CHIGNIK WATERSHED ECOLOGICAL ASSESSMENT PROJECT SEASON REPORT, 2001

By

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ABSTRACT

The Chignik watershed maintains the largest sockeye salmon *Oncorhynchus nerka* fishery on the south side of the Alaska Peninsula. The sockeye salmon escapement goals have not been reassessed since the 1960s. Morphological changes to Black Lake, which maintains an escapement goal range of 350,000 to 400,000 sockeye salmon, have prompted concern for the health and sustainability of future sockeye salmon runs. This study seeks to provide sufficient information on the rearing habits and migratory trends of juvenile Chignik sockeye salmon to reassess the current escapement goals for the Chignik watershed concurrent with present ecological conditions and fishery production levels. This report documents results from the second year of a three-year study. Juvenile sockeye salmon did not overwinter in substantial numbers in Black Lake the winter of 2000-2001. Chignik River and lagoon were important rearing areas for juvenile sockeye salmon in 2001. Both Black and Chignik Lakes were rich in nutrients in 2001 but the zooplankton biomass was less than half that measured in 2000 and species compositions indicated high grazing pressure by planktivorous fishes. Insects and amphipods, however, were important prey items for juvenile sockeye salmon.

INTRODUCTION

The Chignik watershed supports the largest sockeye salmon *Oncorhynchus nerka* fishery on the south side of the Alaska Peninsula (Owen et al. 2000). This fishery drives the Chignik area economy. Weak returns, intermittent throughout the last 30 years (Pappas et al. 2001), have prompted investigations of the watershed concerning the health and ecology of the system and its ability to support and sustain future salmon returns. This study seeks to provide additional insight into the dynamic relationships among the Chignik ecosystem and its juvenile sockeye salmon.

Two lakes, two major rivers, a lagoon, and various small creeks compose the Chignik watershed (Figures 1 through 4). Black Lake, at the head of the system, is an atypical sockeye salmon nursery lake; its surface area is large (41.1 km^2), yet it is shallow (mean depth 1.9 m, maximum depth 4.2 m; Ruggerone et al. 1993), and semi-turbid, depending on wind conditions (Figure 2). Chignik Lake is a more typical sockeye salmon lake in that it has a relatively large surface area (24.1 km^2) but it is also deep (mean depth of 26 m). Black River connects the two lakes (Figure 3). 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 during June and July (escapement goal range of 350,000 to 400,000 sockeye salmon), spawns in Black Lake and its tributaries. The smaller late run (escapement goal range of 200,000 to 250,000 sockeye salmon), 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 (Figure 4). The lagoon is shallow, grassy and is composed of silty and cobbled beaches.

It has been noted that Black Lake has been progressively getting shallower and is approximately half the depth measured in the 1950s (Ruggerone et al. 1999). It has been suggested that a hydrostatic dam, created by a delta that once stood at the confluence of the West Fork and Black rivers, was lost when the confluence of the two rivers moved two to three miles downstream approximately 40 years ago; the movement of the confluence allowed the Black River to increase its velocity and entrench a deeper channel, which drains Black Lake at a quicker rate (Buffington 2001).

A spit has formed across Black Lake which begins approximately 1.5 km north of the Fan Creek outlet and extends across roughly two-thirds of the lake's width. The Alec River, Black Lake's main tributary, used to drain primarily to Alec Bay (on the northern side of the spit), but now partially drains through Fan Creek (on the southern side of the spit; Figure 2). Turbidity in Black Lake is high due to frequent strong winds and the shallow nature of the lake. Ruggerone et al. (1999) suggested that the reduced water volume of Black Lake has compromised effective sockeye salmon rearing habitat. Parr (1972) and Narver (1966) documented the downstream movement of juvenile sockeye salmon from Black Lake to Chignik Lake prior to winter and cited density dependent limitations as the reason for the migration. Narver (1966) suggested that the carrying capacities of both Chignik and Black Lakes were density dependent. Similar studies in other sockeye salmon habitats have indicated that significant density dependent responses occurred within juvenile sockeye salmon populations when their abundance was increased (Kyle et al. 1988; Schindler 1992; Schmidt et al. 1995; Koenings and Kyle 1997; Milovskaya et al. 1998).

Phinney (1968) indicated that migratory movement of juvenile sockeye salmon from Chignik Lake to Chignik Lagoon might also occur. Lagoon growth in juveniles is, at times, quite visible when examining scales from returning sockeye salmon adults (Patricia Nelson, Alaska Dept. of Fish and Game, Kodiak, personal communication). Recent data (Finkle and Bouwens 2001) indicate that juvenile sockeye salmon maintained a dynamic presence in the lagoon throughout the summer months of 2000. Rice et al. (1994) observed that underyearling (age 0.) sockeye salmon could migrate from limited lake-rearing habitats and survive in marine conditions; this could occur in the Chignik watershed if rearing limitations exist in Chignik or Black Lakes. Conversely, Iverson (1966) claimed sockeye salmon fry moved upstream in the Chignik River, suggesting fry may have traveled from the lagoon and Chignik River to over-winter in Chignik Lake. However, this observation has not been documented since the 1960s. Ultimately the nursery role of Chignik Lagoon is still poorly understood, yet the lagoon cannot be dismissed as an alternate nursery for juvenile sockeye salmon.

Chinook salmon *O. tshawytscha*, coho salmon *O. kisutch*, pink salmon *O. gorbuscha*, chum salmon *O. keta*, Dolly Varden *Salvelinus malma*, threespine stickleback *Gasterosteus aculeatus*, ninespine stickleback *Pungitius pungitius*, pond smelt *Hypomesus olidus*, starry flounder *Platyichthys stellatus*, Alaska Blackfish *Dallia pectoralis*, and coastrange sculpin *Cottus aleuticus* are also present throughout the Chignik system (Narver 1966; Parr 1972). Despite such a variety of other species, Parr (1972) downplayed interspecific competition as a limiting factor to sockeye salmon production, citing that divergent food 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 a significant predator-prey relationship with sockeye salmon fry in Chignik Lake.

Definitive ecological assessments of the Chignik watershed have not been performed since the sockeye salmon escapement goals were initially estimated in the 1960s (Narver 1966; Dahlberg 1968; Phinney 1968; Burgner et al. 1969). Because Black Lake is shallower than when the current escapement goals were established, it is necessary to reestablish benchmarks of water quality, primary production and secondary production if the system's ecology is to be understood.

Physical parameters (solar illuminance, temperature, and dissolved oxygen) greatly affect nutrient cycling in lakes (Schlesinger 1991). Sunlight provides the energy that drives photosynthesis, and therefore primary production. Phosphorous (P) and nitrogen (N) are prerequisites for photosynthesis; their concentrations in an aquatic ecosystem can assess the potential for primary production within the system. Chlorophyll *a* levels also are indicators of primary production levels.

The availability of phytoplankton as forage for zooplankton is crucial to the continuity and progression of a lacustrine food chain; zooplankton density and species composition can be regulated from the bottom-up by phytoplankton (and nutrient) availability (Stockner and MacIsaac 1996). Kyle (1992) has suggested that top-down pressures (such as grazing by juvenile sockeye salmon) influenced zooplankton abundance, individual size, and species composition in the Chignik watershed. Other forage available to juvenile sockeye salmon may moderate the influence of top-down pressures on macrozooplankton in the Chignik watershed. Benthic macroinvertebrates have been cited as a significant food source for rearing juvenile sockeye salmon in littoral zones and shallow lakes such as Black Lake (Parr 1972; Honnold et al. 1999). Digestive tract content analysis of juvenile sockeye salmon paired with zooplankton and water quality data would indicate preferred forage, and possibly, resource limitations in the watershed.

Because of the morphologically distinct areas within the Chignik watershed, it is likely that temporal and spatial patterns of habitat use by sockeye salmon exist within and between each of the two sockeye salmon stocks (Narver 1966). Digestive tract content analysis, zooplankton, and water quality data may explain some aspects of juvenile sockeye salmon rearing behavior. To fully understand the ecological interactions within the Chignik watershed, however, individual sockeye salmon must be able to be traced back to their stock-of-origin.

Historically, the majority of the returning adult early run (Black Lake) sockeye salmon spend one winter in the fresh water (age 1.), and the majority of late run (Chignik Lake) sockeye salmon spend two winters in fresh water (age 2.; Bouwens and Edwards 2001). In general, Black Lake fish are able to achieve sufficient growth in one year to emigrate from the watershed while Chignik Lake fish require two seasons to reach threshold size (Bouwens and Edwards 2001). Unfortunately, the disparity in freshwater age between the stocks is not large enough to use as an indicator of stock-of-origin. Scale Pattern Analysis (SPA), which is based on differential freshwater growth as recorded on scales collected from adult fish of known origin, has been used successfully to separate the returning adult Chignik stocks (Bouwens et al. 2001). It is not possible, however, to collect known juvenile Chignik Lake fish to establish a standard for age 0. and age 1. juvenile sockeye salmon as they may be fish that have originally emigrated from Black Lake and continued to rear in Chignik Lake. Therefore, SPA is not currently feasible for juvenile sockeye salmon stock separation in the Chignik watershed. Genetic analysis is a possible means of stock separation, although it is costly and time consuming. Length frequency analysis was used unsuccessfully to estimate the stock-of-origin of rearing sockeye salmon within the Chignik system. In some years (1994-1996), the length distributions of emigrating smolt have shown distinct bimodal distributions by age (Stopha and Barrett 1994; Vania and Swanton 1996; Kaplan and Swanton 1997), while other years (1998-2000) were unimodal (Perez-Fuentetaja et al. 1999; Bouwens et al. 2000; Bouwens and Edwards 2001). The length frequency model relies heavily on assumptions of different growth between stocks, and it does not provide a means of separating two stocks during years of unimodal distribution, thus making it an inadequate method of stock separation for the Chignik system.

Although stock separation does not seem feasible at this time, this study will attempt to define the migratory patterns and habitat use by juvenile sockeye salmon throughout the Chignik watershed. The collection of limnology, zooplankton, digestive tract content, and juvenile sockeye salmon age and abundance data will ideally provide sufficient information on the water quality, nutrient levels, zooplankton abundance and species composition, forage preference and availability, and juvenile sockeye salmon distribution, abundance, and condition. This will establish a platform from which to reassess the current escapement goals for the Chignik watershed relative to the present ecological conditions and fishery production levels.

METHODS

Limnology

In early May 2001, four zooplankton and two limnology sampling stations were established on Chignik Lake; zooplankton stations 2 and 4 coincided with the limnology sampling stations (Figure 3). One station was set on Black Lake in mid May (Figure 2). Each station's location was logged on a global positioning system (GPS) and marked with a buoy (Appendix A). Sampling was conducted following protocols established by Bouwens et al. (2001). Limnology sampling occurred once every three weeks, beginning in May and ending in August (Table 1).

Temperature, Dissolved Oxygen, and Light

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). 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 (1 m depth) and the hypolimnion (29 m depth) of Chignik Lake stations 2 and 4. Because of the shallow nature of Black Lake, water samples were collected from the epilimnion only. 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 assessed on refrigerated water samples using a Corning™ Student pH meter. The pH meter was rinsed with deionized water and calibrated against a factory standard before each use. All laboratory analyses followed the methods of Koenings et al. (1987) and Thomsen et al. (2002).

Filtered and unfiltered (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, chlorophyll *a* and phaeophytin *a*.

Zooplankton

Two vertical zooplankton tows were made at each zooplankton station, once every three weeks, with a 0.2 m diameter, 153 micron net (Table 1). Additional weekly zooplankton tows were made at stations 2 and 4 as the weather allowed. 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. Subsamples of zooplankton were keyed to family or genus and counted on a Sedgewick-Rafter counting slide under 10X magnification. 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; Thomsen et al. 2002). 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

Chignik Lagoon, Chignik River, Chignik Lake, and Black Lake were routinely sampled every three weeks with a beach seine (Table 2; Figures 2 through 4). A 3 mm mesh, 10 m long, 1 m deep seine was used. On July 10, the lagoon beach seine samples from sites three and four were collected in conjunction with the University of Washington, Fisheries Research Institute (FRI) staff, using their gear and following their protocol (Ruggerone et al. 1999).

One beach seine set was made per site, unless the net deployed poorly and required an additional attempt. Either 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, depending on weather conditions. The net was set similarly between sampling events to standardize effort.

Fyke Net

A fyke net with 3.05 m x 1.22 m wings, a 1.22 m x 1.22 m opening and a 3.66 m body with 6.4 mm mesh was used to sample the Black and Chignik rivers. Fyke netting began on the Chignik River on July 17, 2001 after the removal of the smolt screw traps on July 13, 2001 (Table 3; Bouwens and Edwards 2001). The net was staked 100 m below the Chignik River weir. Sets were made weekly and checked every one to three hours depending on the catch rate.

There were three fyke net sites on the Black River. However, the Black River proved more difficult to sample with the fyke net as strong currents and debris often fouled, and sometimes displaced the net; the sampling of Site 2 (Finkle and Bouwens 2001) was discontinued for this reason. Fyke net sampling ran from May 14 until June 14, 2001 in the Black River and from July 17 until August 15, 2001 in the Chignik River (Table 3; Figures 2 and 4).

Townet

Paired tows were made on Chignik Lake approximately once per month (Table 4). Sampling occurred during daylight hours. Tows lasted 10 minutes. Transects ran between the established water sampling sites. 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 of the tows 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 opening was 1.82 m x 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 FRI staff, using FRI gear, following Narver's (1966) protocol. No tows were attempted in Chignik Lagoon in 2001 as it proved too shallow for effectively sampling using ADF&G gear during the 2000 sampling season.

Distribution, Abundance, and Size

Fish collected with the beach seine, fyke net and townet were identified and enumerated. Species abundance of large catches (>500 fish) was estimated to prevent sample 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. (2001), were collected from the first 20 juvenile sockeye salmon. If present in the catch, length measurements only were taken from the second 20 juvenile sockeye salmon. In addition to the regular AWL sample (if present in the catch) an additional five sockeye salmon under 45 mm were sampled as fry for AWL data per collection event. 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 slide. Weight was measured to the nearest 0.1 g, and fork length (FL) was measured to the nearest 1 mm. Condition factor (Bagenal and Tesch 1978) was calculated. All juvenile sockeye salmon scales were aged on a microfiche reader under 36X or 60X magnification and recorded in European notation (Koo 1962).

Digestive Tract Contents

A subsample of up to five juvenile sockeye salmon from each AWL sample group was stored frozen for digestive tract content analysis. Digestive tracts were removed, weighed and inspected according to the protocol described by Bouwens et al. (2001). Digestive tract contents were sorted and the identifiable organisms were tallied into the following categories: copepods, cladocerans, insects, amphipods, and “other”.

Dry weights were calculated for the zooplankton groups assuming the dominant species and size for a given group in the zooplankton samples of a given area represented all the prey items from that group. Dry weights for the copepods and cladocerans were calculated using regression equations as described in Thomsen et al. (2002). A 3 mm long chironomidae larvae was assumed to represent the average insect prey and a 3 mm *Gammarus* was assumed to represent the average amphipod prey and equations from Elliot (1972) were used to calculate the dry weights of these groups. Most of the identifiable gut contents were classified into the above categories, so it was unnecessary to estimate the weights of the “other” category.

RESULTS

Limnology

Temperature and Dissolved Oxygen

Chignik Lake. A thermocline was not present in Chignik Lake in May through August 2001. Temperatures at 1 m depth ranged from 6.7 °C in May to 12.1 °C in August (Table 5). Both temperature and dissolved oxygen (DO) levels remained relatively homogenous over depth. The 1 m depth DO level at was at its maximum at 9.4 mg/L in May (Table 6; Figure 5).

Black Lake. In Black Lake, the temperature at 1 m depth in early June was 11.3 °C, increasing to 13.8 °C in late June and decreasing to 13.6 °C in late July (Table 7). DO levels at 1 m depth varied from 6.1 mg/L in early June to 9.3 mg/L in late June to 7.9 mg/L in July (Table 8; Figure 6).

Light Penetration and Water Transparency

Chignik Lake. Average monthly solar illuminance data for Chignik Lake are listed in Table 9. Chignik Lake had a calculated mean EZD of 15.52 m (Table 10; Figure 7). The euphotic volume (EV) averaged 374.0 x 10^6 m^3 in Chignik Lake for the 2001 season (Table 10). Secchi disk readings for Chignik Lake averaged 2.73 m.

Black Lake. Light penetrated the entire water column of Black Lake throughout the 2001 sampling season (Table 11; Figure 7). For June and July, the calculated EZD was deeper than the average depth of the lake (Table 10). Therefore, the mean depth of the lake, not the actual EZD, was used to calculate the EV of 78.1 x 10^6 m^3. Secchi disk readings for Black Lake averaged 1.5 m.

Available Nutrients

Chignik Lake. Nutrient data for Chignik Lake are listed in Tables 12 and 13. The mean pH of Chignik Lake was 7.50 and alkalinity averaged 25 mg/L $CaCO_3$. TP averaged 28 µg/L P; TFP was 12 µg/L P and the mean FRP was 8 µg/L P. The Chignik Lake mean TKN concentration was 77.0 ug/L N. The mean ammonia concentration of Chignik Lake was 10.3 µg/L N while the nitrate + nitrite level was 192 ug/L N. The mean chlorophyll *a* concentration was 4.74 µg/L and the mean phaeophytin *a* concentration was 1.30 µg/L (Tables 12 and 13).

Black Lake. Nutrient data for Black Lake are listed in Tables 12 and 14. The mean pH of Black Lake was 7.53 and alkalinity averaged 33 mg/L $CaCO_3$. TP averaged 35 µg/L P, TFP averaged 10 µg/L P, and FRP was 7 µg/L P. The mean ammonia in Black Lake it was 3.0 µg/L N and the nitrate + nitrite level was 5 ug/L N. The Black Lake mean chlorophyll *a* level was 4.26 µg/L and the phaeophytin *a* concentration was 11.94 µg/L (Tables 12 and 14).

Zooplankton

Chignik Lake. In Chignik Lake, from May through the beginning of June, copepods were the most abundant zooplankton taxa, but by mid-July, the cladoceran abundance surpassed the copepod abundance, in part due to *Chydorinae* blooms (Figure 8). The principal copepods were *Cyclops* (18,533/m^2) and *Diaptomus* (7,079/m^2), and the cladocerans were mainly comprised of *Bosmina* (16,042/m^2) and C*hydorinae* (19,305/m^2; Table 15; Figure 8; Appendix B).

The biomass of Chignik Lake zooplankton generally increased over the summer, beginning with 30.91 mg/m^2 in May and ending with 558.30 mg/m^2 in August, averaging 183.07 mg/m^2 (Table 16). Copepods biomass was relatively constant from May through mid July, fluctuating from about 22 to 55 mg/m^2. In late July, copepod biomass increased substantially and reached a seasonal high of 262 mg/m^2 on August 2. Cladoceran biomass showed a similar trend, with the biomass generally increasing in July and August. There were fewer cladocerans in the early part of the year than copepods, but they became the larger component of the total biomass in August (Table 16; Figure 9; Appendix C).

The mean sizes of the cladocerans *Bosmina* (0.32 mm), *Daphnia* (0.67 mm) and *Chydorinae* (0.12 mm) were relatively smaller than their copepod counterparts of *Cyclops* (0.80 mm), *Diaptomus* (0.84 mm), and *Epischura* (0.76 mm; Table 17) in Chignik Lake.

Black Lake. Black Lake zooplankton exhibited trends similar to those of Chignik Lake. *Cyclops* (mean: 3,654/m^2) and *Epischura* (mean: 1,327/m^2) were the most abundant copepods, and *Bosmina* (mean: 12,889/m^2) and *Chydorinae* (mean: 263,048/m^2) were the most abundant cladocerans (Table 18). Excluding the May 10 *Chydorinae* abundance estimate, Black Lake copepods, like Chignik Lake copepods, were relatively more abundant than cladocerans until June 30 when the cladoceran abundance became greater than copepod abundance (Table 18; Figure 10; Appendix D).

The biomass of Black Lake zooplankton decreased in early June then increased again over the summer, beginning with 14.12 mg/m^2 in May, decreasing to 2.56 mg/m^2 in early June, then increasing to 49.78 mg/m^2 in late July, averaging 12.98 mg/m^2 (Table 19; Figure 11). Copepods biomass fluctuated from May through late July in response to *Diaptomus* and *Cyclops* blooms. Cladoceran biomass showed a similar trend, with the biomass generally increasing in late June and July. Copepods were generally the larger component of the total biomass in May and early June, and cladocerans were a larger portion of the total biomass in late June and July (Table 19; Figure 11; Appendix E).

The mean sizes of the major zooplankton species in Black Lake varied during the sampling season; *Bosmina* averaged 0.24 mm, *Chydorinae* measured 0.17 mm, *Cyclops* measured 0.56 mm and *Epischura* were 0.53 mm on average (Table 20).

Juvenile Sockeye Salmon Data

Of the 15,654 juvenile sockeye salmon caught by all gear types, in all locations, 46.7% were estimated to be age 0., 48.0% were estimated to be age 1., 5.1% were estimated to be age 2., and 0.1% were estimated to be age 3. sockeye salmon (Table 21).

Black Lake/River

Black Lake beach seine catches were highest in the May with an average catch rate of 75 sockeye salmon caught per haul, decreasing to 11 sockeye salmon per haul in July. The majority of juvenile sockeye salmon caught during May and June beach seine events from Black Lake were less than 45 mm in length. In July, when the catch per haul was greatly decreased, the vast majority of juvenile sockeye salmon over 45 mm in length were caught (Table 22; Appendix F).

One townet haul was performed in Black Lake in conjunction with the Fisheries Research Institute. The July trawl yielded a catch rate of 7,059 juvenile sockeye salmon per hour, all of which were over 45 mm in length (Table 23; Appendix G).

Of the two beach seine sets performed on the Black River in June, 74 juvenile sockeye salmon were caught per haul, which was almost equal to the 75 sockeye salmon caught per haul in Black Lake during May (Table 22; Appendix F).

Black River sockeye salmon were sampled during May and June with a fyke net. Catches averaged 5 sockeye salmon per hour in May; 1 sockeye salmon juvenile was caught per hour in June. All of the juvenile sockeye salmon captured with the fyke net in Black River were greater than 45 mm in length (Table 24; Appendix H).

Almost all of the Black Lake sockeye salmon catches were age 0. Only one fish was captured that was age 1. (Table 25). The majority of the Black Lake fish sampled for age were captured with a beach seine, as only one tow was performed over the course of the summer. A fyke net and a beach seine were used to sample the Black River. All of the sockeye salmon captured during May and June in the Black River were age 0. (Tables 21 and 25).

The mean length of beach seine caught age 0. sockeye salmon in Black Lake increased from 35.5 mm in May to 51.8 mm in July. Condition factors increased slightly from May to July. In general, larger fish were caught in the fyke net and townet than in the beach seine (Table 26; Figure 12).

Chignik Lake

Chignik Lake beach seine catches generally decreased over the summer from a high catch rate of 209 sockeye salmon per haul in May. The majority of juvenile sockeye salmon captured in Chignik Lake were over 45 mm (Table 22; Appendix F).

Townet catches generally increased through the summer in Chignik Lake, beginning at 25 sockeye salmon per hour towed in May, decreasing in June to 12 sockeye per hour, and increasing to 1,377 sockeye per hour in July, and then dropping to 1,306 sockeye salmon per hour towed in August (Table 23; Appendix G). The overwhelming majority of juvenile sockeye salmon captured by townet were over 45 mm in length.

Approximately 27.5% of the juvenile sockeye salmon captured during the season in Chignik Lake were age 0., 66.4% were age 1., and 6.0% were age 2. (Tables 21 and 27; Figure 13). The percentage of age 0. sockeye salmon caught by townet in Chignik Lake was low in May and increased over the summer (Table 27; Figure 13). The age 0. component of Chignik Lake beach seine catches steadily increased from May to July then declined in August. The percentage of age 1. sockeye salmon increased between July and August for beach seine catches; at the same time, the proportion of age 1. fish captured by townet remained constant at about 50% (Table 27; Figure 13). Few age 2. fish were captured in Chignik Lake with either gear type.

In Chignik Lake early in the season there were two distinct length groups of juvenile sockeye salmon. As the summer progressed, the smaller group got larger while the larger modal length decreased. The mean length of age 0. sockeye salmon increased over the summer, while the lengths of the older ages remained relatively constant or decreased with time. Generally, condition factors increased both with time and with age. Fish caught in the townet had higher condition factors, on average, than fish caught with the beach seine (Table 28; Figure 14 and 15).

Chignik River

Beach seine catches in Chignik River increased from an average of 274 sockeye salmon per haul in June to 494 in July and then decreased to 219 in August. The overwhelming majority of juvenile sockeye salmon caught in Chignik River were over 45 mm in length (Table 22; Appendix F).

Monthly fyke net catches in Chignik River fell from a rate of 21 sockeye salmon per hour in July to 9 sockeye salmon per hour in August (Table 24; Appendix H). The majority of juvenile sockeye salmon caught with the fyke net in Chignik River were under 45 mm in length.

The Chignik River yielded 64.5% age 0. and 35.5% age 1. sockeye salmon for all gear types combined (Tables 21 and 29; Figure 16). The majority of the juvenile sockeye salmon catch was captured with a beach seine. The proportion of age 0. sockeye salmon captured by beach seine was 43.6% in June, 65.1% in July and 74.3% in August. Beach seine catches of age 1. fish showed an inverse pattern, with the majority of the catch being age 1. in the spring and fewer age 1. sockeye salmon captured in the fall (Table 29; Figure 16). Fyke net catches in the Chignik River were mostly age 1. sockeye salmon in July (53.1%) and changed to 72.7% age 0. fish in August (Table 29; Figure 16).

The modal length of juvenile sockeye salmon caught in the Chignik River decreased from 60 mm in June to 45-50 mm in August. After June, the mean lengths of both age 0. and age 1. sockeye salmon captured in the Chignik River remained relatively constant or decreased slightly, although the mean weight and condition factors of those fish decreased. In July, the mean lengths of the fish, by age, caught in the fyke net were smaller than the lengths of the fish caught with the beach seine; in August, the pattern was inverse with the fyke net catching larger fish (Table 30; Figures 17 and 18).

Chignik Lagoon

Chignik Lagoon beach seine catches peaked in August with 307 sockeye salmon per haul, up from the June and July rates of 93 and 79 juvenile sockeye salmon per haul. The May catch rate in the lagoon was 218 sockeye salmon per haul, and the majority were under 45 mm in length. Juvenile sockeye salmon under 45 mm in length comprised smaller portions of the catches during June, July, and August (Table 22; Appendix F).

Larger proportions of age 0. (64.1%) juvenile sockeye salmon where caught in the lagoon than age 1. (30.2%); the remainder of the catch was 5.3% age 2. fish and a very small amount were age 3. (0.3%; Tables 21 and 31; Figure 19). As with Black Lake, a beach seine was the only effective means of sampling in the lagoon because of its shallow and grassy nature. The percentage of age 0. sockeye salmon decreased from 61.6% in May to 25.0% of the beach seine catch in June, increasing to 61.5% in July, and up again to 93.5% of the juvenile sockeye salmon caught by beach seine in August. The proportion of age 1. sockeye salmon peaked at 54.2% in June, then dropped to 6.5% in August. Age 2. sockeye salmon catches showed a similar pattern, although the percentages were lower; 19.4% of the lagoon catches for June were age 2., dropping to 2.9% in July (Table 31; Figure 19).

The size distribution of juvenile sockeye salmon caught in Chignik Lagoon varied with time. In May, a small group of sockeye salmon was about 35 mm in length. The majority of the sockeye salmon ranged from about 45 to 85 mm in length, centered at about 60 mm. In June, the smaller fish were still present, but the distribution of the larger group widened, ranging to about 100 mm in length, although the modal length only increased slightly to about 66 mm. In July, the distributions of the two groups came together, and although fish were captured ranging from 40 mm to 103 mm in length, the mode of the distribution dropped to about 48 mm. In August, the larger fish were not caught, and the fish ranged from about 40 mm to 73 mm in length, with the majority centering on about 46 mm. In general, condition factors increased over the summer and the older fish were relatively heavier than the younger fish (Table 32; Figures 20 and 21).

Digestive Tract Contents

A total of 322 juvenile sockeye salmon were sampled for digestive tract content analysis. Although the number of prey items of each group varied widely within and between groups, of the average identifiable prey items, copepods were the most frequently consumed (56.5 organisms/fish), followed by cladocerans (16.1 organisms/fish), then insects (9.0 organisms/fish) and amphipods (3.4 organisms/fish; Table 33; Figure 22). When adjusted for prey size, however, insects accounted for the majority of the biomass in the digestive tracts of the fish captured in

Black Lake, Chignik Lake, and Chignik River, while amphipods and insects were most prevalent in the fish caught in the lagoon (Table 34; Figure 23).

DISCUSSION

Habitat Usage

Black Lake

Juvenile sockeye salmon did not overwinter in significant numbers in Black Lake during the winters of 1999-2000 and 2000-2001. In two years' sampling in Black Lake and Black River, only one age 1. sockeye salmon was caught in either of these locations; the remainder were young of the year. Reduced winter habitat has been speculated as a possible side effect of the shallowing of Black Lake (Ruggerone 1999). Using baited minnow traps, Ruggerone (1999) caught very few juvenile sockeye salmon through the ice in Black Lake in the winters of 1993, 1995, 1996, and 1997, while he did catch sockeye salmon through the ice in Chignik Lake. At least during the winter of 2000-2001, it is unlikely that winterkill was the reason for the lack of age 1. juveniles in Black Lake in the spring because that winter was very mild, and ice did not cover Black Lake for a significant portion of the winter (Edwards and Bouwens 2001). Juvenile sockeye salmon probably would not have died due to adverse winter conditions (low DO) over that winter.

There is a large amount of evidence that suggests that juvenile sockeye salmon move out of Black Lake mid-summer. Ruggerone (1994) documented fry movement down Black River for most of the summer, with the majority of the fish moving down in July. Our data suggest similar trends, with catches decreasing in Black Lake (beach seine) while catches increased (townet) in Chignik Lake in July (Tables 22 and 23). In May, the age 0. sockeye salmon in Black Lake were larger and had higher condition factors than those caught from the rest of the watershed. By June, however, the age 0. fry in Chignik Lake, river, and lagoon were all longer and heavier than those caught in Black Lake at the same time. It is possible that the larger fry moved out of Black Lake and down the system and the smaller fry remained in Black Lake. It is also possible that the larger fry remained in Black Lake, but moved out of the nearshore area where they were susceptible to being captured by a beach seine. In July, the age 0. sockeye salmon caught in Black Lake by beach seine were about 3-4 mm shorter, on average, than those caught in a townet (Table 26).

Ruggerone (1994) noticed a correlation between sockeye salmon movement down Black River and high flows in Black River. Similar patterns of movement have been documented in smolts emigrating from Bear Lake, further south on the Alaska Peninsula (Bouwens 2001 and 2002). Water temperatures in Black Lake may initiate the emigration to Chignik Lake. Ruggerone (1994) reported water temperatures in July (when most fish moved down to Chignik Lake) of about 15 °C. In 2000, water temperatures were cooler in Black Lake in July (~11 °C; Finkle and Bouwens 2001) and in 2001 temperatures in July were about 13 °C (Table 7). These temperatures, although warm for the Chignik watershed, were well within the physiologically acceptable ranges for juvenile sockeye salmon identified by LeBrasseur et al. (1978). There is a relationship between DO and water temperature; warmer water holds less oxygen than cold water. Although wind mixing likely keeps Black Lake well oxygenated most of the time, it is possible that DO levels may drop in the summer during warm, calm periods.

Chignik River

Large numbers of age 0. juvenile sockeye salmon have been captured in the Chignik River as part of this project and as part of the smolt project operated annually at Chignik (Stopha and Barrett 1994; Vania and Swanton 1996; Kaplan and Swanton 1997; Perez-Fuentetaja et al. 1999; Bouwens et al. 2000; Bouwens and Edwards 2001). This is unusual, because sockeye salmon generally rear in lakes. Iverson (1966) cited the Chignik River as an important rearing habitat for both the progeny of the river spawners and, more importantly, from fish that spawned in Chignik Lake. He also claimed sockeye salmon fry moved upstream in the Chignik River, suggesting fry in the river may have traveled from the lagoon or lower river to over-winter in Chignik Lake. This has not been documented again since the 1960s. It is not known if the river is a preferred habitat for sockeye salmon, or if fish are being displaced from more typical pelagic habitats to the river because of overcrowding. Iverson (1966) noticed, and data from this project confirm, that juvenile sockeye salmon caught lower in the watershed are larger at any given time than those caught higher in the watershed. Because movement patterns of juvenile sockeye salmon within the watershed are not well documented, it is not known where these fish obtained their growth; big fish may move downstream or fish grow faster downstream.

Chignik Lagoon

Chignik Lagoon is likely a key component to the high sockeye salmon production from the Chignik watershed. The lagoon is important as an area for post-smolt to obtain additional growth before moving to the open ocean (Phinney 1968). This is supported by the relatively high marine survivals Chignik smolt experience, especially considering their small size (Bouwens and Edwards 2001).

A wide size range of juvenile sockeye salmon were captured in Chignik Lagoon (Figure 20) indicating that it is more than an area for post-smolt cap growth. A number of very small age 0. sockeye salmon were caught in the upper lagoon; some of which still had remains of yolk material attached. Iverson (1966) suggested that fry from sockeye salmon that spawned in Chignik River reared directly in the lagoon. There were also numerous juvenile sockeye salmon caught in the lagoon that were larger than emergent fry (river spawners?) but smaller that the smolt caught in the smolt trap. The external morphological characteristics of these fish were also between a rearing fry and an emigrating smolt. Juvenile sockeye salmon of this size were also caught in the Chignik River, and these fish were likely ones that have moved down from higher in the watershed.

Forage Base

Typically in a sockeye salmon system, nutrients and energy are transferred from elemental nutrients and sunlight to phytoplankton and then to zooplankton and then to sockeye salmon. Many factors including zooplankton abundance, biomass, size, and species composition influence zooplankton availability as sockeye salmon prey. The prey have to be relatively large (over about 0.40 mm in length) because sockeye salmon are sight feeders and they need to be able to visually locate their prey (Kyle 1992). Also, different types of zooplankton transfer nutrients and energy up the food chain differently; large cladocerans are much more efficient than smaller cladocerans, rotifers, and copepods (Mazumder and Edmundson 2002). Furthermore, cladocerans are generally more desirable prey than copepods because they are less motile and easier to catch. Generally, large sized cladocerans, specifically *Daphnia*, are the preferred prey of juvenile sockeye salmon.

There was heavy grazing pressure on the forage base in both Chignik and Black Lakes in 2001. The zooplankton total abundance in both Black and Chignik lakes in 2001 was less than half that observed in 2000. In terms of biomass, the drop was even more precipitous, with the total biomass in 2001 being about 1/3 that observed in 2000. The main reason for the disparity between abundance and biomass was that the average size of most zooplanktors was smaller in 2001 and the species composition switched towards smaller-sized zooplankton. The zooplankton in biomass and abundance was lower in 2000 compared to data collected in previous years (Kyle 1992; Ruggerone et al. 1999). *Daphnia* and other large cladocerans were nearly absent in both lakes in 2001. Small sized cladocerans, copepods, and rotifers, were abundant. Elemental nutrient and phytoplankton levels were relatively high, however, indicating top-down pressure on the zooplankton population. High grazing pressure on zooplankton prevents the efficient transfer of nutrients and energy from phytoplankton to sockeye salmon. High grazing pressure can also influence the species composition and average size of the zooplankton towards smaller prey (Mazumder and Edmundson 2002).

There may be a “safety valve” in the Chignik watershed concerning sockeye salmon feeding. Juvenile sockeye salmon have been known to feed on aquatic insects, especially in shallow lakes (Burgner 1991). Parr (1972) documented insects as important prey items for juvenile sockeye salmon in Black Lake. Our data indicate that insects are also important prey for juvenile sockeye in Chignik Lake and Chignik River. Gammarid amphipods were important prey for juvenile sockeye salmon residing in Chignik Lagoon. It is unknown whether insects and amphipods were selected over more typical zooplankton prey in the Chignik watershed or if they were being eaten because the zooplankton forage base was poor.

Future Direction

Data from the 2002 field season will be combined with the data from the first two field seasons’ data to attempt to clarify some of the questions that still exist concerning the patterns of habitat use by juvenile sockeye salmon. Specifically, stable isotope data are currently being analyzed and they may be able to provide additional insight into the feeding habits of juvenile sockeye salmon. These data, paired with forage availability data, may further define habitat selection by sockeye salmon.

Work is also being done to investigate the relationships between sockeye salmon body weight and length indices and physiological condition as defined by whole body energy content. This information will also be valuable in understanding the ecology of sockeye salmon within the Chignik watershed.

Information from this study will be combined with existing information and ecological models to estimate the current recommended carrying capacity of juvenile sockeye salmon in the watershed. These estimates will be used to review the current Chignik River escapement goals.

LITERATURE CITED

Bagenal, T.B., and F.W. Tesch. 1978. Age and growth. pp. 101-136 in: T. Bagenal, editor. Methods for assessment of fish production in fresh waters. IBP Handbook No. 3, third edition. Blackwell Scientific Publications. London.

Burgner. R.L. 1991. Life history of sockeye salmon (*Oncorhynchus nerka*). *in* C. Groot and L. Margolis, editors: Pacific salmon life histories. UBC Press. Vancouver, Canada.

Burgner, R.L., C. J. DiCostanzo, R.J. Ellis, G.Y. Harry, Jr., W.L. Hartman, O.E. Kerns, Jr., O.A. Mathisen, and W.F. Royce. 1969. Biological studies and estimates of optimum escapements of sockeye salmon in the major river systems in southwestern Alaska. U. S. Fish Wildl. Serv., Fish. Bull. 67(2): 405-459.

Bouwens, K.A. 2001. Bear Lake sockeye salmon smolt enumeration project season report, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Information Report No. 4K01-34.

Bouwens, K.A. 2002. Bear Lake sockeye salmon smolt enumeration project season report, 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Information Report No. 4K01-34.

Bouwens, K.A. and I.J. Edwards. 2001. Sockeye salmon smolt investigations on the Chignik River system, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K01-3.

Bouwens, K.A., G.E. Pappas, M.J. Daigneault and H. Finkle. 2001. Chignik operational plans, 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K01-29.

Bouwens, K.A., A. Pérez-Fuentetaja and I.J. Edwards. 2000. Sockeye salmon smolt investigations on the Chignik River System, 1999. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Information Report No. 4K00-35.

Buffington, J.M. 2001. Geomorphic Reconnaissance of the Black Lake Area, Alaska Peninsula (Draft). University of Idaho. Boise.

Dahlberg, M.L. 1968. Analysis of the dynamics of sockeye salmon returns to the Chignik Lakes, Alaska. Ph. D. Thesis. University of Washington. Seattle. 338 p.

Edmundson, J.A., L.E. White, S.G. Honnold and G.B. Kyle. 1994. Assessments of sockeye salmon production in Akalura Lake. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report No. 5J94-17.

LITERATURE CITED (Cont.)

Edwards, I.J. and K.A. Bouwens. 2002. Sockeye salmon smolt investigations on the Chignik River watershed, 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K02-1.

Elliot, J. M. 1972. Rates of gastric evacuation in brown trout Salmo trutta L.. Freshwater Biology. Vol. 2, pp 1-18.

Finkle, H. and K.A. Bouwens. 2001. Chignik Lakes ecological assessment. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K01-51.

Honnold, S.G., J.A. Edmundson, and S. Schrof. 1996. Limnological and fishery assessment of 23 Alaska Peninsula and Aleutian area lakes, 1993-1995: an evaluation of potential sockeye and coho salmon production. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report No. 4K96-52.

Honnold, S.G., K.A. Bouwens, J.N. McCullough, and S.T. Schrof. 1999. Results of biological assessment and monitoring of anadromous fish ant Summer Bay Lake, Unalaska Island, Alaska, 1998: Juvenile and adult fish production the summer following the M/V Kuroshima oil spill. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K99-62.

INPFC (International North Pacific Fisheries Commission). 1963. Annual Report 1961. Vancouver, British Columbia.

Iverson, R.H. 1966. Biology of juvenile sockeye salmon resident in Chignik River, Alaska. M.S. thesis. Oregon State University. Corvallis. 72 pp.

Kaplan, D.F. and C.O. Swanton. 1997. Chignik Lakes sockeye smolt abundance, age composition, and size characteristics, 1996. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information report No. 4K97-28.

Koenings, J.P., J.A. Edmundson, G.B. Kyle, J.M. Edmundson, and R.B. Burkett. 1987. Limnology field and laboratory manual: Methods for assessing aquatic production. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement, and Development, No. 71. Juneau.

Koenings, J.P., and G.B. Kyle. 1997. Consequences to juvenile sockeye salmon and the zooplankton community resulting from intense predation. Alaska Fisheries Research Bulletin 4(2):120-135.

LITERATURE CITED (Cont.)

Koo, T.S.Y. 1962. Age designation in salmon. Univ. Washington Publ. in Fish., New Ser. 1 (2): 37-48.

Kyle, G.B. 1992. Assessment of lacustrine productivity relative to juvenile sockeye salmon (*Oncorhynchus nerka)* production in Chignik and Black Lakes: Results from 1991 surveys. Alaska Department of Fish and Game, FRED Division Report 119.

Kyle, G.B., J.P. Koenings and B.M. Barrett. 1988. Density-dependent, trophic level responses to an introduced run of sockeye salmon (*Oncorhynchus nerka)* at Frazer Lake, Kodiak Island, Alaska. Can. J. Fish. Aquat. Sci. 45:856-867.

LeBrasseur, R.J., C.D. McAllister, W.E. Barraclough, O.D. Kennedy, J. Manzer, D. Robinson,and K. Stephens. 1978. Enhancement of sockeye salmon (*Onchorynchus nerka*) by lake fertilization in Great Central Lake: summary report. J. Fish Res. Board Can. 35:1580-1596.

Mazumder, A. and J.A. Edmundson. 2002. Impact of fertilization and stocking on trophic interactions and growth of juvenile sockeye salmon (*Oncorhynchus nerka*). Can. J. Fish. Aquat. Sci. 59:1361-1373.

Milovskaya, L.V., M.M. Selifonov, and S.A. Sinyakov. 1998. Ecological functioning of Lake Kuril relative to sockeye salmon production. N. Pac. Anadr. Fish Comm. Bull. No. 1: 434-442.

Narver, D.W. 1966. Pelagial ecology and carrying capacity of sockeye in the Chignik Lakes, Alaska. Ph.D. Thesis. Univ. of Washington, Seattle. 348 p.

Owen, D.L., D.R. Sarafin, G.E. Pappas, and R.T. Baer. 2000. Chignik management area annual finfish management report, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K00-41.

Pappas, G.E., R.T. Baer and M.A. LaCroix. 2001. Chignik management area annual finfish management report, 1999. Alaska department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K01-49.

Parr, W.H., Jr. 1972. Interactions between sockeye salmon and resident lake fish in the Chignik Lakes, Alaska. M. Sc. thesis. Univ. of Washington, Seattle. 103 p.

Perez-Fuentetaja, A., D.F. Kaplan and T. Doubt. 1999. Sockeye salmon smolt emigration studies. Chignik lakes system, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K99-26.

Phinney, D.E., 1968. Distribution, abundance, and growth of postsmolt sockeye salmon in Chignik Lagoon, Alaska. M. Sc. thesis. Univ. of Washington, Seattle. 159 p.

LITERATURE CITED (Cont.)

Rice, S.D., R.E. Thomas, and A. Moles. 1994. Physiological and growth differences in three stocks of underyearling sockeye salmon (*Oncorhynchus nerka*) on early entry into seawater. Can. J. Fish. Aquat. Sci. 51:974-980.

Ruggerone, G.T. 1989. Coho salmon predation on juvenile sockeye salmon in the Chignik Lakes, Alaska. Ph.D. Thesis. University of Washington, Seattle.

Ruggerone, G.T., C. Harvey, J. Bumgarner, and D.E. Rogers. 1993. Investigations of salmon populations, hydrology, and limnology of the Chignik Lakes, Alaska, during 1992. Report for Chignik Regional Aquaculture Association. Univ. of Washington, School of Fisheries, Fish. Res. Inst. FRI-UW-9302.

Ruggerone, G.T. 1999. Winter investigations of salmon in the Chignik Lakes, Alaska, during 1998. Natural Resources Consultants, Inc. Seattle Wa.

Ruggerone, G.T., R. Steen and R. Hilborn. 1999. Chignik Lakes Research: Investigations of salmon populations, hydrology, and limnology of the Chignik Lakes, Alaska. Univ. of Washington School of Fisheries, Fish. Res. Inst. FRI-UW-9907.

Schindler, D.E. 1992. Nutrient regeneration of sockeye salmon (*Oncorhynchus nerka*) fry and subsequent effects on zooplankton and phytoplankton. Can. J. Fish. Aquat. Sci. 49:2498-2506.

Schlesinger, W.H. 1991. Biogeochemistry: an analysis of global change. San Diego. Academic Press, Inc.

Schmidt, D.C., K.E. Tarbox, G.B. Kyle and S.R. Carlson. 1995. Sockeye salmon overescapement: 1993 annual report on Kenai River and Kodiak investigations. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report No. 5J95-15.

Stockner, J.G. and E.A. MacIssac. 1996. British Colombia lake enrichment programme: Two decades of habitat enhancement for sockeye salmon. Regulated Rivers: Research and Management, Vol. 12, 547-561.

Stopha, M.E. and B.M. Barrett. 1994. Sockeye smolt and presmolt abundance, age composition, and condition, and the use of the parasite *Philomena oncorhynchi* as an inseason stock separation estimator for returning adult sockeye salmon, Chignik Lakes, 1994. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report No. 4K94-36.

Templin, W., L. Seeb, P. Crane, and J. Seeb. 1999. Genetic analysis of sockeye salmon populations from the Chignik watershed. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 5J99-08.

Thomsen, S., S. Honnold, S. Schrof, and K. Spalinger. 2002. Kodiak Island Lake Assessment/Limnology Project Laboratory Analysis Operational Plan, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional information Report No. 4K02-36.

Vania, T.D. and C.O. Swanton. 1996. Chignik Lakes sockeye smolt abundance, Age composition, and size characteristics, 1995. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report No. 4K96-22.

Table 1. Limnology and zooplankton sampling dates, 2001.

Lake	Date	Type of sampling
Black Lake	10-May	zooplankton
	30-May	zooplankton
	6-Jun	water and zooplankton
	20-Jun	zooplankton
	30-Jun	water and zooplankton
	21-Jul	water and zooplankton
Chignik Lake	16-May	water and zooplankton
	7-Jun	water and zooplankton
	13-Jun	zooplankton
	21-Jun	zooplankton
	28-Jun	water and zooplankton
	13-Jul	zooplankton
	20-Jul	water and zooplankton
	27-Jul	water and zooplankton
	2-Aug	zooplankton
	10-Aug	water and zooplankton
	17-Aug	zooplankton

Table 2. Dates of beach seine samples, by area and site, 2001.

Area	Site[a]	Date	Area	Site[a]	Date	Area	Site[a]	Date
Black Lake	1	15-May	Chignik Lake	5	11-May	Chignik Lagoon	1	2-Jul
	1	30-May		5	2-Jun		1	25-Jul
	1	14-Jun		5	21-Jun		1	6-Aug
	1	11-Jul		5	16-Jul			
				5	5-Aug	Chignik Lagoon	2	18-May
Black Lake	2	15-May					2	5-Jun
	2	30-May	Chignik Lake	6	11-May		2	18-Jun
	2	15-Jun		6	21-Jun		2	2-Jul
				6	16-Jul		2	26-Jul
Black Lake	3	15-Jun		6	5-Aug			
						Chignik Lagoon	3	5-Jun
Black Lake	4	15-Jun	Chignik Lake	7	11-May		3	19-Jun
	4	30-May		7	2-Jun		3	10-Jul
	4	15-Jun		7	21-Jun		3	30-Jul
				7	16-Jul			
Black Lake	5	15-May		7	5-Aug	Chignik Lagoon	4	18-May
	5	30-May					4	5-Jun
	5	14-Jun	Chignik Lake	8	11-May		4	18-Jun
	5	11-Jul		8	2-Jun		4	2-Jul
				8	21-Jun		4	10-Jul
Black Lake	7	20-Jun		8	16-Jul		4	25-Jul
	7	11-Jul		8	5-Aug		4	6-Aug
Black River	2	20-Jun	Chignik River	1	27-Jun			
				1	25-Jul			
Black River	3	20-Jun		1	2-Aug			
				1	9-Aug			
Chignik Lake	1	11-May		1	15-Aug			
	1	2-Jun						
	1	21-Jun	Chignik River	2	27-Jun			
	1	16-Jul		2	25-Jul			
	1	7-Aug		2	2-Aug			
				2	9-Aug			
Chignik Lake	2	11-May		2	15-Aug			
	2	2-Jun						
	2	21-Jun	Chignik River	3	28-Jun			
	2	16-Jul		3	25-Jul			
	2	7-Aug		3	2-Aug			
				3	9-Aug			
Chignik Lake	3	11-May		3	15-Aug			
	3	2-Jun						
	3	21-Jun	Chignik Lagoon	1	18-May			
	3	16-Jul		1	5-Jun			
	3	7-Aug		1	18-Jun			

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

Table 3. Dates of fyke net samples, by location, 2001.

Location	Date
Black River	14-May
	15-May
	29-May
	14-Jun
Chignik River	17-Jul
	26-Jul
	1-Aug
	6-Aug
	15-Aug

Table 4. Dates of townet samples by transect and location, 2001.

Location	Transect	Site
Black Lake	Hydro Point	3-Jul
Chignik Lake	1 TO 2	24-May
	1 TO 2	16-Jun
	1 TO 2	16-Jun
	1 TO 2	23-Jul
	1 TO 2	23-Jul
	1 TO 2	13-Aug
Chignik Lake	2 TO 3	24-May
	2 TO 3	24-May
	2 TO 3	16-Jun
	2 TO 3	23-Jul
	2 TO 3	23-Jul
	2 TO 3	13-Aug
Chignik Lake	3 TO 4	24-May
	3 TO 4	24-May
	3 TO 4	16-Jun
	3 TO 4	23-Jul
	3 TO 4	23-Jul
	3 TO 4	14-Aug
Chignik Lake	FRI Tow in Clark Bay	9-Jul
	FRI Tow at Delta	9-Jul

Table 5. Water temperature (^{o}C) , averaged over all stations, by depth and date, for Chignik Lake, 2001.

	Date				
Depth (m)	16-May	7-Jun	28-Jun	20-Jul	10-Aug
0.0	7.6	7.4	10.0	10.2	12.4
0.5	6.8	7.2	9.7	10.2	12.2
1.0	6.7	7.1	9.6	10.2	12.1
1.5	6.4	6.9	9.5	10.2	12.0
2.0	5.9	6.7	9.4	10.2	11.9
2.5	5.6	6.7	9.3	10.2	11.8
3.0	5.3	6.5	9.3	10.2	11.7
3.5	5.1	6.4	9.3	10.2	11.7
4.0	5.0	6.3	9.2	10.2	11.6
4.5	4.0	6.3	9.2	10.2	11.5
5.0	4.6	6.3	9.2	10.2	11.4
6.0	4.4	6.2	9.1	10.2	11.4
7.0	4.3	6.2	9.1	10.2	11.4
8.0	4.0	6.2	9.1	10.2	11.3
9.0	3.9	6.1	9.1	10.2	11.3
10.0	3.8	6.1	9.0	10.2	11.3
11.0	3.6	6.1	8.9	10.2	11.2
12.0	3.5	6.0	8.8	10.2	11.2
13.0	3.5	6.0	8.8	10.1	11.2
14.0	3.4	5.9	8.8	10.1	11.2
15.0	3.3	5.9	8.8	10.1	11.2
16.0	3.2	5.9	8.7	10.1	11.2
17.0	3.2	5.8	8.7	10.1	11.2
18.0	3.2	5.8	8.6	10.2	11.1
19.0	3.1	5.8	8.6	10.0	11.1
20.0	3.1	5.8	8.6	10.0	11.1
21.0	3.1	5.8	8.6	10.0	11.0
22.0	3.1	5.8	8.6	10.0	11.0
23.0	3.1	5.8	8.6	10.0	11.0
24.0	3.1	5.7	8.6	10.0	11.2
25.0	3.1	5.7	8.5	10.2	11.1
30.0	3.0	5.6	8.5	10.2	10.8
35.0	3.0	5.5	8.4	10.0	10.7

Table 6. Dissolved oxygen (mg/L) readings, averaged over all stations, by depth and date, for Chignik Lake, 2001.

	Date				
Depth (m)	16-May	7-Jun	28-Jun	20-Jul	10-Aug
0.0	8.8	7.8	6.7	9.0	8.0
0.5	9.4	7.9	6.7	9.0	8.2
1.0	9.4	8.0	6.7	9.0	8.2
1.5	9.4	8.1	6.7	9.0	8.1
2.0	9.5	8.1	6.7	8.9	8.1
2.5	9.4	8.2	6.7	8.9	8.0
3.0	9.6	8.0	6.7	9.0	8.0
3.5	9.8	8.1	6.7	9.0	7.9
4.0	9.7	8.1	6.7	8.9	7.9
4.5	9.7	8.1	6.7	9.0	7.9
5.0	9.6	8.0	6.7	8.9	8.0
6.0	9.8	8.0	6.7	8.9	7.9
7.0	9.7	8.0	6.6	8.9	7.8
8.0	9.8	7.9	6.7	8.9	7.9
9.0	9.9	7.9	6.6	8.9	7.8
10.0	9.9	7.8	6.6	8.9	7.8
11.0	9.8	7.8	6.6	8.9	7.8
12.0	9.8	7.8	6.6	8.9	7.9
13.0	9.8	7.8	6.6	8.9	7.9
14.0	9.8	7.8	6.5	8.9	7.8
15.0	9.8	7.8	6.6	8.9	7.8
16.0	9.7	7.8	6.6	8.8	7.8
17.0	9.5	7.7	6.5	8.9	7.8
18.0	9.7	7.8	6.5	8.8	7.7
19.0	9.7	7.7	6.5	8.8	7.7
20.0	9.6	7.7	6.5	8.9	7.7
21.0	9.6	7.7	6.5	8.9	7.8
22.0	9.6	7.7	6.5	8.9	7.8
23.0	9.7	7.7	6.5	8.8	7.7
24.0	9.8	7.7	6.5	8.9	7.7
25.0	9.9	7.7	6.5	8.9	7.7
30.0	10.1	7.8	6.4	8.9	7.8
35.0	10.1	7.7	6.4	8.8	7.7
40.0	10.5	7.7	6.4	8.8	7.7
45.0	10.4	7.7	6.2	8.5	7.2
50.0	10.2			8.9	

Table 7. Water temperature (^{o}C) of Black Lake, by date and depth, 2001.

Depth	Date		
	6-Jun	30-Jun	21-Jul
0.0	11.4	13.8	13.5
0.5	11.4	13.8	13.6
1.0	11.3	13.8	13.6
1.5	11.2	13.8	13.7
2.0	11.1	13.8	13.7
2.5	11.1	13.8	13.7
3.0			13.7

Table 8. Dissolved oxygen levels (mg/L) of Black Lake, by date and depth, 2001.

Depth	Date		
	6-Jun	30-Jun	21-Jul
0.0	6.1	9.3	8.1
0.5	6.1	9.3	8.1
1.0	6.1	9.3	7.9
1.5	6.2	9.3	8.1
2.0	6.1	9.3	7.8
2.5	6.2	9.3	7.7
3.0	6.2		7.8

Table 9. Average monthly solar illuminance (kLux) readings, by depth, for Chignik Lake, 2001. The 2000 seasonal average is included for comparison.

	2001					2000
Depth	May	June	July	August	Average	Average
0	1,059.8	1,773.4	2,757.7	1,606.5	1,799.3	2,473.4
0.5	670.8	1,032.0	1,565.5	944.8	1,053.3	1,768.3
1	443.3	790.2	1,127.9	573.5	733.7	1,214.3
1.5	375.8	674.7	952.1	453.4	614.0	710.5
2	283.5	508.9	788.5	317.7	474.7	523.8
2.5	264.5	377.7	588.7	238.6	367.4	365.9
3	250.0	312.4	482.1	191.2	308.9	252.8
3.5	242.4	274.4	434.8	131.5	270.8	183.6
4	172.1	228.3	366.3	99.9	216.6	127.3
4.5	138.2	181.3	291.5	75.4	171.6	91.5
5	95.3	150.4	243.5	73.5	140.7	73.4
6	61.7	105.5	171.0	55.0	98.3	36.8
7	42.4	70.2	110.2	45.0	66.9	21.5
8	25.2	45.9	71.9	40.9	46.0	11.5
9	13.9	32.9	48.6	39.1	33.6	6.2
10	7.6	22.5	32.6	36.1	24.7	3.8
11	4.5	16.6	21.6	4.3	11.7	2.3
12	2.8	12.8	14.9	4.0	8.6	1.5
13	1.9	10.3	10.3	3.8	6.5	1.0
14	1.2	8.7	7.4	3.7	5.2	0.7
15	0.9	7.6	5.4	3.6	4.3	0.6
16	0.6	6.8	4.2	3.4	3.8	0.8
17	0.4	6.3	3.2	3.4	3.3	0.7
18	0.3	5.9	2.6		2.9	0.4
19	0.2	5.7	2.3		2.7	0.4
20	0.1	5.5	1.9		2.5	0.4
21	0.2	5.0	1.8		2.3	0.3
22	0.1	5.6	1.9		2.5	0.3
23	0.0	5.5	1.9		2.5	0.2
24		5.0	1.8		3.4	
25		6.2	2.1		4.2	
30		2.1	2.1		2.1	
35		1.6	1.6		1.6	
40		1.5	1.5		1.5	
45		1.6	1.6		1.6	
50		1.5	1.5		1.5	

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

		2001					2000
Lake		May	June	July	August	Average[a]	Average[a]
Chignik	EZD	9.73	16.28	14.47	10.49	15.52	8.22
	Mean EV[c]	234.4	392.3	348.7	252.8	374.0	198.1
Black[b]	EZD	n/a	4.51	5.40	2.24	3.72	3.72
	Mean EV[c]	n/a	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 (kLux) readings, by depth, for Black Lake, 2001. The 2000 seasonal averages are included for comparison.

	2001			2000
Depth	June	July	Average	Average
0	1,598.0	1,171.5	1,384.8	1,998.3
0.5	1,843.0	902.5	1,372.8	1,059.7
1	1,280.0	454.6	867.3	619.3
1.5	688.6	165.9	427.3	309.4
2	493.9	68.2	281.1	166.7
2.5	380.5	31.5	206.0	90.7
3	337.0	17.7	177.4	56.3
3.5		10.7	10.7	24.0

Table 12. Seasonal mean general water quality parameters, nutrient concentrations, and photosynthetic pigments for Chignik Lake, by station, and Black Lake, 2001.

	Chignik Lake			Black Lake
Parameter	Station 2	Station 4	Mean	Mean
pH	7.50	7.50	7.50	7.53
Alkalinity (mg/L)	26	23	25	33
Total P (ug/L P)	26	30	28	35
TFP (ug/L P)	8	16	12	10
FRP (ug/L P)	8	9	8	7
TKN (ug/L N)	47.8	106.2	77.0	n/a
Ammonia (ug/L N)	11.0	9.5	10.3	3.3
Nitrate + Nitrite (ug/L N)	189	194	192	5
Chlorophyll a (ug/L)	5.20	4.27	4.74	4.26
Phaeophytin a (ug/L)	1.50	1.10	1.30	11.94

Table 13. Mean (over station) water quality parameters, nutrient concentrations, and photosynthetic pigments for Chignik Lake, by sample date, 2001. The 2000 seasonal averages are included for comparison.

	2001						2000
Parameter	16-May	7-Jun	28-Jun	20-Jul	10-Aug	Mean	Mean
pH	7.40	7.63	7.53	7.33	7.65	7.50	7.88
Alkalinity (mg/L)	31	27	21	24	25	25	14
Total P (ug/L P)	22	34	22	37	21	28	15
TFP (ug/L P)	9	16	13	8	14	12	6
FRP (ug/L P)	7	8	13	7	7	8	6
TKN (ug/L N)	77.0	n/a	n/a	n/a	n/a	77.0	n/a
Ammonia (ug/L N)	7	5	5	24	11	10	30
Nitrate + Nitrite (ug/L	200	195	195	202	167	192	182
Chlorophyll a (ug/L)	12.74	6.89	2.56	1.37	1.92	5.10	7.33
Phaeophytin a (ug/L)	1.69	1.31	1.03	2.07	0.55	1.33	1.06

Table 14. General water quality parameters, nutrient concentrations, and photosynthetic pigments for Black Lake, by sample date, 2001. The 2000 seasonal averages are included for comparison.

	2001					2000
Parameter	16-May	6-Jun	30-Jun	21-Jul	Mean	Mean
pH	7.20	7.70	7.60	7.60	7.53	7.43
Alkalinity (mg/L)	27	42	31	30	33	13
Total P (ug/L P)	43	29	27	42	35	57
TFP (ug/L P)	10	15	6	8	10	11
FRP (ug/L P)	7	6	12	4	7	4
TKN (ug/L N)	n/a	n/a	n/a	n/a	n/a	n/a
Ammonia (ug/L N)	6	2	4	1	3	37
Nitrate + Nitrite (ug/L N)	1	1	15	1	5	64
Chlorophyll a (ug/L)	2.56	6.73	7.69	0.04	4.26	18.06
Phaeophytin a (ug/L)	2.37	0.04	0.38	44.98	11.94	9.98

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

	2001												2000
	Sample Date											Seasonal	Seasonal
Taxon	5/16	6/7	6/13[a]	6/21[b]	6/28	7/13[b]	7/20	7/27[b]	8/2[b]	8/10	8/17[b]	Average	Average
Copepods:													
Epischura	510	8,901	14,862	7,431	31	5,706	4,313	4,910	531	46	0	4,294	23,013
Ovigerous *Epischura*	0	265	0	0	0	0	0	0	0	0	0	24	119
Diaptomus	0	2,930	0	3,450	577	531	8,404	19,639	26,805	1,337	14,199	7,079	7,793
Ovigerous *Diaptomus*	0	0	0	531	0	0	0	0	0	0	0	48	468
Cyclops	34,155	143	0	1,592	31,383	9,421	16,285	14,729	35,828	32,067	28,264	18,533	90,630
Ovigerous *Cyclops*	0	0	0	0	0	6,237	221	1,990	5,308	4,877	3,583	2,020	1,185
Harpaticus	0	0	0	0	0	531	1,106	531	0	0	398	233	107
Nauplii	7,343	1,603	4,246	1,194	2,827	3,981	14,464	8,891	6,900	1,276	18,843	6,506	23,670
Total copepods:	42,008	13,841	19,108	14,199	34,817	26,407	44,792	50,690	75,372	39,602	65,287	38,738	146,985
Cladocerans:													
Bosmina	5	133	0	1,592	2,884	8,227	15,739	15,260	31,051	32,924	43,524	16,042	33,031
Ovigerous *Bosmina*	0	0	0	0	0	398	5,529	2,389	6,900	5,520	5,573	2,492	8,637
Daphnia longiremis	265	0	0	531	0	1,194	885	1,194	1,858	0	4,246	680	4,964
Ovigerous *Daphnia longiremis*	0	0	0	0	0	0	221	0	265	0	0	48	590
Chydorinae	0	0	0	0	0	35,032	81,638	43,392	26,008	2,335	796	19,305	2,394
Total cladocerans:	270	133	0	2,123	2,884	44,851	104,012	62,235	66,083	40,779	54,140	38,567	49,616
Total Copepods + Cladocerans	42,278	13,974	19,108	16,322	37,701	71,258	148,804	112,925	141,454	80,381	119,427	77,306	196,601

-Continued-

Table 15. (page 2 of 2)

Taxon	2001												2000
	Sample Date											Seasonal	Seasonal
	5/16	6/7	6/13[a]	6/21[b]	6/28	7/13[b]	7/20	7/27[b]	8/2[b]	8/10	8/17[b]	Average	Average
Rotifers:													
Kellicottia	24,959	3,986	25,478	32,245	13,701	46,046	10,498	22,691	27,601	37,750	41,003	25,996	44,285
Asplanchna	2,355	9,304	54,140	2,521	1,689	0	2,912	26,407	32,113	1,347	11,146	13,085	10,787
Keratella	30,424	8,396	95,541	91,959	14,681	5,573	1,113	663	796	937	1,858	22,904	11,524
Conochilus	20,915	1,062	0	1,460	737	0	2,875	3,052	12,473	11,991	25,478	7,277	75,731
other rotifers	796	265	6,369	4,246	1,069	5,573	5,750	1,990	0	0	0	2,369	6,997
Total Rotifers:	79,449	23,013	181,529	132,431	31,878	57,192	23,148	54,804	72,983	52,025	79,485	71,631	149,324
Other:													
Ostracoda	2,123	0	0	0	0	0	0	0	0	0	0	193	119

[a]Only station two sampled.

[b]Only stations two and four sampled.

Table 16. Biomass estimates (mg dry weight/m^2) of the major zooplankton species in Chignik Lake by sample date, 2001. The 2000 season averages are included for comparison.

	2001													2000	
	Sample Date											Seasonal	Weighted	Seasonal	Weighted
Taxon	5/16	6/7	6/13[a]	6/21[b]	6/28	7/13[b]	7/20	7/27[b]	8/2[b]	8/10	8/17[b]	Average	Average	Average	Average
Copepods															
Epischura	0.34	16.15	42.86	26.10	0.03	10.65	11.99	20.30	0.80	0.09	0.00	11.75	13.57	24.34	23.56
Ovigerous *Epischura*	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.06	0.76	0.76
Diaptomus	0.00	5.49	0.00	2.78	0.77	2.22	2.45	56.89	104.35	10.81	88.35	24.92	13.85	39.41	37.64
Ovigerous *Diaptomus*	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.10	3.76	5.05
Cyclops	30.30	0.10	0.00	1.74	51.66	23.26	30.63	41.52	120.94	166.11	128.09	54.03	36.03	115.37	110.52
Ovigerous *Cyclops*	0.00	0.00	0.00	0.00	0.00	19.25	1.18	13.51	36.00	41.75	30.31	12.91	9.55	4.96	4.89
Harpaticus	0.00	0.00	0.00	0.00	0.00	0.00	1.34	0.62	0.00	0.00	0.48	0.22	0.29	0.07	0.07
Total Copepods:	30.64	22.19	42.86	31.35	52.46	55.38	47.58	132.84	262.09	218.75	247.22	103.94	73.44	188.67	182.50
Cladocerans															
Bosmina	0.00	0.09	0.00	1.80	2.65	10.08	18.53	13.08	25.41	34.32	37.14	13.01	5.21	37.81	37.63
Ovigerous *Bosmina*	0.00	0.00	0.00	0.00	0.00	2.37	7.12	2.56	8.56	7.78	7.67	3.28	1.43	13.75	13.70
Daphnia longiremis	0.27	0.00	0.00	0.81	0.00	2.99	1.55	0.89	5.56	0.00	18.19	2.75	3.60	6.35	6.33
Ovigerous *Daphnia longiremis*	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.75	0.00	0.00	0.08	0.10	1.33	1.32
Chydorinae	0.00	0.00	0.00	0.00	0.00	2.26	4.57	2.94	2.04	0.23	0.47	1.14	1.28	1.86	1.83
Total Cladocerans:	0.27	0.09	0.00	2.61	2.65	17.70	31.89	19.48	42.32	442.35	311.08	79.13	11.61	61.11	60.81
Total Biomass	30.91	22.29	42.86	33.95	55.11	73.07	79.48	152.32	304.40	661.10	558.30	183.07	85.05	249.79	243.31

[a]Only station two sampled.

[b]Only stations two and four sampled.

Table 17. Average length (mm) of zooplankton from Chignik Lake, by sample date, 2001. The 2000 seasonal averages are included for comparison.

	2001												2000
	Sample Date											Seasonal	Seasonal
Taxon	5/16	6/7	6/13[a]	6/21[b]	6/28	7/13[b]	7/20	7/27[b]	8/2[b]	8/10	8/17[b]	Average	Average
Copepods:													
Epischura	0.51	0.73	0.86	0.92	0.59	0.73	0.84	0.97	0.68	0.75		0.76	0.67
Ovigerous *Epischura*		0.72										0.72	1.13
Diaptomus		0.74		0.55	0.66	0.99	0.39	0.87	0.97	1.25	1.14	0.84	1.15
Ovigerous *Diaptomus*				0.67								0.67	1.39
Cyclops	0.52	0.47		0.57	0.69	0.84	0.74	0.89	0.97	1.19	1.11	0.80	0.64
Ovigerous *Cyclops*						0.93	1.20	1.35	1.34	1.50	1.49	1.30	1.10
Harpaticus							0.60	0.59			0.60	0.60	0.48
Nauplii	0.32	0.33	0.28	0.23	0.30	0.32	0.27	0.21	0.20	0.12	0.20	0.25	n/a
Cladocerans:													
Bosmina	0.28	0.28		0.35	0.32	0.37	0.36	0.31	0.30	0.34	0.31	0.32	0.39
Ovigerous *Bosmina*						0.78	0.38	0.34	0.37	0.39	0.39	0.44	0.44
Daphnia longiremis	0.50			0.60		0.76	0.64	0.43	0.82		0.97	0.67	0.55
Ovigerous *Daphnia longiremis*							0.39		0.80			0.60	0.70
Chydorinae						0.09	0.08	0.09	0.10	0.11	0.26	0.12	0.29

[a]Only station two sampled.

[b]Only stations two and four sampled.

Table 18. Average number of macrozooplankton per m^2 from Black Lake, by sample date, 2001. The 2000 seasonal averages are included for comparison.

	2001							2000
	Sample date						Seasonal	Seasonal
Taxon	5/10	5/30	6/6	6/20	6/30	7/21	Average	Average
Copepods:								
Epischura	3,185	1,062	1,592	2,123	0	0	1,327	3,925
Ovig *Epischura*	0	0	0	0	0	0	0	64
Diaptomus	0	2,123	0	0	0	1,592	619	1,788
Ovig. *Diaptomus*	0	0	0	0	0	0	0	0
Cyclops	0	4,246	0	0	14,490	3,185	3,654	17,699
Ovig. *Cyclops*	0	0	0	0	0	0	0	0
Harpaticus	0	0	0	0	0	1,592	265	0
Napulii	7,962	0	2,123	531	5,573	3,185	3,229	8,774
Total copepods	11146.497	7,431	3,715	2,654	20,064	9,554	9,094	32,250
Cladocerans:								
Bosmina	2,389	0	1,592	1,062	24,522	47,771	12,889	19,228
Ovig. *Bosmina*	0	0	0	0	1,115	13,535	2,442	5,223
Daphnia l.	0	0	0	0	1,115	0	186	434
Ovig. *Daphnia l.*	0	0	0	0	0	0	0	0
Chydorinae	1,533,439	1,062	0	0	0	43,790	263,048	5,816
Total cladocerans	1,535,828	1,062	1,592	1,062	26,752	105,096	278,565	30,701
Total copepods + cladocerans	1,558,121	15,924	9,023	6,369	66,879	124,204	296,753	95,201
Rotifers:								
Kellicottia	0	1,062	0	0	3,344	0	734	9,841
Asplanchna	0	0	0	0	179,459	0	29,910	60
Keratella	0	36,093	0	0	13,376	0	8,245	16,214
Conochilus	0	18,047	0	0	4,459	0	3,751	86,712
other rotifers	0	11,677	0	0	0	265	1,990	2,309
Total rotifers	0	66,879	0	0	200,637	265	44,630	115,136
Other:								
Ostracoda	21	0	0	0	0	5	4	30,732

Table 19. Biomass estimates (mg dry weight/m^2) of the major Black Lake zooplankton taxon by sample date, 2001. The 2000 season averages are included for comparison.

	2001								2000	
	Sample Date						Seasonal	Weighted	Seasonal	Weighted
Taxon	5/10	5/30	6/6	6/20	6/30	7/21	Average	Average	Average	Average
Copepods:										
Epischura	0.33	0.75	1.79	3.68	0.00	0.00	1.64	0.78	4.46	3.65
Diaptomus	0.00	11.05	0.00	0.00	0.00	2.06	2.18	1.93	4.39	4.43
Cyclops	0.00	5.22	0.00	0.00	20.85	1.72	4.63	4.56	16.78	16.05
Harpaticus	0.00	0.00	0.00	0.00	0.00	2.67	0.45	0.45	n/a	n/a
Total copepods	0.33	17.01	1.79	3.68	20.85	6.46	8.90	7.71	25.63	24.12
Cladocerans:										
Bosmina	0.53	0.00	0.78	0.00	20.32	25.93	0.33	7.90	18.66	16.43
Ovigerous *Bosmina*	0.00	0.00	0.00	0.00	1.03	14.53	0.00	2.59	7.40	6.74
Daphnia longiremis	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.12	0.24	0.23
Chydorinae	13.25	1.41	0.00	0.00	0.00	2.87	3.66	2.53	3.60	3.30
Total cladocerans	13.78	1.41	0.78	0.00	21.65	43.32	3.99	13.13	29.91	26.70
Total Biomass	14.12	18.42	2.56	3.68	42.49	49.78	12.89	20.85	55.54	50.82

Table 20. Average length (mm) of macrozooplankton in Black Lake by sample date, 2001. The 2000 seasonal averages are included for comparison.

	2001							2000
	Sample date						Seasonal	Seasonal
Taxon	5/10	5/30	6/6	6/20	6/30	7/21	Average	Average
Copepods:								
Epischura	0.27	0.52	0.61	0.72			0.53	0.62
Diaptomus		1.07				0.65	0.86	0.82
Cyclops		0.61			0.65	0.41	0.56	0.54
Harpaticus						0.70	0.70	n/a
Nauplii	0.25		0.22	0.41	0.29		0.29	n/a
Cladocerans:								
Bosmina	0.16		0.24		0.30	0.25	0.24	0.33
Ovigerous *Bosmina*				0.28	0.32	0.34	0.31	0.39
Daphnia l.					0.27		0.27	0.38
Chydorinae	0.04	0.38				0.09	0.17	0.27
Other:								
Ostracoda	0.09						0.09	n/a

Table 21. Total catch of juvenile sockeye salmon, by age and location, from the Chignik watershed, 2001.

Location	Total Sockeye Catch		Sample (> 45 mm)					Estimated age[a]				
	< 45 mm	> 45 mm	0.	1.	2.	3.	Total	0.	1.	2.	3.	Total
Black Lake/Black River	778	1,255	98.5%	1.5%	0.0%	0.0%	100.0%	99.9%	0.1%	0.0%	0.0%	100.0%
			65	1	0	0	66	2,032	2	0	0	2,034
Chignik Lake	142	5,519	22.3%	70.6%	7.1%	0.0%	100.0%	27.5%	66.4%	6.0%	0.0%	100.0%
			144	456	46	0	646	1,559	3,761	343	0	5,662
Chignik River	44	4,692	63.6%	36.4%	0.0%	0.0%	100.0%	64.5%	35.5%	0.0%	0.0%	100.0%
			204	117	0	0	321	3,055	1,681	0	0	4,736
Chignik Lagoon	1,192	2,032	34.7%	54.1%	10.5%	0.6%	100.0%	64.1%	30.2%	5.3%	0.3%	100.0%
			109	170	33	2	314	2,067	974	172	10	3,224
Entire watershed	2,156	13,498	38.2%	55.7%	5.9%	0.1%	100.0%	46.7%	48.0%	5.1%	0.1%	100.0%
			514	749	80	2	1,345	7,314	7,517	803	20	15,654

[a] Sampled age compositions are used to apportion the sockeye catches > 45 mm; all sockeye < 45 mm were assumed to be age 0.

Table 22. Total beach seine hauls, total catch, and catch per haul, by month, of juvenile sockeye salmon from Black Lake, Black River, Chignik Lake, Chignik River, and Chignik Lagoon, 2000 and 2001.

		2001							2000		
		Number of	Sockeye Catch			Sockeye Catch/Haul			Sockeye Catch/Haul		
Area	Month	Hauls	< 45 mm	> 45 mm	Total	< 45 mm	> 45 mm	Total	< 45 mm	> 45 mm	Total
Black Lake	May	6	446	1	447	74	0	75	n/a	n/a	n/a
	June	8	117	13	130	15	2	16	1	327	328
	July	3	1	33	34	0	11	11	9	50	59
	August	n/a	n/a	n/a	n/a	n/a	n/a	n/a	14	0	14
Black River	June	2	143	5	148	72	3	74	n/a	n/a	n/a
Chignik Lake	May	7	97	1,367	1,464	14	195	209	n/a	n/a	n/a
	June	13	6	1,219	1,225	0	94	94	1	3	4
	July	7	37	69	106	5	10	15	7	19	26
	August	7	1	153	154	0	22	22	9	0	9
Chignik River	May	n/a	n/a	n/a	n/a	n/a	n/a	n/a	198	0	198
	June	3	27	796	823	9	265	274	n/a	n/a	n/a
	July	3	6	1,477	1,483	2	492	494	331	32	363
	August	9	10	1,963	1,973	1	218	219	218	1	219
Chignik Lagoon	May	3	403	251	654	134	84	218	22	0	22
	June	8	176	569	745	22	71	93	38	1	39
	July	9	8	704	712	1	78	79	14	12	26
	August	2	105	508	613	53	254	307	138	0	138

Table 23. Total hours towed, total catch, and catch per hour, by month, of juvenile sockeye salmon from Black Lake and Chignik Lake, 2000 and 2001.

		2001							2000		
		Total	Sockeye Catch			Sockeye Catch / Hr towed			Sockeye Catch / Hr towed		
Area	Month	hours	< 45 mm	> 45 mm	Total	< 45 mm	> 45 mm	Total	< 45 mm	> 45 mm	Total
Black Lake	June	0.00	n/a	n/a	n/a	n/a	n/a	n/a	194	1,571	1,765
	July	0.17	0	1,200	1,200	0	7,059	7,059	0	588	588
Chignik Lake	May	0.68	0	17	17	0	25	25	0	0	0
	June	1.53	0	18	18	0	12	12	6	44	50
	July	1.39	3	1,911	1,914	2	1,375	1,377	23	72	95
	August	0.51	1	665	666	2	1,304	1,306	63	66	129

Table 24. Fyke net hours fished, total catch, and catch per hour, by month, of juvenile sockeye salmon from Chignik and Black rivers, 2000 and 2001.

		2001							2000		
		Total hours	Sockeye Catch			Catch/Hr.			Catch/Hr.		
Area	Month	fished	< 45 mm	> 45 mm	Total	< 45 mm	> 45 mm	Total	< 45 mm	> 45 mm	Total
Black River	May	12.98	0	67	67	0	5	5	12	1	13
	June	5.50	0	7	7	0	1	1	0	0	0
	July	0.00	n/a	n/a	n/a	n/a	n/a	n/a	77	0	77
Chignik River	July	12.25	255	1	256	21	0	21	0	15	15
	August	15.37	135	0	135	9	0	9	0	14	14
	September	0.00	n/a	n/a	n/a	n/a	n/a	n/a	0	56	56

Table 25. Total catch of juvenile sockeye salmon from Black Lake and Black River, by age and gear type, 2001.

			Total Sockeye Catch		Sample (> 45 mm)					Estimated age[a]				
Area	Gear Type	Month	< 45 mm	> 45 mm	0.	1.	2.	3.	Total	0.	1.	2.	3.	Total
Black Lake	Townet	July	0	1,200	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	1,200	0	0	0	1,200
Black Lake	Beach seine	May	446	1	0.0%	100.0%	0.0%	0.0%	100.0%	99.6%	0.4%	0.0%	0.0%	100.0%
					0	1	0	0	1	446	2	0	0	448
	Beach seine	June	117	13	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
					13	0	0	0	13	130	0	0	0	130
	Beach Seine	July	1	33	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
					25	0	0	0	25	34	0	0	0	34
Black Lake Total	All	All	564	1,247	98.3%	1.7%	0.0%	0.0%	100.0%	99.9%	0.1%	0.0%	0.0%	100.0%
					58	1	0	0	59	1,810	2	0	0	1,812
Black River	Beach Seine	June	142	6	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
					6	0	0	0	6	148	0	0	0	148
	Fyke	May	67	0	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
					0	0	0	0	0	67	0	0	0	67
	Fyke	June	5	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	7	0	0	0	7
	All	All	214	8	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
					7	0	0	0	7	222	0	0	0	222
Black Lake/River Total	All	All	778	1,255	98.5%	1.5%	0.0%	0.0%	100.0%	99.9%	0.1%	0.0%	0.0%	100.0%
					65	1	0	0	66	2,032	2	0	0	2,034

[a] Sampled age compositions are used to apportion the sockeye catches >45 mm; all sockeye <45 mm were assumed to be age 0.

Table 26. Mean length, weight, and condition factor, by age and gear type, of juvenile sockeye salmon captured in Black Lake and Black River, 2001.

			Sample	Length (mm)		Weight (g)		Condition factor	
Gear Type	Month	Age	size	Mean	Standard Dev.	Mean	Standard Dev.	Mean	Standard Dev.
Beach seine	May	0	15	35.5	2.99	0.46	0.17	0.99	0.29
	June	0	77	41.0	4.89	0.71	0.27	0.99	0.13
	July	0	28	51.8	5.75	1.63	0.54	1.13	0.13
Fyke net	May	0	5	32.8	2.28	0.34	0.05	0.98	0.24
	June	0	4	43.8	0.50	0.83	0.13	0.98	0.13
Tow	July	0	20	55.4	5.12	2.09	0.58	1.20	0.09

Table 27. Total catch of juvenile sockeye salmon from Chignik Lake, by age and gear type, 2001.

		Total Sockeye Catch		Sample (> 45 mm)					Estimated age[a]				
Gear Type	Month	< 45 mm	> 45 mm	0.	1.	2.	3.	Total	0.	1.	2.	3.	Total
Townet	May	0	28	3.6%	96.4%	0.0%	0.0%	100.0%	3.6%	96.4%	0.0%	0.0%	100.0%
				1	27	0	0	28	1	27	0	0	28
Townet	June	0	7	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%
				0	7	0	0	7	0	7	0	0	7
Townet	July	1	1,911	48.5%	50.8%	0.8%	0.0%	100.0%	48.5%	50.7%	0.8%	0.0%	100.0%
				63	66	1	0	130	927	970	15	0	1,912
Townet	August	1	665	48.8%	51.2%	0.0%	0.0%	100.0%	48.9%	51.1%	0.0%	0.0%	100.0%
				21	22	0	0	43	326	340	0	0	666
Townet Total	All	2	2,611	40.9%	58.7%	0.5%	0.0%	100.0%	48.0%	51.5%	0.6%	0.0%	100.0%
				85	122	1	0	208	1,254	1,344	15	0	2,613
Beach seine	May	97	1,367	0.0%	91.0%	9.0%	0.0%	100.0%	6.6%	85.0%	8.4%	0.0%	100.0%
				0	91	9	0	100	97	1,244	123	0	1,464
Beach seine	June	6	1,319	8.1%	77.3%	14.6%	0.0%	100.0%	8.5%	76.9%	14.5%	0.0%	100.0%
				15	143	27	0	185	113	1,020	193	0	1,325
Beach Seine	July	37	69	40.6%	52.2%	7.2%	0.0%	100.0%	61.3%	34.0%	4.7%	0.0%	100.0%
				28	36	5	0	69	65	36	5	0	106
Beach Siene	August	1	153	19.0%	76.2%	4.8%	0.0%	100.0%	19.6%	75.7%	4.7%	0.0%	100.0%
				16	64	4	0	84	30	117	7	0	154
Beach Seine Total	All	141	2,908	13.5%	76.3%	10.3%	0.0%	100.0%	10.0%	79.2%	10.8%	0.0%	100.0%
				59	334	45	0	438	305	2,416	328	0	3,049
Total	All	142	5,519	22.3%	70.6%	7.1%	0.0%	100.0%	27.5%	66.4%	6.0%	0.0%	100.0%
				144	456	46	0	646	1,559	3,761	343	0	5,662

[a] Sampled age compositions are used to apportion the sockeye catches > 45 mm; all sockeye < 45 mm were assumed to be age 0.

Table 28. Mean length, weight, and condition factor by age and gear type, of juvenile sockeye salmon captured in Chignik Lake in 2001.

				Length (mm)		Weight (g)		Condition factor	
Gear type	Month	Age	Sample size	Mean	Standard Dev.	Mean	Standard Dev.	Mean	Standard Dev.
Beach seine	May	0	5	33.6	0.55	0.18	0.04	0.47	0.11
		1	91	70.5	6.96	3.02	0.91	0.84	0.10
		2	9	82.7	6.08	5.00	1.21	0.87	0.09
	June	0	19	48.8	6.05	1.24	0.49	1.03	0.10
		1	143	66.1	4.41	2.51	0.50	0.87	0.16
		2	27	83.1	9.06	5.33	1.93	0.89	0.13
	July	0	33	55.2	10.82	1.72	0.94	0.94	0.13
		1	36	66.4	4.74	2.83	0.75	0.95	0.10
		2	5	78.2	4.55	5.04	0.91	1.05	0.17
	August	0	16	62.6	7.46	2.38	0.86	0.94	0.11
		1	64	70.2	4.94	3.36	0.78	0.95	0.07
		2	4	77.0	2.71	4.73	0.53	1.03	0.08
Townet	May	0	1	47.0	n/a	0.90	n/a	0.87	n/a
		1	27	61.7	6.63	2.14	0.60	0.90	0.09
	June	1	7	58.1	5.15	2.04	0.56	1.02	0.06
		0	66	57.2	6.34	2.03	0.62	1.06	0.14
		1	66	64.4	4.69	2.79	0.58	1.04	0.12
	July	2	1	71.0	n/a	4.30	n/a	1.20	n/a
	August	0	22	57.6	6.04	1.90	0.51	0.97	0.07
		1	22	66.6	2.34	2.80	0.29	0.95	0.06

Table 29. Total catch of juvenile sockeye salmon from Chignik River, by age and gear type, 2001.

		Total Sockeye Catch		Sample (> 45 mm)					Estimated age[a]				
Gear Type	Month	< 45 mm	> 45 mm	0.	1.	2.	3.	Total	0.	1.	2.	3.	Total
Beach seine	June	27	796	41.7%	58.3%	0.0%	0.0%	100.0%	43.6%	56.4%	0.0%	0.0%	100.0%
				25	35	0	0	60	359	464	0	0	823
Beach seine	July	6	1,477	65.0%	35.0%	0.0%	0.0%	100.0%	65.1%	34.9%	0.0%	0.0%	100.0%
				39	21	0	0	60	966	517	0	0	1,483
Beach seine	August	10	1,963	74.1%	25.9%	0.0%	0.0%	100.0%	74.3%	25.7%	0.0%	0.0%	100.0%
				86	30	0	0	116	1,465	508	0	0	1,973
Beach Seine Total	All	43	4,236	63.6%	36.4%	0.0%	0.0%	100.0%	65.2%	34.8%	0.0%	0.0%	100.0%
				150	86	0	0	236	2,790	1,489	0	0	4,279
Fyke net	July	1	261	46.7%	53.3%	0.0%	0.0%	100.0%	46.9%	53.1%	0.0%	0.0%	100.0%
				14	16	0	0	30	123	139	0	0	262
Fyke net	August	0	195	72.7%	27.3%	0.0%	0.0%	100.0%	72.7%	27.3%	0.0%	0.0%	100.0%
				40	15	0	0	55	142	53	0	0	195
Fyke Net Total	All	1	456	63.5%	36.5%	0.0%	0.0%	100.0%	57.9%	42.1%	0.0%	0.0%	100.0%
				54	31	0	0	85	265	192	0	0	457
Total	All	44	4,692	63.6%	36.4%	0.0%	0.0%	100.0%	64.5%	35.5%	0.0%	0.0%	100.0%
				204	117	0	0	321	3,055	1,681	0	0	4,736

[a] Sampled age compositions are used to apportion the sockeye catches > 45 mm; all sockeye < 45 mm were assumed to be age 0

Table 30. Mean length, weight, and condition factor by age and gear type, of juvenile sockeye salmon captured in Chignik River in 2001.

				Length (mm)		Weight (g)		Condition factor	
Gear type	Month	Age	Sample size	Mean	Standard Dev.	Mean	Standard Dev.	Mean	Standard Dev.
Beach seine	June	0	25	57.40	5.38	1.47	0.41	0.76	0.08
		1	35	62.50	5.71	1.96	0.66	0.78	0.10
	July	0	39	53.00	5.60	1.74	0.64	1.13	0.12
		1	21	61.30	5.55	2.80	0.94	1.18	0.12
	August	0	126	51.10	5.09	1.42	0.44	1.04	0.15
		1	44	59.00	6.11	2.20	0.73	1.04	0.15
Fyke net	July	0	14	54.80	3.91	1.91	0.37	1.15	0.08
		1	6	60.20	4.40	2.42	0.50	1.10	0.06
	August	0	40	55.90	5.42	1.76	0.56	0.97	0.15
		1	16	62.10	8.76	2.74	1.24	1.07	0.17

Table 31. Total catch, by age, of juvenile sockeye salmon from Chignik Lagoon, 2001.

Gear Type	Month	Total Sockeye Catch < 45 mm	Total Sockeye Catch > 45 mm	Sample (> 45 mm) 0.	1.	2.	3.	Total	Estimated age[a] 0.	1.	2.	3.	Total
Beach seine	May	403	251	0.0%	97.5%	2.5%	0.0%	100.0%	61.6%	37.4%	1.0%	0.0%	100.0%
				0	39	1	0	40	403	245	6	0	654
Beach seine	June	176	569	1.8%	70.9%	25.5%	1.8%	100.0%	25.0%	54.2%	19.4%	1.4%	100.0%
				2	78	28	2	110	186	403	145	10	745
Beach Seine	July	8	704	61.0%	36.0%	2.9%	0.0%	100.0%	61.5%	35.6%	2.9%	0.0%	100.0%
				83	49	4	0	136	438	254	21	0	712
Beach Siene	August	605	508	85.7%	14.3%	0.0%	0.0%	100.0%	93.5%	6.5%	0.0%	0.0%	100.0%
				24	4	0	0	28	1,040	73	0	0	1,113
Beach Seine Total	All	1,192	2,032	34.7%	54.1%	10.5%	0.6%	100.0%	64.1%	30.2%	5.3%	0.3%	100.0%
				109	170	33	2	314	2,067	974	172	10	3,224

[a]Sampled age compositions are used to apportion the sockeye catches > 45 mm; all sockeye < 45 mm were assumed to be age 0.

Table 32. Mean length, weight, and condition factor by age and gear type, of juvenile sockeye salmon captured in Chignik Lagoon in 2001.

				Length (mm)		Weight (g)		Condition factor	
Gear type	Month	Age	Sample size	Mean	SD	Mean	SD	Mean	SD
Beach seine	May	0	2	34.50	0.71	0.30	0.00	0.73	0.04
		1	39	61.90	7.78	1.79	0.82	0.70	0.09
		2	1	73.00	na	2.90	na	0.75	na
	June	0	4	43.50	12.77	1.05	0.75	1.17	0.17
		1	78	64.60	6.24	2.89	0.98	1.05	0.12
		2	28	81.20	8.51	5.79	1.92	1.04	0.08
		3	2	104.00	8.49	12.40	5.37	1.07	0.21
	July	0	93	53.00	8.40	1.72	0.99	1.09	0.15
		1	50	64.60	8.82	3.08	1.29	1.08	0.11
		2	4	89.00	9.63	8.05	2.17	1.13	0.06
	August	0	29	47.70	6.56	1.10	0.44	0.95	0.11
		1	4	50.30	4.27	1.38	0.39	1.06	0.10

Table 33. Average fish weight, stomach weight, and total number of identifiable prey items, by group, of juvenile sockeye salmon from throughout the Chignik watershed, 2001.

Location	n		Fish WT (g)	Stomach WT (g)	Cladocerans	Copepods	Insects	Amphipods
Black Lake	37	Average	0.9	0.1	17.6	120.8	10.4	0.0
		SD	0.6	0.1	83.4	181.7	23.2	0.0
Black River	6	Average	0.7	0.1	0.0	35.8	1.5	0.0
		SD	0.2	0.0	0.0	80.7	2.1	0.0
Chignik Lake	129	Average	2.4	0.2	17.0	47.3	8.4	0.0
		SD	1.1	0.2	100.9	144.2	17.9	0.1
Chignik River	70	Average	1.7	0.2	27.2	12.7	6.6	0.0
		SD	0.8	0.2	59.8	19.5	11.4	0.1
Chingik Lagoon	80	Average	2.6	0.3	5.6	81.7	12.2	13.5
		SD	2.0	0.2	28.3	191.4	29.7	38.2
Entire System	322	Average	2.1	0.2	16.1	56.5	9.0	3.4
		SD	1.4	0.2	76.6	149.3	21.0	19.8

Table 34. Average estimated dry weight (mg) of identifiable prey items, of juvenile sockeye salmon from throughout the Chignik watershed, 2001.

Location	Sample size	Mean fish weight (g)	Cladocerans	Copepods	Insects	Amphipods
Black Lake	37	0.9	0.01	0.13	0.62	0.00
Black River	6	0.7	0.00	0.04	0.09	0.00
Chignik Lake	129	2.4	0.02	0.11	0.50	0.00
Chignik River	70	1.7	0.03	0.03	0.39	0.00
Chingik Lagoon	80	2.6	0.01	0.18	0.73	3.38

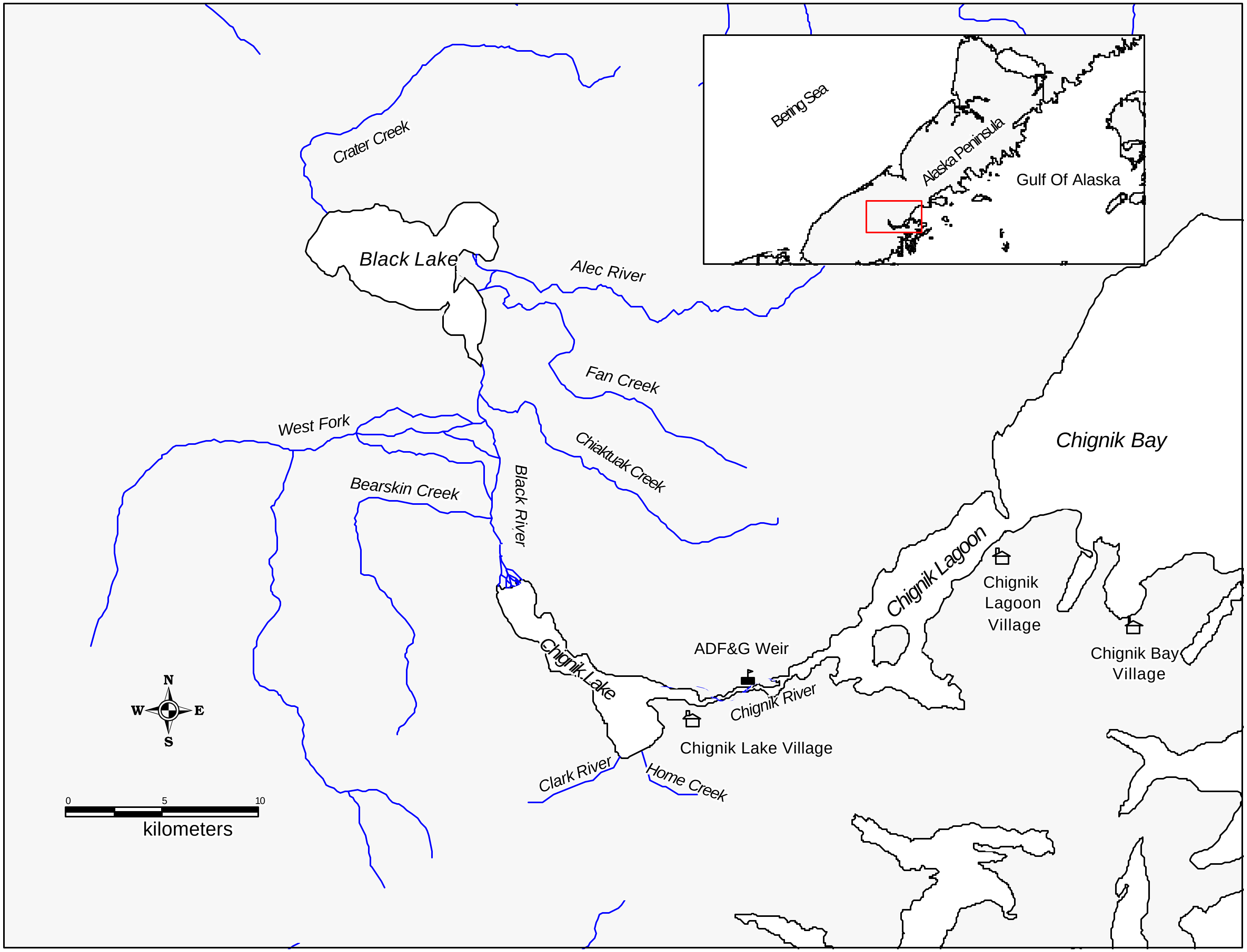


Figure 1. Map of the Chignik watershed with an inset of the Alaska Peninsula.

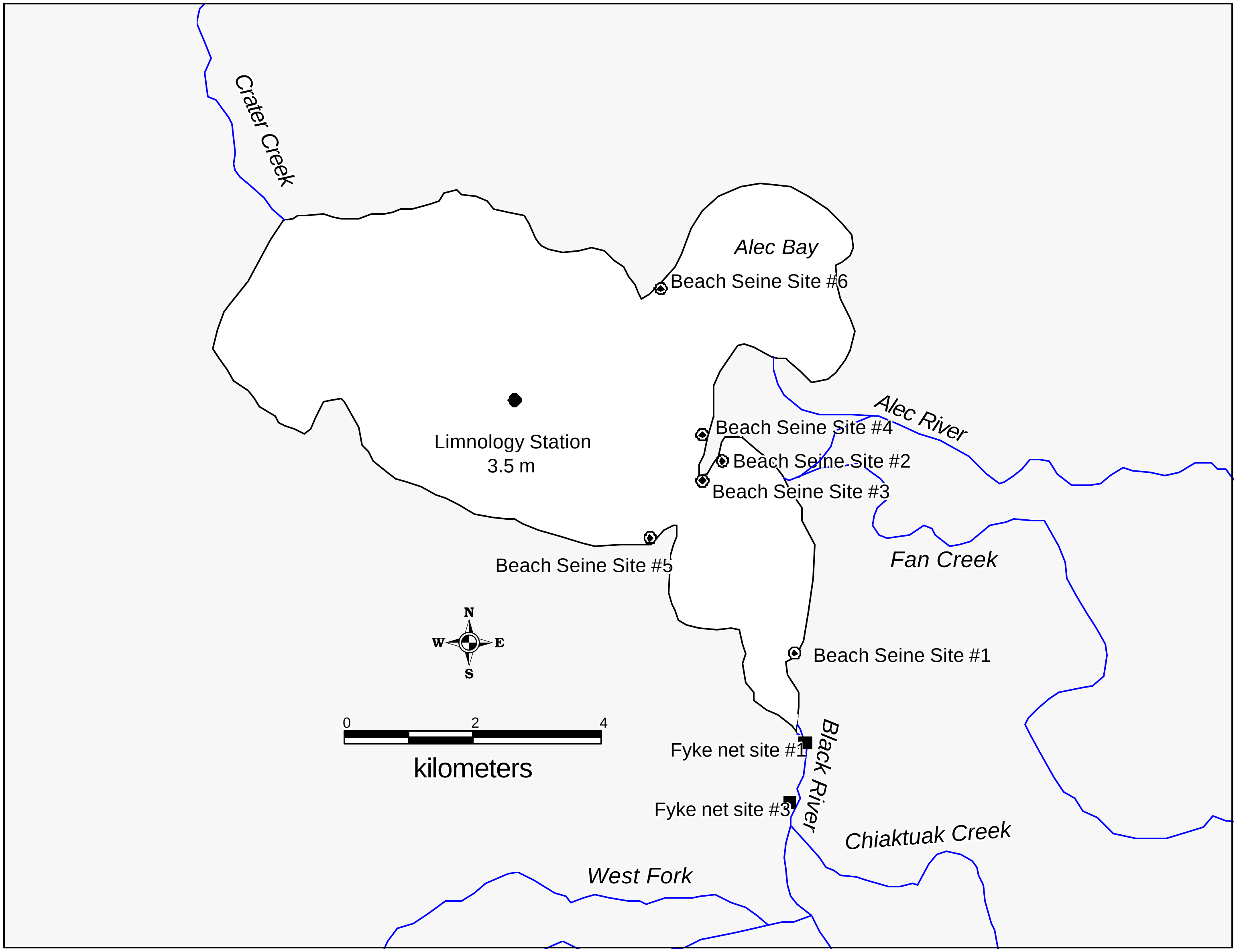


Figure 2. Map of Black Lake depicting the limnology station, beach seine sites, and fyke net sites.

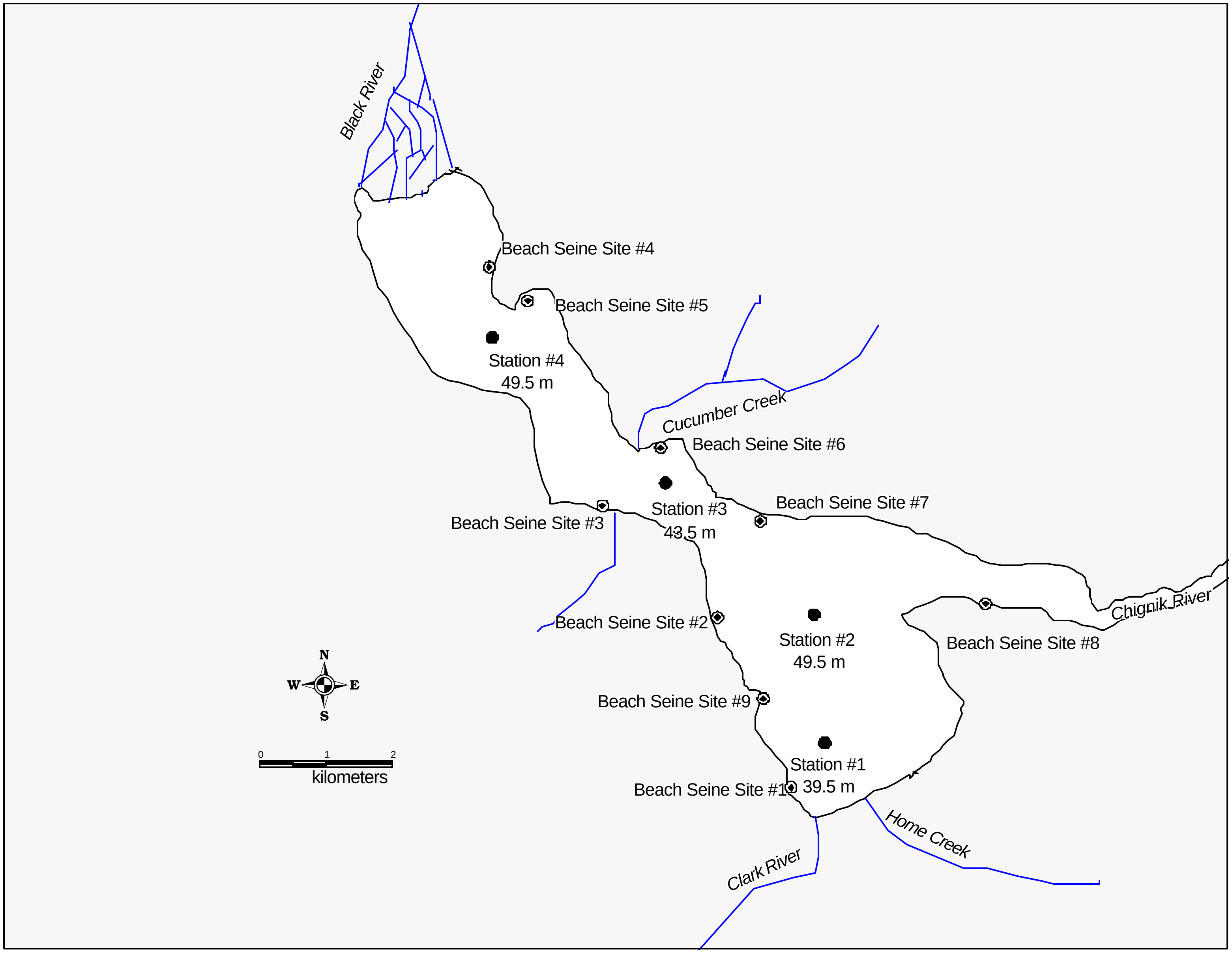


Figure 3. Map of Chignik Lake depicting the limnology stations and the beach seine sites

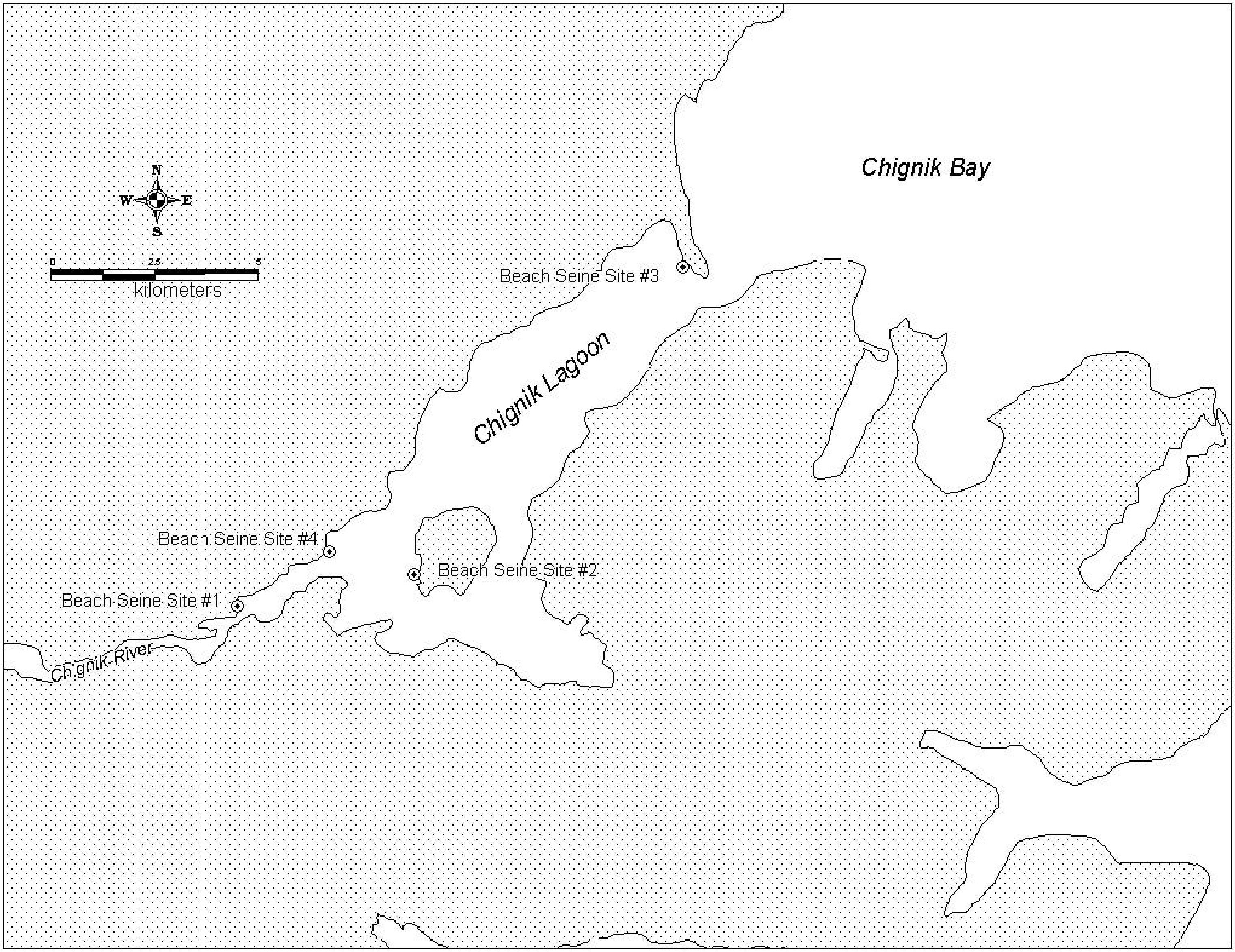


Figure 4. Map of Chignik Lagoon depicting the beach seine sites.

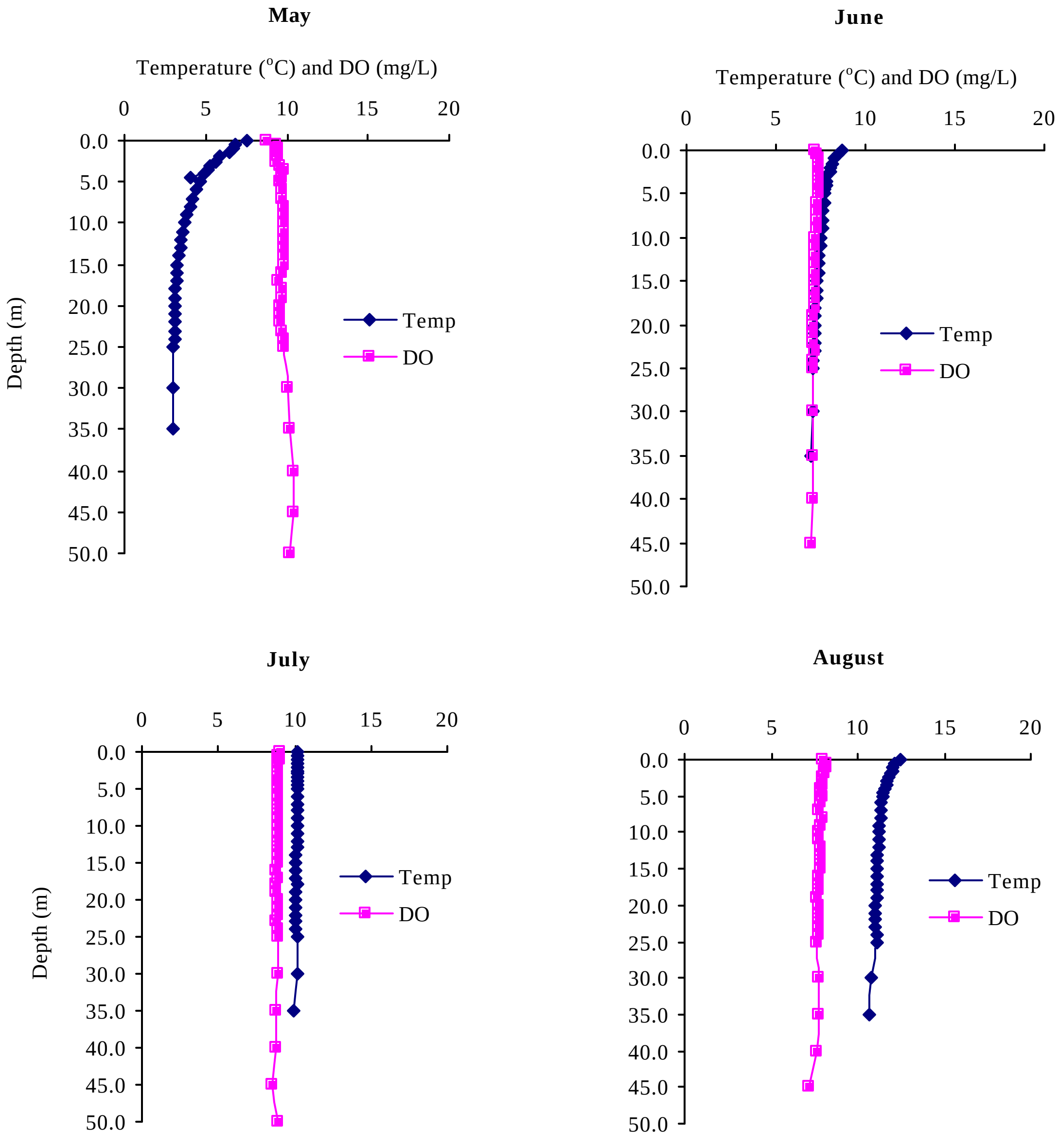


Figure 5. Mean monthly temperature and dissolved oxygen profiles for Chignik Lake, 2001.

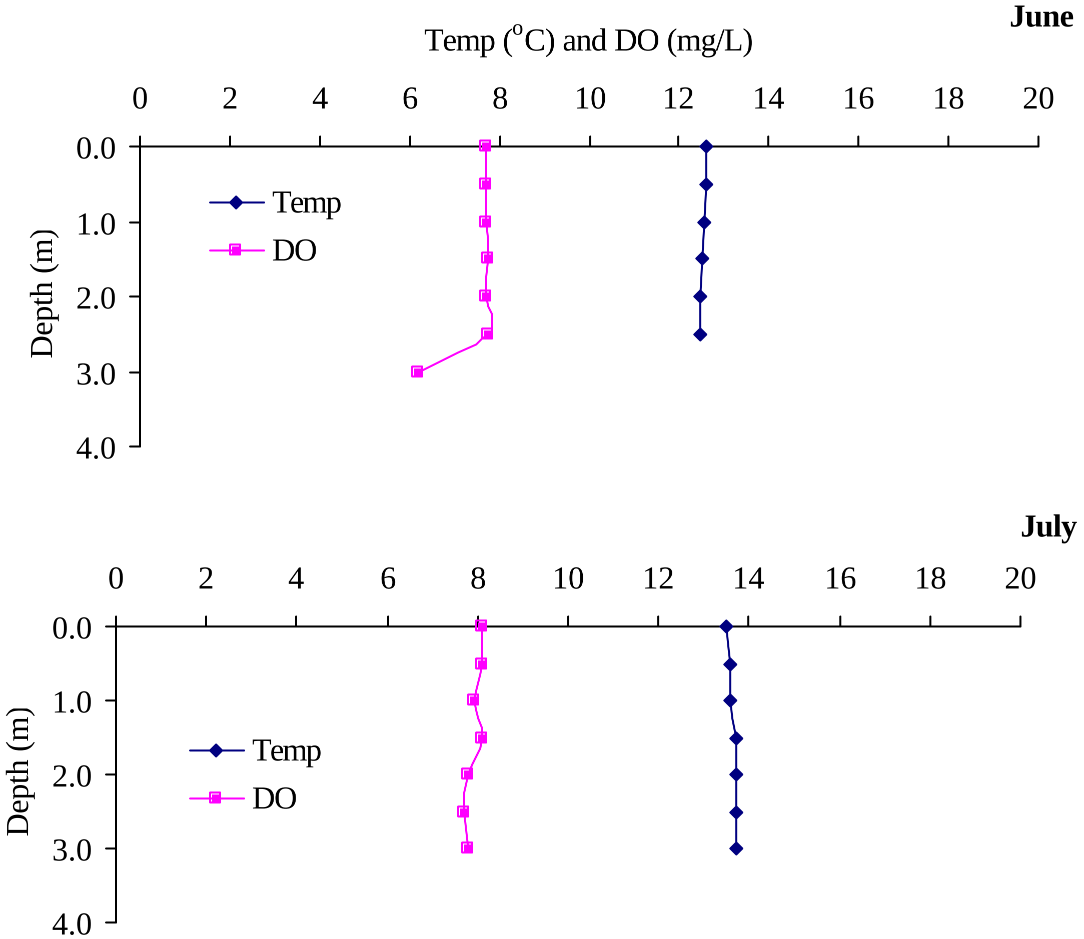


Figure 6. Mean monthly temperature and dissolved oxygen profiles for Black Lake, 2001.

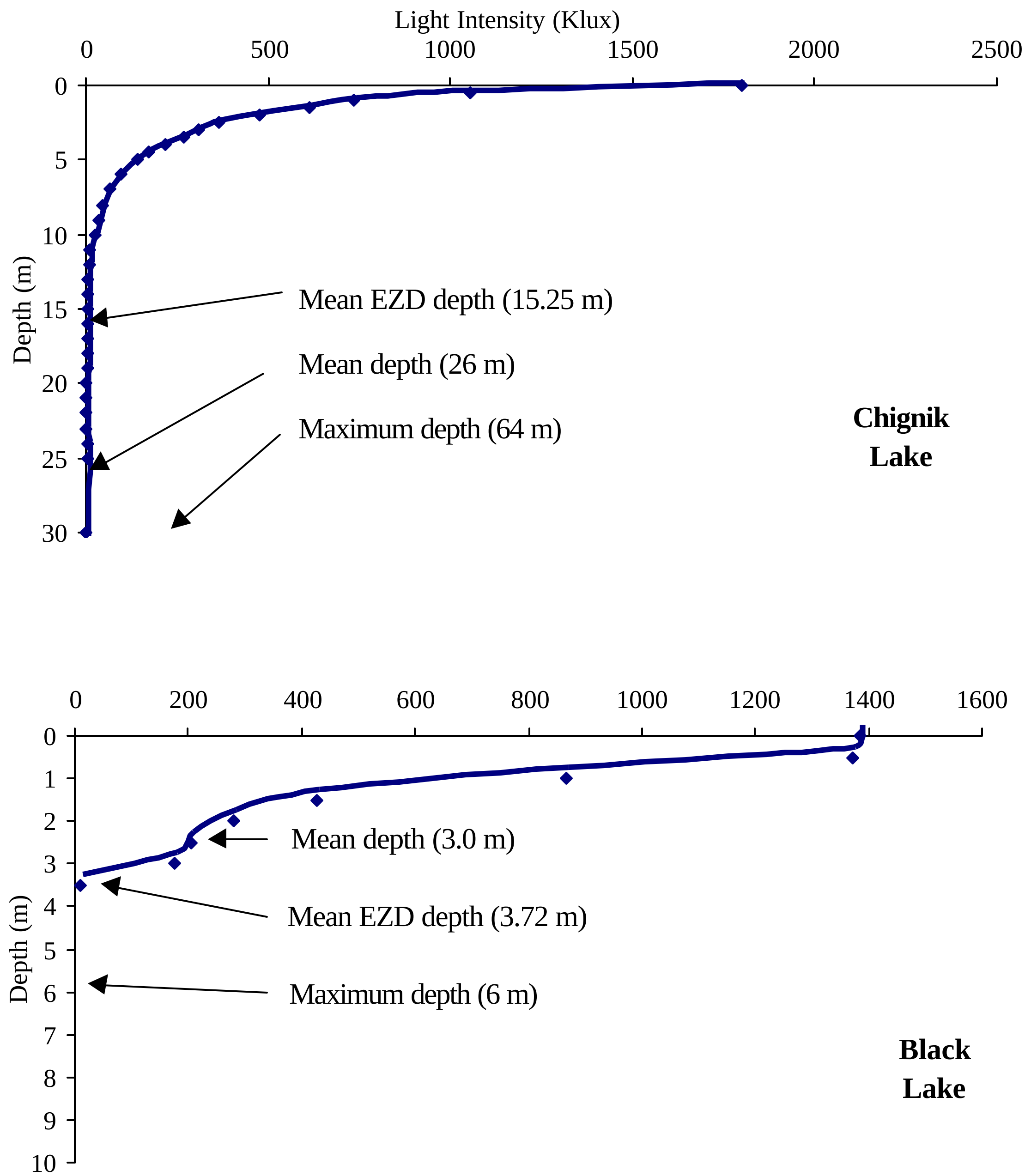


Figure 7. Light penetration curves in relationship to the mean depths, EZDs and maximum depths of Chignik and Black lakes.

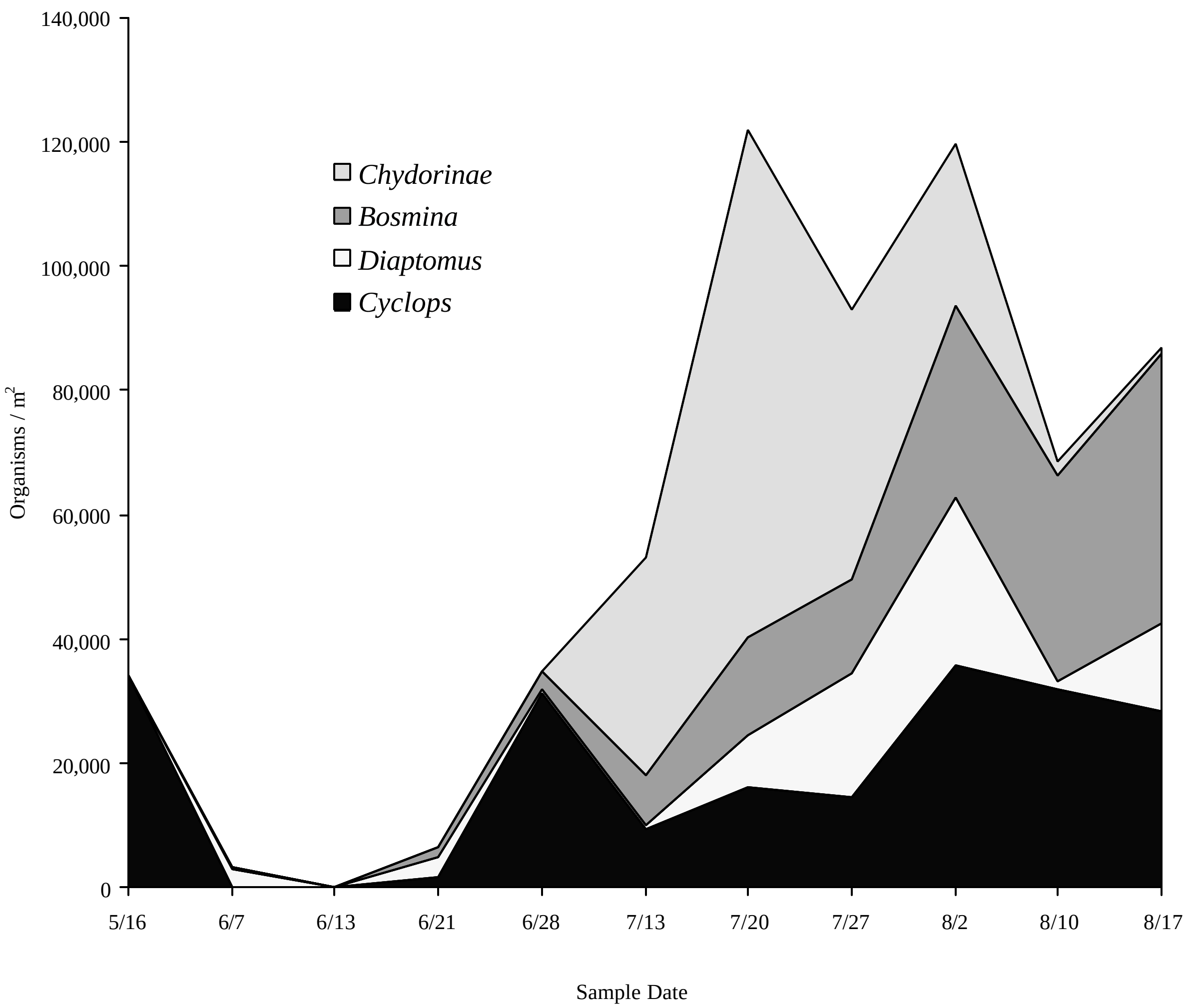


Figure 8. Number of organisms per m^2 of the major copepods (*Cyclops* and *Diaptomus*) and cladocerans (*Bosmina* and *Chydorinae*) in Chignik Lake, by sample date, 2001.

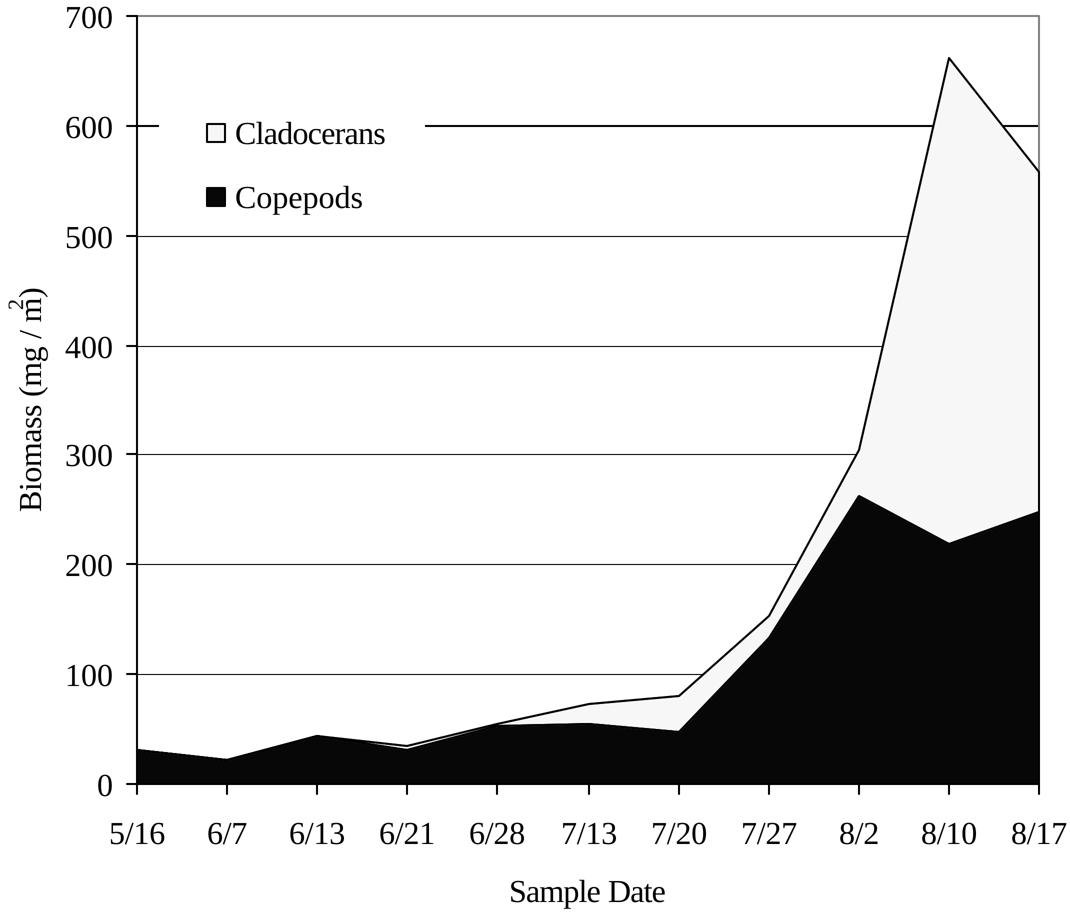


Figure 9. Mean biomass per m^2 of the major copepods and cladocerans in Chignik Lake, by sample date, 2001.

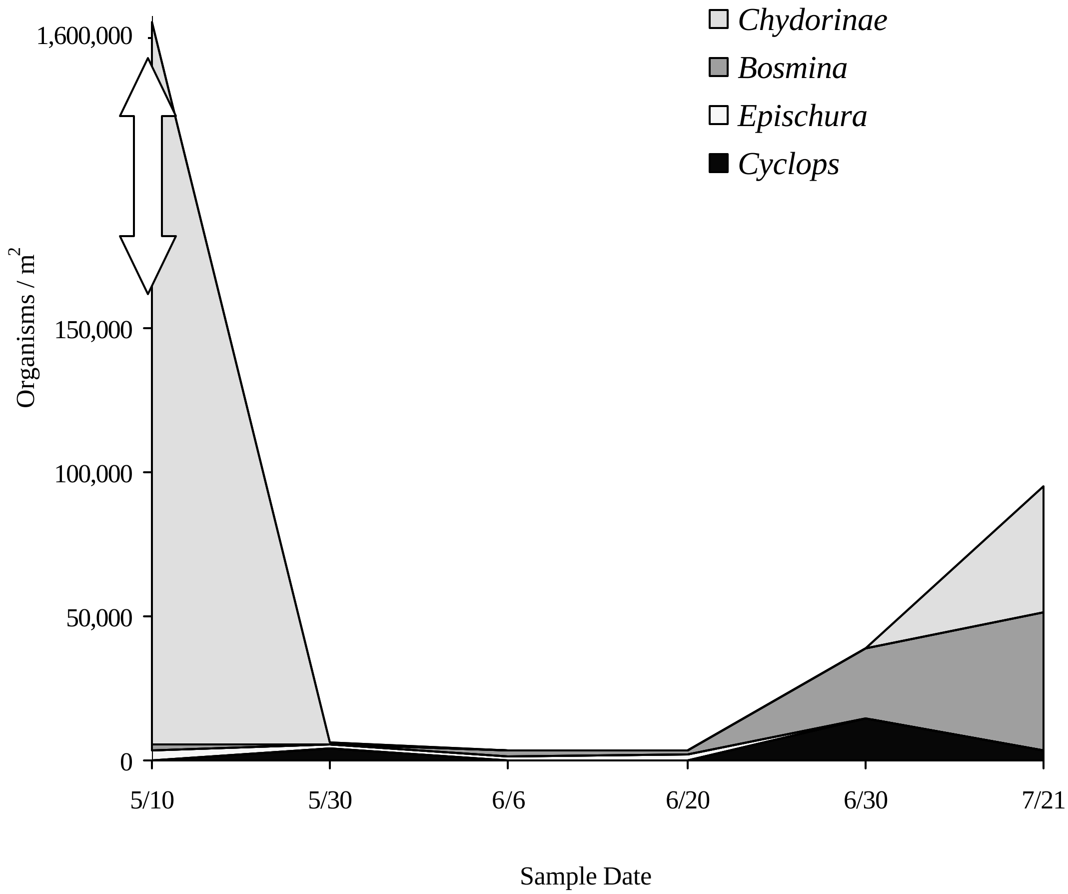


Figure 10. Number of organisms per m^2 of the major copepods (*Cyclops* and *Epischura*) and cladocerans (*Bosmina* and *Chydorinae*) in Black Lake, by sample date, 2001. Note the broken y-axis.

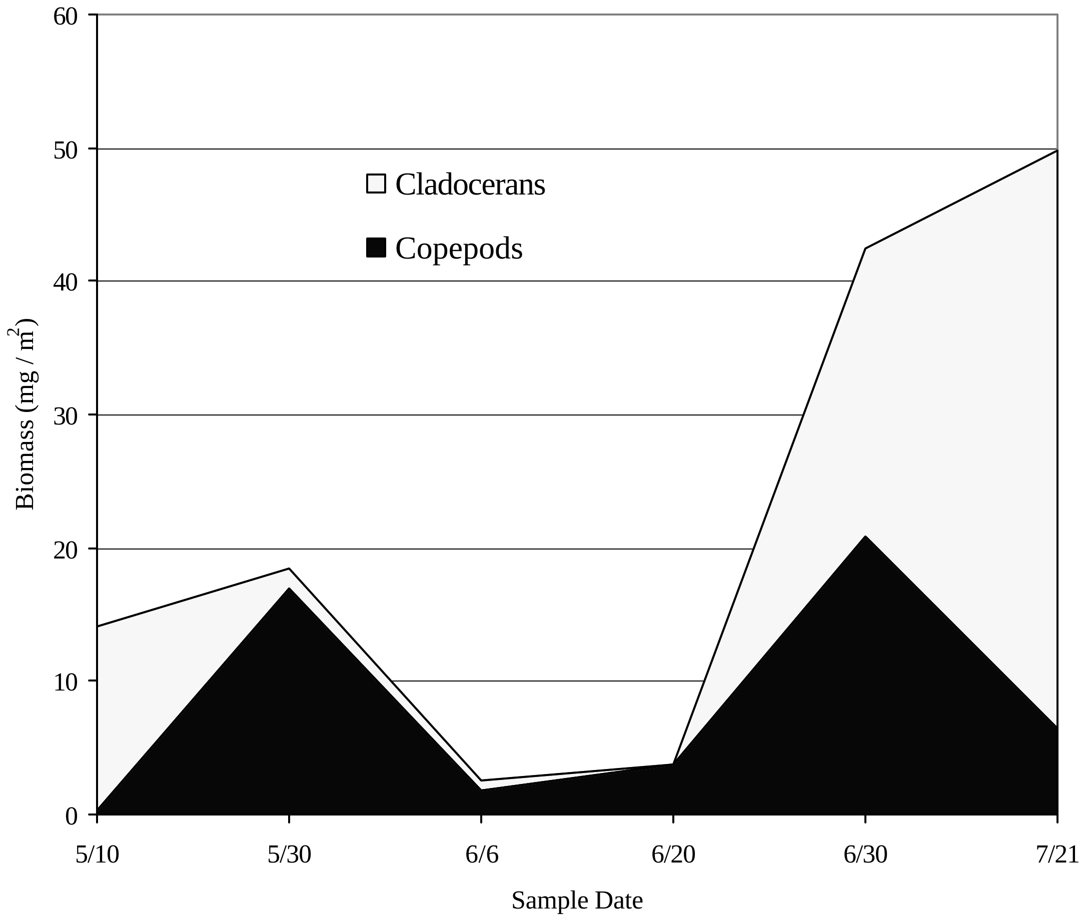


Figure 11. Mean biomass per m^2 of the major copepods and cladocerans in Black Lake, by sample date, 2001.

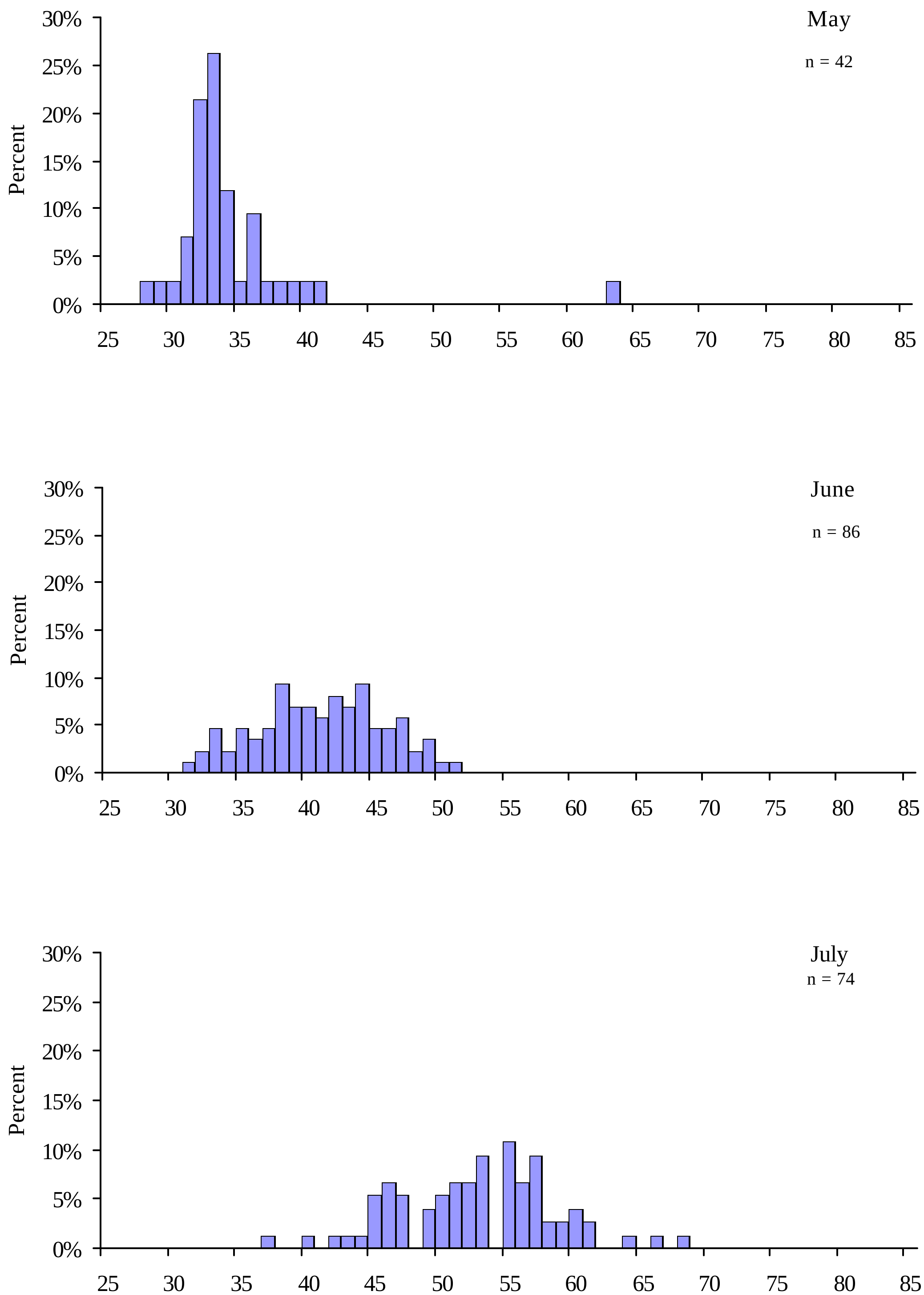
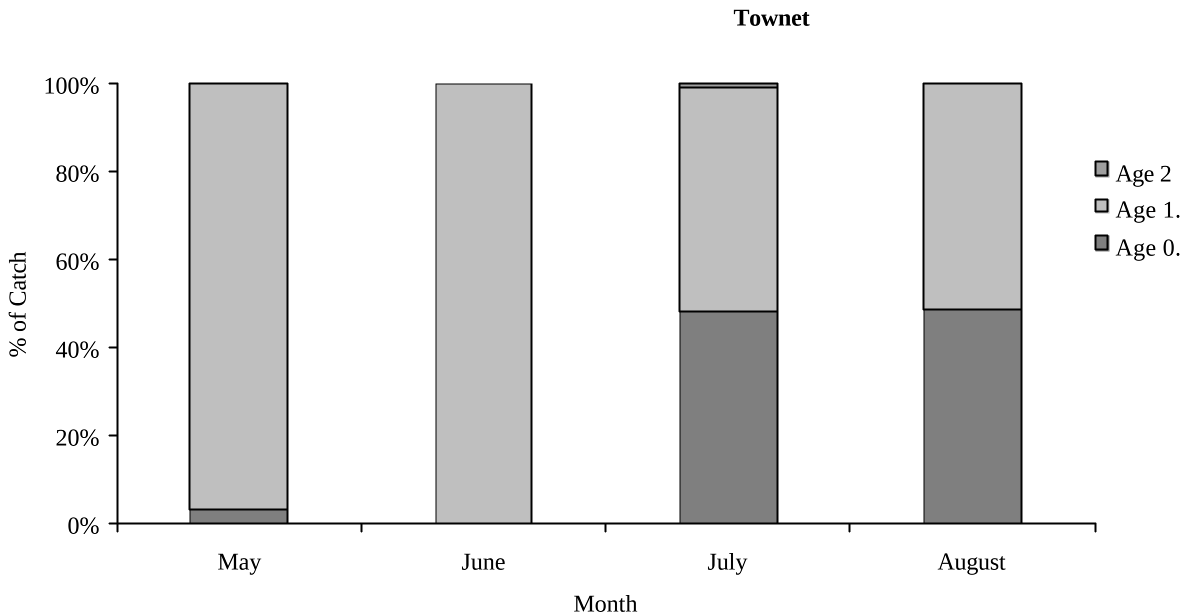


Figure 12. Length frequency histograms of juvenile sockeye salmon captured with a beach seine, fyke net and townet (July only) from Black Lake and Black River, by month, 2001.



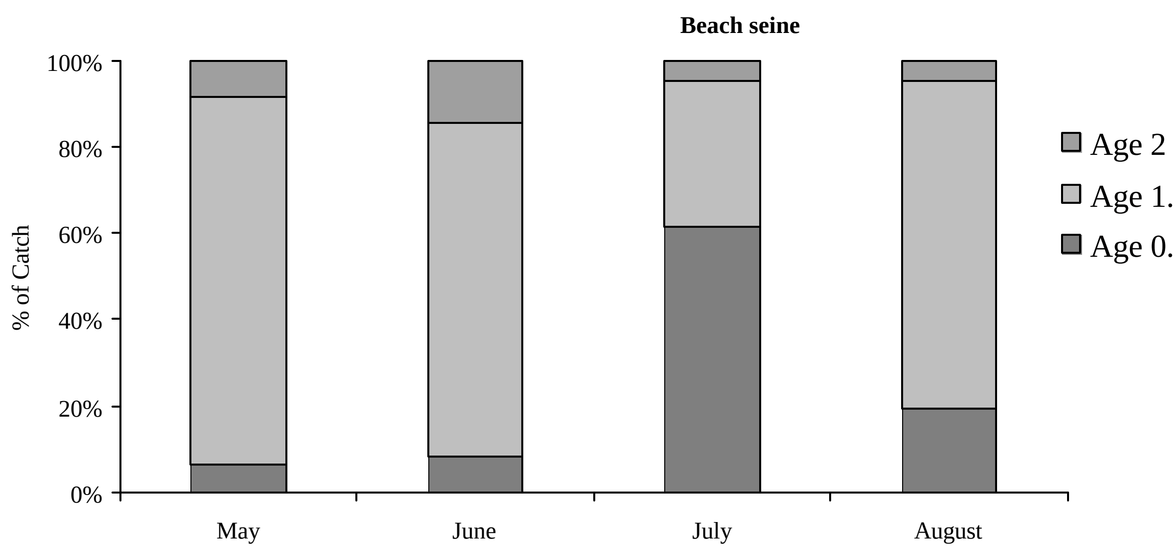


Figure 13. Estimated percent age in beach seine and townet catches from Chignik Lake, by month, 2001.

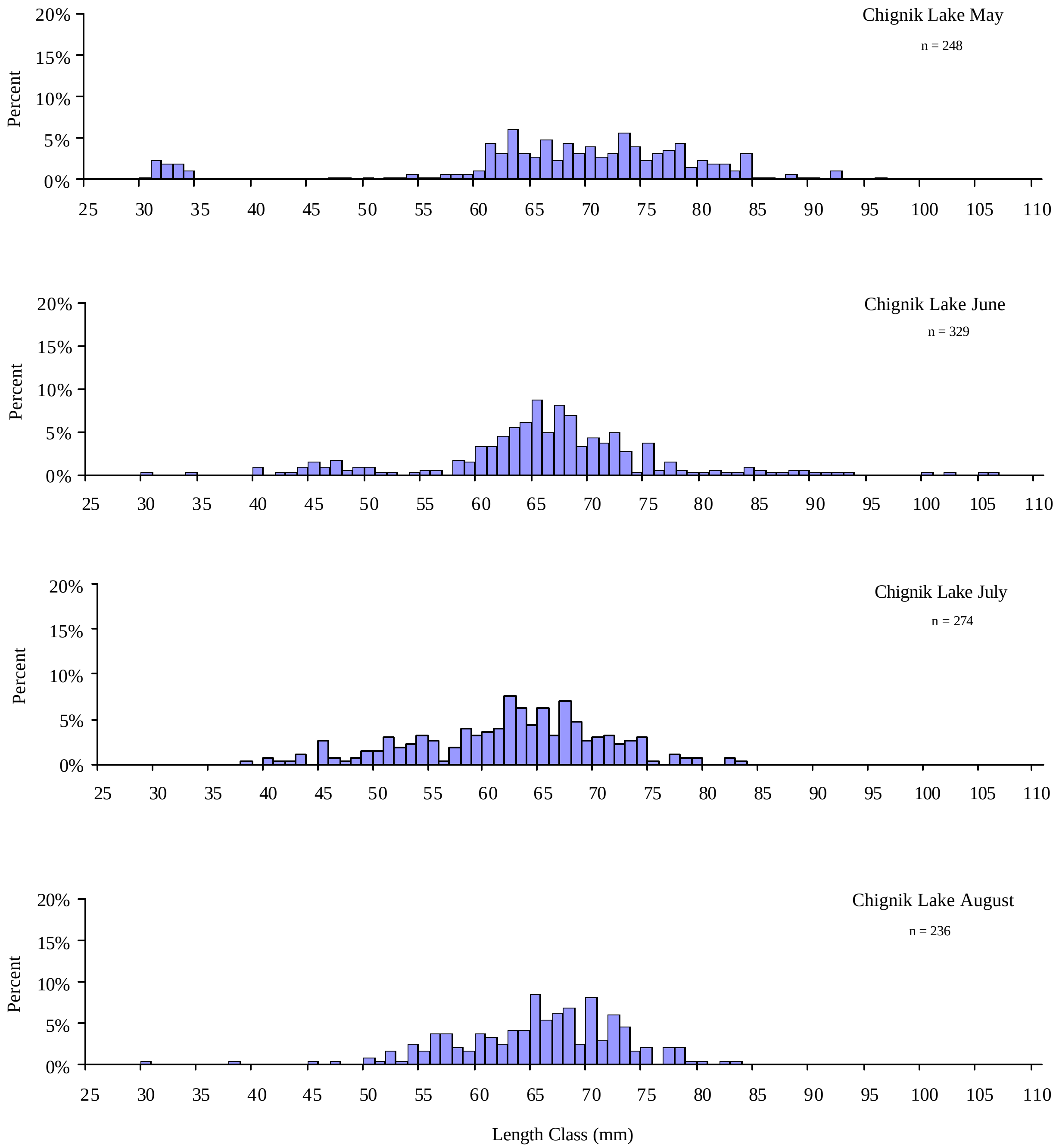


Figure 14. Length frequency histograms of juvenile sockeye salmon captured with a beach seine and a townet from Chignik Lake, by month, 2001.

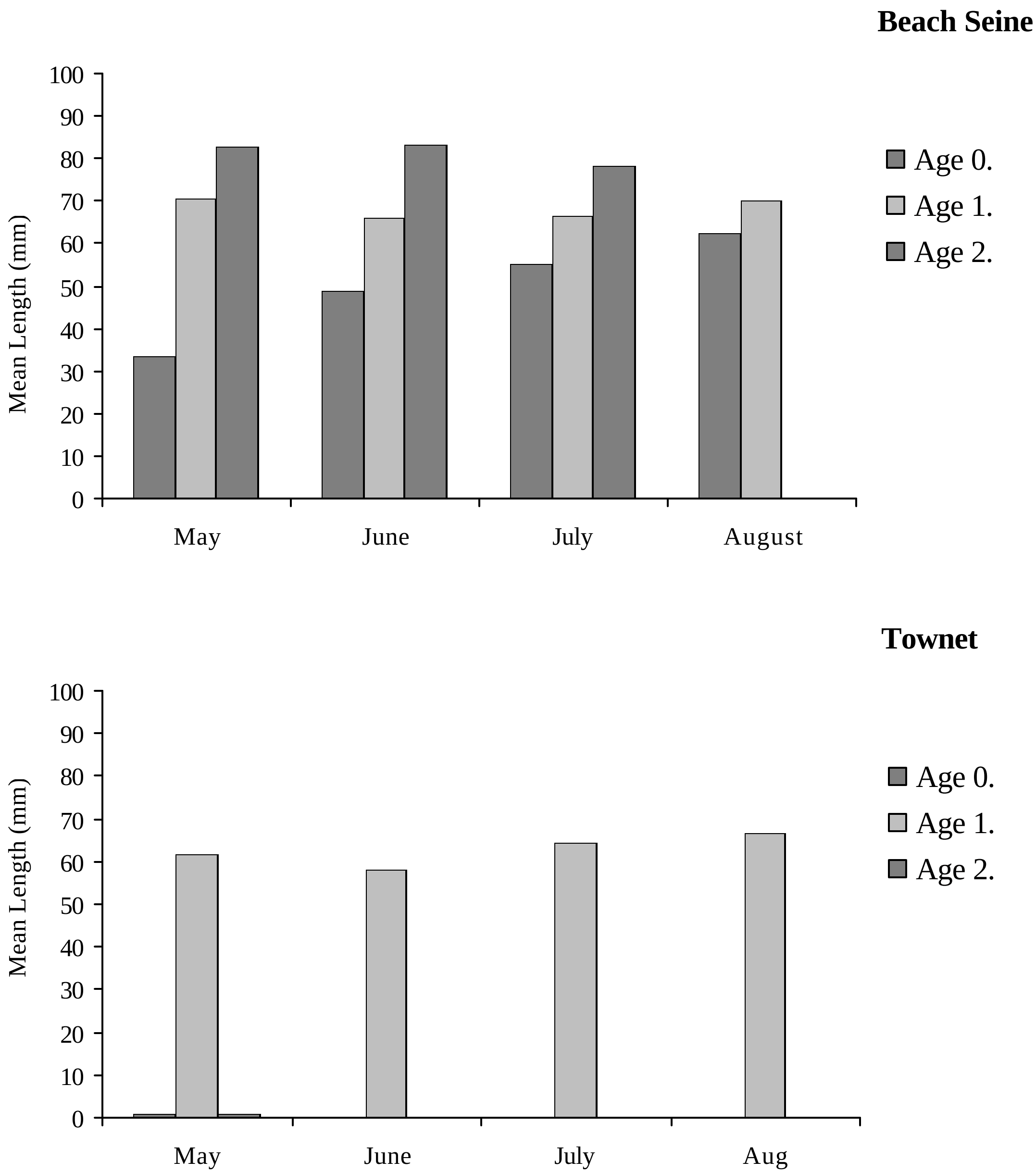
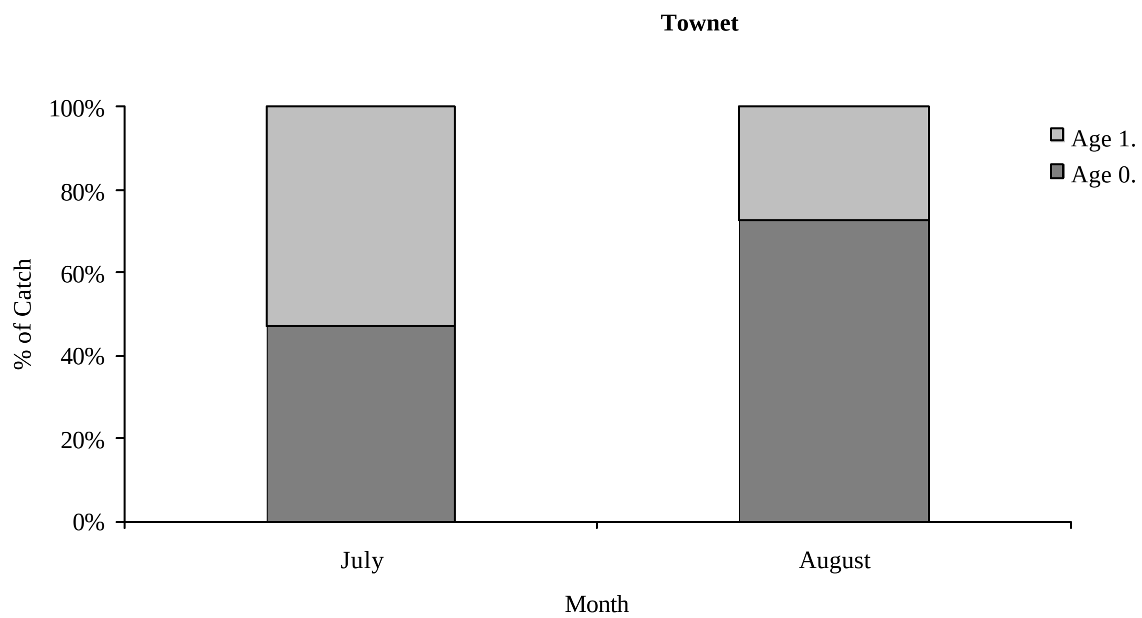


Figure 15. Mean lengths of townet and beach seine catches from Chignik Lake, by age and month, 2001.



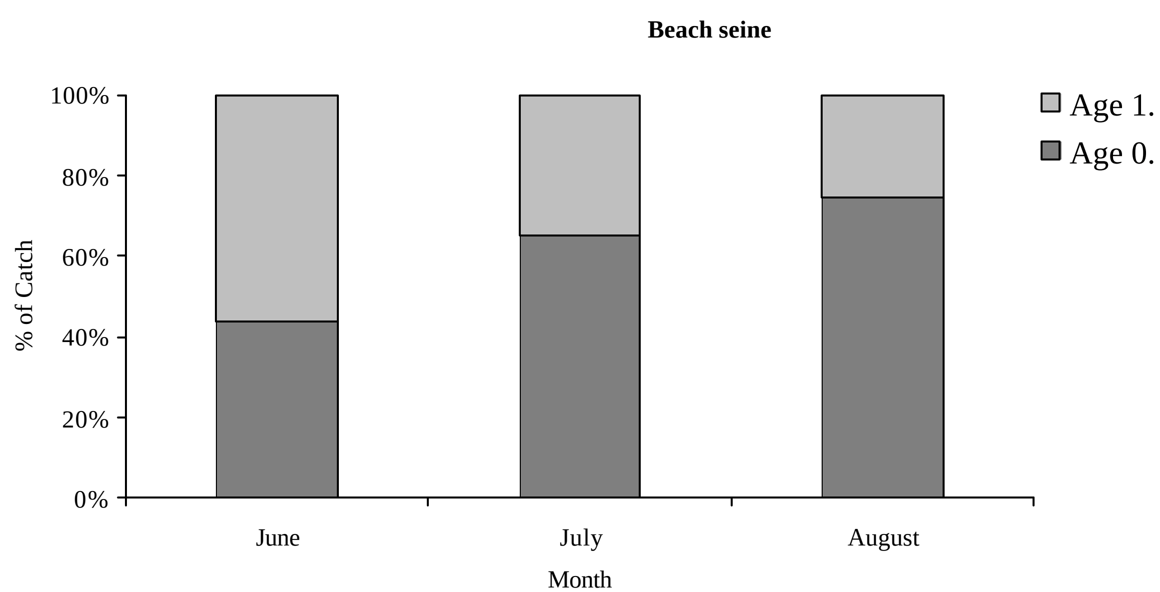


Figure 16. Mean lengths of townet and beach seine catches from Chignik Lake, by age and month, 2001.

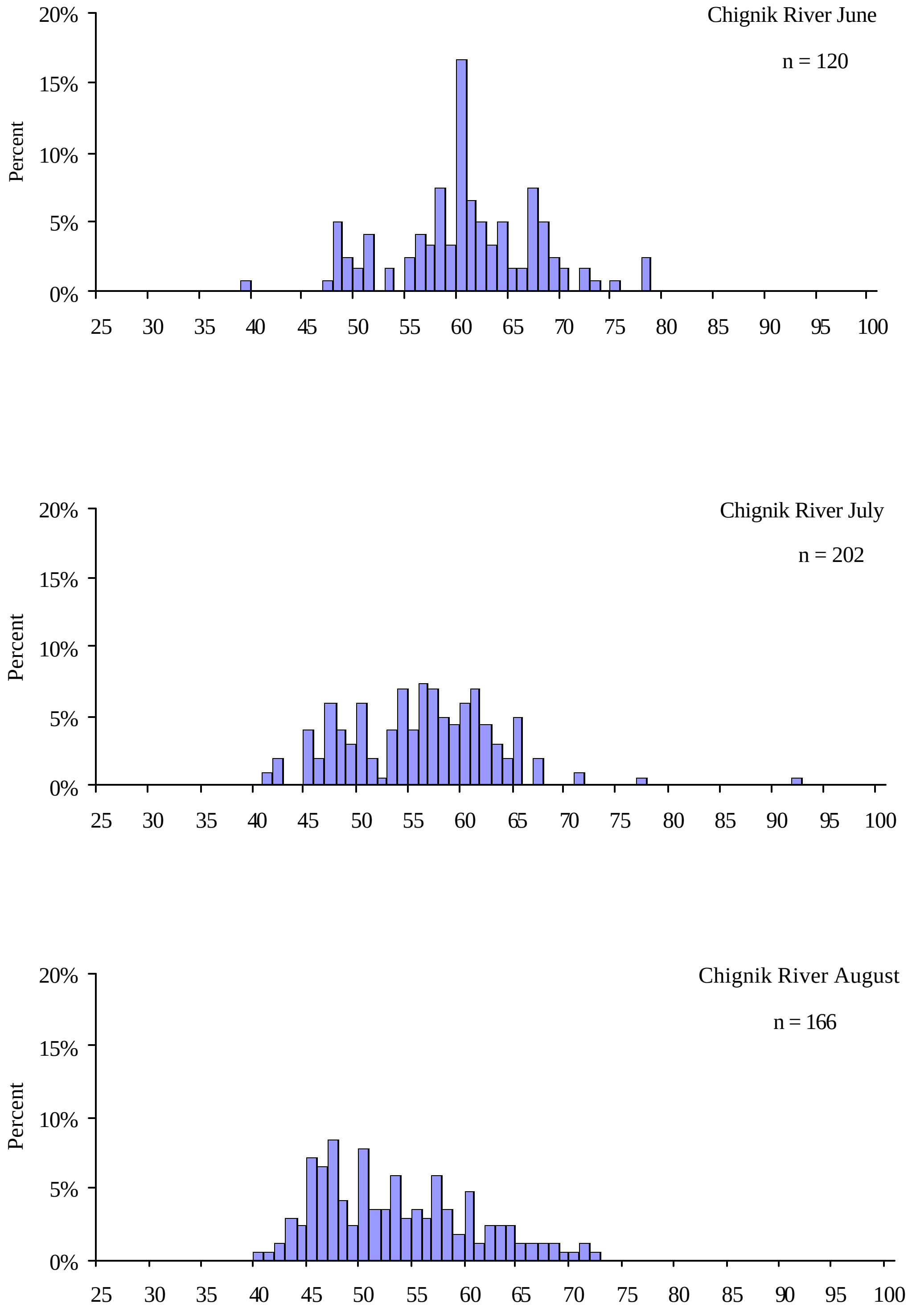


Figure 17. Length frequency histograms of juvenile sockeye salmon captured with a beach seine or a fyke net from Chignik River, by month, 2001.

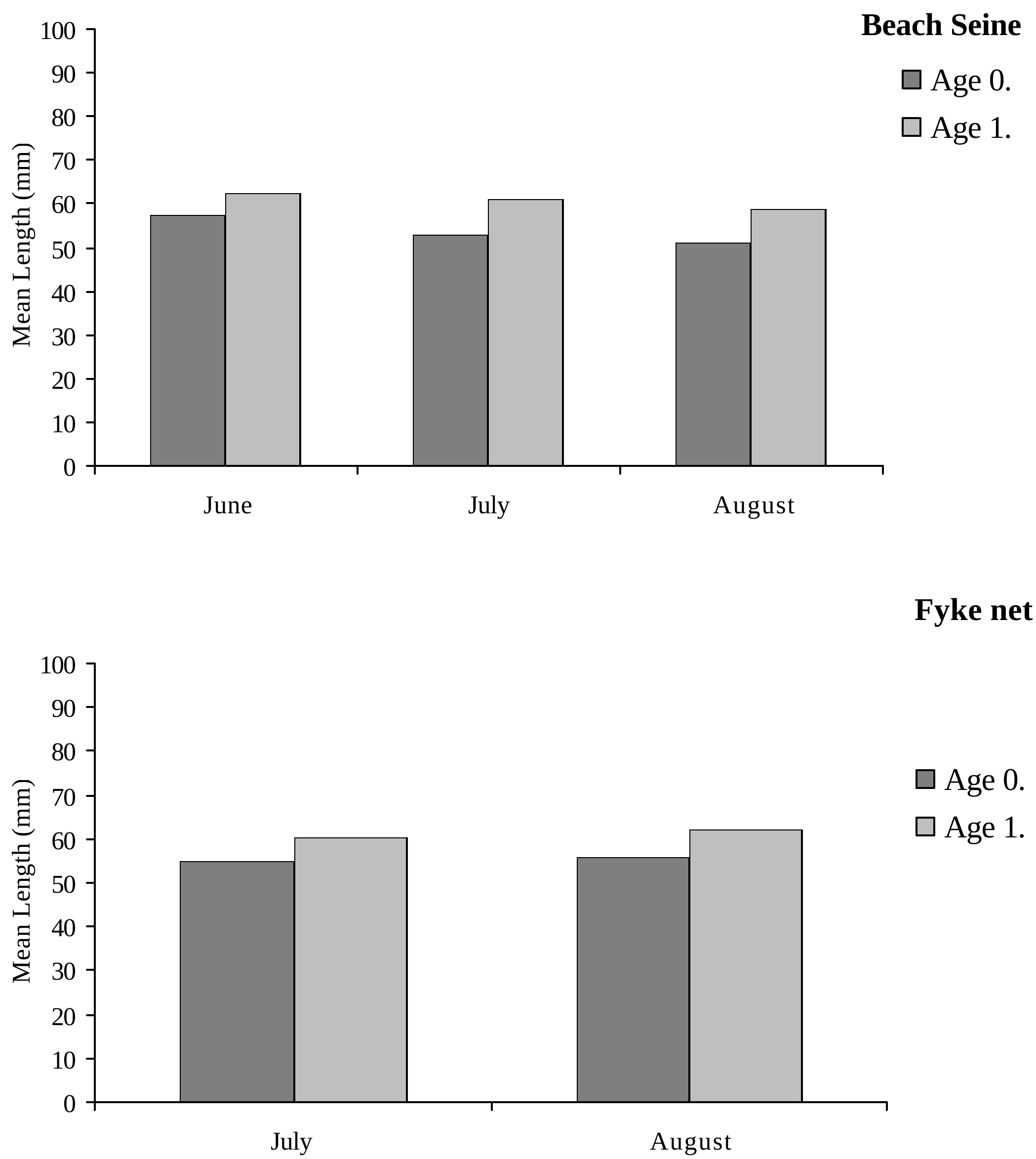


Figure 18. Mean lengths of beach seine and fyke net catches from Chignik River, by age and month, 2001.

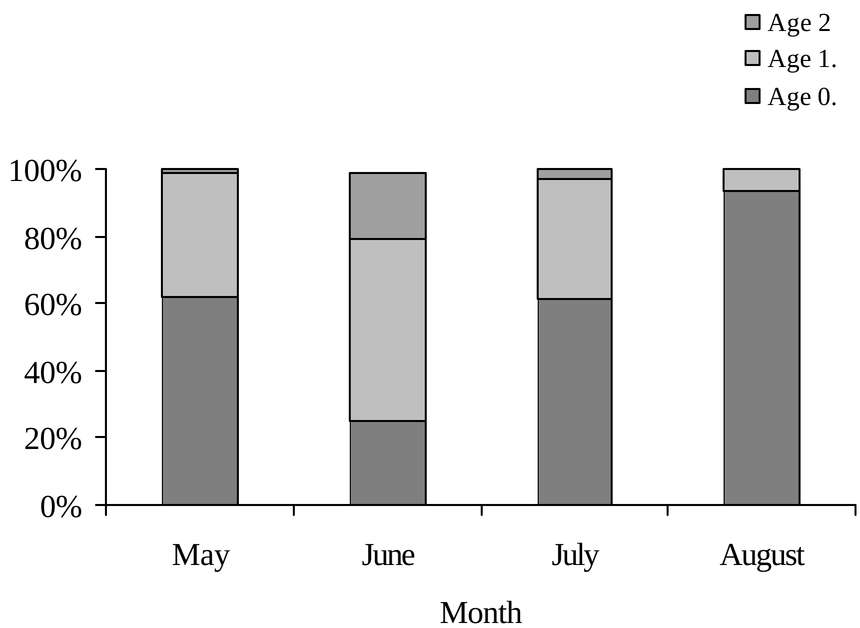


Figure 19. Estimated percent age in beach seine catches from Chignik Lagoon, by month, 2001.

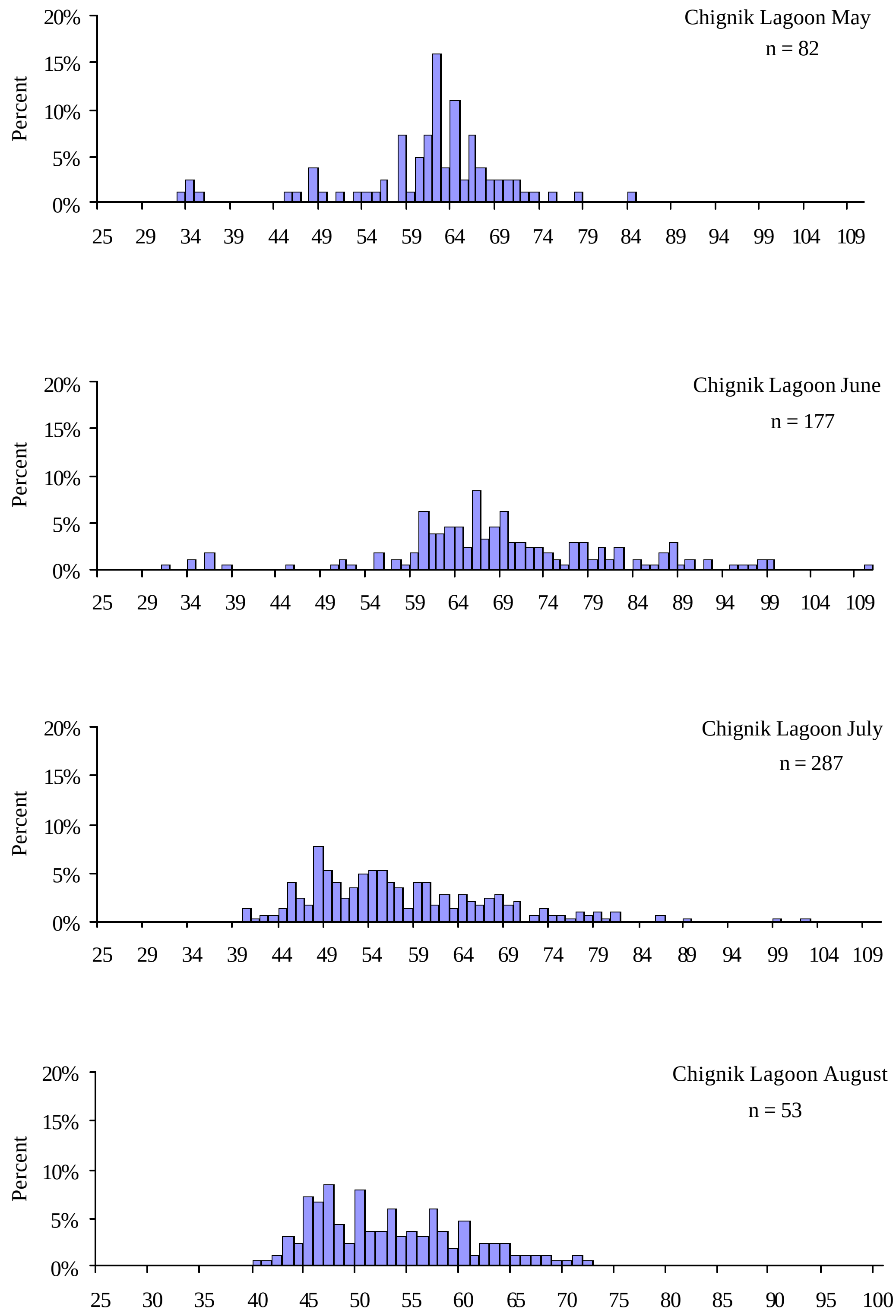


Figure 20. Length frequency histograms of juvenile sockeye salmon captured with a beach seine from Chignik Lagoon, by month, 2001.

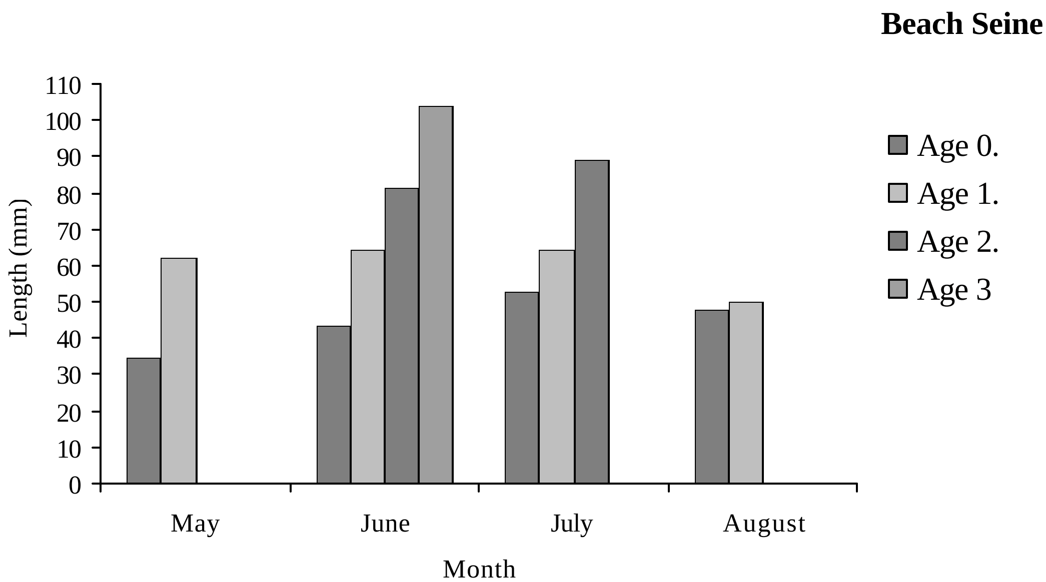


Figure 21. Mean lengths of beach seine catches from Chignik Lagoon, by age and month, 2001.

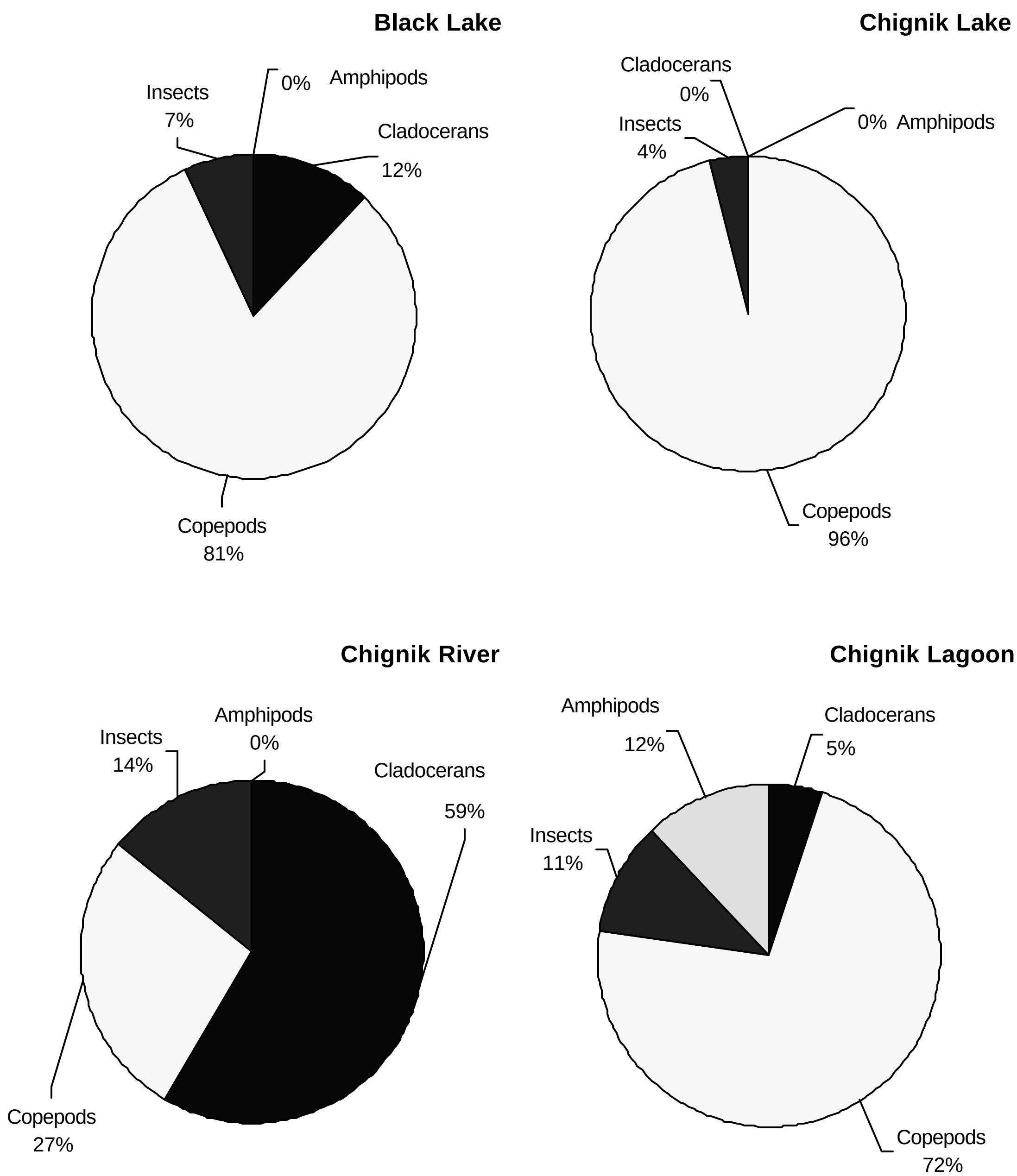


Figure 22. Percentage, by number, of identifiable groups of prey items in the digestive tracts of juvenile sockeye salmon from Black Lake, Chignik Lake, Chignik River, and Chignik Lagoon, 2001.

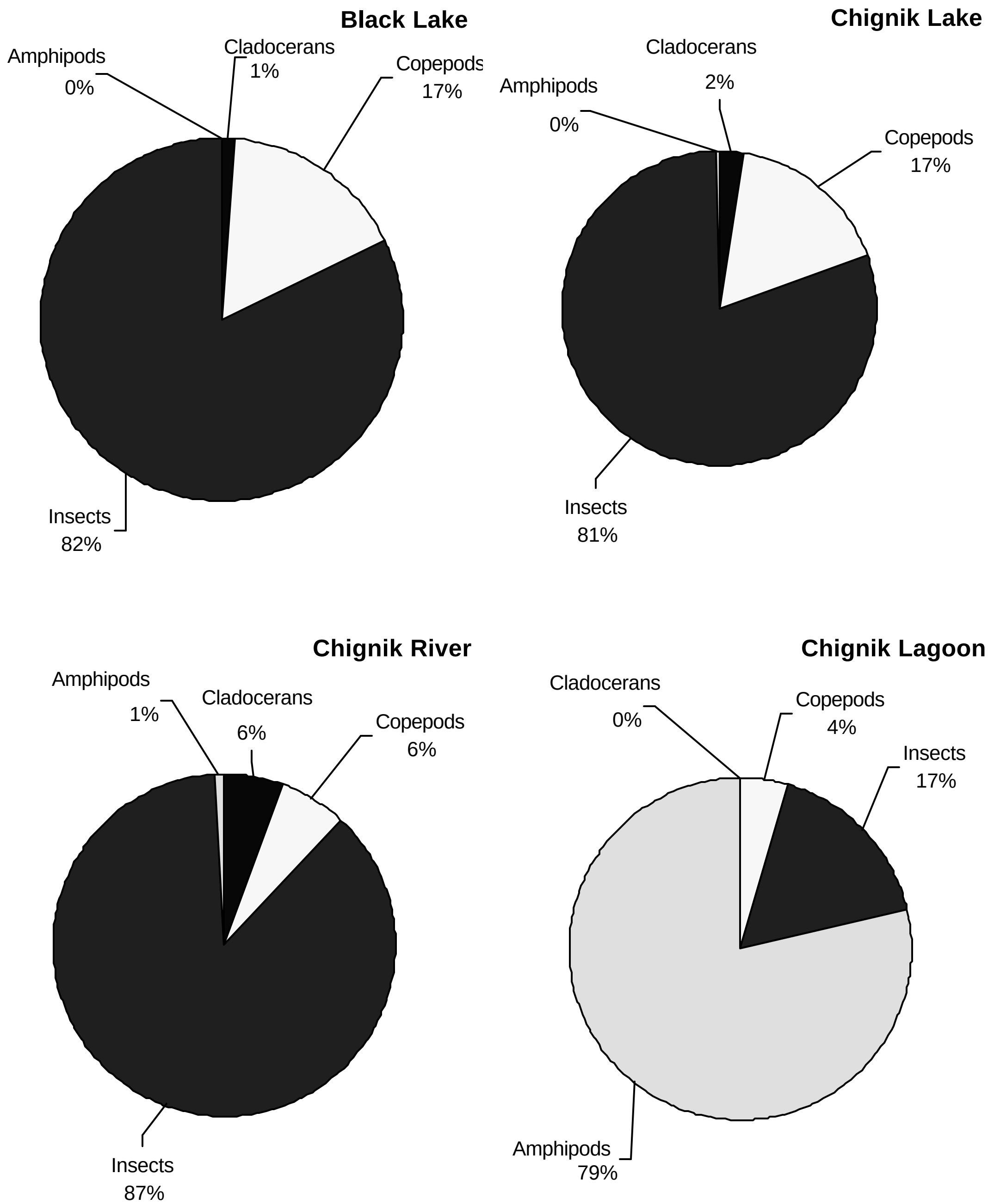


Figure 23. Percentage, by dry weight, of identifiable groups of prey items in the digestive tracts of juvenile sockeye salmon from Black Lake, Chignik Lake, Chignik River, and Chignik Lagoon, 2001.

APPENDIX

Appendix A. Location of the limnology sampling stations in Black and Chignik lakes, 2001.

Lake	Station	°Latitude (N)	°Longitude (W)
Black	1	56°27.207'	158°59.701'
Chignik	1	56°14.366'	158°48.834'
	2	56°15.344'	158°49.483'
	3	56°16.122'	158°50.612'
	4	56°17.316'	158°53.386'

Appendix B. Average number of zooplankton per m^3 from Chignik Lake, 2001.

Taxon	Sample date											Average
	5/16	6/7	6/13[a]	6/21[b]	6/28	7/13[b]	7/20	7/27[b]	8/2[b]	8/10	8/17[b]	
Copepods:												
Epischura	54.50	190.75	278.00	143.00	30.50	111.50	192.67	96.00	10.50	45.93	0.00	104.85
Ovigerous *Epischura*	0.00	13.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25
Diaptomus	0.00	69.50	0.00	66.50	56.25	10.00	163.33	385.50	525.50	296.77	277.70	168.28
Ovigerous *Diaptomus*	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91
Cyclops	795.75	13.25	0.00	31.00	623.50	181.50	328.00	289.00	702.50	796.90	547.30	391.70
Ovigerous *Cyclops*	0.00	0.00	0.00	0.00	0.00	120.50	4.33	39.00	104.00	101.63	69.35	39.89
Harpaticus	0.00	0.00	0.00	0.00	0.00	10.00	32.00	10.50	0.00	0.00	7.81	5.48
Nauplii	194.00	43.50	79.00	23.50	163.00	77.50	465.67	174.50	135.00	139.72	368.07	169.41
Total copepods:	1,044.25	330.75	357.00	274.00	873.25	511.00	1,186.00	994.50	1,477.50	1,380.95	1,270.22	881.77
Cladocerans:												
Bosmina	5.00	3.00	0.00	20.67	86.25	159.50	339.67	299.50	609.00	1,447.86	850.22	347.33
Ovigerous *Bosmina*	0.00	0.00	0.00	0.00	0.00	8.00	106.33	46.50	135.00	157.86	108.68	51.12
Daphnia longiremis	0.00	0.00	0.00	0.00	0.00	23.50	17.00	23.50	36.50	0.00	82.56	16.64
Ovigerous *Daphnia longiremi*	0.00	0.00	0.00	0.00	0.00	0.00	4.33	0.00	5.00	0.00	0.00	0.85
Chydorinae	0.00	0.00	0.00	0.00	0.00	673.50	2,471.52	850.92	509.89	650.22	15.31	470.12
Total cladocerans:	5.00	3.00	0.00	20.67	86.25	864.50	2,938.86	1,220.42	1,295.39	2,255.94	1,056.77	886.07
Total Copepods + Cladocerans	1,049.25	333.75	357.00	294.67	959.50	1,375.50	4,124.86	2,214.92	2,772.89	3,636.89	2,326.99	1,767.84

-Continued-

Appendix B. (page 2 of 2)

Taxon	Sample date											
	5/16	6/7	6/13[a]	6/21[b]	6/28	7/13[b]	7/20	7/27[b]	8/2[b]	8/10	8/17[b]	Average
Rotifers:												
Kellicottia	562.17	85.51	274.54	626.86	377.41	895.25	521.76	444.92	541.19	891.47	797.08	547.10
Asplanchna	47.22	231.96	568.43	49.24	62.93	0.00	92.48	517.78	629.66	860.58	218.56	298.08
Keratella	690.38	242.46	939.74	1,786.90	387.30	108.38	28.72	13.01	15.61	26.22	36.33	388.64
Conochilus	448.01	27.22	0.00	28.22	22.43	0.00	56.21	59.84	244.58	361.84	496.86	158.66
other rotifers	16.59	6.80	59.53	82.86	29.22	107.48	112.50	39.03	0.00	0.00	0.00	41.27
Total Rotifers:	1,764.37	593.95	1,842.24	2,574.07	879.29	1,111.11	811.67	1,074.58	1,431.04	2,140.12	1,548.83	1,433.75
Other:												
Ostracoda	11.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01

[a]Only station two sampled.

[b]Only stations two and four sampled.

Appendix C. Biomass estimates (mg dry weight/m^3) of the major zooplankton species, by sample date, from Chignik Lake, 2001.

	Sample date											
Taxon	5/16	6/7	6/13[a]	6/21[b]	6/28	7/13[b]	7/20	7/27[b]	8/2[b]	8/10	8/17[b]	Average
Copepods:												
Epischura	0.81	0.81	0.80	0.50	0.78	0.21	7.61	0.40	0.02	2.36	0.00	1.30
Ovigerous *Epischura*	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diaptomus	0.00	0.61	0.00	0.05	1.60	0.04	0.05	1.12	2.05	58.09	1.73	5.94
Ovigerous *Diaptomus*	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyclops	2.63	0.19	0.00	0.03	1.03	0.45	6.91	0.81	2.37	23.96	2.48	3.71
Ovigerous *Cyclops*	0.00	0.00	0.00	0.00	0.00	0.37	0.02	0.26	0.71	0.87	0.59	0.26
Harpaticus	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.01	0.00
Total copepods:	3.44	1.61	0.80	0.60	3.41	1.07	14.62	2.60	5.14	85.27	4.80	11.22
Cladocerans:												
Bosmina	0.09	0.00	0.00	0.04	0.78	0.19	1.40	0.26	0.50	22.66	0.73	2.42
Ovigerous *Bosmina*	0.00	0.00	0.00	0.00	0.00	0.05	0.14	0.05	0.17	1.84	0.15	0.22
Daphnia longiremis	0.01	0.00	0.00	0.02	0.00	0.06	0.03	0.02	0.11	0.00	0.35	0.05
Ovigerous *Daphnia longiremis*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Chydorinae	0.00	0.00	0.00	0.00	0.00	0.04	0.14	0.06	4.18	0.23	0.13	0.44
Total cladocerans:	0.10	0.00	0.00	0.05	0.78	0.34	1.71	0.38	4.97	24.73	1.36	3.13
Total Copepods + Cladocerans	3.54	1.62	0.80	0.65	4.19	1.41	16.33	2.99	10.11	110.00	6.17	14.35

[a]Only station two sampled.

[b]Only stations two and four sampled.

Appendix D. Average number of macrozooplankton per m^3 from Black Lake, by sample date, 2001.

Taxon	5/10	5/30	6/6	6/20	6/30	7/21	Average
Copepods:							
Epischura	1,592	531	796	1,062	0	0	663
Ovig. *Epischura*	0	0	0	0	0	0	0
Diaptomus	0	1,062	0	0	0	579	273
Ovig. *Diaptomus*	0	0	0	0	0	0	0
Cyclops	0	2,123	0	0	7,245	1,158	1,754
Ovig. *Cyclops*	0	0	0	0	0	0	0
Harpaticus	0	0	0	0	0	579	97
Nauplii	3,981	0	1,062	265	2,787	1,158	1,542
Total copepods	5,573	3,715	1,858	1,327	10,032	3,474	4,330
Cladocerans:							
Bosmina	1,194	0	796	531	12,261	17,371	5,359
Ovig. *Bosmina*	0	0	0	0	557	4,922	913
Daphnia l.	0	0	0	0	557	0	93
Ovig. *Daphnia l.*	0	0	0	0	0	0	0
Chydorinae	766,720	531	0	0	0	15,924	130,529
Total cladocerans	767,914	531	796	531	13,376	38,217	136,894
Total copepods + cladocerans	773,487	4,246	2,654	1,858	23,408	41,691	141,224
Rotifers:							
Kellicottia	0	531	0	0	1,672	0	367
Asplanchna	0	0	0	0	89,729	0	14,955
Keratella	0	18,047	0	0	6,688	0	4,122
Conochilus	0	9,023	0	0	2,229	0	1,875
other rotifers	0	5,839	0	0	0	97	989
Total rotifers	0	33,439	0	0	100,318	97	22,309
Other:							
Ostracoda	11	0	0	0	0	2	2

Appendix E. Biomass estimates (mg dry weight/m^3) of the major zooplankton species, by sample date, from Black Lake, 2001.

Taxon	5/10	5/30	6/6	6/20	6/30	7/21	Average	Weighted average
Copepods:								
Epischura	0.17	0.37	0.89	1.84	0.00	0.00	0.55	0.39
Diaptomus	0.00	5.53	0.00	0.00	0.00	0.75	1.05	0.94
Cyclops	0.00	2.61	0.00	0.00	10.42	0.63	2.28	2.24
Harpaticus	0.00	0.00	0.00	0.00	0.00	0.97	0.16	0.16
Total copepods	0.17	8.51	0.89	1.84	10.42	2.35	4.03	3.73
Cladocerans:								
Bosmina	0.27	0.00	0.39	0.00	10.08	9.43	3.36	3.37
Ovig. *Bosmina*	0.00	0.00	0.00	0.00	0.51	5.28	0.97	0.97
Daphnia l.	0.00	0.00	0.00	0.00	0.15	0.00	0.02	0.02
Chydorinae	6.63	0.01	0.00	0.00	0.00	1.04	1.28	1.22
Total cladocerans	6.89	0.01	0.39	0.00	10.74	15.75	5.63	5.58
Copepods to cladocerans	0.02	1558.62	2.30	na	0.97	0.15	0.72	0.67
Total Biomass	7.06	8.51	1.28	1.84	21.16	18.10	9.66	9.31

Appendix F. Beach seine catch data by location, site, and date, 2001.

Location	Site	Date	Water temp (°C)	Sockeye salmon > 45 mm	Sockeye salmon < 45 mm	Sockeye salmon Total	Coho	King	Stickleback	Pond smelt	DollyVarden	Other
Chignik Lake	1	5/11	3.0	0	18	18	0	0	1	0	0	
	1	6/2	6.0	7	0	7	23	25	1	0	145	
	1	6/21	11.0	192	2	194	7	18	17	0	2	
	1	7/16	9.5	4	0	4	21	9	0	0	111	
	1	8/7	12.0	38	0	38	2	3	14	17	10	
Chignik Lake	2	5/11	2.5	137	52	189	0	0	66	0	0	
	2	6/2	6.0	600	0	600	21	11	300	25	51	
	2	6/21	9.0	181	0	181	24	2	6	0	2	
	2	7/16	10.0	18	33	51	10	1	29	12	26	
	2	8/7	11.5	4	1	5	2	6	5	6	7	
Chignik Lake	3	5/11	4.0	152	7	159	0	0	3	0	0	
	3	6/2	3.0	1	0	1	0	0	1	0	0	
	3	6/21	7.0	3	1	4	0	0	1	0	2	
	3	7/16	9.0	5	1	6	0	0	0	0	0	
	3	8/7	10.0	29	0	29	0	0	3	5	0	
Chignik Lake	5	5/11	6.5	2	3	5	0	0	0	0	1	2 sculpin
	5	6/2	5.0	23	1	24	0	93	6	0	14	1 sculpin
	5	6/21	8.0	7	0	7	0	8	1	0	31	
	5	7/16	10.0	6	2	8	0	0	3	0	0	
	5	8/5	12.0	38	0	38	8	0	0	1	3	
Chignik Lake	6	5/11	7.0	147	0	147	2	0	150	0	0	
	6	6/21	8.0	45	0	45	0	1	42	0	1	
	6	7/16	10.0	7	0	7	0	2	2	0	0	
	6	8/5	11.5	0	0	0	0	0	0	0	0	
Chignik Lake	7	5/11	3.5	268	12	280	1	2	25	0	0	

-Continued-

Location	Site	Date	Water temp (°C)	Sockeye salmon > 45 mm	Sockeye salmon < 45 mm	Sockeye salmon Total	Coho	King	Stickleback	Pond smelt	Dolly Varden	Other
	7	6/2	6.0	14	0	14	0	7	15	0	1	
	7	6/21	10.0	24	2	26	9	0	147	0	4	1 sculpin
	7	7/16	11.0	13	0	13	0	0	2	0	12	
	7	8/5	13.0	2	0	2	1	0	6	0	0	
Chignik Lake	8	5/11	3.5	661	5	666	26	4	55	0	4	
	8	6/2	5.0	81	0	81	31	0	13	0	5	
	8	6/21	11.0	41	0	41	74	3	270	1	47	
	8	7/16	11.0	16	1	17	5	0	126	0	0	
	8	8/5	14.0	42	0	42	14	0	55	0	15	
Chignik River	1	6/27	9.5	259	4	263	0	0	51	1	0	
	1	7/25	11.5	45	0	45	2	0	14	0	0	
	1	8/2	12.0	280	3	283	4	5	211	8	4	5 sculpin
	1	8/9	12.0	119	0	119	36	5	11	48	5	5 sculpin
	1	8/15	13.0	7	3	10	6	0	10	1	1	1 sculpin
Chignik River	2	6/27	9.5	341	20	361	2	2	315	60	1	2 Sculpin
	2	7/25	11.5	817	3	820	10	2	879	7	3	7sculpin
	2	8/2	12.0	162	2	164	15	2	301	14	5	
	2	8/9	13.0	699	0	699	9	3	396	10	3	6 sculpin
	2	8/15	14.0	71	0	71	1	0	116	0	0	
Chignik River	3	6/28	9.0	196	3	199	25	2	119	12	1	
	3	7/25	13.0	615	3	618	16	0	876	41	3	1 sculpin
	3	8/2	12.5	150	2	152	11	1	164	2	2	
	3	8/9	14.0	404	0	404	23	8	1169	2	1	9 flounder, 2 sculpin
	3	8/15	13.5	71	0	71	3	2	49	0	0	

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Location	Site	Date	Water temp (°C)	Sockeye salmon > 45 mm	Sockeye salmon < 45 mm	Sockeye salmon Total	Coho	King	Stickleback	Pond smelt	Dolly Varden	Other
Lagoon	1	5/18	6.0	135	283	418	31	0	44	0	0	
	1	6/5	10.0	43	2	45	3	0	36	9	10	
	1	6/18	10.5	73	0	73	19	24	45	3	4	
	1	7/2	10.0	19	0	19	22	0	14	0	4	
	1	7/26	13.5	165	0	165	1	2	19	0	0	
	1	8/6	17.0	499	101	600	0	20	50	1	20	
Lagoon	2	5/18	7.0	1	0	1	0	0	1	0	0	1 poacher
	2	6/5	9.0	61	0	61	0	0	13	0	3	2 sculpin
	2	6/18	11.0	11	2	13	0	0	2	0	2	
	2	7/2	12.0	18	4	22	1	0	1	0	3	
	2	7/26	12.0	84	2	86	0	0	4	0	1	
Lagoon	3	6/5	8.0	0	0	0	0	0	0	0	81	2 Sculpin
	3	6/19	9.5	0	0	0	0	0	0	0	1	1 kelp greenling, 2 sculpin, 1 humpy
	3	7/10	8.4	2	0	2	0	0	0	0	100	30 sculpin
	3	7/30	12.0	267	0	267	0	0	0	0	3	2 Sculpin
Lagoon	4	5/18	8.5	115	120	235	0	0	25	0	0	1 flounder
	4	6/5	9.0	311	171	482	0	0	165	0	11	7 flounder
	4	6/18	10.0	70	1	71	0	11	105	0	2	15 flounder
	4	7/2	14.0	9	2	11	0	0	83	0	0	228 flounder
	4	7/10	8.4	120	0	120	10	0	100	5	40	0
	4	7/25	13.5	20	0	20	1	0	5	0	0	0
	4	8/6	17.5	9	4	13	1	0	0	0	0	75 flounder, 90 sculpin
Black Lake	1	5/15	9.5	0	3	3	0	0	4	0	0	
	1	5/30	11.0	1	82	83	0	0	0	1	0	
	1	6/14	8.5	0	2	2	0	0	0	0	0	
	1	7/11	10.5	3	0	3	0	0	2	0	1	

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Location	Site	Date	Water temp (°C)	Sockeye salmon > 45 mm	Sockeye salmon < 45 mm	Sockeye salmon Total	Coho	King	Stickleback	Pond smelt	Dolly Varden	Other
Black Lake	2	5/15	8.5	0	17	17	0	0	0	0	0	
	2	5/30	10.0	0	71	71	1	0	0	0	2	
	2	6/15	8.0	0	20	20	0	0	1	0	0	
Black Lake	3	6/15	8.0	2	2	4	2	0	21	0	0	
Black Lake	4	5/15	8.0	0	0	0	0	0	0	1	0	
	4	5/30	9.0	0	118	118	0	0	0	0	0	
	4	6/15	8.0	0	0	0	0	0	0	0	0	
Black Lake	5	5/14	12.0	0	33	33	0	0	32	0	4	3 blackfish
	5	5/29	12.0	0	122	122	6	1	76	0	9	
	5	6/14	9.0	4	8	12	1	0	1	0	1	
	5	7/11	11.0	26	0	26	12	0	5	0	4	
Black Lake	7	6/20	12.0	7	85	92	0	0	19	0	0	
	7	7/11	11.0	4	1	5	0	0	0	0	0	
Black River	3	6/20	13.0	5	142	147	0	0	63	0	0	
						0						
Black River	2	6/20	9.5	0	1	1	0	0	2	0	0	

Appendix G. Townet catch data by location, transect, and date, 2001.

Location	Transect	Date	Time start	Time stop	Tow duration (hrs)	Boat speed (mph)	Depth (m)	Water temp (C)	Sockeye > 45 mm	Sockeye < 45 mm	Coho DollyVarden	King	Stickleback	Pond smelt	Dolly Varden
Chignik Lake	1 TO 2	5/24	13:54	14:04	0.17	2.4	0	4.5	1	0	0	0	7	0	1
		6/16	14:34	14:44	0.17	3.6	10	8.5	2	0	0	0	0	0	0
		6/16	15:05	15:15	0.17	1.5	20	9.0	3	0	0	0	16	0	4
		7/23	9:55	10:05	0.17	3.6	0	11.0	717	2	0	0	0	0	14
		7/23	12:41	12:51	0.17	4.3	10	12.0	4	0	0	0	1	0	10
		8/13	14:20	14:30	0.17	3.3	0	n/a	191	0	0	0	2	0	393
Chignik Lake	2 TO 3	5/24	14:21	14:31	0.17	3.5	0	5.0	0	0	0	0	1	0	0
		5/24	16:55	17:05	0.17	3.0	10	4.5	11	0	0	0	7	0	0
		6/16	15:40	15:50	0.17	3.3	20	9.5	1	0	0	0	1	0	0
		7/23	10:30	10:40	0.17	4.2	0	11.0	1,046	0	0	0	0	0	0
		7/23	12:16	12:26	0.17	4.1	10	12.0	15	0	0	0	1	0	0
		8/13	14:51	15:01	0.17	4.3	0	n/a	470	0	0	0	0	0	0
Chignik Lake	3 TO 4	5/24	14:47	14:57	0.17	3.3	0	5.5	0	0	0	0	0	0	0
		5/24	16:00	16:10	0.17	3.0	10	5.0	16	0	0	0	0	0	0
		6/16	16:06	16:16	0.17	3.2	20	9.0	1	0	0	0	0	0	0
		7/23	11:08	11:18	0.17	4.0	0	11.5	87	0	0	0	1	0	0
		7/23	11:46	11:56	0.17	4.2	10	11.5	19	1	0	0	2	1	0
		8/14	13:45	13:55	0.17	4.0	0	13.0	4	1	0	0	16	0	0
Chignik Lake	FRI /Clark[a]	7/9	15:00	15:12	0.2	3.0	0	11.0	7	0	0	0	0	0	0
	FRI/Delta[b]	7/9	14:32	14:44	0.17	2.8	0	10.0	16	0	0	0	4	0	0
Black Lake	FRI tows[c]	7/3	12:00	12:10	0.17	3.3	0	13.0	1,200	0	0	0	0	200	0

[a] Chignik Lake, by the mouth of Clark River

[b] Chignik Lake, below the Black River Delta

[c]Black Lake FRI tows begin approximately .5km west of Hydro Point

Appendix H. Fyke net catch data by location and date, 2001.

		Time		Total time	Temp °C		Sockeye Catch			Other Catch			
Location	Date	Set	Pulled	(hrs)	Water	Air	> 45 mm	< 45 mm	Total	Coho	Chinook	Stickleback	Other
										DollyVarden			
Black River	5/14	12:06	16:00	3.90	8.5	21.5	0	15	15	0	0	1	0
Black River	5/15	11:45	12:45	1.00	8.0	7.5	0	13	13	0	0	2	0
Black River	5/29	11:15	14:20	3.08	10.0	10.5	0	0	0	0	0	0	0
		14:50	19:50	5.00	15.0	13.0	0	39	39	0	0	19	0
Black River	6/14	11:50	14:20	2.50	8.5	9.0	0	7	7	2	0	4	0
		15:00	18:00	3.00	9.5	8.0	0	0	0	1	0	14	0
Chignik River	7/17	9:45	11:00	1.25	10.0	15.0	10	0	10	0	1	0	1
	7/17	11:15	13:10	1.92	10.5	15.0	47	0	47	0	0	25	0
	7/17	13:25	15:30	2.08	11.0	15.0	37	0	37	0	1	7	0
Chignik River	7/26	9:00	16:00	7.00	11.5	12.0	161	1	162	0	1	2	0
Chignik River	8/1	13:15	15:25	2.17	12.0	17.0	17	0	17	0	4	12	0
Chignik River	8/6	9:43	13:15	3.53	12.0	13.5	31	0	31	6	6	94	2
	8/6	13:30	16:30	3.00	13.0	18.0	29	0	29	1	3	98	4
Chignik River	8/15	9:30	16:10	6.67	13.0	15.0	58	0	58	0	12	44	0