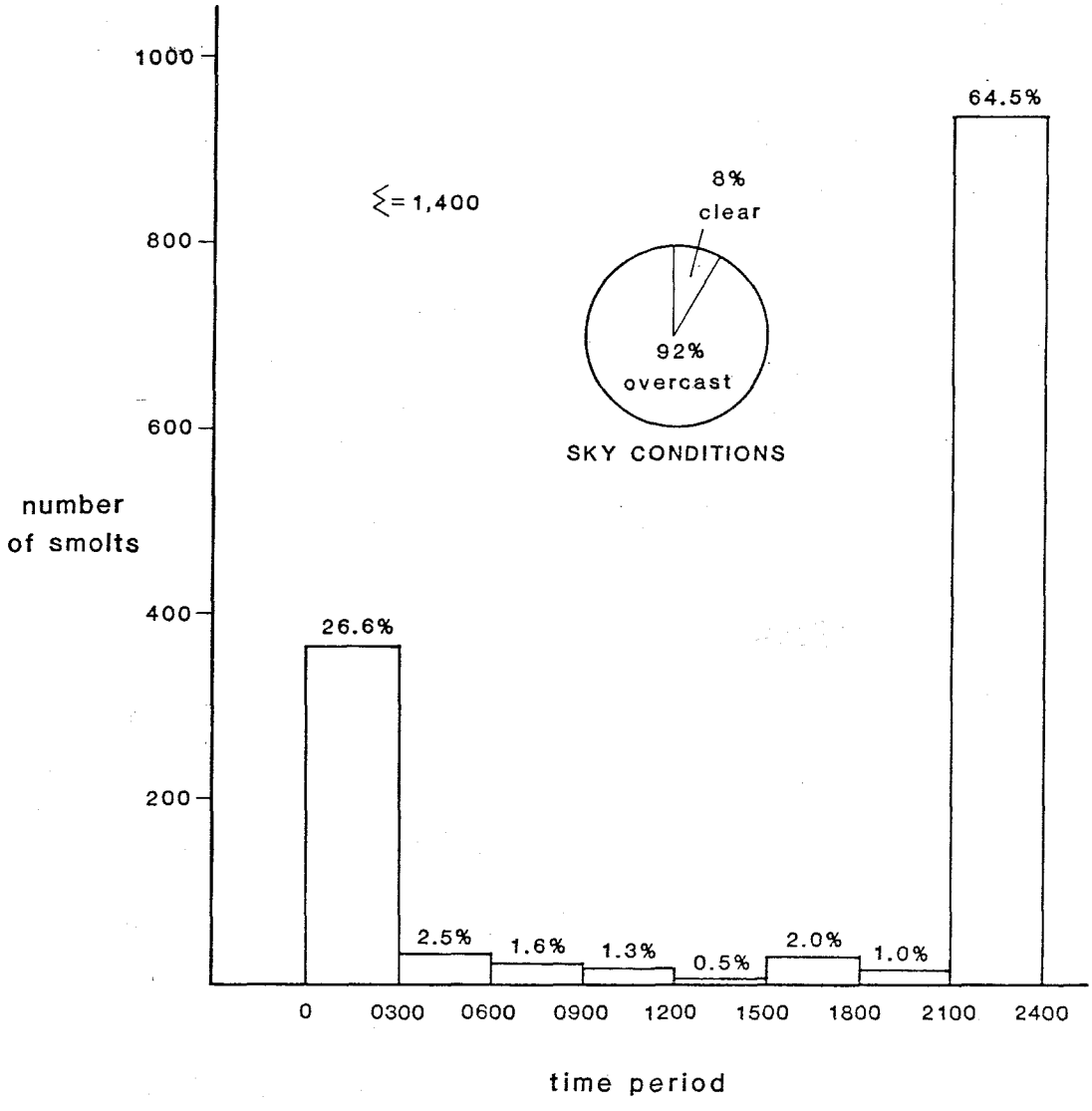

Figure 7. Diel emigration pattern of Larson Lake coho salmon smolts, 28 May - 24 June 1982.

Table 4. Weekly mean lengths, weights, and age composition of coho salmon smolts emigrating from Larson Lake, 1982.

Period	Number	Mean		Age Composition (%)		
		Length (mm)	Weight (g)	1.0	2.0	3.0
6/3 - 6/9	86	126	19.5	12.8	86.0	1.2
6/10 - 6/16	32	124	18.7	12.5	78.1	9.4
6/17 -6/23	58	132	22.1	5.2	89.7	5.1
Total	176	128	20.2	10.2	85.8	4.0

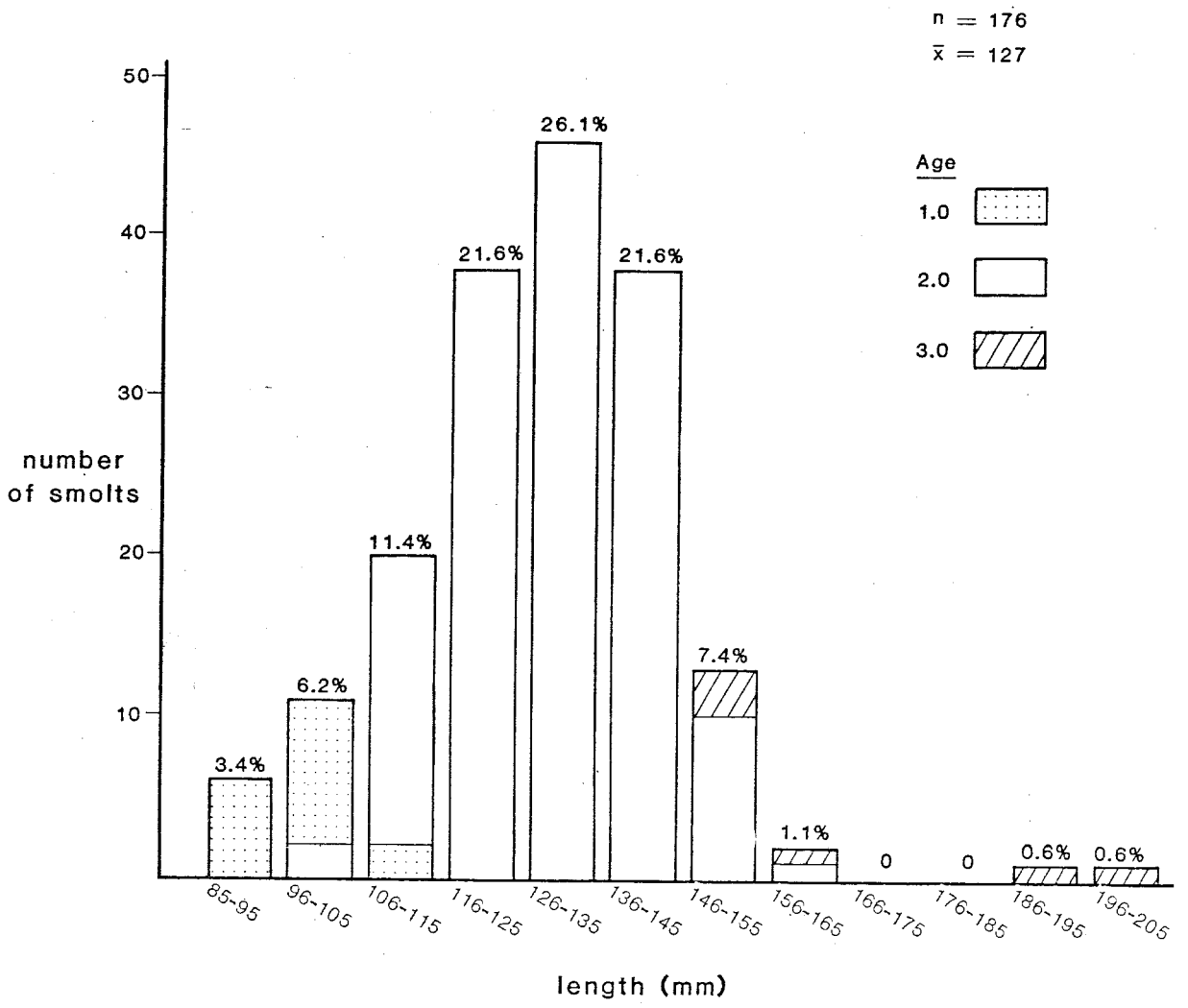

Figure 8. Length frequency of coho salmon smolts sampled from Larson Creek, 2 - 21 June 1982.

Table 5. Weekly age distribution by length of coho salmon smolts sampled from Larson Lake, 1982.

Length (mm)	Age	Week			Total
		3 - 9 June	10 - 16 June	17 - 23 June	
85 - 95	1.0	4	1	1	6
96 - 105	1.0	5	3	1	9
	2.0	1	1	-	2
106 - 115	1.0	1	-	1	2
	2.0	7	8	3	18
116 - 125	2.0	23	4	11	38
126 - 135	2.0	28	7	11	46
136 - 145	2.0	13	3	22	38
146 - 155	2.0	3	2	5	10
	3.0	-	1	2	3

-Continued-

Table 5. Continued.

Length (mm)	Age	Week: 3 - 9 June	Week: 10 - 16 June	Week: 17 - 23 June	Total
156 - 165	2.0	-	1	-	1
	3.0	-	-	1	1
186 - 195	3.0	-	1	-	1
196 - 205	3.0	1	-	-	1
Total Sampled		86	32	58	176

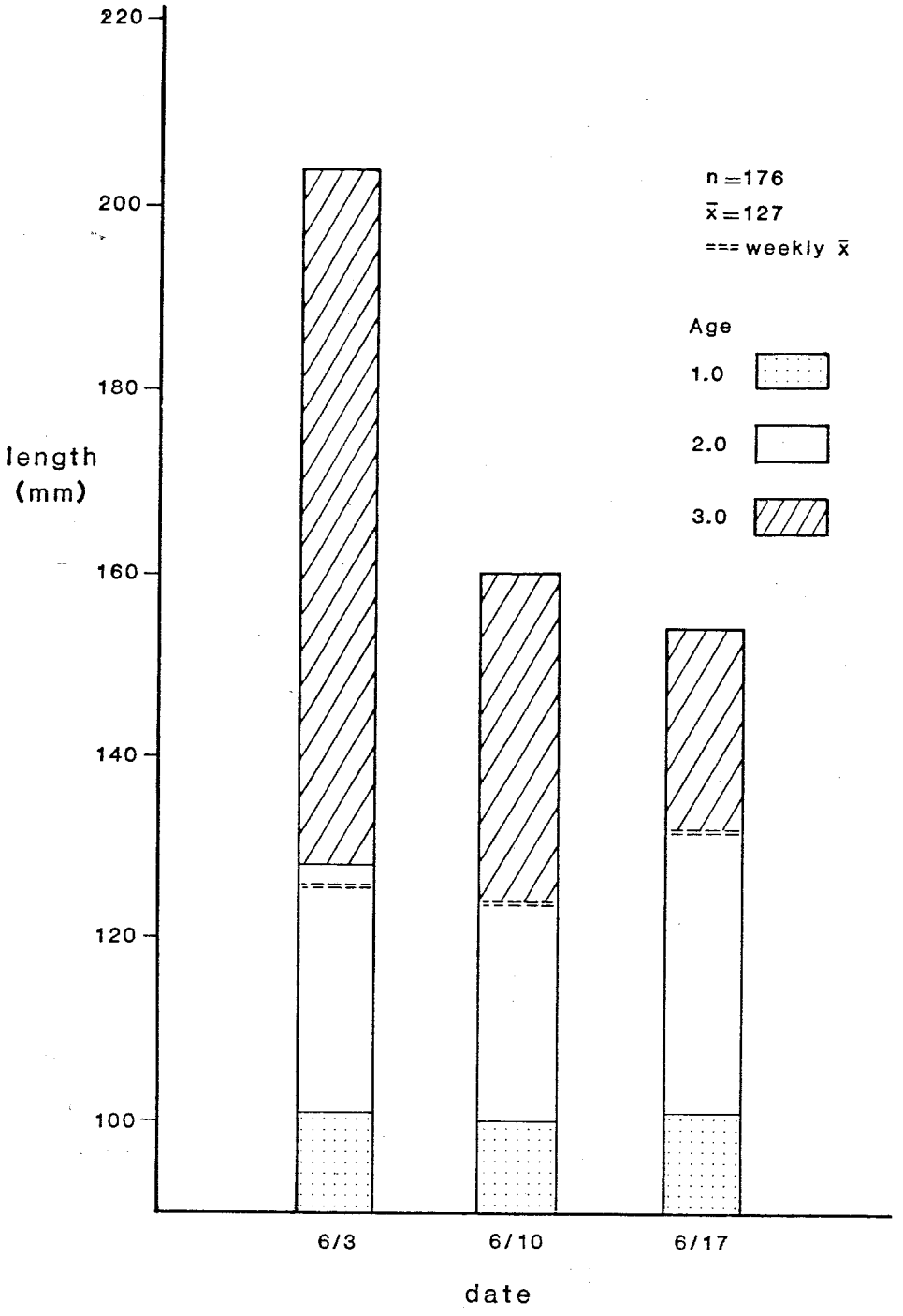

Figure 9. Weekly mean lengths of coho salmon smolts sampled from Larson Creek, 2 - 21 June 1982.

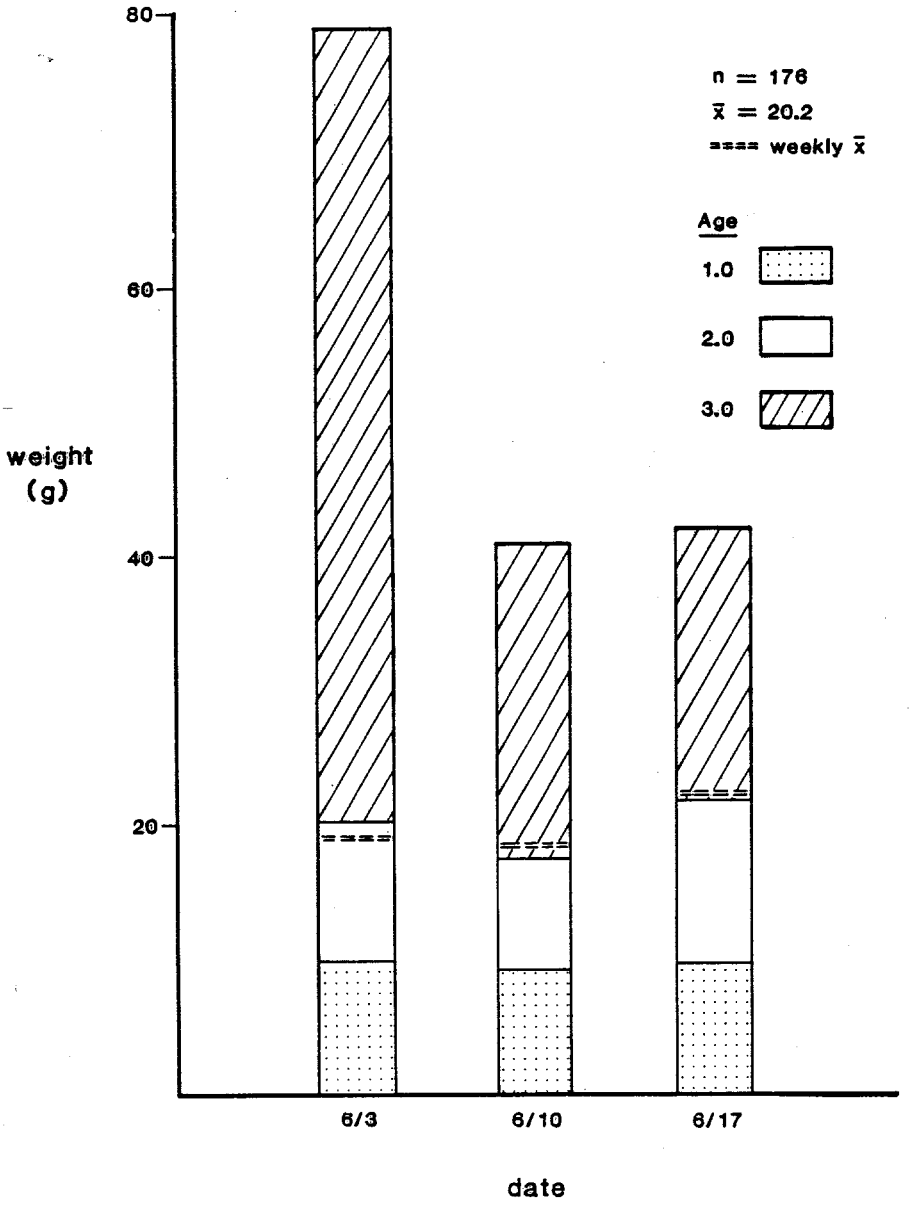

Figure 10. Weekly mean weights of coho salmon smolts sampled from Larson Creek, 2 - 21 June 1982.

species are presented in Figure 11. Seventy-seven percent of the rainbow trout were captured between 1800-0600 h, with the majority (56.0%) collected between 0000-0600 h. The largest (74.5%) movement of slimy sculpin occurred between 0600-1800 h, with 45.9% of these taken between 0600-1200 h.

Physical and Climatological Parameters

Larson Lake and the outlet creek remained clear throughout the study period. Water temperature was stable at 3.0°C in the creek until ice out on 6 June, then it slowly increased to a maximum of 14.0°C on 23 June (Table 6). The creek stage height varied 5.4 cm during a 13 day period. The weather was primarily overcast, with moderate precipitation. This was often accompanied by strong southerly winds, which subjected the outlet and the sampling site to rough water.

DISCUSSION

Sockeye and coho salmon smolts were migrating before 28 May 1982 when smolt sampling began at Larson Lake. Although an estimated 644,000 sockeye and 1,400 coho salmon smolts left the system during the sampling period, an unknown number migrated earlier. Thus, an estimate of the total number of coho and salmon smolts cannot be made. However, based on daily smolt emigration patterns (Figures 2 & 6), it is evident that migration intensities were increasing toward a peak, which occurred during the first week of June. As such, most smolts probably left the lake after the initiation of sampling, but these data can be considered conservative estimates since the smolt migration began while there was a still a heavy ice cover on the lake. Consequently, future smolt programs on Larson Lake should begin no later than 20 May to obtain a good estimate of the entire sockeye salmon smolt population.

The sockeye salmon smolt outmigration consisted entirely of age 1.0 smolts of moderate size (Table 7). The age and size representation of Larson

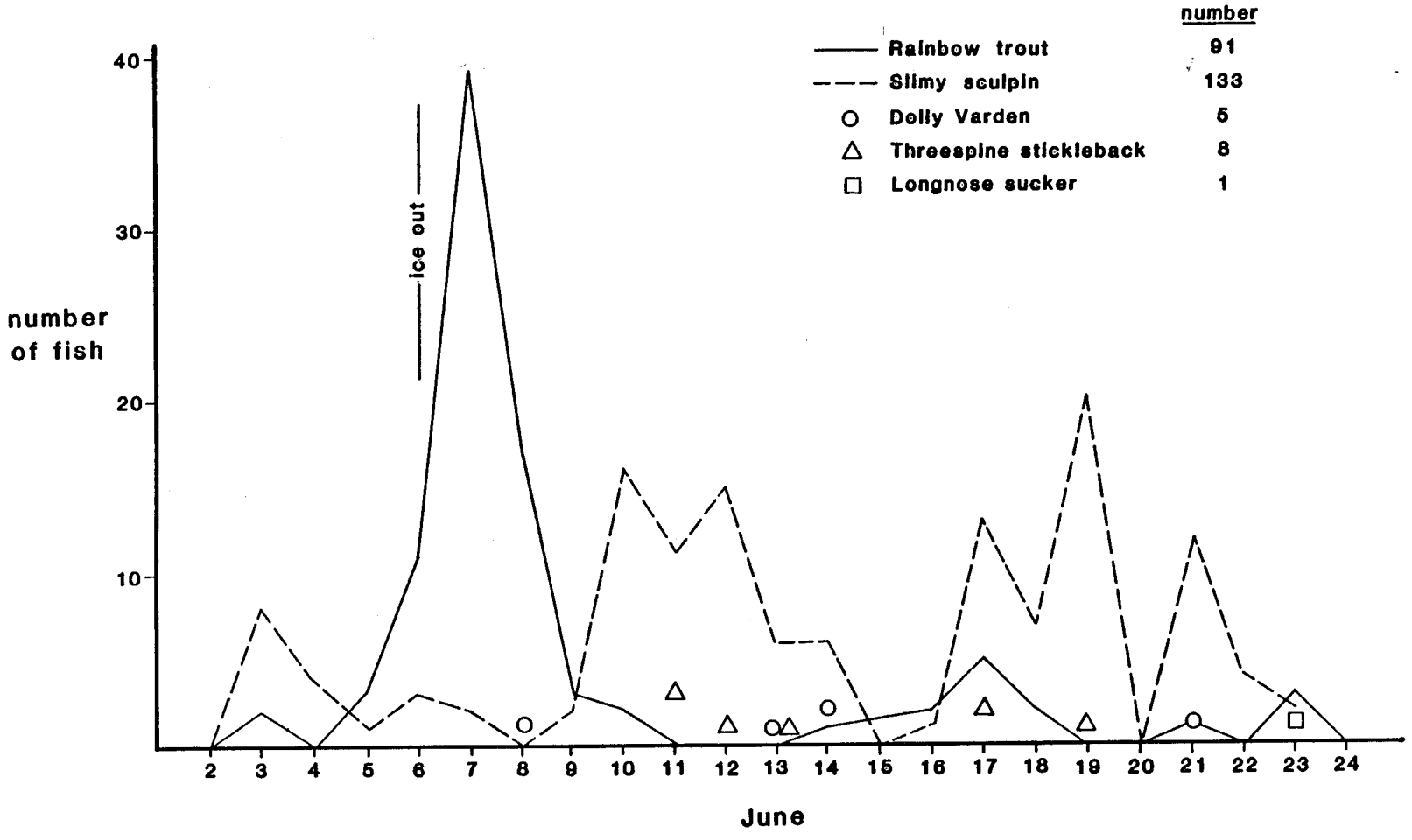

Figure 11. Total daily emigration of Larson Lake resident fish species, 2 - 24 June 1982.

Table 6. Larson Creek stage height, mean temperature and climatological data, 28 May - 23 June 1982.

Date	Daily Mean Temperatures (°C) Water	Air	Creek Stage Height (cm)	Weather
5/28	-	-	-	Overcast
5/29	-	-	-	Overcast
5/30	-	-	-	-
5/31	-	-	-	-
6/1	-	-	-	-
6/2	3.0	1.0	-	Hail; thunderstorm
6/3	3.0	5.0	-	Overcast
6/4	3.0	6.0	-	Intermittent rain
6/5	3.0	5.0	-	Continuous rain
6/6	5.0	7.0	-	Continuous rain
6/7	5.0	7.0	-	Continuous rain
6/8	5.0	6.0	-	Intermittent rain
6/9	6.0	7.5	-	Intermittent rain
6/10	6.0	7.5	-	Intermittent rain
6/11	6.5	8.5	48.8	Intermittent rain
6/12	7.0	10.0	48.8	Intermittent rain
6/13	8.0	9.0	47.8	Overcast
6/14	8.0	11.0	ND[1/]	Intermittent rain
6/15	8.0	11.0	46.5	Continuous rain
6/16	8.0	7.0	47.4	Intermittent rain
6/17	9.0	12.0	47.4	Clear

-Continued-

[1/] High waves - not measurable.

Table 6. Continued.

Date	Daily Mean Temperatures (°C) Water	Air	Creek Stage Height (cm)	Weather
6/18	7.0	13.0	47.5	Intermittent rain
6/19	8.0	13.5	47.5	Intermittent rain
6/20	9.0	8.0	49.7	Continuous rain
6/21	10.0	14.0	52.8	Overcast
6/22	10.0	8.0	52.0	Overcast
6/23	14.0	15.0	51.0	Clear

Table 7. Size characteristics of age 1.0 sockeye salmon smolts sampled from various systems in southcentral Alaska during 1982 (Chlupach pers. comm., 26 Nov 1982; Kyle, pers. comm., 6 Dec 1982).

	Age 1.0		
Location	Percent of Catch	Mean Length (mm)	Mean Weight (g)
Hidden Creek (Hidden Lk.)	98.5	144	27.6
Fish Creek (Big Lk.)	86.8	126	19.3
Cottonwood Creek	99.0	81	4.6
Larson Creek (Larson Lk.)	100.0	76	3.7
Kasilof River (Tustumena Lk.)	80.0	69	2.9
Crescent River (Crescent Lk.)	39.6	68	2.7
Quartz Creek (Kenai system)	97.5	65	2.7

Lake sockeye salmon smolts at migration may in part be attributed to rearing conditions present in the lake. However, since adult escapements and rearing fry densities are unknown, the rearing conditions may not be entirely dependent on the lake's productivity. Examining these data in combination with the quality and quantity of zooplankton in the system should provide an insight into Larson Lake sockeye salmon production. Similar studies conducted at Crescent and McDonald Lakes suggested that fry growth was not purely a function of environmental conditions in those systems (Kyle and Koenings 1982; Koenings et al. 1982).

The coho salmon smolts migrating from the system exhibited an age and size distribution similar to those of two other upper Cook Inlet lakes (Table 8). This is possibly a function of similar food availability (i.e. type and size) and of the preference of juvenile coho salmon for rearing in littoral zones within the three lake systems.

This study provides baseline information on Larson Lake sockeye and coho salmon smolts and resident fish species. Additional pre-treatment assessment will, however, require juvenile salmon fry studies and adult salmon escapement information.

Recommendations

1. Continue pre-fertilization evaluation of sockeye and coho salmon production from Larson Lake.

2. In particular, initiate smolt studies by 20 May and weir the creek to enumerate returning adults.

3. Install a floating log boom across the lake outlet above the sampling site to minimize ice flow into the creek and to dampen wave action.

4. Modify fyke net live-box to provide low velocity water flow for trapped smolts.

Table 8. Size characteristics of coho salmon smolts sampled from upper Cook Inlet systems during 1982 (Chlupach 1982).

Location	Percent of Catch	Mean length (mm)	Mean weight (g)
	Age 1.0		
Fish Creek	16.0	105	10.9
Cottonwood Creek	16.6	115	13.5
Larson Creek	9.6	99	9.4
	Age 2.0		
Fish Creek	75.7	125	19.3
Cottonwood Creek	72.6	121	19.2
Larson Creek	86.4	120	20.1
	Age 3.0		
Fish Creek	8.3	158	35.3
Cottonwood Creek	10.7	148	33.1
Larson Creek	4.0	163	46.8

5. Sample smolt size at various time intervals during each 3 h sampling period.

6. Provide a separate live-box to hold smolts for convenient processing after enumeration procedures are completed.

7. Implement studies of juvenile sockeye and coho salmon in Larson Lake, including: diet of sockeye and coho salmon juveniles, population densities, and seasonal migration patterns using hydroacoustic techniques.

ACKNOWLEDGEMENTS

Appreciation is extended to Rebecca Wetherell, Theresa Keklak-Sandone, Nick Cassara and Jeff Fox for all their efforts in collecting and compiling the smolt information.

REFERENCES

Chlupach, R. S. 1982. Compilation of age, length, weight, condition factor, water temperature and run timing for sockeye and coho salmon smolt in three upper Cook Inlet watersheds; Big Lake, Nancy Lake and Cottonwood Lake, 1978 - 1982. Alaska Department of Fish and Game. Data Report (in press).

Koenings, J. P., Kyle, G. B., Haddix, M., Peltz, L. and B. Campbell. 1982. Limnology and fisheries investigations at McDonald Lake (1979 - 1982). Alaska Department of Fish and Game. Unpub. Report. Part I - 47 p., Part II - 24 p.

Kyle, G. B. and J. P. Koenings. 1982. Crescent Lake sockeye salmon smolt enumeration and sampling, 1981. Alaska Department of Fish and Game. Unpub. Annual Report. 27 p.

Lebida, R. C. 1977. Upper Cook Inlet salmon incubation site selection inventory - 1976. Alaska Department of Fish and Game. Unpub. Data Report.