Fishery Management Report No. 05-20

Chignik Watershed Ecological Assessment Project Season Report, 2003

by

Heather Finkle

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Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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by

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ABSTRACT

The Chignik watershed supports one of the largest sockeye salmon *Oncorhynchus nerka* fisheries on the south side of the Alaska Peninsula. Data collected during the 2003 field season have helped establish a foundation to reassess habitat quality and sockeye salmon production trends in the Chignik watershed, which were relative to current morphological conditions in the watershed. Several habitat types have been found in the nursery areas for rearing juvenile sockeye salmon in the watershed. Black Lake, located at the head of the watershed is shallow and turbid. Chignik Lake, which is relatively deep, drains into the tidally influenced Chignik Lagoon. During 2003, limnological data inclusive of nutrient, physical, and zooplankton data indicated that although primary production was not limiting to zooplankton production in both lakes, top-down grazing pressure by juvenile sockeye salmon was present. Continued study of the Chignik watershed is still needed to describe trends in habitat use and rearing limitations by juvenile sockeye salmon.

Key words: Chignik watershed, euphotic volume, limnology, juvenile sockeye salmon, zooplankton.

INTRODUCTION

The Chignik watershed supports one of the largest sockeye salmon *Oncorhynchus nerka* fisheries on the south side of the Alaska Peninsula (Owen et al. 2000). The carrying capacities for the lakes in the watershed were originally established in 1966, but have not been re-assessed to date despite morphological changes to the watershed within the last 40 years (Buffington 2001; Bouwens and Finkle 2003; Finkle 2004). Recent Chignik watershed ecological assessment data have been used to identify current sockeye salmon production trends. This report seeks to document the findings of the relationships between juvenile sockeye salmon and their rearing conditions in the watershed during the 2003 sampling season.

Two lakes, two rivers, a lagoon, and various small creeks compose the Chignik watershed (Figure 1). Black Lake, located at the head of the system, is an atypical sockeye salmon nursery lake; it is large (41.1 km^2), shallow (mean depth of 1.9 m, maximum depth 4.2 m; Ruggerone et al. 1993), and turbid. The large (24.1 km^2) and deep (mean depth of 26 m) Chignik Lake receives Black Lake run-off via the Black River. Both lakes are considered oligotrophic (Kyle 1992) and each maintains its own genetically distinct sockeye salmon run (Templin et al. 1999). The early run, which returns between June and July (biological escapement goal of 350,00 to 400,000 sockeye salmon; Nelson and Lloyd 2001), spawns in Black Lake and its tributaries. The generally smaller late run (biological escapement goal of 200,000 to 250,000 sockeye salmon; Nelson and Lloyd 2001), which returns between July and September, utilizes the beaches of Chignik Lake and its tributaries for spawning. Chignik Lake drains into the Chignik Lagoon through the Chignik River. The lagoon is shallow (<20 m), grassy and has bottom substrate composed of silted and cobbled beaches.

Over the last 20 years, Black Lake has been progressively getting shallower; currently it is at two-thirds of its 1968 mean depth of 3.0 m (Dahlberg 1968; Ruggerone et al. 1999). It was suggested that 40 years ago a natural sill, which created a hydrostatic dam, was lost when the confluence of the West Fork and Black Rivers shifted approximately three miles downstream (Buffington 2001). The loss of the hydrostatic dam increased the velocity of effluent flow from Black Lake, reducing lake depth (Buffington 2001). With the reduction of lake depth, the Alec River, Black Lake's main tributary, now partially drains through Fan Creek (Figure 2). A sand spit has also formed, which begins approximately 1.5 km north of the Fan Creek outlet and extends across roughly two-thirds of the lake's width.

Due to the shallow depth and silted substrate of Black Lake, frequent strong winds have created a turbid environment for its rearing juvenile sockeye salmon. Warm summer temperatures, due to the shallow depth of Black Lake, have also been shown to influence the rearing behavior of Black Lake juvenile sockeye salmon (Finkle 2004). Density dependence has been considered to affect the carrying capacities in both Black and Chignik Lakes (Narver 1966). Similar sockeye salmon habitat studies have indicated significant density dependent responses occur within juvenile sockeye salmon populations when their abundance increased (Kyle et al. 1988; Schindler 1992; Schmidt et al. 1995; Koenings and Kyle 1997; Milovskaya et al. 1998). The reduced water volume of Black Lake has been thought to diminish effective sockeye salmon rearing habitat (Ruggerone et al. 1999). The loss of rearing habitat, in turn, may intensify density dependent effects in the watershed. The downstream migration of Black Lake juvenile sockeye salmon into Chignik Lake can increase density dependence (namely competition) and subsequently create top-down pressures on the available forage base in Chignik Lake. Top-down pressures are often reflected by decreased zooplankton size, which have been observed in Chignik and Black Lake *Bosmina* (Kerfoot 1987; Kyle 1992; Bouwens and Finkle 2003). Density dependent limitations have also been suggested to influence the downstream migration of Black Lake juvenile sockeye salmon into Chignik Lake to overwinter, however, these observations were made prior to the atrophy of Black Lake (Parr 1972; Narver 1966).

Chinook salmon *O. tshawytscha*, coho salmon *O. kisutch*, pink salmon *O. gorbuscha*, Dolly Varden *Salvelinus malma*, threespine stickleback *Gasterosteus aculeatus*, ninespine stickleback *Pungitius pungitius*, pond smelt *Hypomesus olidus*, starry flounder *Platyichthys stellatus*, and coastrange sculpin *Cottus aleuticus* are also present throughout the Chignik system (Narver 1966; Parr 1972). Ecological niche models among juvenile sockeye salmon, threespine stickleback, ninespine stickleback, and pond smelt were used to determine the carrying capacities of each lake (Narver 1966). Despite this and the variety of other species present in the watershed, Parr (1972) downplayed interspecific competition as a limiting factor to sockeye salmon production, citing that divergent feeding habits prevented resource limitations. Juvenile sockeye salmon have also been documented as having a competitive edge over sticklebacks (Edmundson et al. 1994), which are abundant throughout the Chignik watershed (Narver 1966; Parr 1972). However, Ruggerone (1989) suggested that juvenile coho salmon maintained significant interactions with sockeye salmon fry in Chignik Lake through a predator-prey relationship.

The nursery role of Chignik Lagoon is still poorly understood. Chignik Lagoon may be a vital rearing ground for juvenile sockeye salmon seeking refuge from rearing limitations and density dependent factors in the watershed. Phinney (1968) indicated that migratory movement of juvenile sockeye salmon from Chignik Lake to Chignik Lagoon might occur. Underyearling (age 0.) sockeye salmon have been observed to migrate from limited lake-rearing habitats and survive in marine conditions (Rice et al. 1994). This migratory behavior may exist in the Chignik watershed, if rearing limitations occur in Chignik or Black Lakes. Conversely, the upstream movement of sockeye salmon fry in the Chignik River may indicate fry travel from Chignik Lagoon and Chignik River to over-winter in Chignik Lake (Iverson 1966). However, this observation has not been documented since the 1960s. Ultimately, the lagoon cannot be dismissed as an alternate nursery area for juvenile sockeye salmon.

Definitive ecological assessments of the Chignik watershed have not been performed since the sockeye salmon escapement goals were initially estimated in the late 1960s (Narver 1966; Dahlberg 1968; Phinney 1968; Burgner et al. 1969). With the recent morphological changes to

Black Lake, it is necessary to reestablish benchmarks of water quality, primary production and secondary production; past sockeye salmon production levels may not accurately reflect what the system can optimally produce today. In this study, physical parameter (temperature, dissolved oxygen, and light penetration) and available nutrient data (nitrogen, phosphorous, chlorophyll *a*, and phaeophytin) were collected as an indicator of conditions suited to zooplankton production, the preferred juvenile sockeye salmon forage, and juvenile fish growth in both lakes. Juvenile sockeye salmon age, length, weight, and distribution data were also collected to corroborate the presence of density dependence, preferred nursery areas, and migratory trends in both lakes. These 2003 Chignik watershed ecological assessment data enable the construction of a platform from which to reassess the current carrying capacity and thus escapement goals for the Chignik watershed relative to the present ecological conditions and fishery production levels.

OBJECTIVES

The objectives of this project were to:

1. Describe the physical characteristics of Black and Chignik Lakes, which include temperature, dissolved oxygen, and light penetration profiles,
2. Describe the nutrient availability and primary production of Black and Chignik Lakes,
3. Describe the zooplankton forage base available to juvenile sockeye salmon in Black and Chignik Lakes,
4. Document the relative abundance of juvenile sockeye salmon throughout the Chignik watershed,
5. Describe the age and size characteristics of juvenile sockeye salmon throughout the Chignik watershed.

METHODS

LIMNOLOGY

One limnology/zooplankton station was established on Black Lake in mid May 2003 (Figure 2; Appendix A). In early May 2003, four sampling stations were established on Chignik Lake. Zooplankton samples and temperature, dissolved oxygen, and light penetration data were gathered at all four Chignik Lake stations, but only two stations were dedicated to the collection of water samples (Figure 3). Each station's location was logged on a global positioning system (GPS) and marked with a buoy. Sampling was conducted following protocols established by Finkle and Bouwens (2001). Limnology and zooplankton sampling occurred once every three weeks, beginning in May and ending in August (Table 1).

Dissolved Oxygen, Light, and Temperature

Water temperature (°C) and dissolved oxygen (mg/L) levels were measured with a WTW™ Oxi 197 meter. Readings were recorded at half-meter intervals to a depth of 5 m, then the intervals increased to every meter. Upon reaching a depth of 20 m, the intervals increased to every five meters. A mercury thermometer was used to ensure the meter's calibration. Measurements of photosynthetically active wavelengths (kLux) were taken with a Li-Cor™ Li-250 photometer.

Readings began at the surface and proceeded at half-meter intervals until reaching a depth of 5 m. Readings were then recorded at one-meter intervals until the lake bottom or 0 kLux light penetration was reached. The mean euphotic zone depth (EZD) was determined (Koenings et al. 1987) for each lake and incorporated into a model for estimating sockeye salmon fry production (Koenings and Kyle 1997). Mean lake depth was used as the EZD when 0 klux light penetration could not be achieved in the water column. Secchi disc readings were collected from each station to measure water transparency. The depths at which the disc disappeared when lowered into the water column and reappeared when raised in the water column were recorded and averaged.

Water Sampling

Seven to eight liters of water were collected with a Van Dorn bottle from the epilimnion (depth of 1 m) of each station and from the hypolimnion (depth of 29 m) of Chignik Lake stations 2 and 4. Water samples were stored in polyethylene (poly) carboys and refrigerated until processed.

One-liter samples were passed through 4.25-cm diameter 0.7-µm Whatman™ GF/F filters under 15 to 20-psi vacuum pressure for particulate N, P, and C analyses. Chlorophyll *a* was also a particulate sample; one liter of lake water from each depth sampled was run through a 4.25-cm diameter 0.7-µm Whatman™ GF/F filter, adding approximately 5 ml of $MgCO_3$ solution to the last 50 ml of the remaining unfiltered chlorophyll *a* sample water. Upon completion of filtration, all filters were placed in individual petri dishes, labeled and frozen. For each sampled depth, 120 ml of sample water and 2 ml of Lugol's acetate were placed in a 125-ml poly bottle for phytoplankton analysis and stored at room temperature until processing.

The water chemistry parameters of pH and alkalinity were also assessed with a Corning Student pH meter. One hundred milliliters of refrigerated lake water were heated to 25 °C and titrated with 0.02-N sulfuric acid following the methods of Thomsen et al. (2002).

Filtered and unfiltered (refrigerated and frozen) water samples were collected in clean poly bottles. Water analyses were performed at the Alaska Department of Fish & Game (ADF&G) Near Island laboratory for total phosphorous (TP), total filterable phosphorous (TFP), filterable reactive phosphorous (FRP), total ammonia (TA), nitrate + nitrite, total Kjeldahl nitrogen (TKN), chlorophyll *a* and phaeophytin *a*. All laboratory analyses adhered to the methods of Koenings et al. (1987) and Thomsen et al. (2002).

Zooplankton

Two vertical zooplankton tows were made at each limnology station with a 0.2-m diameter, 153-micron net. All plankton tows started one meter above the lake bottom. One sample was placed in a 125-ml poly bottle containing 12.5 ml of concentrated formalin to yield a 10% buffered formalin solution. Samples were stored for analysis at the ADF&G Near Island lab. Subsamples of zooplankton were keyed to family or genus and counted on a Sedgewick-Rafter counting slide. This process was replicated three times per sample then averaged and extrapolated over the entire sample. Mean length measurements (0.01 mm) from each family or genus, per plankton tow, were taken from a subsample of up to 15 individuals, which is a sample size derived from a student's t-test to achieve a confidence level of 95% (Koenings et al. 1987). Biomass was calculated via species-specific linear regression equations between weight and length measurements (Koenings et al. 1987). The other 125-ml sample was stored in a poly bottle and frozen for stable isotope analysis to be conducted at a later date.

JUVENILE SOCKEYE SALMON SAMPLING

Three gear types were used to sample juvenile sockeye salmon: beach seine, fyke net and pelagic trawl (townet). The sampling protocol was as follows:

Beach Seine

Eighteen sites (four Black Lake sites, seven Chignik Lake sites, three Chignik River sites and four Chignik Lagoon sites; Figures 2 to 4) were routinely sampled every three weeks beginning in May (Table 2). The beach seine sampling cycle started in Chignik Lagoon and proceeded upstream to minimize recapturing outmigrating fish. A 3-mm mesh, 10-m long, 1-m deep seine was used.

One beach seine set was made per site, unless the net deployed poorly and required an additional attempt. Two people (one on shore acting as an anchor and the other wading off shore to make the haul) or a boat (haul) and one person (anchor) were used to make the set, dependent on weather conditions. The net was set similarly between sampling events to standardize effort.

Fyke Net

A fyke net with 3.05 by 1.22-m wings, a 1.22 by 1.22-m opening and a 3.66-m body with 6.4-mm mesh was used to sample the Black River. The net was set at a site by the effluent of Black Lake roughly once a month; this sampling event overlapped with the occurrence of other sampling duties at Black Lake. (Table 3).

Townet

Paired tows were made on Chignik Lake approximately once per month (Table 4). Tows lasted 10 minutes. Transects ran between the established limnology stations. Tows were intended to sample the water column at the surface and at depth. Tow depths were adjusted by two sets of metered drop lines (10 and 20 m) that attached to each side of the net's opening (on the top corners) and to buoys on the other end of the drop lines. The actual depths are unknown because the net's drag would cause it to rise in the water column. The townet consisted of 10-mm mesh tapering down to a 1-mm mesh cod end, for a total length of 4.6 m. The net opening was 1.82 by 1.82 m. Boat speed was maintained at approximately 4.5 km/hr. The townet was retrieved by hand.

Tows were made in Black Lake in cooperation with the University of Washington, Fisheries Research Institute (FRI) staff , using FRI gear, following Narver's (1966) protocol.

Distribution, Abundance, and Size

Fish collected with the beach seine, fyke net, or townet were identified and enumerated. Species abundance of large catches (>500 fish) was estimated to prevent sampling mortality. Up to 40 juvenile sockeye salmon and up to 20 juvenile chinook and coho salmon each were randomly sampled per sampling event. Age, weight, and length (AWL) data, as described by Bouwens et al. (2000), were collected from the first 20 juvenile sockeye salmon. Length measurements, only, were taken from an additional 20 juvenile sockeye salmon if present in the catch. Juvenile coho and chinook salmon (up to 20 for each species) caught during a sampling event were sampled only for length. AWL sampled fish were stored in a plastic ziplock bag with water until processed.

Scales were taken from the preferred area (INPFC 1963) of each fish sampled for AWL and placed on a labeled glass microscope slide. Weight was measured to the nearest 0.1 g, and fork length (FL) was measured to the nearest 1 mm. All juvenile sockeye salmon scales were aged using a microfiche reader (Eyecom 3000) under 36X or 60X magnification and recorded in European notation (Koo 1962). AWL data were compiled in a database for comparison.

RESULTS

LIMNOLOGY

Temperature and Dissolved Oxygen

Black Lake

Meter malfunctions prevented the collection of May and June dissolved oxygen and temperature profiles. On July 26, the 1-m temperature in Black Lake was 13.7°C, decreasing to 13.5 °C by August 18 (Table 5; Figure 6). Dissolved oxygen levels at the 1-m depth went from 9.7 mg/L on July 26 to 9.2 mg/L on August 18 (Table 6; Figure 6). During both July and August, temperature and dissolved oxygen levels remained similar throughout the water column (Figure 6).

Chignik Lake

Meter malfunctions prevented the collection of May dissolved oxygen and temperature profiles. June temperatures in Chignik Lake were homogenous over depth, with a 1-m temperature of 8.7 °C (Table 7; Figure 7). By July 25, temperature variability existed over depth and the 1-m temperature increased to 12.2 °C from the June 25 1-m temperature of 8.7 °C (Table 7; Figure 7). By August 18, the 1-m temperature reached 12.7 °C and a thermocline was absent from the water column (Table 7; Figure 7). Dissolved oxygen levels increased with depth in July and August (Table 8; Figure 7). The 1-m July 25 dissolved oxygen level was 10.6 mg/L compared to 12.0 mg/L on August 18 (Table 8; Figure 7).

Light Penetration and Water Transparency

Black Lake

Light penetrated the entire water column in Black Lake during the 2003 sampling season (Table 9; Figure 8). The EZD of Black Lake exceeded its average depth of 1.9 m; therefore, the mean lake depth was used to calculate the euphotic volume (EV) of 78.1 x 106 m3 (Table 10; Figure 8).

Chignik Lake

Light penetration ceased at a depth of 14 m in July and at 13 m in August (Table 11; Figure 8). The EZD decreased from 4.97 m in July to 4.76 m in August (Table 10). The EV in Chignik Lake averaged 120.1 x 106 m3 for the 2003 sampling season (Table 10; Figure 8).

Water Quality Parameters, Nutrient Levels, and Photosynthetic Pigments

Black Lake

The pH in Black Lake averaged 7.46 and alkalinity averaged 32.3 mg/L $CaCO_3$ (Tables 12 and 13). All phosphorous based nutrient concentrations in Black Lake were greater than or equal to Chignik Lake phosphorous concentrations (Table 12). Total P (TP), average TFP, and FRP in Black Lake in 2003 were similar 2000, 2001, and 2002 averages (Tables 12 and 13). TKN (256.8 μg/L N) was lower on average in Black Lake in 2003 compared to 2002 (Tables 12 and 13). Ammonia was approximately 3.7 μg/L N, and nitrate + nitrite had an average of 25.2 μg/L N in 2003 (Tables 12 and 13). Of the photosynthetic pigments, chlorophyll-*a* levels and phaeophytin-*a* levels were lower than those of 2000 and greater than those of 2002 (Tables 12 and 13).

Chignik Lake

The pH in Chignik Lake averaged 7.38 and alkalinity averaged approximately 23.6 mg/L CaCO3 (Tables 12 and 14). Total P, and average TFP and FRP in Chignik Lake tended to be lower in 2003 than in the past three years (Tables 12 and 14). TKN (99.0 μg/L N) in 2003 was greater on average in Chignik Lake than in past years (Tables 12 and 14). Ammonia was approximately 10.1 μg/L N, and nitrate + nitrite had a mean of 166.6 μg/L N in 2003 (Tables 12 and 14). Of the photosynthetic pigments, chlorophyll-*a* and phaeophytin-*a* levels had lower seasonal averages than those of Black Lake in 2003 and past Chignik Lake seasonal averages (Tables 12 and 14).

Zooplankton

Black Lake

Copepod abundance (59,449/m^2) was greater than cladoceran abundance (20,701/m^2) on May 28 in Black Lake (Table 15; Figures 9; Appendix B). However, by June 27 the cladoceran abundance (67,941/m^2) exceeded the copepod abundance (41,932/m^2; Table 15; Figure 9; Appendix B). On average, the most prevalent identifiable species of copepods was *Cyclops* (9,521/m^2) and *Diaptomus* (5,540 /m^2); napulii were the most abundant copepods with a seasonal mean of 12,175/m^2 (Table 15; Figure 9; Appendix B).

Copepod biomass was dominated by *Diaptomus* in May (26.21 mg/m^2) and June (17.48 mg/m^2) and by *Cyclops* in July (4.14 mg/m^2) and August (4.87 mg/m^2; Table 16). The majority of cladoceran biomass was comprised of *Bosmina* throughout the 2003 sampling season with an average of 137.38 mg/m^2 (Table 16). For the season, cladoceran volume (176.51 mg/m^2) was greater on average than copepod volume (18.86 mg/m^2; Table 16 Figure 10).

Average seasonal lengths of the major species in Black Lake were 0.84 mm for *Diaptomu*s*,* 0.50 mm for C*yclops*, 0.32 mm for *Bosmina*, and 0.28 mm for *Chydorinae* (Table 17). Ovigerous *Bosmina* were longer than non-egg bearing *Bosmina*.

Chignik Lake

The average seasonal copepod abundance (114,610/m^2) was greater than the average seasonal cladoceran abundance (82,040/m^2) in 2003 (Table 18). Only on September 13 was the cladoceran abundance (134,820/m^2) greater than the copepod abundance (44,055/m^2; Table 18; Figure 11). *Epischura* (35,310/m^2), *Diaptomus* (31,137/m^2), and napulii (27,986/m^2) were the most abundant copepods on average during the 2003 season. *Bosmina* (36,724/m^2) and *Daphnia* (34,037/m^2) were the most abundant cladoceran species (Table 18; Figure 11). The total abundance of copepod and cladoceran zooplankton in Black Lake (196,623/m^2) was similar to that in Chignik Lake (196,649/m^2) in 2003 (Tables 15 and 18).

Biomass estimates of the copepod *Cyclops* (25.33 mg/m^2) were greater in May than those of the cladoceran *Bosmina* (1.47 mg/m^2; Table 19). The copepod *Diaptomus* had the greatest biomasses in June (51.26 mg/m^2), July (102.23 mg/m^2), and August (153.02 mg/m^2: Table 19). Non-ovigerous *Bosmina* biomass levels approached those of *Diaptomus* in June at 83.63 mg/m^2, and had the greatest biomass of any cladoceran from May to August, however, they did not exceed those of *Diaptomus* (Table 19). For the 2003 season, copepods (106.38 mg/m^2) had a greater biomass on average than cladocerans (76.43 mg/m^2) for a total of 182.81 mg/m^2 Chignik Lake zooplankton biomass, which was slightly less than that of Black Lake (Table 19; Figure 12).

Average seasonal lengths of the major non-egg bearing zooplankton species in Chignik Lake were 0.83 mm for *Diaptomus*, 0.53 mm for *Cyclops*, 0.35 mm for *Bosmina*, and 0.52 mm for *Daphnia* (Table 20). Ovigerous zooplankton were consistently longer than non-egg bearing species.

JUVENILE SOCKEYE SALMON

Of the 710 AWL sampled juvenile sockeye salmon that were captured throughout the entire watershed by all gear types, 24.5% were estimated to be age 0., 57.5% were age 1., were 18.0% were age 2., and no age 3. fish were captured (Table 21).

Black Lake and Black River

Beach seine catch rates in Black Lake were the greatest during May with 23 fish per haul; catch rates declined to one fish per haul by August (Table 22). Pond smelt and juvenile coho salmon were more abundant than juvenile sockeye salmon in July and August beach seine catches (Appendix F).

One trawl was executed in conjunction with FRI during July. No juvenile sockeye salmon were captured, however approximately 1,000 pond smelt were caught by the townet (Table 23; Appendix G).

Fyke net catches in the Black River yielded only two sockeye salmon in July (Table 24). July and August fyke net catches were comprised of pond smelt, juvenile coho salmon, and stickleback (Appendix H).

Of the 157 sockeye salmon caught in Black Lake and Black River, all were age 0. fish (Table 25).

The mean length of Black Lake juvenile sockeye was 37.3 mm in May, which increased to 57.2 mm in July, but declined to 43.0 mm by August (Table 26; Figure 13). Condition factor for Black Lake age 0. sockeye salmon increased from 1.01 in May to 1.18 in July, and decreased to 0.91 in August (Table 26). The two sockeye salmon captured in Black River were 54.0 mm on average and had a condition factor of 1.07 (Table 26).

Chignik Lake

Beach seine catch rates in Chignik Lake ranged from 3 to 6 fish per haul from June to August (Table 22). Stickleback, Dolly Varden, and juvenile coho salmon were also common in the beach seine catches (Appendix F).

Townet catch rates in Chignik Lake went from 8 fish per hour in June to 441 fish per hour in July. Forty one pond smelt, one Dolly Varden, and one stickleback were captured in two of the July trawls; no other fish species were captured by the townet (Appendix G).

The age composition of all Chignik Lake captured sockeye salmon was 11.3% age 0., 79.4% age 1. , and 9.3% age 2. fish (Table 27). For townet caught sockeye salmon, 100% of the June catch was age 1., which declined to 85.7% age 1. with 14.3% age 0. fish in July (Table 27; Figure 14). The seasonal average age composition of beach seine caught fish in Chignik Lake was 4.8% age 0., 63.2% age 1., and 32.0% age 2. fish (Table 27; Figure 14). The age 0. and age 1.

components increased from June to July and declined in August for beach seine captured fish (Table 27; Figure 14). The age 0. component was not present in June townet catches (Table 27; Figure 14).

Average lengths of beach seine captured juvenile sockeye salmon, by age, increased from June to August with the exception age 1. fish in July and age 2. fish in August (Table 28; Figure 15). Townet captured age 1. sockeye salmon were similar in size to beach seine captured age 1. sockeye salmon for the months of June and July (Table 28; Figure 15). Both June and August appeared to have single, distinct length modes for juvenile sockeye salmon captured by beach and townet combined, unlike July, which appeared to be bimodal (Figure 16). Condition factor indices were the lowest (<0.78) for beach seined fish in June, but generally increased over time for each age group (Table 28). All age groups of townet catches had condition factor indices >0.94 on average (Table 28).

Chignik River

Beach seine catch rates were greatest (>103 fish per haul) in the Chignik River compared to other seined locations in the watershed (Table 22). Catch rates declined from 443 fish per haul in June to 104 fish per haul in August (Table 22). Stickleback and juvenile coho salmon were also abundant in the beach seine catches (Appendix F).

The seasonal age composition of Chignik River juvenile sockeye salmon was 12.2% age 0., 65.2% age 1., and 25.5% age 2. fish (Table 29; Figure 17). The percentage age 1. fish increased from June to August (Table 29; Figure 17). The percentage of age 2. fish declined over the same period (Table 29; Figure 17). The percentage of age 0. fish was greatest during July in Chignik River (Table 29: Figure 17).

Average lengths increased for age 0. sockeye salmon from 53.8 mm in June to 62.2 mm in August (Table 30; Figure 18). Age 1. and 2. sockeye salmon increased in length from June to July, however, decreased in August (Table 30; Figure 18). The size range of Chignik River juvenile sockeye salmon spanned between 50 and 70 mm for the entire season, with larger size groups present in June and July and smaller size groups present in August (Figure 19). Condition factor indices were lowest (<0.80) in June for all age groups and increased over time for age 1. and 2. fish (Table 30). Age 0. fish condition factor indices declined from 0.93 in July to 0.75 in August (Table 30).

Chignik Lagoon

Chignik Lagoon beach seine catch rates increased from 12 fish per haul in May to 50 fish per haul in July (Table 22). Catch rates declined to four fish per haul in August (Table 22). Dolly Varden were common in Chignik Lagoon catches (Appendix F).

The seasonal age composition for Chignik Lagoon beach seine catches was 18.9% age 0., 61.4% age 1., and 19.7% age 2. fish (Table 31; Figure 20). The age 0. component increased from 15.2% in May to 52.9% in August (Table 31; Figure 20). Age 1. and age 2. percentages declined from May to August (Table 31; Figure 20).

Average lengths of Chignik Lagoon juvenile sockeye salmon varied over the sampling season (Table 32; Figure 21). The majority of juvenile sockeye salmon in May and June fell between 65 and 75 mm long (Figure 22). The size distribution ranged from 38 to 86 mm in July and from 48 to 95 mm in August (Figure 22). The August size distribution had a mode at 70 mm (Figure 22). Condition factor indices during the sampling season for age groups were greater than 0.85 (Table 32).

DISCUSSION

A comprehensive study of the Chignik watershed has not been performed since the carrying capacities of Black and Chignik Lakes were originally estimated in 1966 (Narver 1966; Bouwens and Finkle 2003). In light of the physical changes to Black Lake and Black River, reassessment of the sockeye salmon production capabilities of the watershed would be germane to the fishery's management. Data from this study constitute only one component of an ongoing ecological assessment of the Chignik watershed. This report serves to summarize the findings of the 2003 sampling season.

Based on the 2003 water quality data, nutrient levels in both lakes fell into low production (oligotrophic) levels as defined by several trophic state indices (Carlson 1977; Forsberg and Ryding 1980, Carlson and Simpson 1996). Nutrient levels during the 2003 sampling season in Black Lake and Chignik Lake were lower than in the past three years, but were comparable to other Alaskan lakes (Honnold et al. 1996; Schrof and Honnold 2003).

Nutrient data can indicate limitations in aquatic environments. A comparison of total nitrogen (TN) to total phosphorous is a simple indicator of aquatic ecosystem health as both are necessary for primary production (Wetzel 1983; UF 2000). Nitrogen-phosphorous ratios of less than 10:1 indicate nitrogen limitations (USEPA 2000). The average ratio of total nitrogen to total phosphorous (6.9 TN:1 TP) suggested that nitrogen was a limiting nutrient in Black Lake (USEPA 2000). However, a comparison of the photosynthetic pigment, chlorophyll *a,* to its byproduct, phaeophytin *a,* showed that chlorophyll-*a* concentrations were proportionally high (seasonal mean of 11.29 chlorophyll *a* to 1 phaeophytin *a*). This indicated that the potential for rapid algal (phytoplankton) growth existed in Black Lake because chlorophyll *a* was readily available for photosynthesis (COLAP 2001). Thus, despite the nitrogen limitations described by the TN/TP ratios, an adequate volume of nitrogen was available for phytoplankton production, and capable of meeting primary (zooplankton) consumption demands. In other words, nitrogen was not necessarily a limiting nutrient, but phosphorous concentrations in Black Lake were in excess of the levels needed for primary production. The chlorophyll-*a* production in Chignik Lake was also considered high with a seasonal mean chlorophyll-*a*: phaeophytin-*a* ratio of 4.81:1, which indicated adequate nutrient availability and therefore unrestricted phytoplankton forage for zooplankton.

Bottom-up limitations, such as changes in algal production, can be very influential on zooplankton communities (Kerfoot 1987; Kyle 1996; Stockner and MacIsaac 1996). Changes in phytoplankton species composition mediated by biotic, physical, or nutrient factors can negatively affect zooplankton consumption and assimilation rates (Wetzel 1983). Cladocerans, which are selective feeders, can be susceptible to periods of reduced growth or reproduction in the absence of preferred forage (Dodson and Frey 2001). When primary production is taxed, phaeophytin-*a* levels tend to exceed chlorophyll-*a* levels (COLAP 2001). The chlorophyll-*a* levels in both Black and Chignik Lakes indicated that phytoplankton abundance was not a limiting factor to foraging zooplankton. Phaeophytin-*a* levels did not exceed chlorophyll-*a* levels in either lake in 2003. In Chignik Lake, photosynthetic nutrient levels were more concentrated in 2000, 2001, and 2002 than in 2003, and zooplankton abundance in 2003 was considered low (Mazumder and Edmundson 2002), although greater than or comparable to those past years. The high nutrient concentrations and relatively low zooplankton abundance suggested bottom-up limitations were not significantly influencing Black and Chignik Lakes zooplankton populations.

Additionally, in 2003, the chlorophyll-*a* levels were lower and zooplankton abundance was comparable to or greater than past years, which suggested that the zooplankton population was utilizing its forage base more efficiently (UF 2000; Bouwens and Finkle 2003).

Top-down pressures on zooplankton communities can be exerted by planktivorous fishes (Kyle 1996; Stockner and MacIsaac 1996). Evidence of overgrazed zooplankton populations can be reflected in a reduction in zooplankton length and shifts in species composition (Kyle 1992; Schindler 1992). In Chignik and Black Lakes, *Bosmina* on average were smaller than 0.38 mm, which falls below the minimum elective feeding threshold of 0.40 mm for juvenile sockeye salmon (Kyle 1992). This suggested that top-down grazing pressures were removing the larger *Bosmina* from the zooplankton population. Density estimates for copepods fluctuated in species composition on intra- and interannual time scales in Black and Chignik Lakes. Chignik Lake *Cyclops* had a greater average biomass than other copepod species in 2000, 2001, and 2002, however, *Diaptomus* was the densest copepod species on average in 2003. During the 2003 sampling season, the dominant zooplankton species in Chignik Lake fluctuated among *Cyclops*, *Diaptomus*, and *Daphnia*. In Black Lake, *Bosmina* maintained the greatest zooplankton biomass from June through August, with *Diaptomus* having a greater density in May. These changes suggested top-down limitations occured as the nutrients that drove primary production, chlorophyll *a* and phaeophytin *a*, fluctuated minimally over the 2003 sampling season.

Changes in nutrients and forage bases can significantly impact higher trophic levels such as secondary or tertiary consumers (Kyle et al. 1988; Milovskaya et al. 1998). For the Chignik watershed, these negative changes could cause migratory behavior and/or decreased juvenile sockeye salmon freshwater survival (Parr 1972; Ruggerone 1994; Bouwens and Finkle 2003). Thus, it is important to know and understand patterns of resource abundance and habitat usage in the watershed if the carrying capacities for each lake are to be estimated.

It has been suggested that juvenile sockeye salmon have migrated in July from Black Lake to Chignik Lake (Narver 1966; Parr 1972; Ruggerone 1994). In contrast with historic data (Narver 1966), the lack of any age 1. sockeye salmon in 2000, 2002, and 2003 Black Lake catches supported this observation because it indicated that they are leaving the lake before the onset of winter. Similarly, Black Lake juvenile sockeye salmon catch rates declined from May to August during all four years of this study (Bouwens and Finkle 2003). Causes for the downstream migration of Black Lake fish have been attributed to low winter oxygen levels (Ruggerone 1994), density dependence (Narver 1966; Parr 1972), and temperature (Finkle 2004). The relatively high temperatures (~20 °C) that Black Lake can reach may influence the juvenile sockeye salmon rearing habitat in multiple ways. Field observations from the 2003 sampling season noted that in July when the temperature exceeded 15 °C, which is considered a metabolic productivity threshold for sockeye salmon (Brett et al. 1969), catch rates declined considerably. The warm water temperatures also coincided with the hatch of chironomid larvae, which are vital forage for Black Lake fish (Bouwens and Finkle 2003). Thus, when the chironomid larvae hatch, they become an unavailable food source, which increased the grazing pressure on the existing zooplankton population. This increase in competition for food and the metabolically taxing rearing temperatures may contribute to the causes of the downstream migration of Black Lake juvenile sockeye salmon (Finkle 2004). The shallow nature of Black Lake prevents thermocline formation in the water column. This abnegates vertical migration by juvenile sockeye salmon from the warm to cool temperatures as shown by fishes exposed to similar conditions in other studies (Sogard and Olla 2000; Morgan and Metcalfe 2001). Thus, Black Lake fish may be seeking the cooler, and less metabolically taxing, rearing environment of Chignik Lake. However, further investigations are still required to validate these observations.

The migration of Black Lake fish has forced Chignik Lake to support the majority of the watershed's juvenile sockeye salmon during the overwintering period. This increased rearing population can negatively impact resource availability in Chignik Lake. Comparisons of juvenile sockeye salmon age class compositions may offer evidence of rearing limitations in Chignik Lake. Data from the Chignik River smolt enumeration project showed an increase in outmigrating age 0. and 1. sockeye salmon and a decline in the percentage of outmigrating age 2. sockeye salmon in 2002 and 2003 compared to past outmigration data (Bouwens and Newland 2004). An age 3. component was also not present in the 2002 and 2003 data unlike in past years, which suggested that the age 2. fish did not survive the winter. Catch data from Chignik Lake in 2003 also showed a low proportion of age 2. fish and no age 3. component compared to past beach seine and townet data (Bouwens and Finkle 2003). These declines sequentially followed large escapements to both lakes in 2001 (a total of 1,136,918 sockeye salmon escaped) and to Chignik Lake in 2002 (344,519 sockeye salmon escaped). This may suggest that the age 2. population had poor freshwater rearing conditions, and therefore survival, due to increased competition from the increase in 2001 and 2002 offspring. Poor rearing conditions and increased competition may also have prevented annulus formation, making an age 2. or 3. fish appear to be a year younger (M.B. Foster, Commercial Fisheries Biologist, ADF&G; personal communication).

Underyearling sockeye salmon may successfully migrate to sea from resource limited freshwater rearing environments (Rice et al. 1994). Relatively substantial numbers of pre-smolt sockeye salmon have been captured in Chignik Lagoon and Chignik River in 2003 and in past years (Bouwens and Finkle 2003). Juvenile sockeye salmon have been observed to migrate upstream from Chignik Lagoon to Chignik Lake as age 0. fish and outmigrate to sea the following spring (Iverson 1966). However, it is uncertain what proportion of these pre-smolt sockeye salmon go to sea, continue to rear in the lagoon, or return to rear and overwinter in Chignik Lake. Chignik Lagoon has provided a strong forage base of amphipods, pericardians, and other small crustacean taxa, which may alleviate some of the top-down pressure in Chignik Lake (Bouwens and Finkle 2003). Although the rearing and migratory behavior of juvenile sockeye salmon in Chignik Lagoon is not completely understood, they do show the lagoon to be another rearing habitat for juvenile sockeye salmon.

In light of the 2003 Chignik watershed ecological assessment data, it was apparent that certain seasonal migratory and abundance trends have reoccurred. Repeated observation of these trends elucidates patterns of habitat use and resource limitations, which are useful tools for estimating the carrying capacity of the watershed. These data paired with Chignik River sockeye salmon smolt outmigration and past ecological assessment data have also proven instrumental in targeting the lower end of the biological escapement goals of the watershed. The data from these studies have been incorporated into current management decisions with the aim of improving maximum sustainable sockeye salmon production relative to smolt survival and the availability zooplankton forage. Continued observation of the watershed following these effects may indicate if the rearing environments are at their peak production levels or are limited or overtaxed.

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TABLES AND FIGURES

Table 1.-Limnology and zooplankton sampling dates, 2003.

Lake	Date	Type of sampling
Black Lake	28-May	Water and zooplankton
	27-Jun	Water and zooplankton
	26-Jul	Water and zooplankton
	18-Aug	Water and zooplankton
Chignik Lake	26-May	Water and zooplankton
	25-Jun	Water and zooplankton
	25-Jul	Water and zooplankton
	18-Aug	Water and zooplankton
	13-Sep	Water

Table 2.-Dates of beach seine sample sites by area and site, 2003.

Black Lake		Chignik Lake		Chignik River		Chignik Lagoon	
Site[a]	Date	Site[a]	Date	Site[a]	Date	Site[a]	Date
1	28-May	1	3-Jun	1	2-Jun	1	30-May
1	21-Jun	1	19-Jun	1	18-Jun	1	17-Jun
1	12-Jul	1	11-Jul	1	10-Jul	1	9-Jul
1	2-Aug	1	1-Aug	1	31-Jul	1	30-Jul
1	18-Aug	1	14-Aug	1	14-Aug	1	13-Aug
2	28-May	2	3-Jun	2	2-Jun	2	30-May
2	21-Jun	2	19-Jun	2	18-Jun	2	17-Jun
2	12-Jul	2	11-Jul	2	10-Jul	2	9-Jul
2	2-Aug	2	1-Aug	2	31-Jul	2	30-Jul
2	18-Aug	2	14-Aug	2	14-Aug	2	13-Aug
4	28-May	3	3-Jun	3	2-Jun	3	30-May
4	21-Jun	3	19-Jun	3	18-Jun	3	17-Jun
4	12-Jul	3	11-Jul	3	10-Jul	3	9-Jul
4	2-Aug	3	1-Aug	3	31-Jul	3	30-Jul
4	18-Aug	3	14-Aug	3	14-Aug	3	13-Aug
5	28-May	5	3-Jun			4	30-May
5	21-Jun	5	19-Jun			4	17-Jun
5	21-Jun	5	11-Jul			4	9-Jul
5	2-Aug	5	1-Aug			4	30-Jul
5	18-Aug	5	14-Aug			4	13-Aug
		6	3-Jun				
		6	19-Jun				
		6	11-Jul				
		6	1-Aug				
		6	14-Aug				
		7	3-Jun				
		7	19-Jun				
		7	11-Jul				
		7	1-Aug				
		7	14-Aug				
		8	3-Jun				
		8	19-Jun				
		8	11-Jul				
		8	1-Aug				
		8	14-Aug				

[a] Site locations are found in Figures 2 through 4.

Table 3.-Dates of fyke net samples in Black River, 2003.

Date
14-Jun
8-Jul
9-Aug

Table 4.-Dates of townet samples by location, 2003.

Location	Transect	Date
Black Lake	Hydro Point	12-Jul
Chignik Lake	1 to 2	30-Jun
	1 to 2	30-Jun
	1 to 2	22-Jul
Chignik Lake	2 to 3	30-Jun
	2 to 3	30-Jun
	2 to 3	22-Jul
Chignik Lake	3 to 4	30-Jun
	3 to 4	30-Jun
	3 to 4	22-Jul

Table 5.-Water temperature, by depth and date, for Black Lake, 2003**.**

Depth	Temperature (°C)	
(m)	26-Jul	18-Aug
0.0	13.5	13.2
0.5	13.5	13.5
1.0	13.7	13.5
1.5	13.7	13.7
2.0	13.7	13.5
2.5	13.7	13.5
3.0	13.7	13.2
3.5	13.7	

Table 6.-Dissolved oxygen levels by depth and date, for Black Lake, 2003**.**

Depth	Dissolved oxygen (mg/L)	
(m)	26-Jul	18-Aug
0.0	9.6	9.8
0.5	9.6	9.4
1.0	9.7	9.2
1.5	9.5	9.2
2.0	9.3	9.1
2.5	9.4	9.1
3.0	9.5	9.2
3.5	9.2	

Table 7.-Water temperature, averaged over all stations, by depth and date for Chignik Lake, 2003**.**

Depth	Temperature (°C)		
(m)	25-Jun	25-July[a]	18-Aug[a]
0.0	8.7	12.3	12.6
0.5	8.7	12.1	12.7
1.0	8.7	12.2	12.7
1.5	8.6	12.1	12.6
2.0	8.6	11.5	12.9
2.5	8.6	11.9	12.7
3.0	8.6	12.0	12.6
3.5	8.6	12.1	12.7
4.0	8.6	12.0	12.5
4.5	8.6	12.0	12.5
5.0	8.6	11.9	12.5
6.0	8.6	11.8	12.5
7.0	8.6	11.6	12.4
8.0	8.6	11.9	12.4
9.0	8.6	11.7	12.4
10.0	8.6	11.6	12.5
11.0	8.6	11.7	12.4
12.0	8.6	11.8	12.3
13.0	8.6	11.5	12.4
14.0	8.6	11.7	12.5
15.0	8.6	11.3	12.5
16.0	8.6	11.4	12.4
17.0	8.6	11.4	12.6
18.0	8.6	11.4	12.6
19.0	8.5	11.4	12.6
20.0	8.5	11.4	12.6
21.0	8.5		
22.0	8.4		
23.0	8.3		
24.0	8.2		
25.0	8.2		
30.0	8.2		
35.0	8.5		
40.0	8.3		

[a] Meter cable only 20 m long.

Table 8.-Dissolved oxygen levels, averaged over all stations, by depth and date for Chignik Lake, 2003.

Depth	Temperature (°C)	
(m)	25-July[a]	18-Aug[a]
0.0	10.8	12.4
0.5	10.7	12.1
1.0	10.6	12.0
1.5	10.7	12.1
2.0	10.7	12.0
2.5	10.6	12.0
3.0	10.5	12.0
3.5	10.5	12.1
4.0	10.5	12.2
4.5	10.4	12.2
5.0	10.8	12.2
6.0	11.0	12.3
7.0	11.1	12.3
8.0	11.1	12.3
9.0	11.1	12.3
10.0	11.1	12.3
11.0	11.2	12.4
12.0	11.1	12.4
13.0	11.4	12.4
14.0	11.3	12.6
15.0	11.4	12.5
16.0	11.3	12.6
17.0	11.4	12.6
18.0	11.3	12.6
19.0	11.4	12.6
20.0	11.3	12.6

[a] Meter cable only 20 m long.

Table 9.-Average monthly solar illuminance readings by depth and date for Black Lake, 2003. Seasonal averages for 2000, 2001, and 2002 are provided for comparison.

	Solar illuminance (kLux)					
	2003			2000	2001	2002
Depth	July	August	Average	Average	Average	Average
0.0	658.6	633.8	329.3	1,998.3	1,372.8	6,204.5
0.5	178.5	555.1	89.3	1,059.7	867.3	3,594.0
1.0	47.7	418.0	23.9	619.3	427.3	2,496.5
1.5	9.4	280.3	4.7	309.4	281.1	1,273.2
2.0	5.3	112.6	2.7	166.7	206.0	498.0
2.5	3.2	52.8	1.6	90.7	177.4	336.2
3.0	2.6	29.9	1.3	56.3	10.7	414.1
3.5				24.0		

Table 10.-Euphotic Zone Depth (EZD) and Euphotic Volume (EV) of Black and Chignik Lakes, by month, 2003. The 2000, 2001, and 2002 seasonal averages are provided for comparison.

		2003			2000	2001	2002
Lake		July	August	Average[a]	Average[a]	Average[a]	Average[a]
Chignik	EZD	4.97	4.76	4.98	8.22	15.52	14.99
	Mean EV[c]	119.8	114.7	120.1	198.1	374.0	361.4
Black[b]	EZD	2.08	4.44	3.76	3.72	3.72	4.94
	Mean EV[c]	78.1	78.1	78.1	78.1	78.1	78.1

[a] Averages calculated from mean light reading (kLux) data.

[b] The mean depth of Black Lake is 1.9 m; this value was used for the EV calculations instead of the EZD's, which exceeded 1.9 m.

[c] EV units = x 10^6 m^3.

Table 11.-Average monthly solar illuminance readings by depth and date for Chignik Lake, 2003. Seasonal averages for 2000, 2001, and 2002 are provided for comparison.

	Solar illuminance (kLux)					
	2003			2000	2001	2002
Depth	July	August	Average	Average	Average	Average
0.0	1,385.7	928.0	1,156.8	2,473.4	1,799.3	1,393.3
0.5	869.6	493.6	681.6	1,768.3	1,053.3	1,040.9
1.0	478.1	348.8	413.5	1,214.3	733.7	746.5
1.5	203.2	132.9	168.0	710.5	614.0	1,023.8
2.0	117.5	63.5	90.5	523.8	474.7	417.1
2.5	67.4	47.8	57.6	365.9	367.4	283.4
3.0	41.8	19.7	30.7	252.8	308.9	214.8
3.5	25.5	15.5	20.5	183.6	270.8	158.9
4.0	17.2	8.2	12.7	127.3	216.6	122.4
4.5	11.9	4.2	8.1	91.5	171.6	87.9
5.0	7.4	2.4	4.9	73.4	140.7	67.2
6.0	3.7	1.7	2.7	36.8	98.3	39.9
7.0	1.8	1.0	1.4	21.5	66.9	24.1
8.0	0.7	0.7	0.7	11.5	46.0	15.6
9.0	0.7	0.4	0.6	6.2	33.6	9.6
10.0	0.4	0.6	0.5	3.8	24.7	6.4
11.0	0.2	0.5	0.3	2.3	11.7	4.6
12.0	0.2	0.6	0.4	1.5	8.6	3.8
13.0	0.1			1.0	6.5	3.3
14.0				0.7	5.2	2.9
15.0				0.6	4.3	2.4
16.0				0.8	3.8	2.4
17.0				0.7	3.3	1.9
18.0				0.4	2.9	2.9
19.0				0.4	2.7	2.7
20.0				0.4	2.5	2.5
21.0				0.3	2.3	2.3
22.0				0.3	2.5	2.5
23.0				0.2	2.5	2.5
24.0					3.4	3.4
25.0					4.2	4.2
30.0					2.1	2.1
35.0					1.6	1.6
40.0					1.5	1.5
45.0					1.6	1.6
50.0					1.5	1.5

Table 12.-Seasonal water quality parameters, nutrient concentrations, and photosynthetic pigments for Chignik Lake (by station) and Black Lake, 2003.

	Chignik Lake			Black Lake
	Station 2	Station 4	Average[a]	Average
pH	7.37	7.39	7.38	7.46
Alkalinity (mg/L)	24.9	22.4	23.6	32.3
Total P (mg/L P)	16.0	17.4	16.7	41.7
TFP (mg/L P)	5.9	9.0	7.5	9.8
FRP (μg/L P)	4.8	6.8	5.8	5.8
TKN (μg/L N)	99.0	n/a	99.0	256.8
Ammonia (μg/L N)	10.0	10.3	10.1	3.7
Nitrate + Nitrite (μg/L N)	160.2	173.1	166.6	25.2
Chlorophyll *a* (μg/L)	2.20	2.40	2.3	5.12
Phaeophytin *a* (μg/L)	0.47	0.56	0.5	1.78

[a] Averaged values do not always exactly match the values reported in Table 14 due to rounding.

Table 13.-Water quality parameters, nutrient concentrations, and photosynthetic pigments by sample date for Black Lake, 2003. Seasonal averages from 2000, 2001, and 2002 are provided for comparison.

	2003					2000	2001	2002
	26-May	25-Jun	25-Jul	16-Aug	Average	Average	Average	Average
pH	7.59	7.23	7.55	7.46	7.46	7.43	7.53	7.45
Alkalinity (mg/L)	31.0	31.0	32.0	35.0	32.3	13.0	32.5	32.3
Total P (mg/L P)	79.8	21.9	33.1	31.9	41.7	57.0	35.0	22.0
TFP (mg/L P)	9.6	5.4	8.9	15.4	9.8	11.0	10.0	10.0
FRP (μg/L P)	5.4	2.2	5.8	9.8	5.8	4.0	7.0	5.0
TKN (μg/L N)	398.0	224.0	178.0	227.0	256.8	n/a	n/a	323.5
Ammonia (μg/L N)	5.5	2.1	3.5	3.6	3.7	37.0	3.3	4.4
Nitrate + Nitrite (μg/L N)	36.7	39.2	13.1	11.9	25.2	64.0	4.5	8.3
Chlorophyll *a* (μg/L)	11.53	2.56	3.20	3.20	5.12	18.06	4.26	2.64
Phaeophytin *a* (μg/L)	6.41	0.13	0.21	0.38	1.78	9.98	11.94	1.44

Table 14.-Water quality parameters, nutrient concentrations, and photosynthetic pigments by sample date for Chignik Lake, 2003. All stations and depths are averaged for each sample date. Seasonal averages from 2000, 2001, and 2002 are provided for comparison.

	2003					2000	2001	2002
	26-May	25-Jun	25-Jul	16-Aug	Average[a]	Average	Average	Average
pH	7.40	7.34	7.43	7.35	7.38	7.88	7.51	7.45
Alkalinity (mg/L)	26.8	25.0	20.0	22.8	23.6	14.0	25.5	25.5
Total P (mg/L P)	16.8	11.9	22.3	15.8	16.7	15.0	27.3	27.3
TFP (mg/L P)	7.0	6.6	6.7	9.7	7.5	6.0	12.0	12.0
FRP (µg/L P)	4.9	5.1	5.7	7.5	5.8	6.0	8.3	8.3
TKN (µg/L N)	117.0	109.0	98.0	72.0	99.0	ND	77.0	77.0
Ammonia (µg/L N)	8.7	11.1	13.9	6.9	10.1	30.0	10.1	10.1
Nitrate + Nitrite (µg/L N)	203.7	174.6	140.5	147.8	166.6	182.0	191.8	191.8
Chlorophyll *a* (µg/L)	1.92	1.60	2.56	3.12	2.30	7.33	5.10	5.10
Phaeophytin *a* (µg/L)	0.66	0.53	0.35	0.52	0.51	1.06	1.33	1.33

[a] Averaged values do not always exactly match the values reported in Table 12 due to rounding.

Table 15.-Average number of zooplankton per m^2 from Black Lake by sample date, 2003. The 2000, 2001, and 2002 seasonal averages are included for comparison.

	2003					2000	2001	2002
	Sample date				Seasonal	Seasonal	Seasonal	Seasonal
Taxon	5/28	6/27	7/26	8/18	Average	Average	Average	Average
Copepods:								
Epischura	2,123	6,900	1,990	1,592	3,151	3,925	1,327	4,517
Ovig. *Epischura*	0	0	0	0	0	64	0	-
Diaptomus	12,739	8,493	398	531	5,540	1,788	619	3,381
Ovig. *Diaptomus*	2,654	0	0	0	664	-	0	-
Cyclops	15,924	7,431	6,768	7,962	9,521	17,699	3,654	39,618
Ovig. *Cyclops*	531	0	0	0	133	-	0	-
Harpaticus	1,062	0	0	0	266	-	265	-
Napulii	24,416	19,108	1,990	3,185	12,175	8,774	3,229	15,037
Total copepods	59,449	41,932	11,146	13,270	31,449	32,250	9,094	62,553
Cladocerans:								
Bosmina	13,270	44,586	307,723	205,414	142,748	19,228	12,889	99,846
Ovig. *Bosmina*	5,839	22,293	30,255	21,231	19,905	5,223	2,442	26,975
Daphnia l.	0	0	398	2,654	763	434	186	-
Ovig. *Daphnia l.*	0	0	0	0	0	-	0	-
Chydorinae	1,592	1,062	4,379	0	1,758	5,816	263,048	18,408
Total cladocerans	20,701	67,941	342,755	229,299	165,174	30,701	278,565	145,228
Total copepods + cladocerans	80,150	109,873	353,901	242,569	196,623	95,201	296,753	270,335
Rotifers:								
Kellicottia	1,592	89,172	84,793	7,962	45,880	9,841	734	12,771
Asplanchna	0	0	1,194	0	299	60	29,910	5,770
Keratella	41,401	4,777	1,194	1,592	12,241	16,214	8,245	15,000
Conochilus	3,185	501,592	167,197	42,994	178,742	86,712	3,751	115,166
other rotifers	2,229,299	318,471	2,389	509,554	764,928	2,309	1,990	190,650
Total rotifers	2,275,477	914,012	256,767	562,102	1,002,090	115,136	44,630	339,355
Other:								
Ostracoda	17,102	1,990	0	0	4,773	30,732	4	3,818

Table 16.-Biomass estimates (mg dry weight/m^2) of the major Black Lake zooplankton taxon by sample date, 2003. The 2000, 2001, and 2002 season averages are included for comparison.

	2003						2000		2001		2002	
	Sample date				Seasonal	Weighted	Seasonal	Weighted	Seasonal	Weighted	Seasonal	Weighted
Taxon	5/28	6/27	7/26	8/18	average	average	average	average	average	average	average	average
Copepods:												
Epischura	0.99	3.22	0.93	0.74	1.47	1.80	4.46	3.65	1.64	0.78	4.70	2.48
Diaptomus	26.21	17.48	0.82	1.09	11.40	21.09	4.39	4.43	2.18	1.93	10.88	7.36
Cyclops	9.73	4.54	4.14	4.87	5.82	9.15	16.78	16.05	4.63	4.56	18.66	26.94
Harpaticus	0.69	0.00	0.00	0.00	0.17	0.17	n/a	n/a	0.45	0.45	0	0
Total copepods	37.63	25.23	5.88	6.70	18.86	32.21	25.63	24.12	8.90	7.71	34.24	36.78
Cladocerans:												
Bosmina	12.77	42.91	296.16	197.69	137.38	145.02	18.66	16.43	0.33	7.90	41.91	80.89
Ovigerous *Bosmina*	10.87	41.52	56.35	39.54	37.07	38.81	7.40	6.74	0.00	2.59	27.89	34.79
Daphnia longiremis	0.00	0.00	0.92	6.17	1.77	1.15	0.24	0.23	0.00	0.12	0.00	0.00
Chydorinae	0.26	0.18	0.72	0.00	0.29	1.19	3.60	3.30	3.66	2.53	2.04	9.96
Total cladocerans	23.91	84.60	354.15	243.40	176.51	186.16	29.91	26.70	3.99	13.13	71.84	125.64
Total Biomass	61.53	109.84	360.03	250.10	195.38	218.38	55.54	50.82	12.89	20.85	106.08	162.42

Table 17.-Average lengths (mm) of zooplankton in Black Lake by sample date, 2003. The 2000, 2001, and 2003 seasonal averages are included for comparison.

	2003					2000	2001	2002
	Sample date				Seasonal	Seasonal	Seasonal	Seasonal
Taxon	5/28	6/27	7/26	8/18	average	average	average	average
Copepods:								
Epischura	0.67	0.44	0.46	0.45	0.51	0.62	0.53	0.79
Diaptomus	1.04	0.86	0.73	0.72	0.84	0.82	0.86	0.63
Cyclops	0.68	0.49	0.38	0.44	0.50	0.54	0.56	0.47
Harpaticus	0.45	n/a	n/a	n/a	0.45	n/a	0.70	0.20
Napulii	n/a	n/a	n/a	n/a	n/a	n/a	0.29	0.20
Cladocerans:								
Bosmina	0.31	0.31	0.35	0.32	0.32	0.33	0.24	0.32
Ovigerous *Bosmina*	0.52	0.41	0.49	0.44	0.47	0.39	0.31	0.37
Daphnia l.	n/a	n/a	0.91	0.55	0.73	0.38	0.27	n/a
Chydorinae	0.21	0.36	0.28	n/a	0.28	0.27	0.17	0.24

Table 18.-Average number of zooplankton per m^2 from Chignik Lake, by sample date, 2003. The 2000, 2001, and 2002 seasonal averages are included for comparison.

	2003						2000	2001	2002
	Sample date					Seasonal	Seasonal	Seasonal	Seasonal
Taxon	5/26	6/25	7/25	8/16	9/13[a]	average	average	average	average
Copepods:									
Epischura	3,118	15,260	49,595	95,840	12,739	35,310	23,013	4,294	19,858
Ovigerous *Epischura*	0	0	0	0	0	0	119	24	-
Diaptomus	2,887	18,312	45,681	80,845	7,962	31,137	7,793	7,079	14,159
Ovigerous *Diaptomus*	0	133	2,190	1,161	0	697	468	48	1,911
Cyclops	20,634	17,251	22,990	19,639	13,800	18,863	90,630	18,533	74,320
Ovigerous *Cyclops*	0	266	1,227	597	0	418	1,185	2,020	5,812
Harpaticus	66	398	365	166	0	199	107	233	608
Napulii	5,573	13,800	46,079	64,922	9,554	27,986	23,670	6,506	41,136
Total copepods:	32,279	65,420	168,126	263,170	44,055	114,610	146,985	38,738	157,803
Cladocerans:									
Bosmina	1,227	10,616	84,528	72,386	14,862	36,724	33,031	16,042	28,046
Ovigerous *Bosmina*	431	6,635	23,089	5,739	0	7,179	8,637	2,492	7,849
Daphnia longiremis	1,825	1,725	11,611	35,596	119,427	34,037	4,964	680	8,446
Ovigerous *Daphnia longiremis*	365	664	4,645	12,042	0	3,543	590	48	4,187
Chydorinae	0	398	962	896	531	557	2,394	19,305	4,088
Total cladocerans:	3,848	20,038	124,835	126,659	134,820	82,040	49,616	38,567	52,615
Total Copepods + Cladocerans	36,126	85,457	292,960	389,828	178,875	196,649	196,601	77,306	210,418

-continued-

Table 18.-Page 2 of 2.

Taxon	2003 Sample date 5/26	6/25	7/25	8/16	9/13[a]	2003 Seasonal average	2000 Seasonal average	2001 Seasonal average	2002 Seasonal average
Rotifers:									
Kellicottia	34,833	175,956	65,884	17,815	1,592	59,216	44,285	25,996	105,693
Asplanchna	498	2,190	1,195	299	1,592	1,154	10,787	13,085	43,551
Keratella	119,427	35,828	1,692	0	0	31,389	11,524	22,904	41,355
Conochilus	5,374	167,198	84,694	10,848	0	53,623	75,731	7,277	94,599
other rotifers	11,346	207,405	380,673	455,812	0	211,047	6,997	2,369	293,093
Total Rotifers:	171,477	588,575	534,137	484,773	3,184	356,429	149,324	71,631	578,291
Other:									
Ostracoda	n/a	n/a	n/a	n/a	n/a	n/a	119	193	n/a

[a] Only station one sampled.

Table 19.-Biomass estimates (mg dry weight/m^2) of the major zooplankton species in Chignik Lake by sample date, 2003. The 2000, 2001, and 2002 season averages are included for comparison.

	2003							2000		2001		2002	
	Sample date					Seasonal	Weighted	Seasonal	Weighted	Seasonal	Weighted	Seasonal	Weighted
Taxon	5/26	6/25	7/25	8/16	9/13[a]	average	average	average	average	average	average	average	average
Copepods													
Epischura	2.87	10.38	25.40	48.23	2.62	17.90	21.07	24.34	23.56	11.75	13.57	25.00	16.71
Ovigerous *Epischura*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.76	0.04	0.06	0.00	0.00
Diaptomus	7.48	51.26	102.23	153.02	6.16	64.03	74.46	39.41	37.64	24.92	13.85	59.58	58.24
Ovigerous *Diaptomus*	0.00	0.85	7.51	5.52	0.00	2.78	4.31	3.76	5.05	0.07	0.10	11.95	13.66
Cyclops	25.33	36.70	20.39	14.33	2.47	19.84	23.04	115.37	110.52	54.03	36.03	84.69	102.45
Ovigerous *Cyclops*	0.00	0.96	5.08	2.46	0.00	1.70	2.83	4.96	4.89	12.91	9.55	21.33	30.10
Harpaticus	0.04	0.25	0.29	0.09	0.00	0.13	0.22	0.07	0.07	0.22	0.29	0.11	0.46
Total Copepods:	35.72	100.39	160.89	223.65	11.25	106.38	125.93	188.67	182.50	103.94	73.44	202.67	221.62
Cladocerans													
Bosmina	1.47	10.00	83.63	82.69	4.65	36.49	42.77	37.81	37.63	13.01	5.21	24.19	28.30
Ovigerous *Bosmina*	0.90	12.05	34.76	9.05	0.00	11.35	13.19	13.75	13.70	3.28	1.43	11.19	12.54
Daphnia longiremis	1.91	2.12	12.63	44.67	33.23	18.91	33.07	6.35	6.33	2.75	3.60	10.30	17.05
Ovigerous *Daphnia longiremis*	1.07	1.92	13.14	32.10	0.00	9.64	13.88	1.33	1.32	0.08	0.10	14.14	16.99
Chydorinae	0.00	0.04	0.05	0.07	0.02	0.04	0.36	1.86	1.83	1.14	1.28	0.53	3.47
Total Cladocerans:	5.35	26.12	144.22	168.57	37.90	76.43	103.28	61.11	60.81	79.13	11.61	60.35	78.36
Total Biomass	41.07	126.51	305.11	392.23	49.16	182.81	229.20	249.79	243.31	183.07	85.05	263.02	299.98

[a] Only station one sampled.

Table 20.-Average length (mm) of zooplankton from Chignik Lake by sample date, 2003. The 2000, 2001, and 2002 seasonal averages are included for comparison.

Taxon	2003 Sample date 5/26	6/25	7/25	8/16	9/13[a]	2003 Seasonal average	2000 Seasonal average	2001 Seasonal average	2002 Seasonal average
Copepods:									
Epischura	0.55	0.51	0.46	0.46	0.55	0.51	0.67	0.76	0.68
Ovigerous *Epischura*	n/a	n/a	n/a	n/a	n/a	n/a	1.13	0.72	n/a
Diaptomus	0.83	0.90	0.79	0.75	0.89	0.83	1.15	0.84	1.02
Ovigerous *Diaptomus*	n/a	1.15	1.08	1.04	n/a	1.09	1.39	0.67	1.16
Cyclops	0.58	0.63	0.52	0.47	0.47	0.53	0.64	0.80	0.55
Ovigerous *Cyclops*	n/a	1.00	1.09	1.04	n/a	1.04	1.10	1.30	0.96
Harpaticus	0.45	0.44	0.49	0.42	n/a	0.45	0.48	0.60	0.46
Napulii	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.25	0.26
Cladocerans:									
Bosmina	0.36	0.32	0.33	0.36	0.37	0.35	0.39	0.32	0.31
Ovigerous *Bosmina*	0.43	0.44	0.40	0.41		0.42	0.44	0.44	0.40
Daphnia longiremis	0.50	0.55	0.51	0.54	0.52	0.52	0.55	0.67	0.55
Ovigerous *Daphnia longiremis*	0.83	0.83	0.82	0.77		0.81	0.70	0.60	0.87
Chydorinae	n/a	0.24	0.25	0.23	0.33	0.26	0.29	0.12	0.28

[a] Only station one sampled.

Table 21.-Total catch of juvenile sockeye salmon, by age and location, from the Chignik watershed, 2003.

Location		Age 0.	1.	2.	3.	Total
Black Lake/Black River		100.0%	0.0%	0.0%	0.0%	100.0%
	Sample	87	0	0	0	87
	Total catch[a]	157	0	0	0	157
Chignik Lake		5.8%	68.2%	26.0%	0.0%	100.0%
	Sample	9	105	40	0	154
	Total catch[a]	25	297	113	0	435
Chignik River		12.8%	68.4%	18.8%	0.0%	100.0%
	Sample	34	182	50	0	266
	Total catch[a]	588	3,148	865	0	4,601
Chignik Lagoon		16.5%	45.5%	14.3%	0.0%	100.0%
	Sample	44	121	38	0	203
	Total catch[a]	107	295	93	0	649
Entire watershed		24.5%	57.5%	18.0%	0.0%	100.0%
	Sample	174	408	128	0	710
	Total catch[a]	1,432	3,357	1,053	0	5,842

[a] Total sockeye catches are not apportioned based on fish lengths greater or less than 45 mm.

Table 22.-Total beach seine hauls, total catch, and catch per haul, by month, of juvenile sockeye salmon from the Chignik watershed, 2003. Catch per haul data from 2000, 2001, and 2002 are provided for comparison.

		2003			2000	2001	2002
		Number of	Sockeye catch	Sockeye	Sockeye	Sockeye	Sockeye
Area	Month	hauls	Total	catch/haul	catch/haul	catch/haul	catch/haul
Black Lake	May	4	93	23	n/a	75	241
	June	4	43	11	328	16	405
	July	4	14	4	59	11	225
	August	8	5	1	14	n/a	3
Chignik Lake	May	0	n/a	n/a	n/a	209	31
	June	14	39	3	4	94	24
	July	7	40	6	26	15	32
	August	14	48	3	9	22	19
Chignik River	May	0	n/a	n/a	198	n/a	406
	June	6	2,656	443	n/a	274	492
	July	6	1,634	272	363	494	262
	August	3	311	104	219	219	n/a
Chignik Lagoon	May	4	46	12	22	218	3
	June	4	188	47	39	93	200
	July	8	398	50	26	79	141
	August	4	17	4	138	307	n/a

Table 23.-Total hours towed, total catch, and catch per hour, by month, of juvenile sockeye salmon from Black Lake and Chignik Lake, 2003. Tow data from 2000, 2001, and 2002 are provided for comparison.

		2003			2000	2001	2002
Area	Month	Total hours	Total sockeye catch	Sockeye catch/hour towed	Sockeye catch/hour towed	Sockeye catch/hour towed	Sockeye catch/hour towed
Black Lake	May	0	n/a	n/a	n/a	75	241
	June	0	n/a	n/a	328	16	405
	July	0.17	0	0	59	11	225
	August	0	n/a	n/a	14	n/a	3
Chignik Lake	May	0	n/a	n/a	n/a	209	31
	June	1.02	8	8	4	94	24
	July	0.68	300	441	26	15	32
	August	0	n/a	n/a	9	22	19

Table 24.-Fyke net hours fished, total catch, and catch per hour, by month, of juvenile sockeye salmon from Black River, 2003. Fyke net catch data from 2000, 2001, and 2002 are provided for comparison.

	2003			2000	2001	2002
Month	Total hours	Total sockeye catch	Sockeye catch/hour towed	Sockeye catch/hour towed	Sockeye catch/hour towed	Sockeye catch/hour towed
May	n/a	n/a	n/a	13	5	n/a
June	1.42	0	0	0	1	1
July	20.90	2	0.10	77	n/a	11
August	15.83	0	0	n/a	n/a	1

Table 25.-Total catch of juvenile sockeye salmon from Black Lake and Black River, by age and gear type, 2003.

			Total sockeye	Sample					Estimated age[a]				
Area	Gear type	Month	catch	0.	1.	2.	3.	Total	0.	1.	2.	3.	Total
Black Lake	Beach seine	May	93	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
				46	0	0	0	46	93	0	0	0	93
	Beach seine	June	43	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
				20	0	0	0	20	43	0	0	0	43
	Beach seine	July	14	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
				14	0	0	0	14	14	0	0	0	14
	Beach seine	August	5	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
				5	0	0	0	5	5	0	0	0	5
Black Lake Total	All	All	155	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
				85	0	0	0	85	155	0	0	0	155
Black River	Fyke	July	2	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
				2	0	0	0	2	2	0	0	0	2
Black Lake/River Total	All	All	157	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
				87	0	0	0	87	157	0	0	0	157

[a] Age compositions are not apportioned to total sockeye catches based on fish lengths greater or less than 45 mm.

Table 26.-Average length, weight, and condition factor by age and gear type for juvenile sockeye salmon captured in Black Lake and Black River, 2003.

Gear type	Month	Age	Sample size	Length (mm)		Weight (g)		Condition factor	
				Average	SD	Average	SD	Average	SD
Beach seine	May	0	46	37.3	12.33	0.54	0.19	1.01	0.34
	June	0	20	52.5	11.88	0.26	0.36	1.02	0.23
	July	0	14	57.2	10.97	2.33	0.48	1.18	0.23
	August	0	5	43.0	5.05	0.80	0.11	0.91	0.11
Fyke net	June	0	2	54.0	3.95	1.90	0.14	1.07	0.09

Table 27.-Total catch of juvenile sockeye salmon from Chignik Lake, by age and gear type, 2003.

		Total sockeye	Sample					Estimated age[a]				
Gear type	Month	catch	0.	1.	2.	3.	Total	0.	1.	2.	3.	Total
Townet	June	8	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%
			0	8	0	0	8	0	8	0	0	8
Townet	July	300	14.3%	85.7%	0.0%	0.0%	100.0%	14.3%	85.7%	0.0%	0.0%	100.0%
			3	18	0	0	21	43	257	0	0	300
Townet Total	All	308	10.3%	89.7%	0.0%	0.0%	100.0%	13.9%	86.1%	0.0%	0.0%	100.0%
			3	26	0	0	29	43	265	0	0	308
Beach seine	June	39	5.1%	61.5%	33.3%	0.0%	100.0%	5.1%	61.5%	33.3%	0.0%	100.0%
			2	24	13	0	39	2	24	13	0	39
Beach seine	July	40	7.7%	76.9%	15.4%	0.0%	100.0%	7.7%	76.9%	15.4%	0.0%	100.0%
			3	30	6	0	39	3	31	6	0	40
Beach seine	August	48	2.1%	53.2%	44.7%	0.0%	100.0%	2.1%	53.2%	44.7%	0.0%	100.0%
			1	25	21	0	47	1	26	21	0	48
Beach Seine Total	All	127	4.8%	63.2%	32.0%	0.0%	100.0%	4.8%	63.2%	32.0%	0.0%	100.0%
			6	79	40	0	125	6	80	41	0	127
Total	All	435	5.8%	68.2%	26.0%	0.0%	100.0%	11.3%	79.4%	9.3%	0.0%	100.0%
			9	105	40	0	154	49	345	41	0	435

[a] Age compositions are not apportioned to total sockeye catches based on fish lengths greater or less than 45 mm.

Table 28.-Average length, weight, and condition factor by age and gear type, of juvenile sockeye salmon captured in Chignik Lake, 2003.

				Length (mm)		Weight (g)		Condition factor	
Gear type	Month	Age	Sample size	Average	SD	Average	SD	Average	SD
Beach seine	June	0	2	30.0	1.90	0.20	0.01	0.67	0.04
		1	24	66.0	14.13	2.22	0.48	0.77	0.17
		2	3	69.1	11.01	2.51	0.40	0.76	0.12
	July	0	3	54.7	5.35	3.63	0.30	1.08	0.08
		1	30	64.7	17.29	3.53	0.86	0.91	0.22
		2	6	75.5	7.90	3.38	0.37	0.88	0.08
	August	0	1	60.0	2.68	1.90	0.08	0.88	0.04
		1	25	72.6	15.91	3.81	0.89	0.96	0.21
		2	21	73.6	14.85	4.18	0.86	1.12	0.26
Townet	June	1	8	65.0	8.19	2.99	0.38	1.10	0.14
	July	0	3	71.3	5.55	3.93	0.31	1.09	0.09
		1	18	65.3	12.21	2.69	0.52	0.94	0.18

Table 29.-Total beach seine catch by age of juvenile sockeye salmon from Chignik River, 2003.

	Total sockeye	Sample					Estimated age[a]				
Month	catch	0.	1.	2.	3.	Total	0.	1.	2.	3.	Total
June	2,656	8.8%	58.8%	32.5%	0.0%	100.0%	8.8%	58.8%	32.5%	0.0%	100.0%
		10	67	37	0	114	233	1,561	862	0	2,656
July	1,634	18.1%	72.4%	9.5%	0.0%	100.0%	18.1%	72.4%	9.5%	0.0%	100.0%
		19	76	10	0	105	296	1,183	156	0	1,634
August	311	10.6%	83.0%	6.4%	0.0%	100.0%	10.6%	83.0%	6.4%	0.0%	100.0%
		5	39	3	0	47	33	258	20	0	311
All	4,601	12.8%	68.4%	18.8%	0.0%	100.0%	12.2%	65.2%	22.5%	0.0%	100.0%
		34	182	50	0	266	562	3,002	1,038	0	4,601

[a] Age compositions are not apportioned to total sockeye catches based on fish lengths greater or less than 45 mm.

Table 30.-Average length, weight, and condition factor by age for juvenile sockeye salmon captured in the Chignik River, 2003.

Month	Age	Sample size	Length (mm)		Weight (g)		Condition factor	
			Average	SD	Average	SD	Average	SD
June	0	10	53.8	7.61	1.21	0.18	0.70	0.10
	1	67	62.5	21.38	1.99	0.72	0.79	0.27
	2	37	68.4	18.06	2.63	0.80	0.78	0.20
July	0	19	55.3	10.62	1.58	0.32	0.93	0.18
	1	76	63.5	22.90	2.34	0.88	0.89	0.32
	2	10	73.1	10.29	3.37	0.50	0.84	0.12
August	0	5	62.2	6.20	1.84	0.19	0.75	0.08
	1	39	60.4	16.32	2.10	0.60	0.92	0.25
	2	3	69.3	5.36	3.10	0.24	0.93	0.07

Table 31.-Total beach seine catch, by age, of juvenile sockeye salmon from Chignik Lagoon, 2003.

	Total sockeye	Sample					Estimated age[1]				
Month	catch	0.	1.	2.	3.	Total	0.	1.	2.	3.	Total
May	46	15.2%	60.9%	23.9%	0.0%	100.0%	15.2%	60.9%	23.9%	0.0%	100.0%
		7	28	11	0	46	7	28	11	0	46
June	188	11.8%	61.8%	26.5%	0.0%	100.0%	11.8%	61.8%	26.5%	0.0%	100.0%
		4	21	9	0	34	22	116	50	0	188
July	398	22.6%	61.3%	16.0%	0.0%	100.0%	22.6%	61.3%	16.0%	0.0%	100.0%
		24	65	17	0	106	90	244	64	0	398
August	17	52.9%	41.2%	5.9%	0.0%	100.0%	52.9%	41.2%	5.9%	0.0%	100.0%
		9	7	1	0	17	9	7	1	0	17
All	649	21.7%	59.6%	18.7%	0.0%	100.0%	18.9%	61.4%	19.7%	0.0%	100.0%
		44	121	38	0	203	119	388	125	0	632

[a] Age compositions are not apportioned to total sockeye catches based on fish lengths greater or less than 45 mm.

Table 32.-Average length, weight, and condition factor by age of juvenile sockeye salmon captured by beach seine in Chignik Lagoon, 2003.

			Length (mm)		Weight (g)		Condition factor	
Month	Age	Sample size	Average	SD	Average	SD	Average	SD
May	0	7	51.1	7.40	1.30	0.20	0.94	0.14
	1	28	66.1	18.36	2.96	0.89	0.97	0.27
	2	11	71.7	12.79	6.00	0.72	1.00	0.18
June	0	4	48.0	5.30	1.35	0.16	1.26	0.14
	1	21	66.2	16.16	2.63	0.69	0.86	0.21
	2	9	73.6	11.89	3.57	1.00	0.87	0.14
July	0	24	68.0	17.62	3.45	0.94	1.06	0.27
	1	65	69.9	27.92	3.87	1.69	1.06	0.43
	2	17	70.6	15.58	4.23	1.00	1.13	0.25
August	0	9	57.1	9.26	1.86	7.65	0.98	0.16
	1	7	59.7	8.51	2.04	7.02	1.00	0.14
	2	1	74.0	4.02	3.90	3.31	0.96	0.05

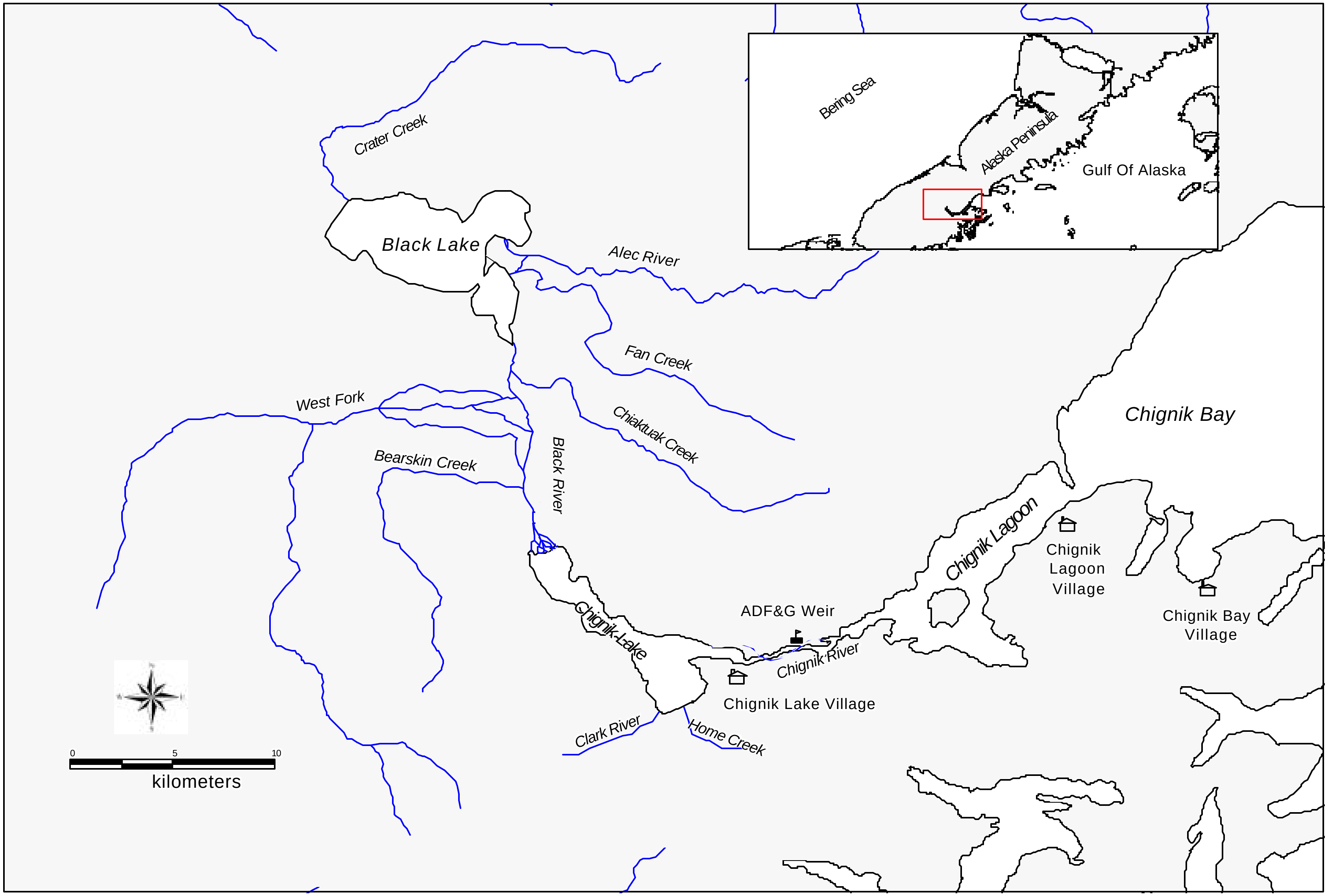


Figure 1.-Chignik watershed and location on the Alaska Peninsula (inset).

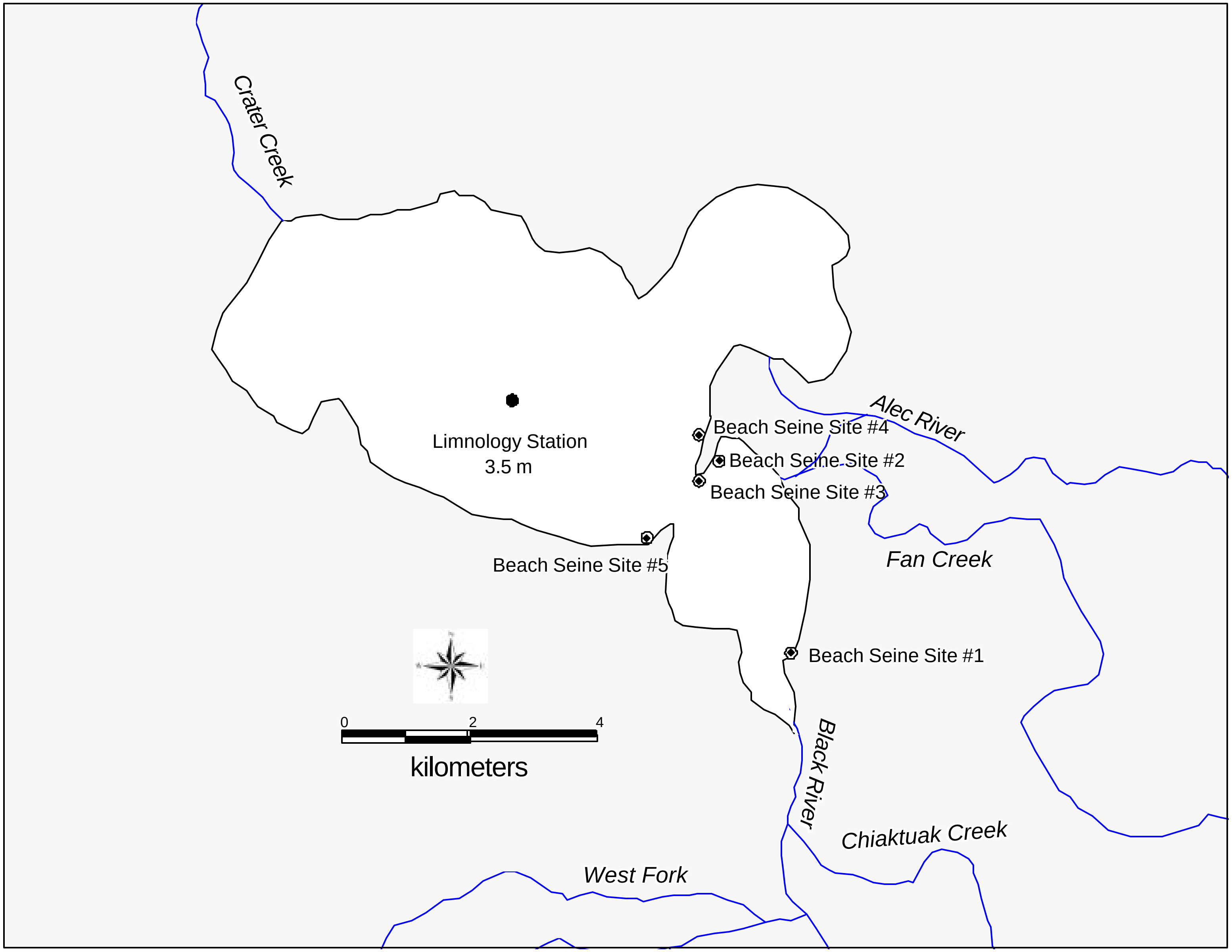


Figure 2.-Black Lake and its sampling sites.

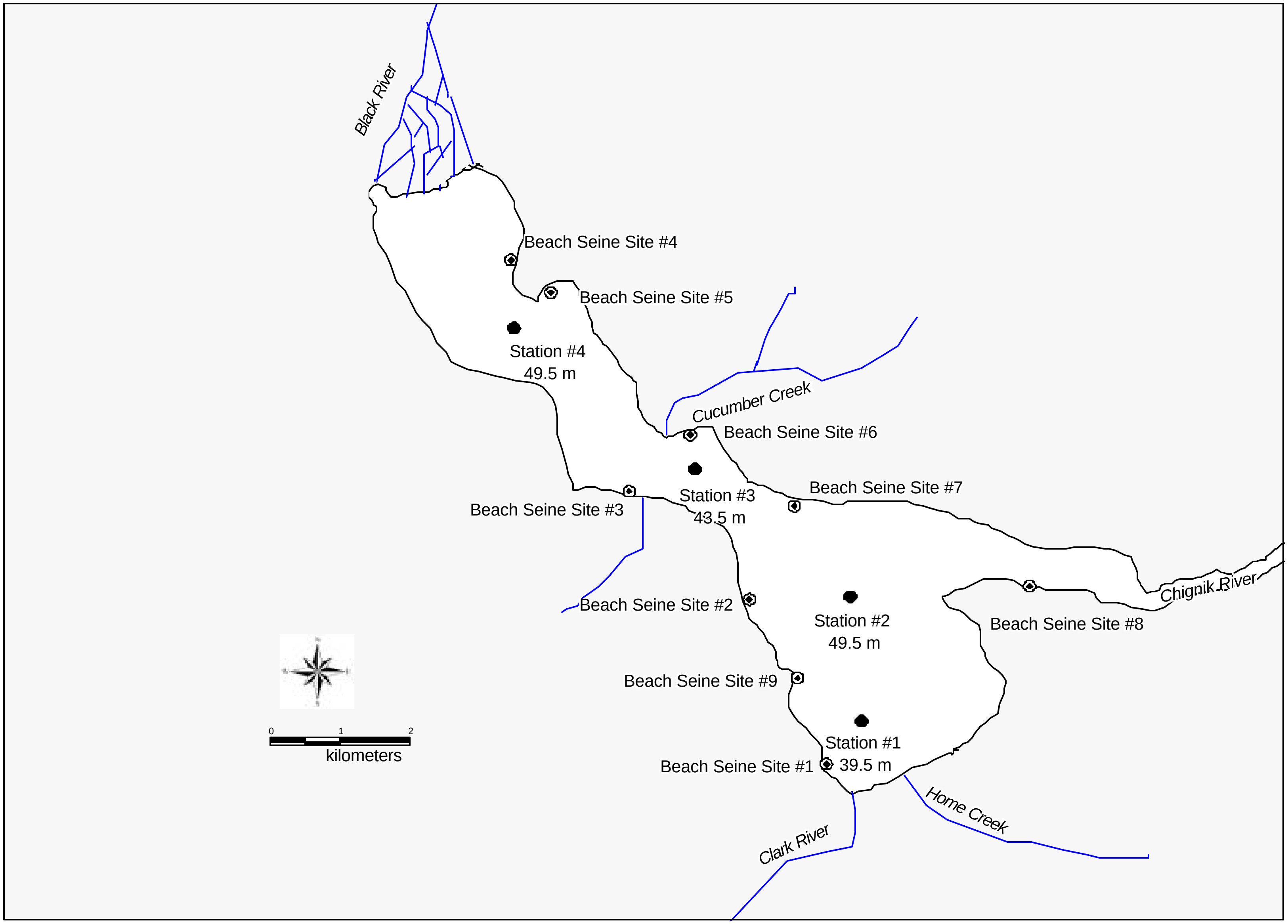


Figure 3.-Chignik Lake and its sampling sites.

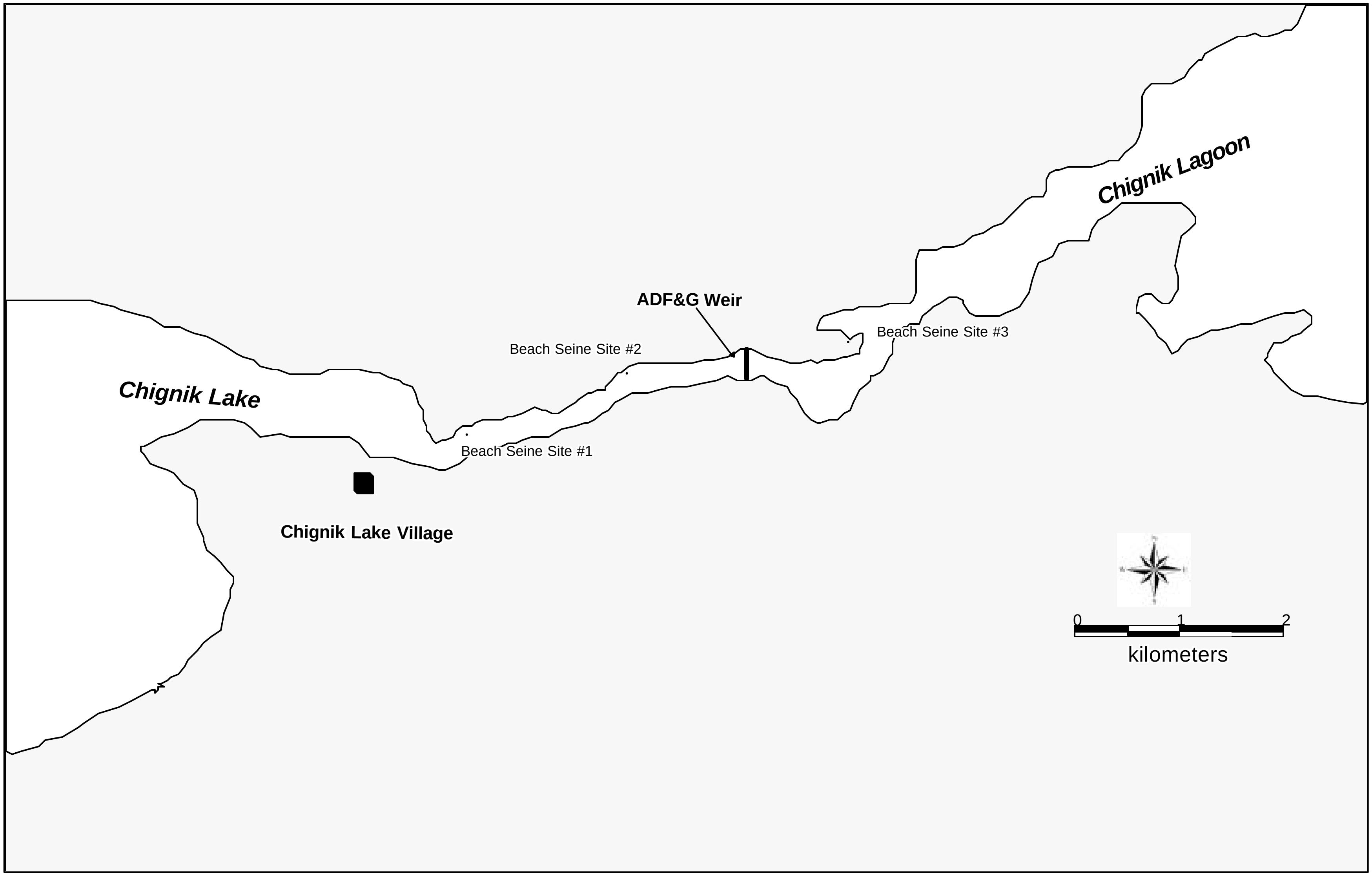


Figure 4.-Chignik River and its sampling sites.

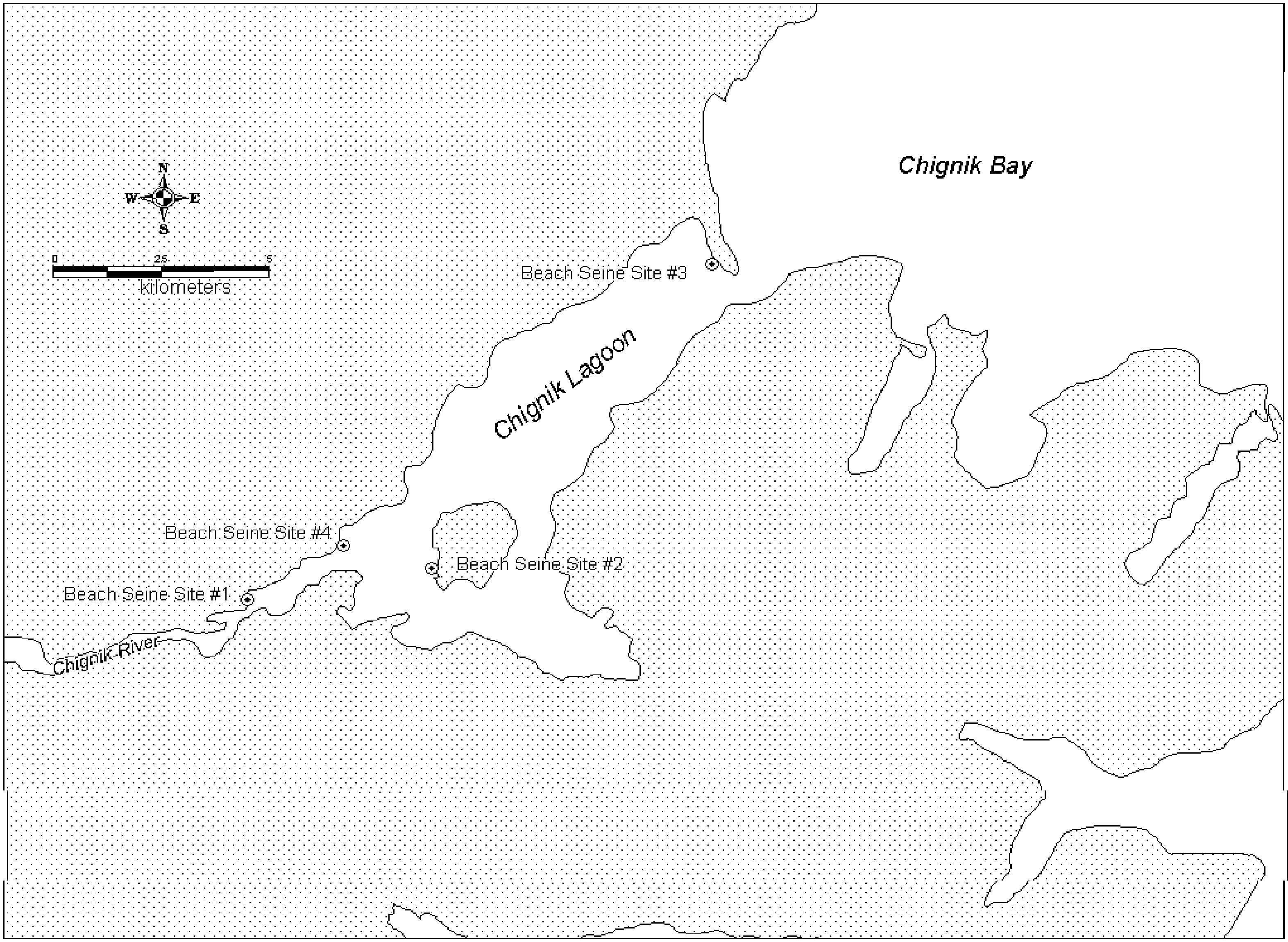


Figure 5.-Chignik Lagoon and its sampling site.

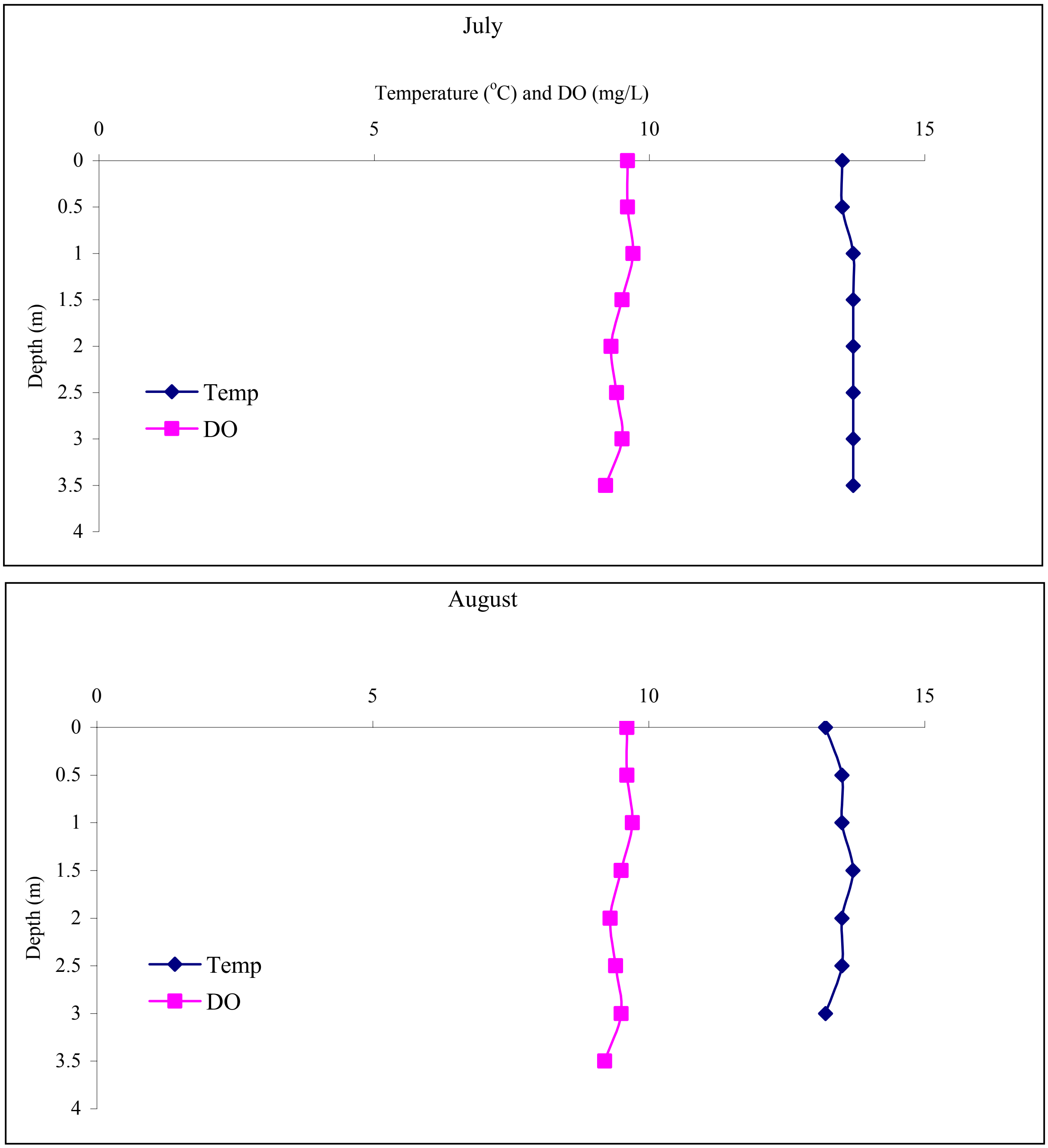


Figure 6.-Mean monthly temperature and dissolved oxygen profiles for Black Lake, 2003.

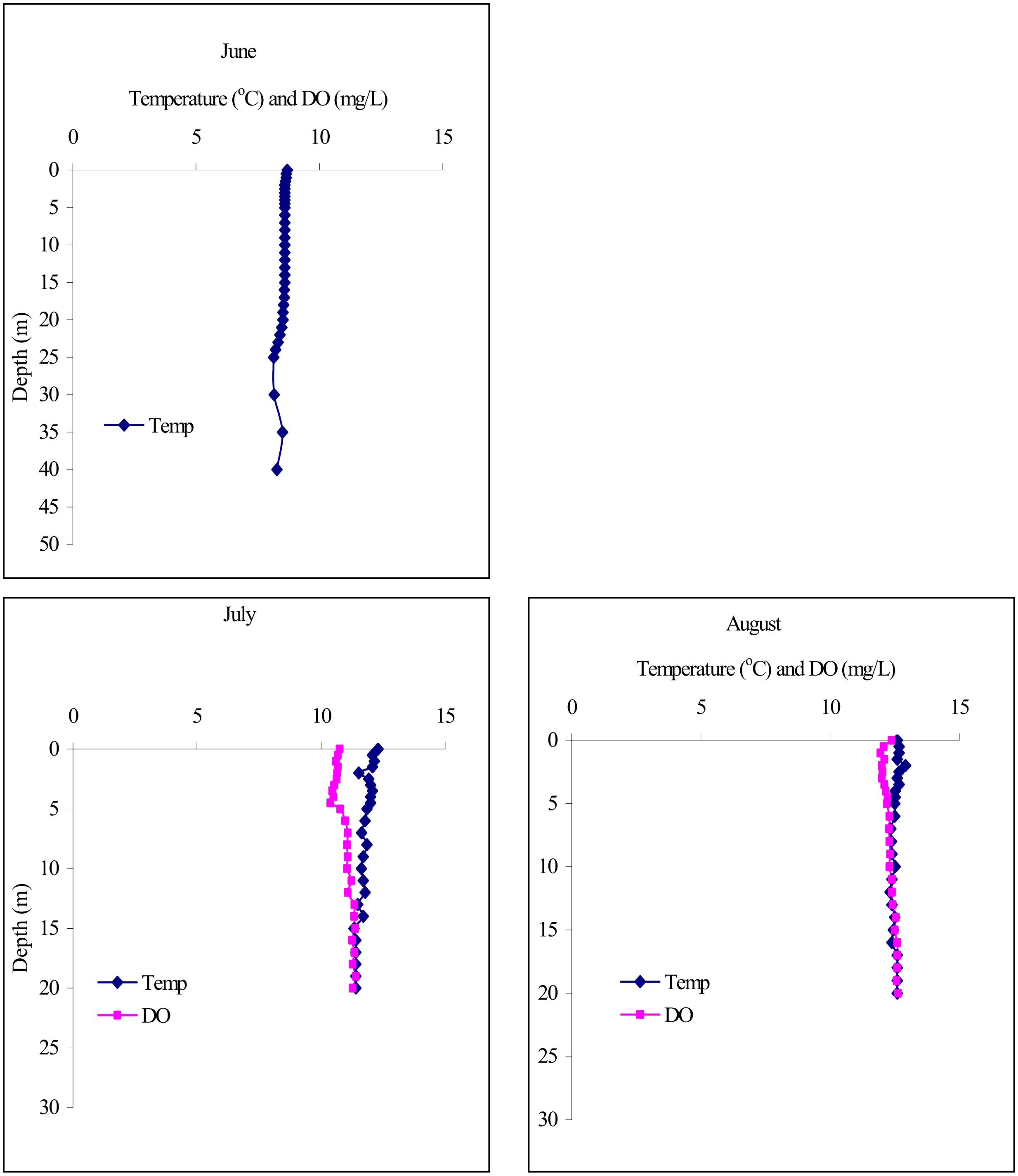
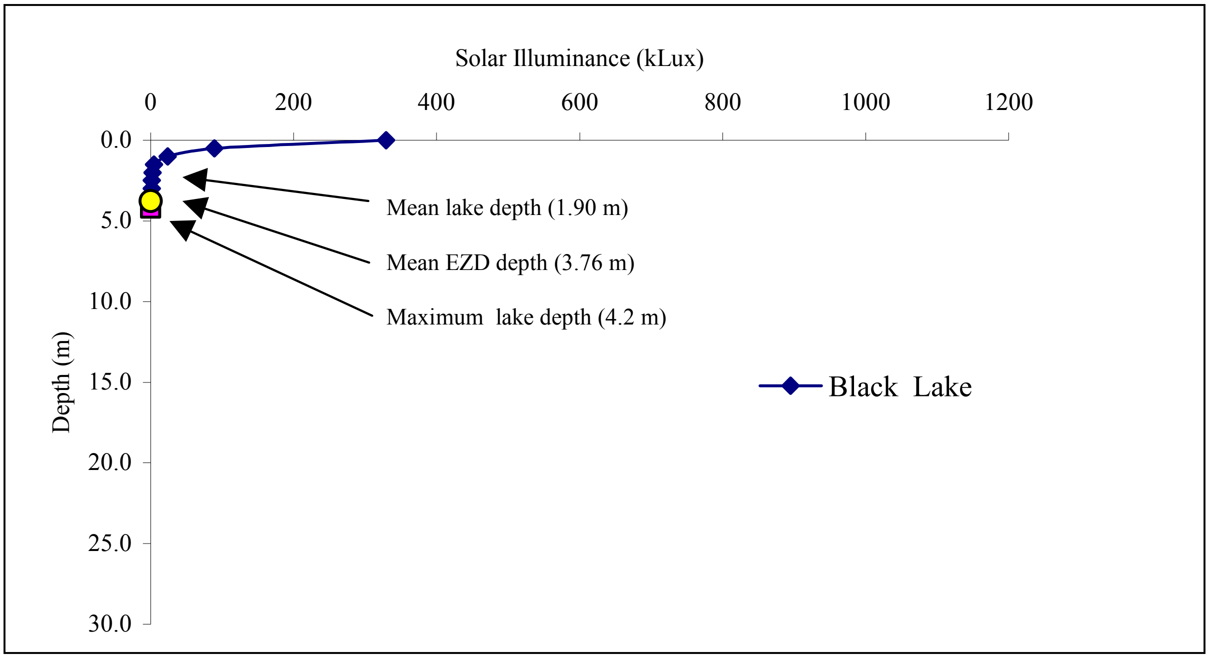


Figure 7.-Mean monthly temperature and dissolved oxygen profiles for Chignik Lake, 2003. A dissolved oxygen profile was not taken in June, 2003. July and August profiles were limited to a depth of 20 m.



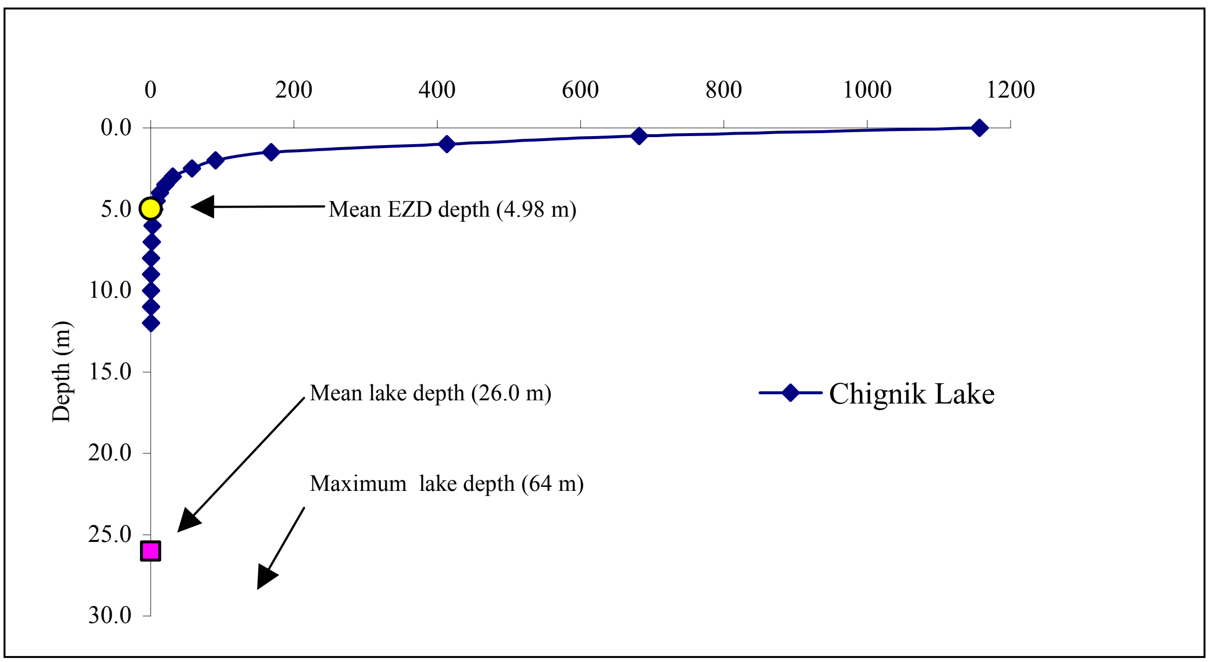


Figure 8.-Light penetration curves relative to mean depth, EZD, and maximum depth for Black Lakes and Chignik Lakes, 2003.

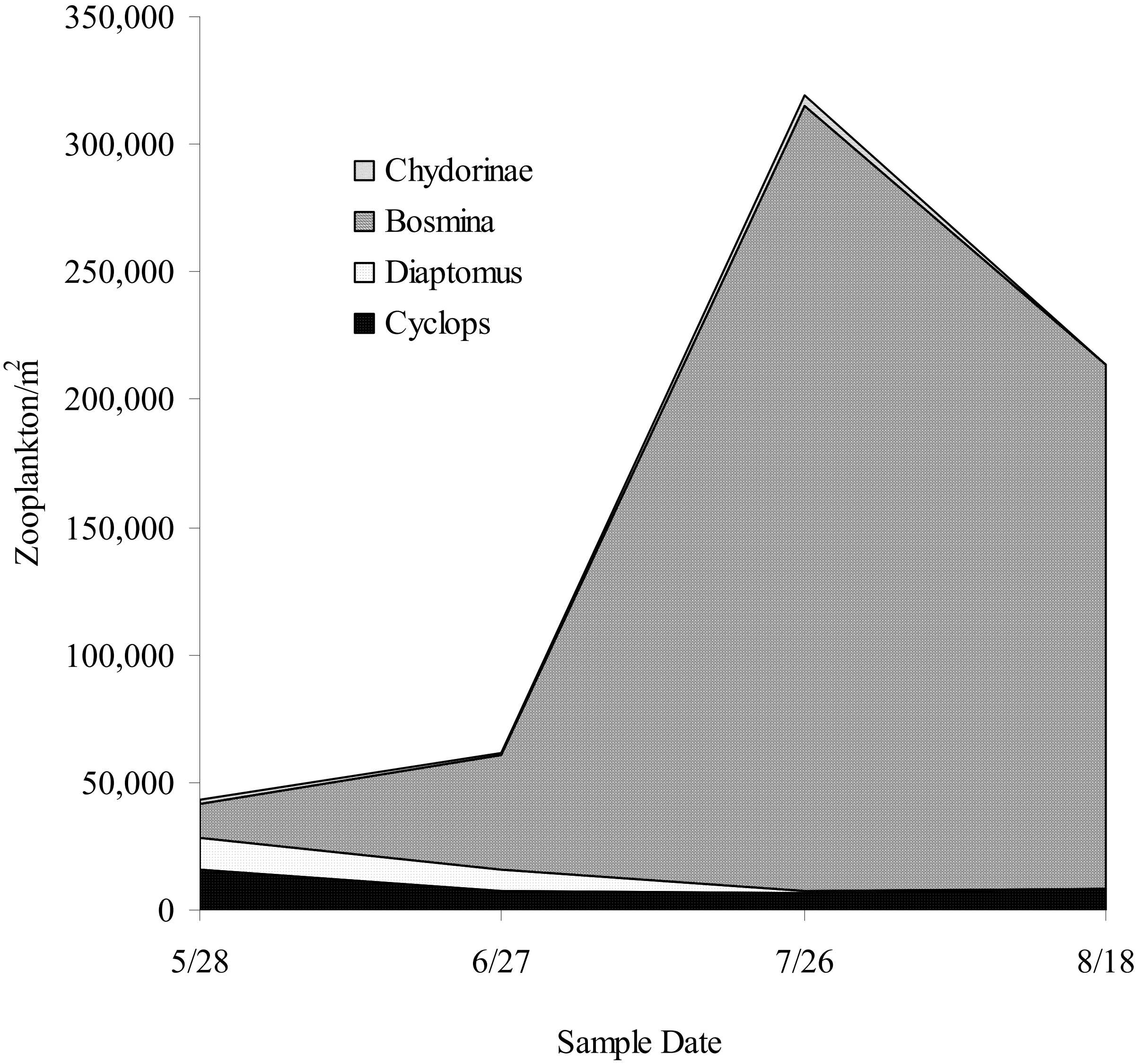


Figure 9.-Number of zooplankton per m^2 of the major copepods (*Cyclops* and *Diaptomus*) and cladocerans (*Bosmina* and *Chydorinae*) in Black Lake, by sample date, 2003.

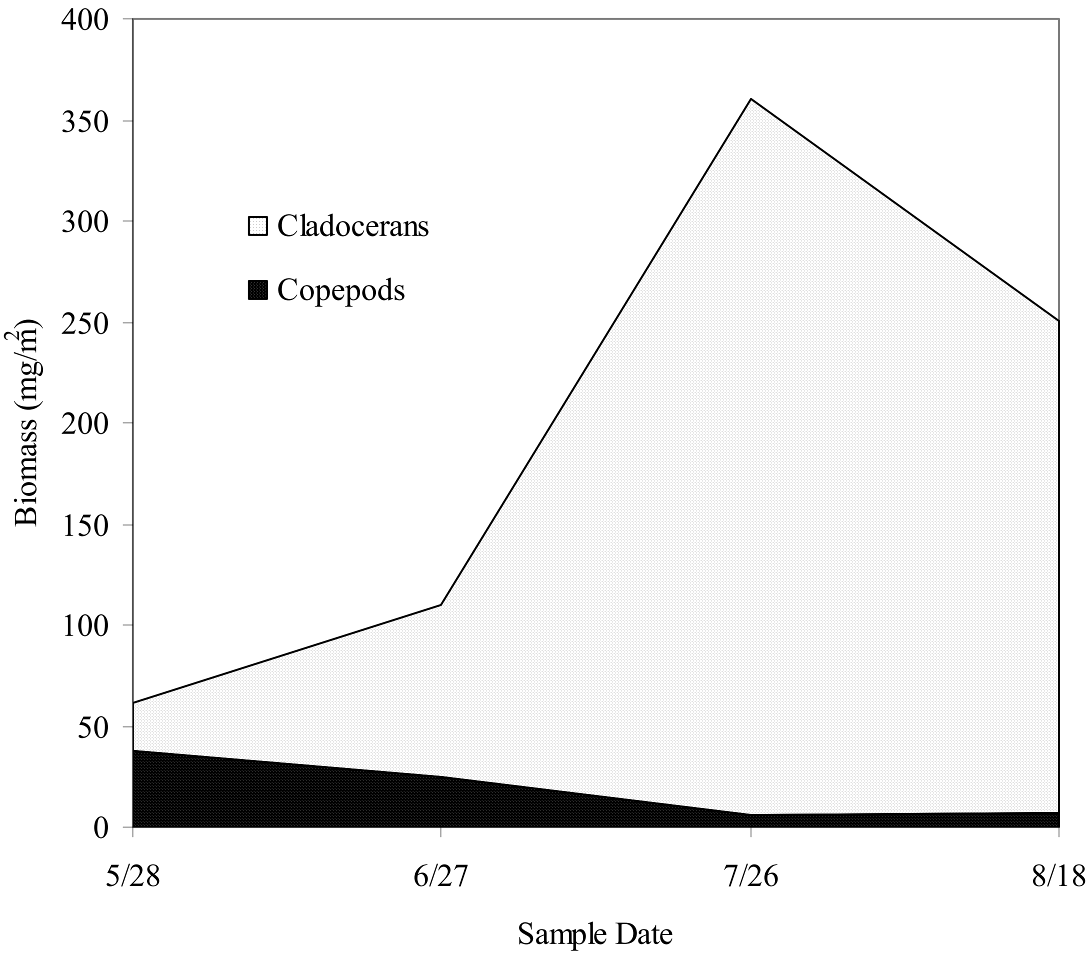


Figure 10.-Mean biomass per m^2 of the major copepods and cladocerans in Black Lake, by sample date, 2003.

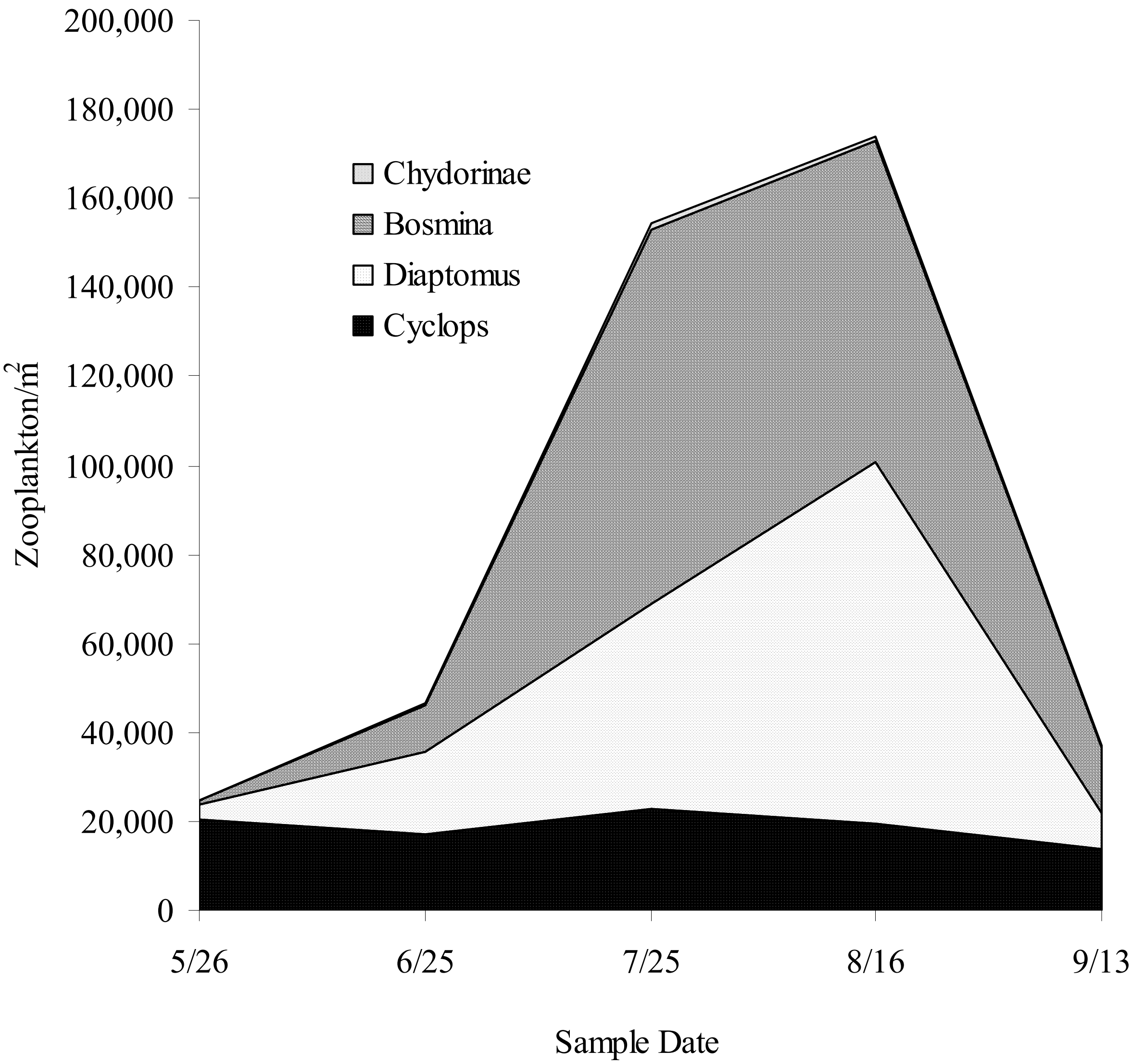


Figure 11.-Number of zooplankton per m^2 of the major copepods (*Cyclops* and *Diaptomus*) and cladocerans (*Bosmina* and *Chydorinae*) in Chignik Lake, by sample date, 2003. On 9/13/03 only station one was sampled.

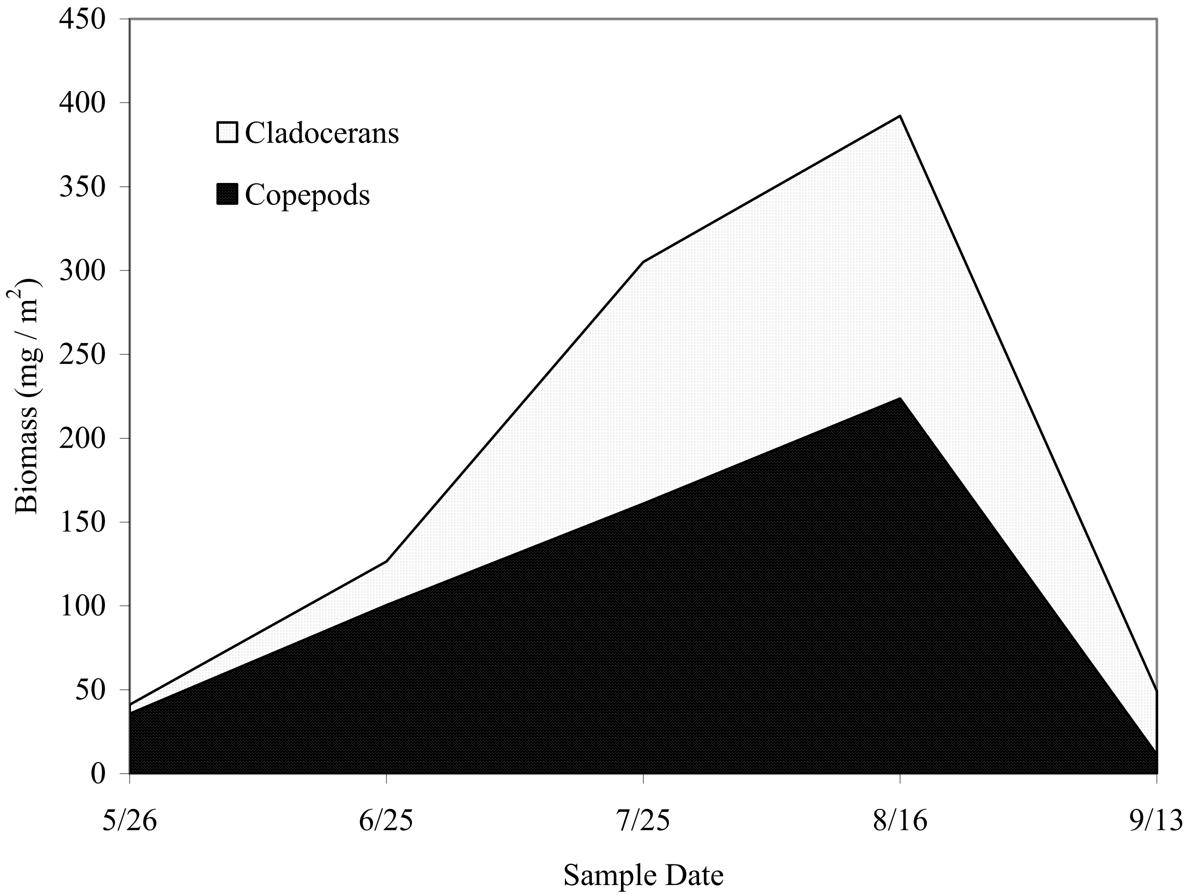


Figure 12.-Mean biomass per m^2 of the major copepods and cladocerans in Chignik Lake, by sample date, 2003. On September 13, 2003 only station one was sampled.

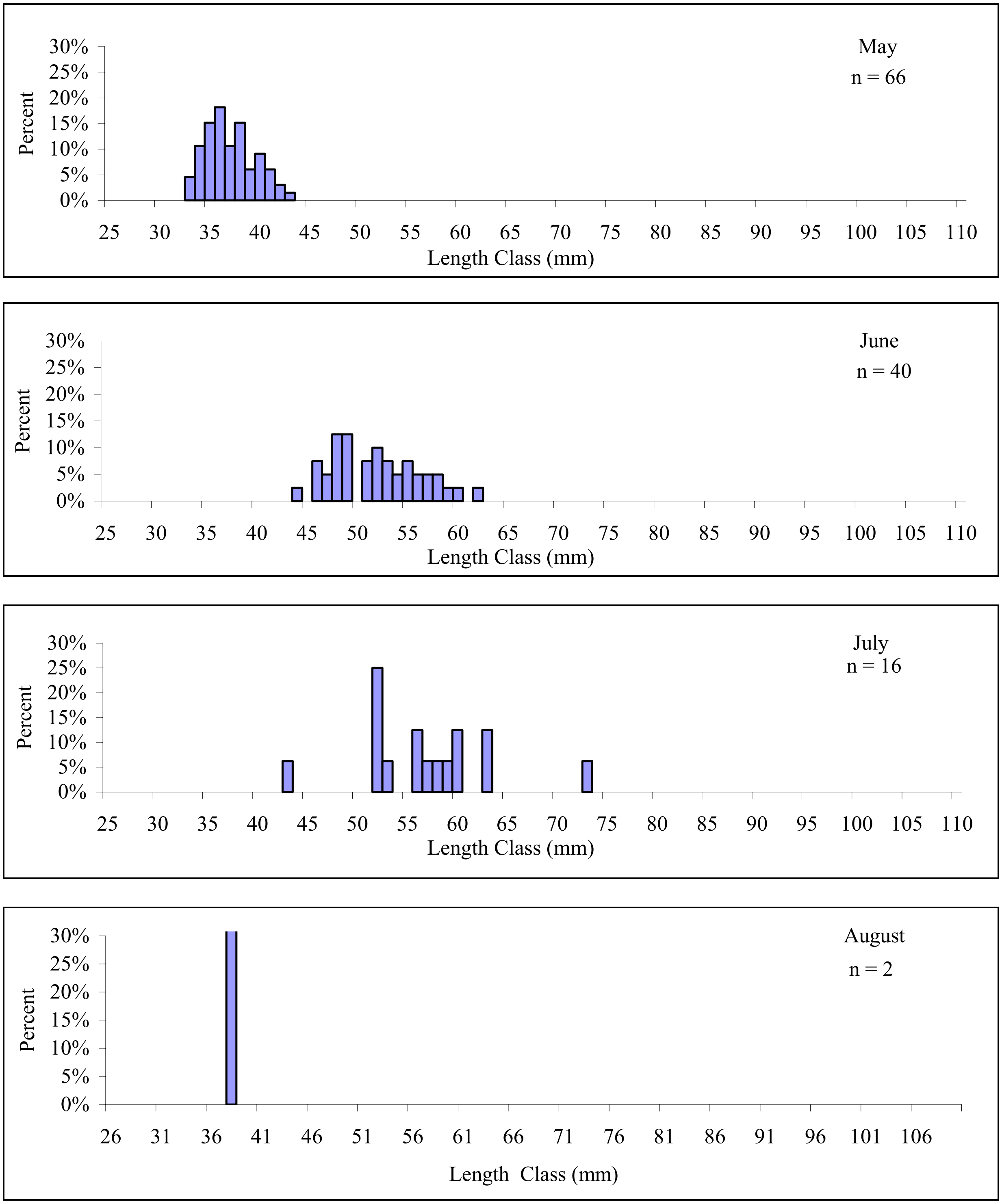
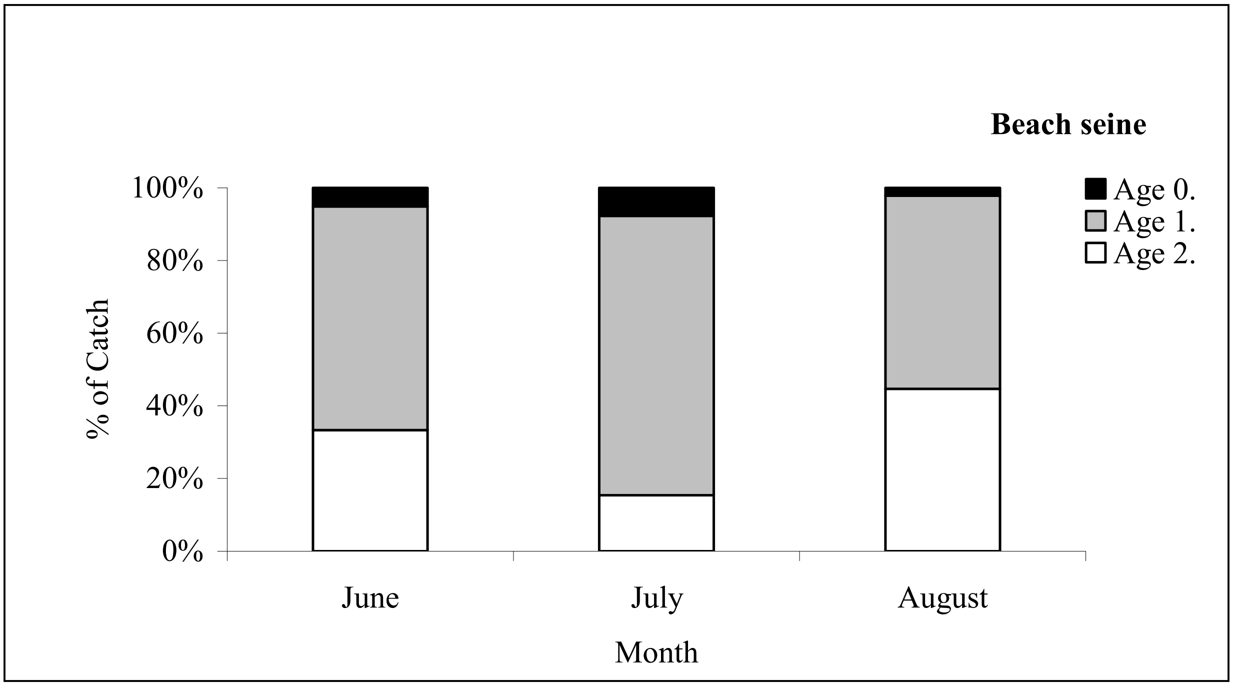


Figure 13.-Length frequency histograms by month of juvenile sockeye salmon captured with a beach seine, and fyke net from Black Lake and Black River, 2003.



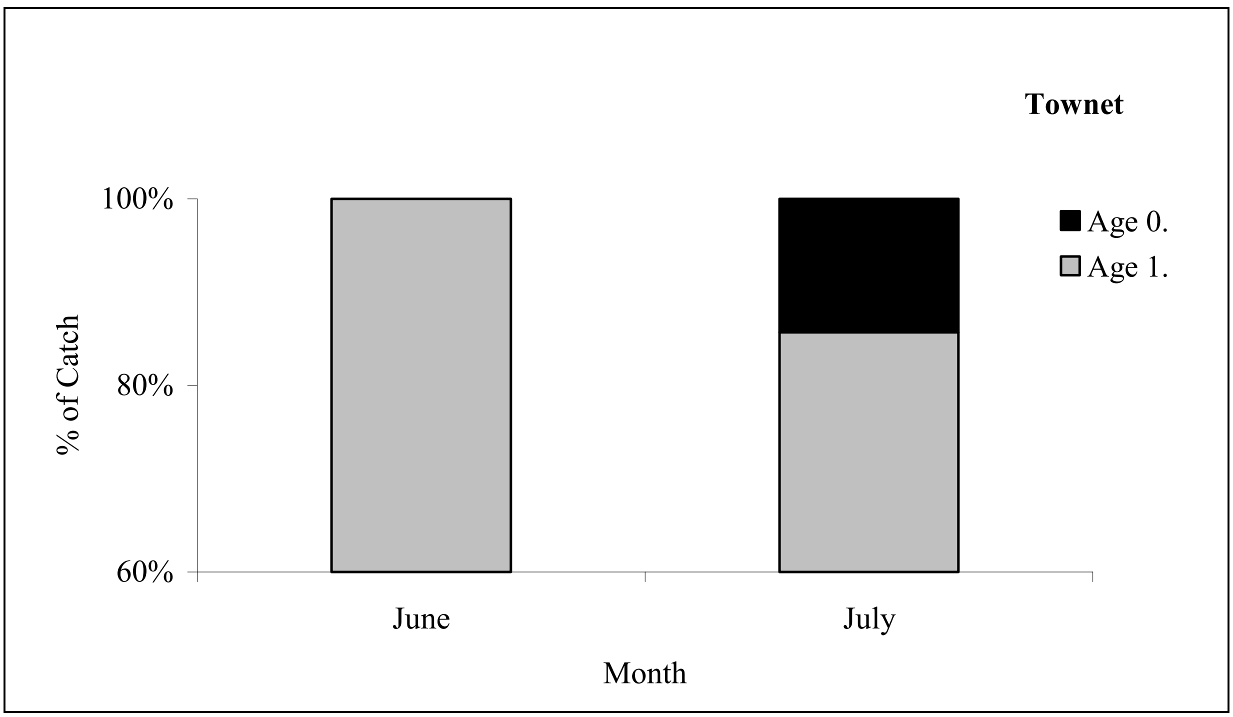


Figure 14.-Estimated age percentages in beach seine and townet catches by month from Chignik Lake, 2003.

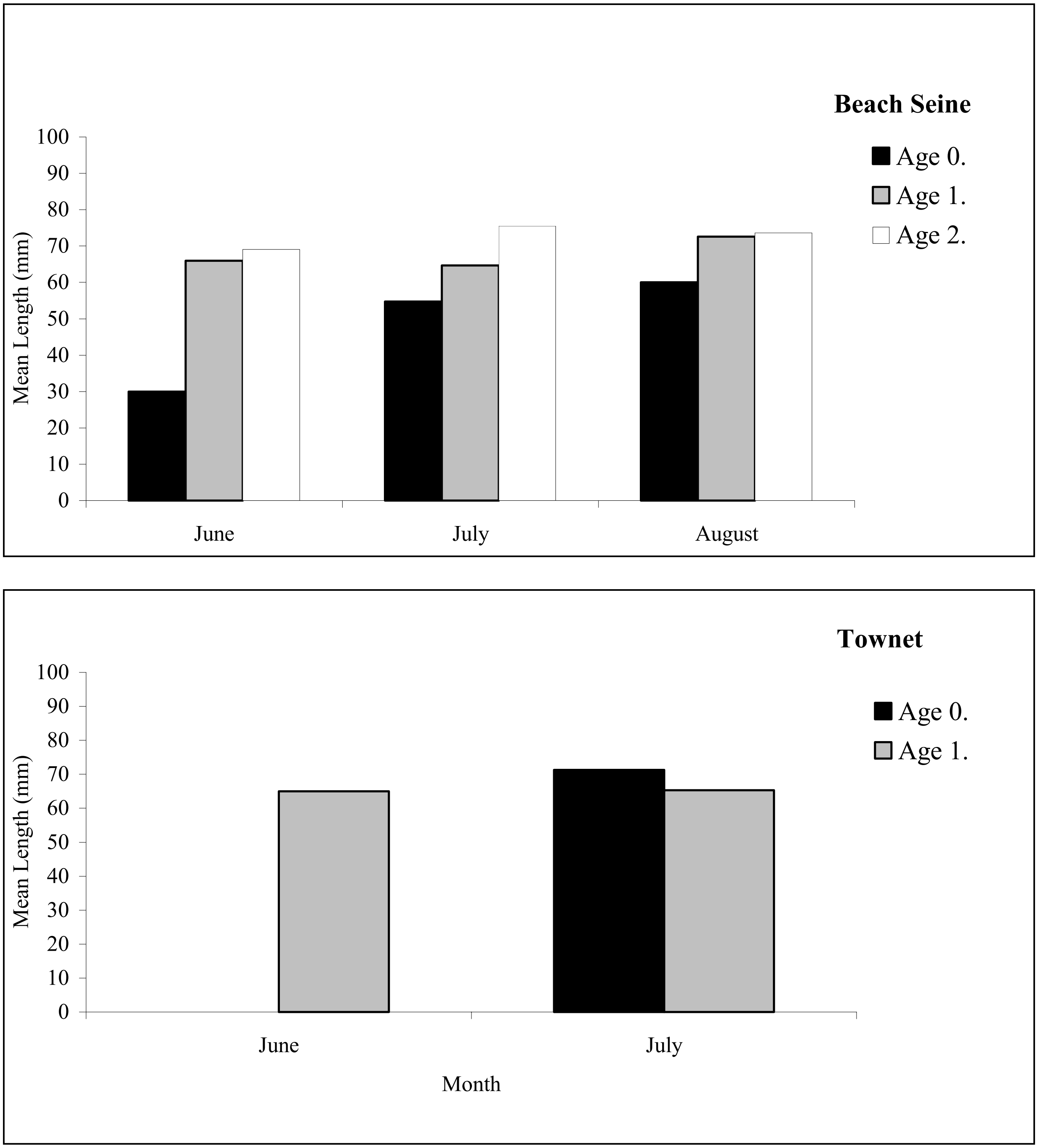


Figure 15.-Mean lengths of beach seine and townet catches by age and month from Chignik Lake, 2003.

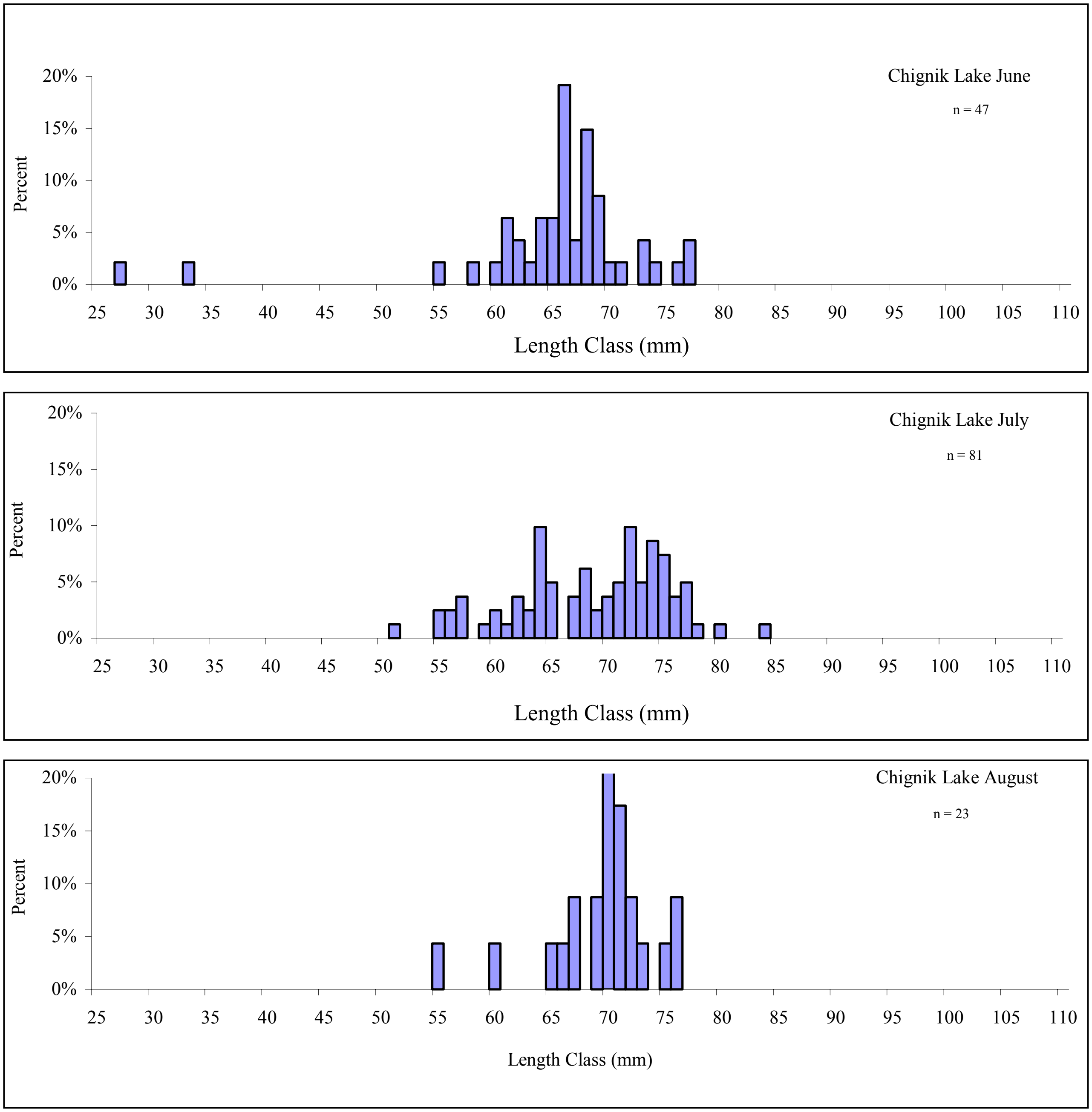


Figure 16.-Length frequency histograms by month of juvenile sockeye salmon captured with a beach seine and a townet from Chignik Lake, 2003.

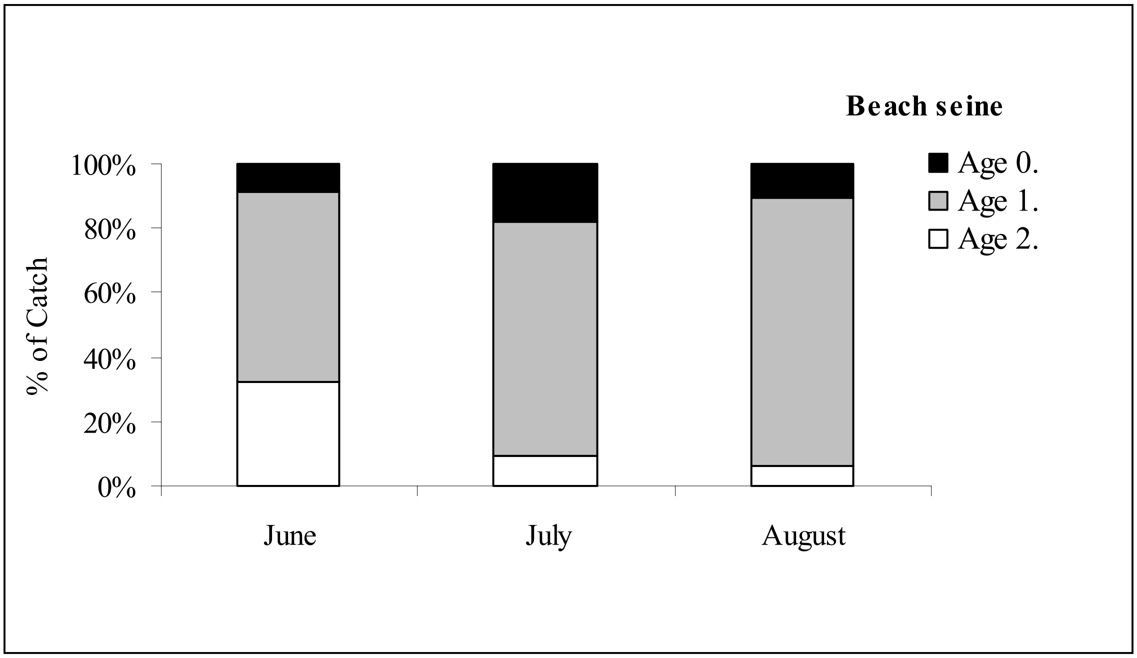


Figure 17.-Estimated age percentages in beach seine catches by month from Chignik River, 2003.

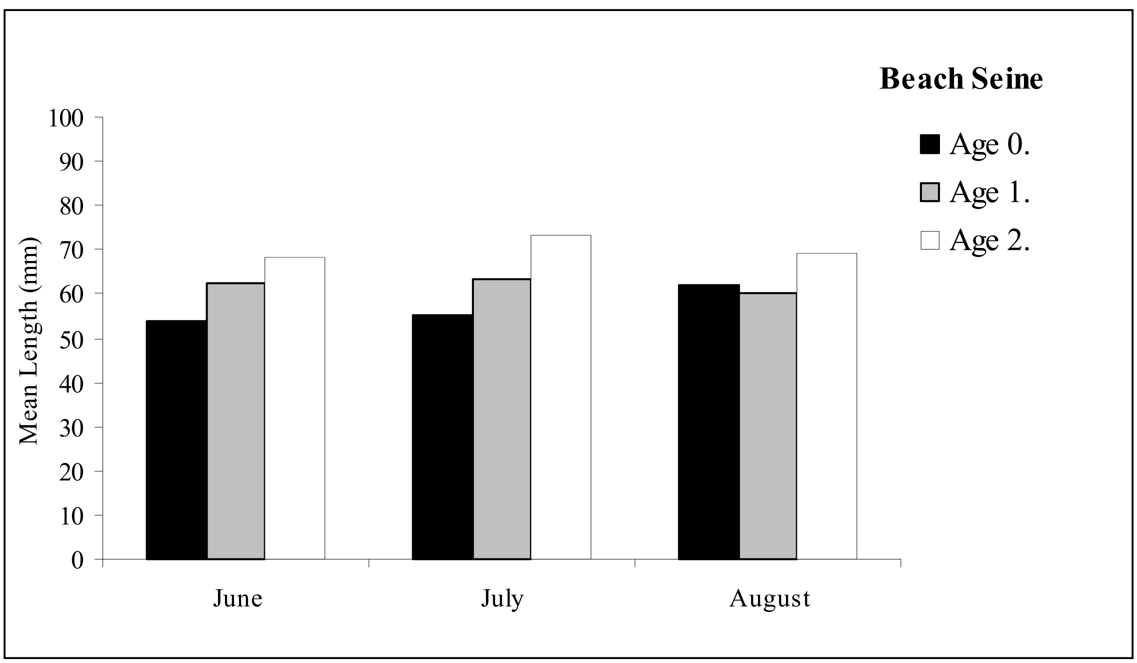


Figure 18.-Mean lengths of beach seine catches by age and month from Chignik River, 2003.

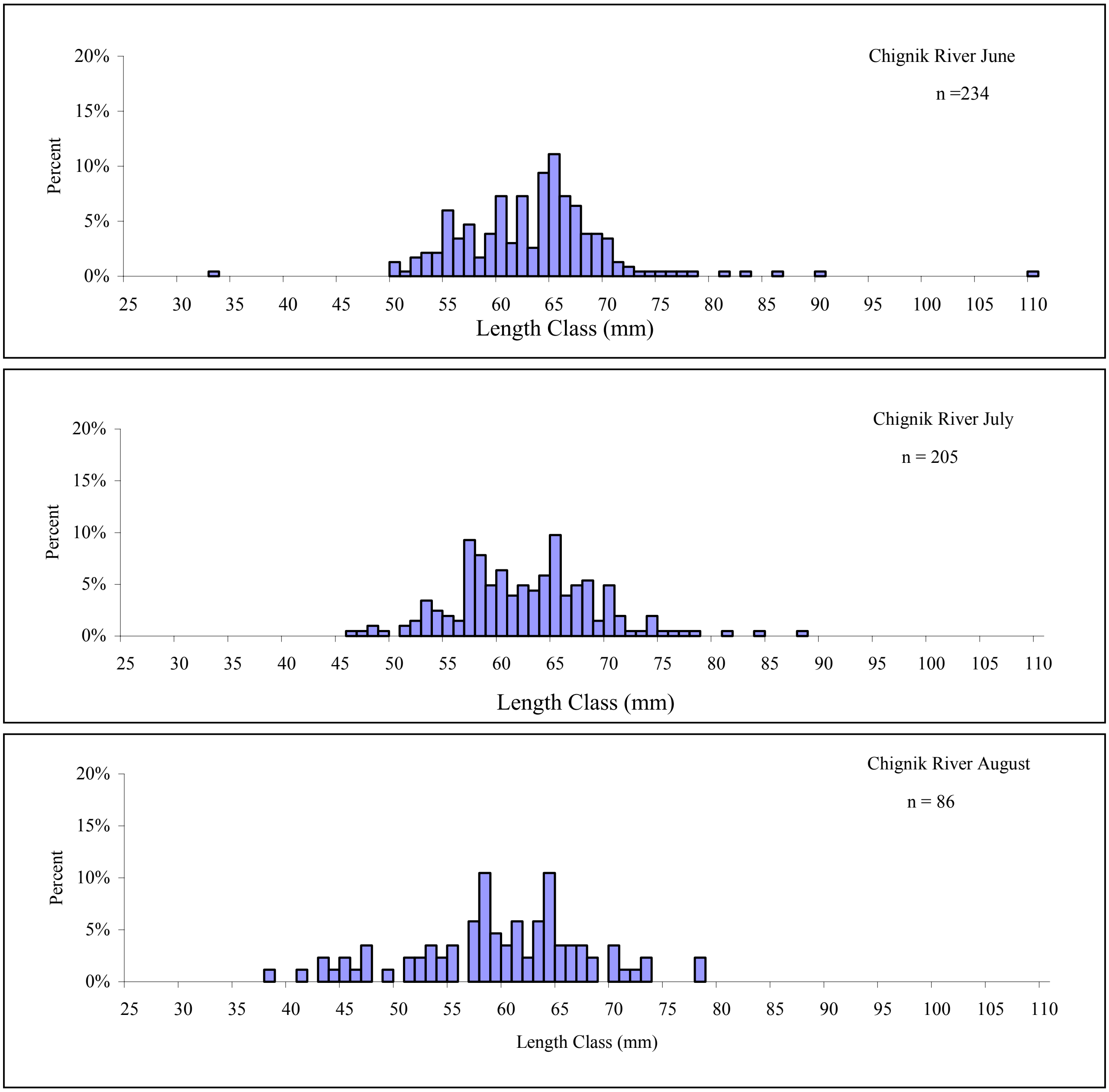


Figure 19.-Length frequency histograms by month of juvenile sockeye salmon captured with a beach seine from Chignik River, 2003.

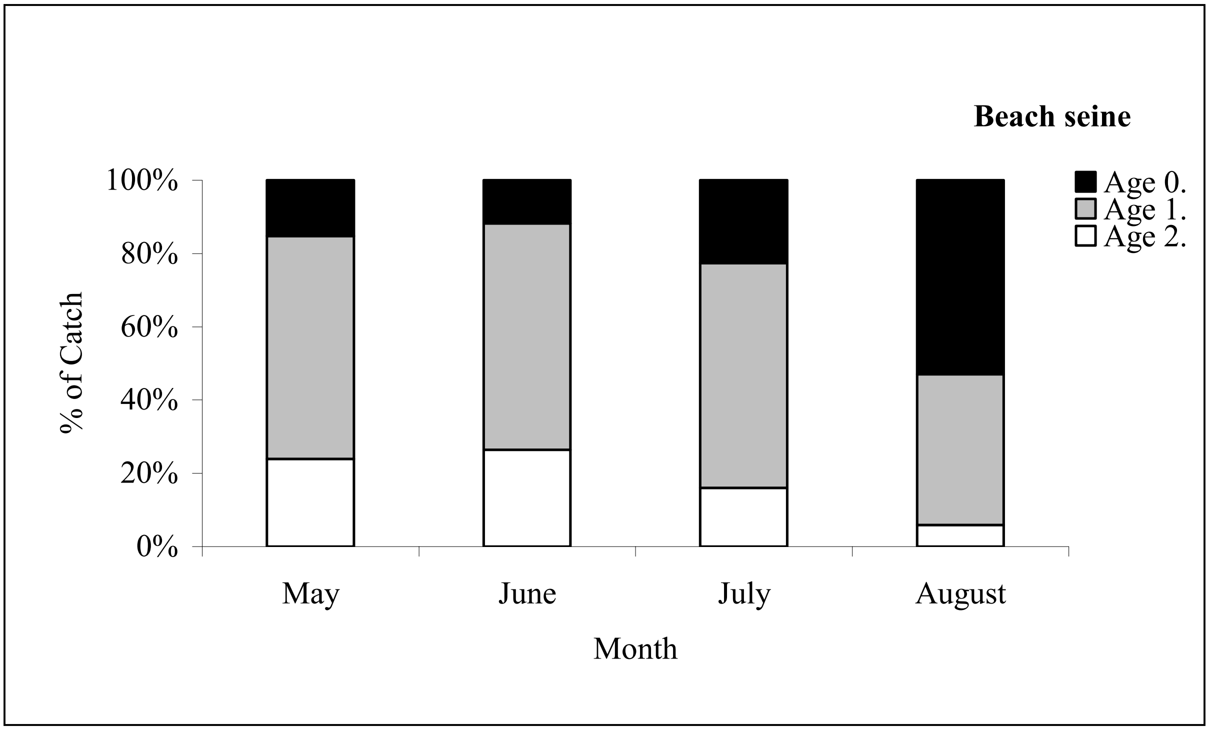


Figure 20.-Estimated age percentages in beach seine catches by month from Chignik Lagoon, 2003.

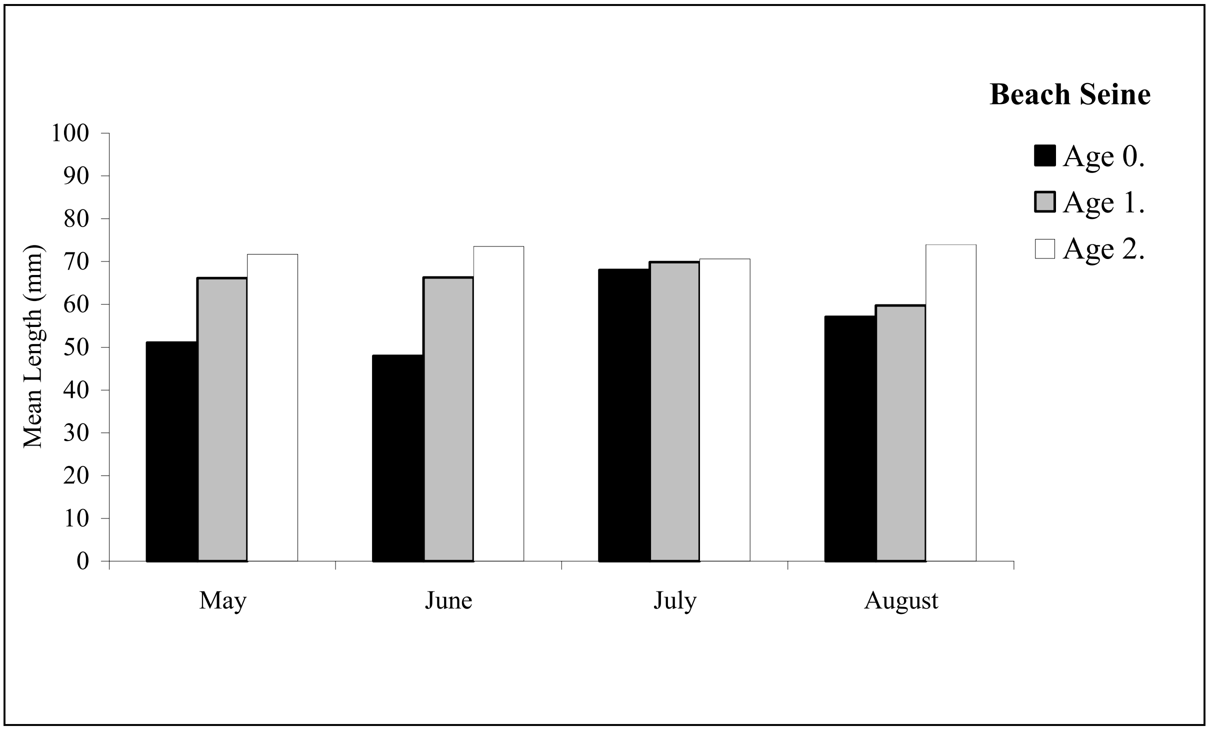


Figure 21.-Mean lengths of beach seine catches by age and month from Chignik Lagoon, 2003.

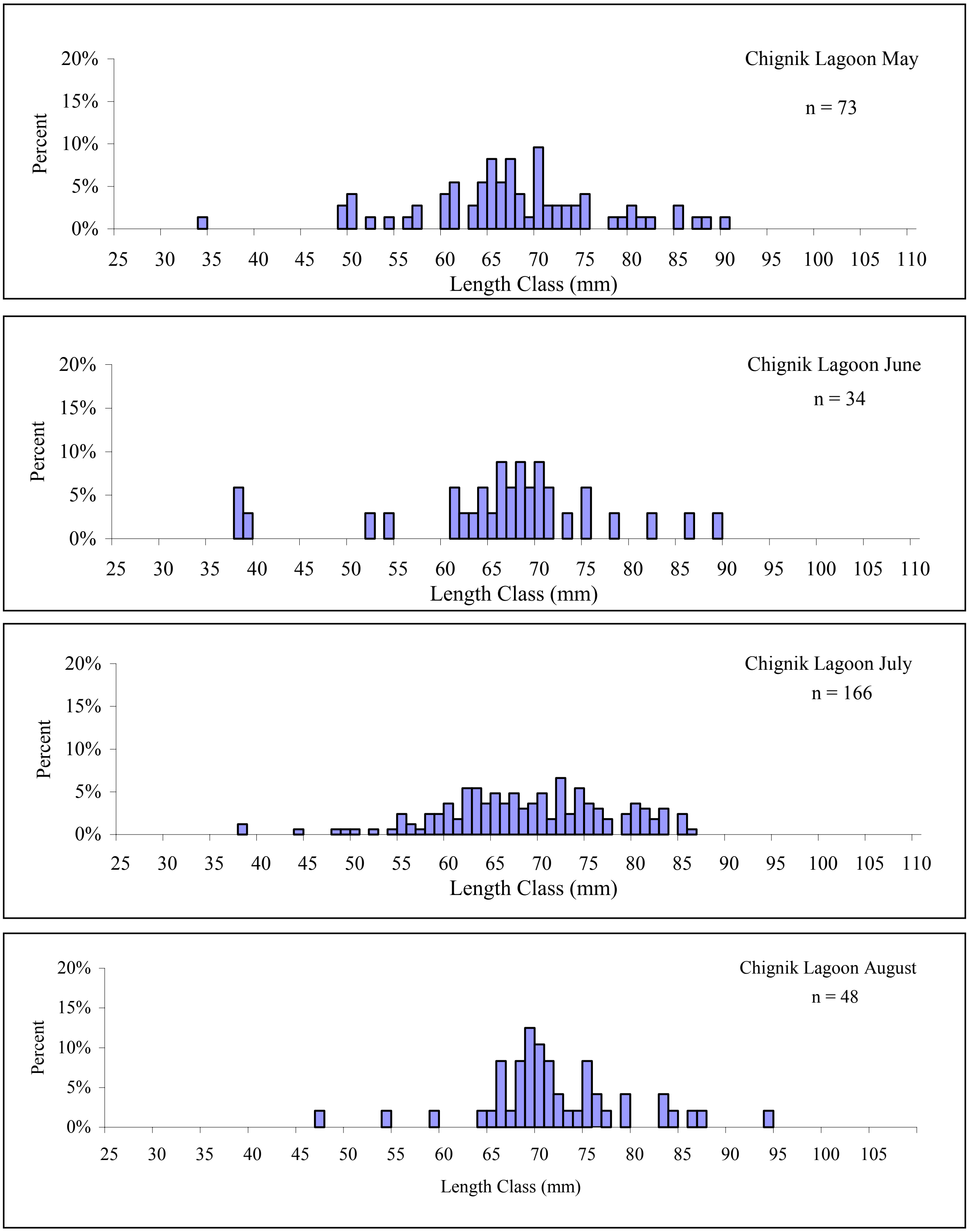


Figure 22.-Length frequency histograms by month of juvenile sockeye salmon captured with a beach seine from Chignik Lagoon, 2003.

APPENDIX A:
LOCATION OF THE LIMNOLOGY SAMPLING STATIONS IN BLACK AND CHIGNIK LAKES, 2003

Appendix A1.-Location of the limnology sampling stations in Black and Chignik lakes, 2003. Coordinates are in degrees and decimals.

Lake	Station	Latitude (N)	Longitude (W)
Black	1	56.458698	-159.007037
Chignik	1	56.238455	-158.813778
	2	56.255011	-158.816263
	3	56.271962	-158.850692
	4	56.290686	-158.890802

APPENDIX B:
AVERAGE NUMBER OF ZOOPLANKTON PER M^3 FROM BLACK LAKE BY SAMPLE DATE, 2003

Appendix B1.-Average number of zooplankton per m^3 from Black Lake by sample date, 2003.

Taxon	Sample Date 5/28	6/27	7/26	8/18	Average
Copepods:					
Epischura	849	1,840	724	637	1,013
Ovig. *Epischura*	0	0	0	0	0
Diaptomus	5,096	2,265	145	212	1,930
Ovig. *Diaptomus*	1062	0	0	0	266
Cyclops	6,369	1,982	2,461	3,185	3,499
Ovig. *Cyclops*	212	0	0	0	53
Harpaticus	425	0	0	0	106
Napulii	9,766	5,096	724	1,274	4,215
Total copepods	23,779	11,183	4,054	5,308	11,081
Cladocerans:					
Bosmina	5,308	11,890	111,899	82,166	52,816
Ovig. *Bosmina*	2,335	5,945	11,002	8,493	6,944
Daphnia l.	0	0	145	1,062	302
Ovig. *Daphnia l.*	0	0	0	0	0
Chydorinae	637	283	1,592	0	628
Total cladocerans	8,280	18,118	124,638	91,721	60,689
Total copepods + cladocerans	32,059	29,301	128,692	97,029	71,770
Rotifers:					
Kellicottia	637	23,779	30,834	3,185	14,609
Asplanchna	0	0	434	0	109
Keratella	16,561	1,274	434	637	4,727
Conochilus	1,274	133,758	60,799	17,197	53,257
other rotifers	891,720	84,926	869	203,822	295,334
Total rotifers	910,192	243,737	93,370	224,841	368,035

APPENDIX C:
BIOMASS ESTIMATES OF THE MAJOR ZOOPLANKTON SPECIES, BY SAMPLE DATE, FROM BLACK LAKE, 2003

Appendix C1.-Biomass estimates (mg dry weight/m^3) of the major zooplankton species, by sample date, from Black Lake, 2003.

Taxon	Sample Date 5/25	6/22	7/19	8/15	Average	Weighted average
Copepods:						
Epischura	0.40	0.86	0.34	0.30	0.47	0.61
Diaptomus	10.49	4.66	0.30	0.44	3.97	7.67
Cyclops	3.89	1.21	1.50	1.95	2.14	3.45
Harpaticus	0.28	0.00	0.00	0.00	0.07	0.07
Total copepods	15.05	6.73	2.14	2.68	6.65	11.80
Cladocerans:						
Bosmina	5.11	11.44	107.69	79.08	50.83	53.63
Ovig. *Bosmina*	4.35	11.07	20.49	15.82	12.93	13.77
Daphnia l.	0.00	0.00	0.34	2.47	0.70	0.45
Chydorinae	0.10	0.05	0.26	0.00	0.10	0.41
Total cladocerans	9.56	22.56	128.78	97.36	64.57	68.25
Copepods to cladocerans	n/a	0.30	0.02	0.03	0.10	0.17
Total Biomass	24.61	29.29	130.92	100.04	71.22	80.05

APPENDIX D:
AVERAGE NUMBER OF ZOOPLANKTON PER M^3 FROM CHIGNIK LAKE, 2003.

Appendix D1.-Average number of zooplankton per m^3 from Chignik Lake, 2003.

Taxon	Sample Date 5/26	6/25	7/25	8/16	9/13[a]	Average
Copepods:						
Epischura	62	320	1,026	2,034	303	749
Ovigerous *Epischura*	0	0	0	0	0	0
Diaptomus	60	389	972	1,727	190	667
Ovigerous *Diaptomus*	0	3	46	24	0	15
Cyclops	420	354	483	418	329	401
Ovigerous *Cyclops*	0	5	25	12	0	8
Harpaticus	1	8	7	4	0	4
Napulii	114	294	953	1,385	227	594
Total copepods:	657	1,372	3,512	5,602	1,049	2,438
Cladocerans:						
Bosmina	26	224	1,759	1,566	354	786
Ovigerous *Bosmina*	9	141	492	125	0	153
Daphnia longiremis	37	36	242	769	2,843	785
Ovigerous *Daphnia longiremis*	7	14	102	261	0	77
Chydorinae		8	20	19	13	15
Total cladocerans:	79	422	2,615	2,739	3,210	1,813
Total Copepods + Cladocerans	735	1,794	6,127	8,341	4,259	4,251
Rotifers:						
Kellicottia	672	3,703	1,967	398	38	1,356
Asplanchna	9	0	56	0	38	21
Keratella	2,052	815	112	0	0	596
Conochilus	106	2,296	3,035	114	0	1,110
other rotifers	389	6,110	15,174	22,179	0	8,770
Total Rotifers:	3,228	12,924	20,344	22,691	76	11,853

[a] Only station two sampled.

APPENDIX E:
BIOMASS ESTIMATES OF THE MAJOR ZOOPLANKTON SPECIES, BY SAMPLE DATE, FROM CHIGNIK LAKE, 2003

Appendix E1.-Biomass estimates (mg dry weight/m^3) of the major zooplankton species, by sample date, from Chignik Lake, 2003.

Taxon	Sample Date 5/26	6/25	7/25	8/16	9/13[a]	Average	Weighted Average
Copepods:							
Epischura	0.06	0.22	0.52	1.04	0.06	0.38	0.36
Ovigerous *Epischura*	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diaptomus	0.15	1.08	2.19	3.27	0.15	1.37	1.26
Ovigerous *Diaptomus*	0.00	0.02	0.15	0.12	0.00	0.06	0.94
Cyclops	0.51	0.74	0.43	0.30	0.06	0.41	0.39
Ovigerous *Cyclops*	0.00	0.02	0.10	0.05	0.00	0.03	0.54
Harpaticus	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Total copepods:	0.72	2.08	3.40	4.77	0.27	2.24	2.55
Cladocerans:							
Bosmina	0.03	0.21	1.73	1.78	0.11	0.77	0.74
Ovigerous *Bosmina*	0.02	0.26	0.74	0.20	0.00	0.24	0.53
Daphnia longiremis	0.04	0.04	0.26	0.97	0.79	0.42	0.69
Ovigerous *Daphnia longiremis*	0.02	0.04	0.29	0.69	0.00	0.21	0.47
Chydorinae	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total cladocerans:	0.11	0.55	3.03	3.64	0.90	1.65	2.43
Copepods to cladocerans	6.65	3.77	1.12	1.31	0.30	1.36	1.05
Total Copepods + Cladocerans	0.82	2.63	6.42	8.41	1.17	3.89	4.98

[a] Only station two sampled.

APPENDIX F:
BEACH SEINE CATCH DATA, 2003

Appendix F1.-Beach seine catch data, 2003.

Location	Site	Date	Water temp (°C)	Total sockeye catch	Coho	King	Stickleback	Pond smelt	Dolly Varden	Other
Chignik Lake	1	6/3	6.0	1	2	0	0	0	1	1 sculpin
	1	6/19	8.5	4	1	0	0	0	1	1 sculpin
	1	7/11	11.0	0	0	0	1	0	1	1 sculpin
	1	8/1	n/a	2	2	3	0	0	6	0
	1	8/14	13.0	0	16	0	4	13	1	0
Chignik Lake	2	6/3	6.5	1	4	0	0	0	11	0
	2	6/19	9.5	0	2	0	1	0	7	0
	2	7/11	10.0	0	3	0	0	0	1	1 isopod
	2	8/1	n/a	0	1	0	0	0	0	0
	2	8/14	12.5	6	17	0	1	7	12	0
Chignik Lake	3	6/3	5.5	0	0	0	0	0	0	0
	3	6/19	8.0	0	0	0	0	0	0	0
	3	7/11	10.0	16	3	2	0	0	2	0
	3	8/1	n/a	0	0	0	0	0	0	0
	3	8/14	13.0	0	1	0	0	1	10	0
Chignik Lake	5	6/3	8.0	1	9	0	2	0	2	1 sculpin
	5	6/19	10.0	10	4	0	3	1	2	4 sculpin
	5	7/11	12.0	18	100	0	0	2	44	0
	5	8/1	n/a	0	0	0	0	2	1	0
	5	8/14	13.5	0	14	0	3	27	5	7-sculpin
Chignik Lake	6	6/3	7.5	1	3	0	0	0	1	0
	6	6/19	9.0	4	0	0	1	0	2	0
	6	7/11	11.0	2	1	0	0	0	0	4 sculpin
	6	8/1	n/a	0	0	0	1	0	0	0
	6	8/14	13.5	0	2	0	1	9	0	1 flounder

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Appendix F1.-Page 2 of 4.

Location	Site	Date	Water temp (°C)	Total sockeye catch	Coho	King	Stickleback	Pond smelt	Dolly Varden	Other
Chignik Lake	7	6/3	7.0	2	3	0	0	0	0	0
	7	6/19	9.0	0	2	0	1	0	4	1 sculpin
	7	7/11	12.0	0	0	0	0	0	0	0
	7	8/1	n/a	21	24	4	304	16	43	0
	7	8/14	13.0	19	33	1	2	4	16	0
Chignik Lake	8	6/3	7.0	6	6	0	0	0	9	0
	8	6/19	9.0	19	19	2	39	0	6	0
	8	7/11	12.0	101	101	0	100	0	6	0
	8	8/1	11.5	13	13	3	0	14	20	0
	8	8/14	13.0	71	71	0	9	13	6	0
Chignik River	1	6/2	12.0	327	16	2	70	12	23	1 sculpin
	1	6/18	9.0	794	32	4	83	35	6	2 sculpin
	1	7/10	13.0	849	9	1	150	100	8	1 chum
	1	7/31	12.0	88	1	1	46	24	0	0
	1	8/14	12.5	226	30	0	61	55	2	8 sculpin
Chignik River	2	6/2	12.0	151	13	6	162	1	1	4 flounder, 1 sculpin
	2	6/18	8.5	234	14	17	409	2	2	4 flounder, 1 sculpin
	2	7/10	15.0	217	5	3	131	3	6	1 flounder, 4 sculpin
	2	7/31	12.0	420	24	10	195	70	3	1 sculpin, 1 flounder
	2	8/14	12.5	80	25	0	155	5	2	1 chum
Chignik River	3	6/2	12.0	250	31	7	450	1	17	0
	3	6/18	12.0	900	125	0	700	0	0	4 flounder
	3	7/10	14.0	10	15	0	2	0	2	0
	3	7/31	13.0	50	33	10	539	0	0	8 flounder
	3	8/14	12.0	5	33	0	0	0	0	0

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Appendix F1.-Page 3 of 4.

Location	Site	Date	Water temp (°C)	Total sockeye catch	Coho	King	Stickleback	Pond smelt	Dolly Varden	Other
Lagoon	1	5/30	11.0	20	2	1	28	0	0	1 humpy
	1	6/17	9.0	174	7	0	4	1	0	0
	1	7/9	14.0	208	16	0	9	32	5	0
	1	7/30	9.5	59	1	0	0	0	0	0
	1	8/13	12.5	17	15	0	0	4	9	0
Lagoon	2	5/30	7.0	20	0	0	2	0	1	0
	2	6/17	9.0	2	0	0	1	0	0	1 transparent fish
	2	7/9	14.5	20	2	0	0	1	1	0
	2	7/30	13.0	0	2	0	4	14	0	2 crescent gunnels
	2	8/13	13.5	0	0	0	0	0	0	5-crescent gunnels
Lagoon	3	5/30	9.5	0	5	0	0	0	33	0
	3	6/17	9.5	3	2	0	0	0	19	1 crescent gunnel
	3	7/9	15.0	35	0	0	3	0	1	2 sculpin
	3	7/30	13.0	7	0	0	12	0	14	0
	3	8/13	14.0	0	0	0	0	0	0	0
Lagoon	4	5/30	10.0	6	0	0	0	0	0	14 flounder, 1 candlefish
	4	6/17	9.5	9	0	0	0	0	1	0
	4	7/9	14.5	69	4	0	1	2	2	6 sculpin, 13 flounder
	4	7/30	10.5	0	1	1	0	2	27	0
	4	8/13	13.0	0	0	0	0	7	4	2 sculpin

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Appendix F1.-Page 4 of 4.

Location	Site	Date	Water temp (°C)	Total sockeye catch	Coho	King	Stickleback	Pond smelt	Dolly Varden	Other
Black Lake	1	5/28	11.5	13	9	0	15	0	0	0
	1	6/21	10.5	43	0	0	11	0	0	0
	1	7/12	12.0	1	6	0	1	32	0	0
	1	8/2	n/a	0	197	0	19	127	1	0
	1	8/18	14.5	2	4	0	32	2	0	1 sculpin
Black Lake	2	5/28	12.0	67	9	0	5	1	0	0
	2	6/21	10.5	0	0	0	0	0	0	0
	2	7/12	13.5	2	0	0	0	33	0	0
	2	8/2	n/a	2	1	0	4	12	0	0
	2	8/18	14.5	0	0	0	2	24	0	2 scupin
Black Lake	4	5/28	12.0	13	0	0	0	1	0	0
	4	6/21	10.5	0	0	0	0	0	0	0
	4	7/12	13.5	0	0	0	0	33	0	0
	4	8/2	n/a	0	3	0	8	35	0	0
	4	8/18	15	1	0	0	6	6	0	0
Black Lake	5	5/28	12.5	0	0	0	1	0	0	0
	5	6/21	10.0	0	4	0	14	0	0	0
	5	6/21	13.0	11	80	0	17	0	0	0
	5	8/2	n/a	0	9	0	81	0	0	0
	5	8/18	14.5	0	22	0	150	0	0	0

APPENDIX G:
TOWNET CATCH DATA, 2003

Appendix G1.-Townet catch data, 2003.

Location	Transect	Date	Time start	Time stop	Tow duration (hrs)	Boat Speed (mph)	Depth (m)	Water temp (C)	Total sockeye catch	Coho	King	Stickleback	Pond smelt	Dolly Varden
Chignik Lake	1 TO 2	6/30	12:54	13:04	0.17	4.8	0	11.5	0	0	0	0	0	0
		6/30	15:48	15:58	0.17	4.4	10	11.0	3	0	0	0	0	0
		7/22	13:06	13:16	0.17	3.5	0	13.0	1	0	0	0	0	0
Chignik Lake	2 TO 3	6/30	13:17	13:27	0.17	4.5	0	11.0	0	0	0	0	0	0
		6/30	15:09	15:19	0.17	3.8	10	12.0	1	0	0	0	0	0
		7/22	13:31	13:41	0.17	4.2	0	12.0	0	0	0	0	0	0
Chignik Lake	3 TO 4	6/30	13:36	13:47	0.18	4.5	0	11.0	4	0	0	0	0	0
		6/30	14:24	14:34	0.17	3.8	10	11.0	0	0	0	0	0	0
		7/22	14:57	15:07	0.17	4.9	0	12.0	0	0	0	0	0	1
		7/22	15:34	15:44	0.17	3.9	10	10.0	299	0	0	1	41	0
Black Lake	FRI tows[a]	7/12	14:50	15:00	0.17	2.7	0	13.0	0	3	0	0	1000	0

[a] Black Lake FRI tows begin approximately 0.5km west of Hydro Point.

APPENDIX H:
FYKE NET CATCH DATA FROM BLACK RIVER, 2003

Appendix H1.-Fyke net catch data from Black River, 2003.

Date	Time		Total	Temp °C		Sockeye catch	Other Catch				
pulled	Set	Pulled	time (hrs)	Water	Air	total	Coho	Chinook	Stickleback	Dolly	Other
6/14	11:16	14:37	1.4	11.5	17.0	0	0	3	6	0	0
7/8	14:50[a]	11:04	20.9	16	15	2	12	0	20	12	8 sculpin
8/9	15:00[b]	12:50	15.8	21.5	22.5	0	123	0	155	1	166 pond smelt

[a] Fyke net set on July 7, 2003.

[b] Fyke net set on August 8, 2003.