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# Chignik Lakes Research

## Investigations of Salmon Populations, Hydrology, and Limnology of the Chignik Lakes, Alaska

ALASKA SALMON PROGRAM

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**Semi-Annual Report**
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## Key words

Alec River, beach seine, Black Lake, Chignik Lake, escapement goals, fry emergence, hydrology, limnology, long-term trends, *Oncorhynchus nerka*, Ricker recruitment curve, sockeye salmon, townet

# CHIGNIK SALMON STUDIES

## Investigations of Salmon Populations, Hydrology, and Limnology of the Chignik Lakes, Alaska

G.T. RUGGERONE, R. STEEN, AND R. HILBORN

### INTRODUCTION

The purpose of this work is to annually measure the relative abundance and size of juvenile sockeye salmon (*Oncorhynchus nerka*), relative abundance of potential competitor and predator species, and the biological and physical environment for sockeye salmon in the lakes during spring through fall. These data are complementary to sockeye smolt studies conducted by Alaska Department of Fish and Game (ADFG) and winter ecology studies by Dr. Greg Ruggerone. A long-term database resulting from these measurements provides a basis from which to evaluate changes in the production of adult sockeye salmon from the Chignik Lakes and perhaps a means of stabilizing or increasing production.

A key concern among Chignik fishermen, residents, and biologists has been the substantial change in the water volume of Black Lake since the late 1960s. This change appears to have caused greater premature outmigration of Black Lake sockeye to Chignik Lake (Ruggerone et al. 1993, Ruggerone 1994). Large emigrations of fry appear to have a significant adverse effect on adult returns to Chignik Lake. The exceptionally low water volume and adverse conditions during some winters appear to reduce survival of juvenile sockeye in Black Lake and influence large annual fluctuations in adult returns (Ruggerone 1997).

The objective of the 1999 research and monitoring at Chignik was to continue the basic monitoring of biological and physical characteristics that were monitored in past years and to conduct three additional projects: (1) Alec River hydrology, (2) initiation of a juvenile sockeye sampling protocol in the Chignik lagoon, and (3) sampling of potential predators of salmon immediately outside Chignik Lagoon. The Alec River hydrology project stems from past measurements documenting the shifting of the Alec River from Alec Bay to the Black Lake outlet (Ruggerone 1997). In Chignik Lagoon, we collected juvenile salmon from the inner and outer lagoon and examined their length, stomach contents and scales in an effort to reexamine use of the lagoon by salmon. Outside Chignik Lagoon, we tried to capture Pacific cod (*Gadus macrocephalus*) and walleye pollock (*Theragra chalcogramma*) by hook and line in an effort to examine predation on salmon smolts during the spring outmigration. However, nearly all cod had left Chignik Bay in late May according to local cod fishermen, and our catches of cod were too small to provide relevant information on predation. The apparent emigration of cod was an unusual event according to fishermen. Future sampling of predation by cod on salmon could benefit from sampling of commercial fishing boats taking cod in pots near the sandspit.

The 1999 fieldwork was completed in two periods: 8 June through 6 July, and 4 September through 8 September. The following work was done:

- Temperature, water transparency (Secchi depth), phytoplankton (chlorophyll *a*), and zooplankton densities were measured to assess the summer standing crop of primary producers and zooplankton (the main source of food for sockeye salmon in Chignik Lake).
- Data from automatic temperature loggers were downloaded and the temperature loggers were re-deployed to record continuously until collection in summer 2000 (Chignik air temperatures, Chignik River, and Black Lake).
- Emergent fry traps were deployed along Hatchery Beach and Delta Beach. The traps were set in mid-June and checked about every 6 days to assess the relative abundance and timing of emergent sockeye fry.
- Beaches were seined weekly at seven established stations on Chignik Lake and in Chignik Lagoon from June to July to assess the relative abundance of juvenile sockeye salmon and associated species nearshore.
- Townetting was conducted in both Black and Chignik lakes during early September to assess the relative abundance and lengths of juvenile sockeye salmon in the pelagic region.
- Measurements of discharge in the south and north forks of the Alec River were made on five occasions, and bank erosion of the south fork was monitored.

## LIMNOLOGY

### Methods

Water temperature, water transparency, phytoplankton, and zooplankton samples were collected five times on both Black Lake (three stations, Fig.1) and Chignik Lake (two stations, Fig. 2). Water clarity was estimated with a Secchi disk. Water temperatures were taken with a pocket thermometer on the lake's surface at Black Lake and from water taken at several depths with a van Dorn bottle at Chignik Lake. Additionally, data were collected from automatic, year-round temperature loggers deployed in Black Lake, Chignik River, and out of the water to measure air temperature. After the data from these loggers were downloaded, the loggers were reset to record continuously until retrieval in the summer 2000. Water samples were taken immediately below the surface for Black Lake, which is shallow and well mixed, and at 0, 1, 5, 10, and 20 m below the surface in Chignik Lake. Chlorophyll *a* analysis was performed on water that was sieved through Millipore filters (0.48μ); the amount filtered depended on how much algae was in the water (i.e., denser samples clogged the filter faster). The filters were then processed with a Spectronic 20 spectrophotometer. Zooplankton samples were taken with a 153μ-mesh, 0.5-m diameter net in Chignik Lake by hauling the net 40 m vertically through the water. In Black Lake, zooplankton were collected by hauling the net horizontally along the lake surface for approximately 20 m.

### Results

Black Lake is shallow and turbid. Water temperature responds quickly to air temperature and increases rapidly after ice-out. In 1999, water temperature reached 12°C at one site by the end of June and remained relatively constant at 10-11°C into July and in September (Table 1). A continuous temperature logger recorded water temperatures of nearly 15°C during some periods in July and August, 1998 and <2°C at times in November 1998 and May 1999 (Fig. 3). The temperature time-series indicates Black Lake was covered in ice from late November through late April. Exceptionally cold temperatures occurred during 2 weeks in early February. Typically, Black Lake warms more rapidly than Chignik Lake during spring and summer, but temperature also declines more rapidly in the fall (Ruggerone 1997).

Secchi readings (water clarity) in Black Lake are influenced by both phytoplankton and suspended sediments caused by windstorms. Secchi depths in 1999 (1.2 m) were on the low end of those recorded in previous years (1.3–2.2 m) (Tables 1 and 2). Chlorophyll *a* measurements were exceptionally high during mid-summer, averaging 3.37 mg/m$^3$. High concentrations were found at all three sites in Black Lake with the highest values recorded at Alec Bay and the outlet. In many years the outlet and Alec Bay, which are both greatly influenced by runoff from Alec River, have had lower concentrations than Hydro Point. Chlorophyll *a* in Black Lake is high compared with that of other sockeye lakes in Alaska (Burgner et al. 1969, Ruggerone 1994).

Zooplankton densities in Black Lake were low compared to those in Chignik Lake (Table 3). However, relatively high densities were sampled at Hydro Point in late June and early July due to high *Bosmina* abundance. The lower density probably reflects the shallow depth of the lake, high density of planktivores, high levels of suspended sediments during wind events, and less efficient sampling by the plankton net, which often clogged with filamentous diatoms. Zooplankton densities in Black Lake during 1999 were much higher than in previous years (Table 4). The high zooplankton counts occurred among all species and time periods. The reason for the relatively great zooplankton densities is unknown, but we note that sockeye density during fall was somewhat below average. Insects are important sockeye prey in Black Lake compared with Chignik Lake (Parr 1972, Ruggerone 1994).

Chignik Lake is much deeper than Black Lake and the water column is typically well mixed by the strong, consistent winds. Water temperature averaged approximately 6.3°C in June. Temperatures were very cold in early June (4–5°C) and warmed up to about 10°C by early September (Table 5). Temperature during 1999 was colder than that of most previous years (Table 6). Secchi readings ranged from 0.5–3.5 m, but water transparency was much lower in 1999 compared with past years, owing to significant glacial waters originating from the West Fork River. Lower transparency occurred near the northwest portion of the lake where the relatively turbid Black and West Fork rivers enter the lake. Low water clarity occurred from mid-June through at least September. Similar events have occurred occasionally in the past although turbidity in 1999 seemed to persist for a relatively long time.

Chignik Lake typically has an exceptionally high concentration of phytoplankton compared with other major sockeye lakes. In 1999, chlorophyll *a* averaged 3.42 mg/m$^3$, which is slightly higher than observed in past years (Tables 5 and 6), suggesting that turbidity and low temperatures may not have significantly reduced the standing crop of phytoplankton.

Zooplankton in Chignik Lake displayed the typical seasonal pattern of relatively high abundance of *Cyclops* spp. during early summer followed by an increase in numbers of cladocerans during late summer and fall. Abundance of zooplankton in 1999 was high (2,009,000 m$^{-2}$) compared with most years (range: 393,000 to 4 million m$^{-2}$) (Table 7). Only zooplankton densities during 1997 (a year of calm, sunny days) were greater, suggesting that the high turbidity and low temperature did not reduce zooplankton abundance. Zooplankton abundance in Chignik Lake is high compared with sockeye lakes in central and southeast Alaska (228,000 ± 48,000 $m^{-2}$) (Kyle 1991) and western Alaska (250,000 $m^{-2}$ for 60-m haul) (D.E. Rogers, Univ. Washington School of Fisheries, unpubl. data). The exceptional zooplankton abundance in 1997 (4.0 million $m^{-2}$) was associated with the exceptionally abundant smolt outmigration in 1998 (Perez-Fuentetaja et al. 1999).

## Emergent Fry

Since 1986, numbers of emergent fry have been estimated on two beach spawning areas of Chignik Lake using conical-shaped traps (Ruggerone 1994). Peak emergence appears to be in early June, but many fry can emerge in May. The fry emergence index period consistently used in the historical database spans the month of June. No fieldwork was done in 1994, but our sampling resumed in 1995 on the Hatchery and Delta beaches.

In 1999, sampling did not begin until June 13. A total of 20 traps were deployed from June 13 to July 4. Monthly fry counts ($m^2$) during June were 5.2 along Hatchery Beach and 7.4 along Delta Beach (Table 8). The counts undoubtedly underestimated the rate of emergence compared with previous years because peak emergence occurs in early June. These estimates were below average but not exceptionally low compared with several past years.

Note that the exceptionally high emergence rate at Hatchery Beach (a major spawning ground) in 1996 corresponds to the exceptionally large smolt emigration in 1998.

Too few data are available for the purpose of comparing emergence rates with adult returns. However, available data suggest adult returns to Chignik Lake may be positively correlated with emergence rates and negatively correlated with large returns to Black Lake (multiple regression, $n = 8$, overall $p = 0.08$). These preliminary results are consistent with other data that suggest large emigration of fry from Black Lake to Chignik Lake has an adverse effect on adult returns to Chignik Lake (Ruggerone 1996).

## Townet Sampling

Townet hauls were made annually in the Chignik Lakes from 1960 to 1973 (Rogers et al. 1996). Although tow lengths sometimes varied, all catches were standardized to 10 min (Parr 1972). Arithmetic and geometric means have been calculated in the past; however, only arithmetic means are presented here. Since 1973, townetting has been sporadic; however, since the development of relatively stable funding provided by Chignik Regional Aquaculture Association, we have sampled both lakes since 1992, except for 1994[1] (Tables 9 and 10). Catches of juvenile sockeye were low for Chignik Lake and, compared with recent years, about average for Black Lake.

Scales were taken from Black Lake and Chignik Lake sockeye for aging. Approximately 60% of the sockeye in Chignik Lake were young-of-the-year fish. Chignik fry were primarily 50–60 mm in length and yearlings were primarily 60–70 mm in length. Black Lake juvenile sockeye were all young-of-the-year fish with the majority falling between 60–80 mm in length (Fig. 4). In comparison to sockeye lengths collected during past winter studies, the Chignik Lake yearlings in 1999 were small and the Black Lake sockeye were large (Ruggerone 1999).

## Beach Seining

### Chignik Lake

Beach seining was conducted in Chignik Lake in several years prior to 1973 and since the mid-1980s (Ruggerone 1989, Rogers et al. 1996). Catches of juvenile sockeye salmon have been recorded as larger or smaller than 45 mm. The small fish were likely to be fry (age 0) whereas the larger fish likely were a mixture of yearlings from Chignik Lake and large fry from Black Lake. Juvenile coho salmon are usually more abundant in beach seine catches than in townet catches, which reflects their preference for the nearshore habitat (Ruggerone 1989).

Catches of juvenile sockeye salmon were slightly lower than the recent year overall catches. Catches of sockeye <45 mm in length compsed a higher proportion of the fish sampled (Table 11). However, beach seine sampling may not reflect abundance of Chignik Lake sockeye, especially fry, because fry are readily consumed by juvenile coho, which that are most abundant nearshore (Ruggerone 1989). Coho, char, and threespine stickleback (*Gasterosteus aculeatus*) catches were about equal to the historical average but were much lower than the recent 2 years. Additionally, some juvenile coho were sampled for stomach content analysis. An intensive study of coho predation on sockeye salmon during the mid-1980s showed that coho consumed approximately 24–78 million sockeye salmon fry depending on year, or approximately 59% of the emerging sockeye population (Ruggerone and Rogers 1992). The number of sockeye fry per coho stomach in 1999 averaged approximately 1.1 (range 0–3 fry), which was similar to past estimates (Table 12).

### Chignik Lagoon

Beach seine sampling was conducted in Chignik Lagoon in June and the early part of July (Table 13). Three locations were sampled: the sandspit at the outer lagoon, Pt. Hume near the upper lagoon, and a lower river area strongly

[1]Sampling by ADFG in 1994 using a net towed by a single boat produced only a few sockeye per tow.

influenced by tidal flows. In addition to the many sockeye smolts that were caught, some recently emerged sockeye fry (30 mm) appeared in catches near the sandspit (outer lagoon). Although it would seem that these fry might have been washed downstream from the Chignik River spawning area, it is unusual that they would be found in the outer lagoon, where salinity was that of marine waters. Additionally, approximately 500 fry were captured in a single set made in the lower river area during early July. The average length and weight of sockeye smolts captured in the lagoon were 77 mm and 5 grams (Fig. 4). Scales of sockeye salmon have been collected and pressed so that spring plus growth may be examined as an index of rearing time in the lagoon. This analysis may be conducted following next year's sampling.

Stomach contents of sockeye salmon smolts were examined for visual estimates of stomach fullness and the presence of various prey types. No obvious trends in stomach fullness and prey types were observed among the three locations and time periods, although fish larvae (present in 2% of sockeye) were only found in sockeye captured at the lagoon spit (Table 14). Approximately 85% of the sockeye had consumed amphipods, which were the dominant prey. Immature insects (mainly pupae) were frequently consumed by sockeye (32% of fish) at all locations, suggesting that sockeye either foraged on drift entering the lagoon from small streams or they rapidly moved from freshwater to the outer lagoon. Stomach fullness averaged 49% at the three locations and only 3% of the 263 sampled sockeye contained <5% stomach fullness, indicating the majority of sockeye were actively feeding and finding prey in Chignik Lagoon.

## ALEC RIVER HYDROLOGY

Previous research has shown that the south channel of the lower Alec River leading into the lake outlet is becoming larger relative to the north channel leading into the main lake (Ruggerone 1994, 1997). The cause of the shifting Alec River channels appears to be related to the lowering of Black Lake elevation, which was apparently initiated by downstream migration of the West Fork River and subsequent degradation of Black River since the late 1960s[2]. The migration of Alec River channels is important to sockeye salmon because greater discharge to the south channel during early spring will likely carry larger numbers of emerging sockeye fry to the outlet of Black Lake and may encourage more fry to emigrate to Chignik Lake. During low water periods, an exposed sandspit crosses approximately 80% of the lake and separates the main lake from the outlet.

Erosion of the banks along the south channel of Alec River has been monitored since 1991 (Ruggerone and Denman 1990), and in 1993 the relationship between total river discharge and the percentage of river water entering the south channel was quantified. During low flows, such as those occurring during fry emergence, approximately 70% of the river flow (and presumably 70% of fry) entered the lake outlet. During exceptionally high flow events, the percentage of total discharge to the outlet declined to approximately 40%.

The purpose of the 1998 and 1999 Alec River investigations was to continue monitoring the river bank erosion and to measure river discharge in the two channels to determine the extent to which discharge was shifting toward the south channel and the lake outlet (Ruggerone 1994, 1997).

### *Results*

Annual measurements of erosion along the south channel riverbank at nine locations indicated that approximately 0.33–0.45 m of the right bank is lost per year, depending on location (Table 15). This represents an increase in river width of approximately 1.2% per year. Greatest erosion is occurring at the river wye and along the river bend approximately 150 m downstream from the wye. Significant sloughing and sinking of the wye occurred during 1997–98.

We attempted to measure discharge in each channel at a variety of discharge levels, but exceptionally low and high flow conditions were not available during the 1998–99 sampling period. River discharge was measured on nine occasions. Total discharge ranged from 575 cubic feet per second (cfs) to 2,017 cfs, which is intermediate to the previously documented range of 196–3,070 cfs. Seven of the nine discharge measurements displayed slightly greater flow to the south channel compared with the regression relationship derived from 1992–93. At a given total discharge level, 1.2% more water flowed through the south channel in 1998–99 on average, compared with the earlier measurements (Fig. 5). Greater discharge through the south channel is consistent with measurements of bank erosion in the south channel. These data indicate river flow is continuing to shift toward the lake outlet, an effect that likely has important consequences for sockeye salmon production in the Chignik system.

During the fall 1999 field season, we observed a broad sandspit extending west from the Alec River delta and across most of Alec Bay toward the old Fisheries Research

[2]Significant changes in the Black River channel continue to occur between Chiatuak Creek and the area immediately below the old West Fork channel. At the FRI camp across from Chiaktuak Creek, approximately 50 feet or more of the bank has been lost, including two cabins since 1984. During the past 6–7 years, the large sandbars in this area have been invaded by dense perennial vegetation. It appears that the channel is continuing to degrade since the sandbars appear to be covered less frequently by river flows. The implication of channel degradation is additional lowering of Black Lake water elevation.

Institute (FRI) cabin. This spit was visible during fall 1990, but only when the lake level was extremely low and wind was approximately 60 mph from the southeast. During 1999, the spit was visible during calm winds and moderately low water, indicating potentially significant deposition of sediment in this area. Past research indicated significant sediment transport from Alec River (Ruggerone 1994). Observations of this area should continue in the future and profiling of the lake depth contours should be considered. The depth contours of Black Lake were last estimated in 1993 (Ruggerone 1994).

During September 1999, we were unable to sample fish in the Black Lake outlet with the 4-foot-deep townet, which was specially designed for the outlet in the early 1990s, because water depth has become too shallow. Water depth across the lake outlet near the river head was approximately 45 cm (18 in), which is too shallow to operate propeller skiffs at night (we used two jet boats). As described in previous reports, FRI regularly sampled this area with a six foot deep townet in the 1960s.

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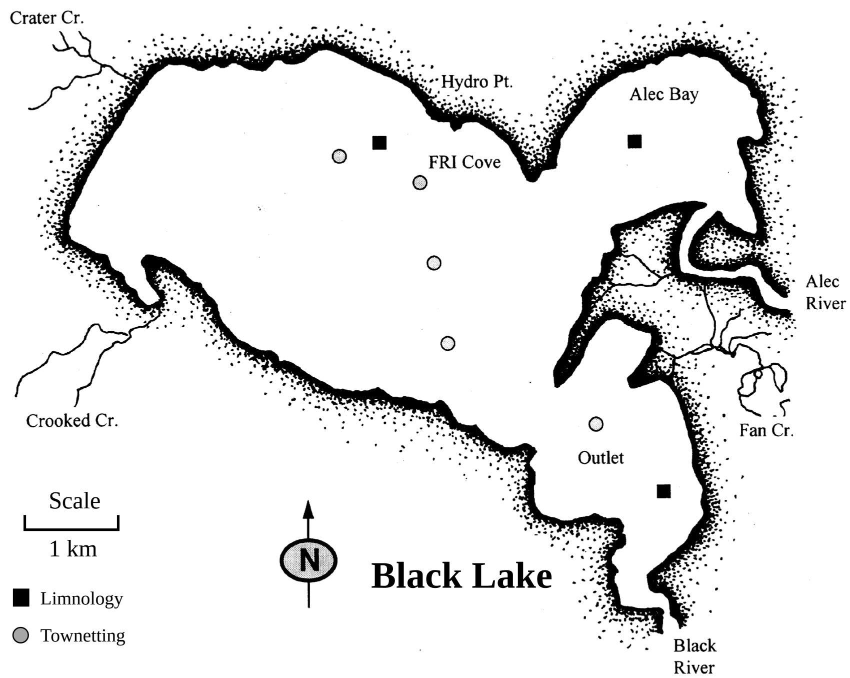


Figure 1. Black Lake sampling sites.

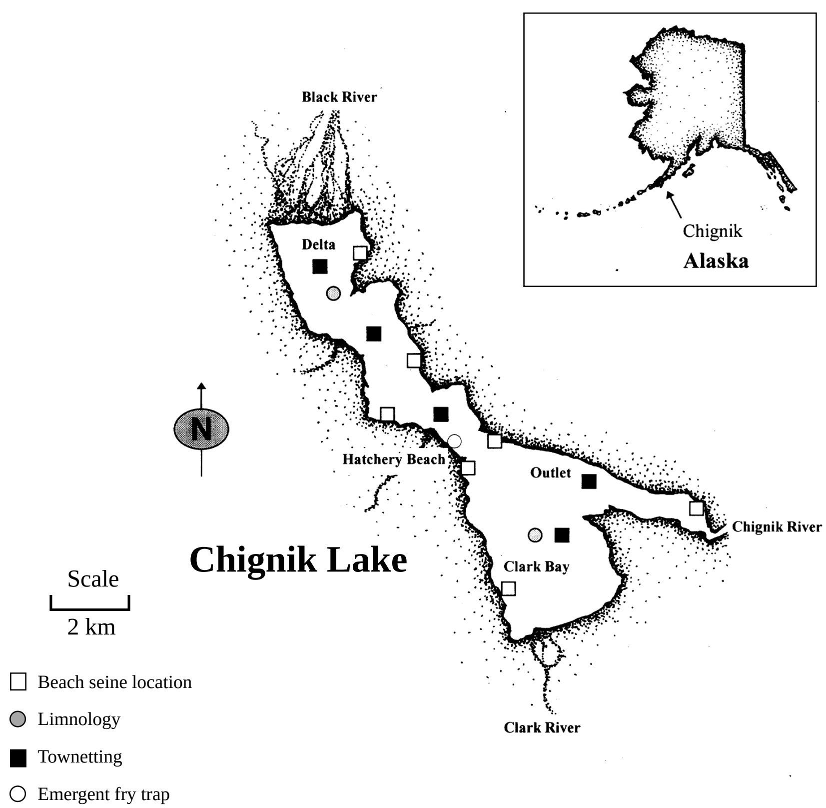


Figure 2. Chignik Lake sampling sites.

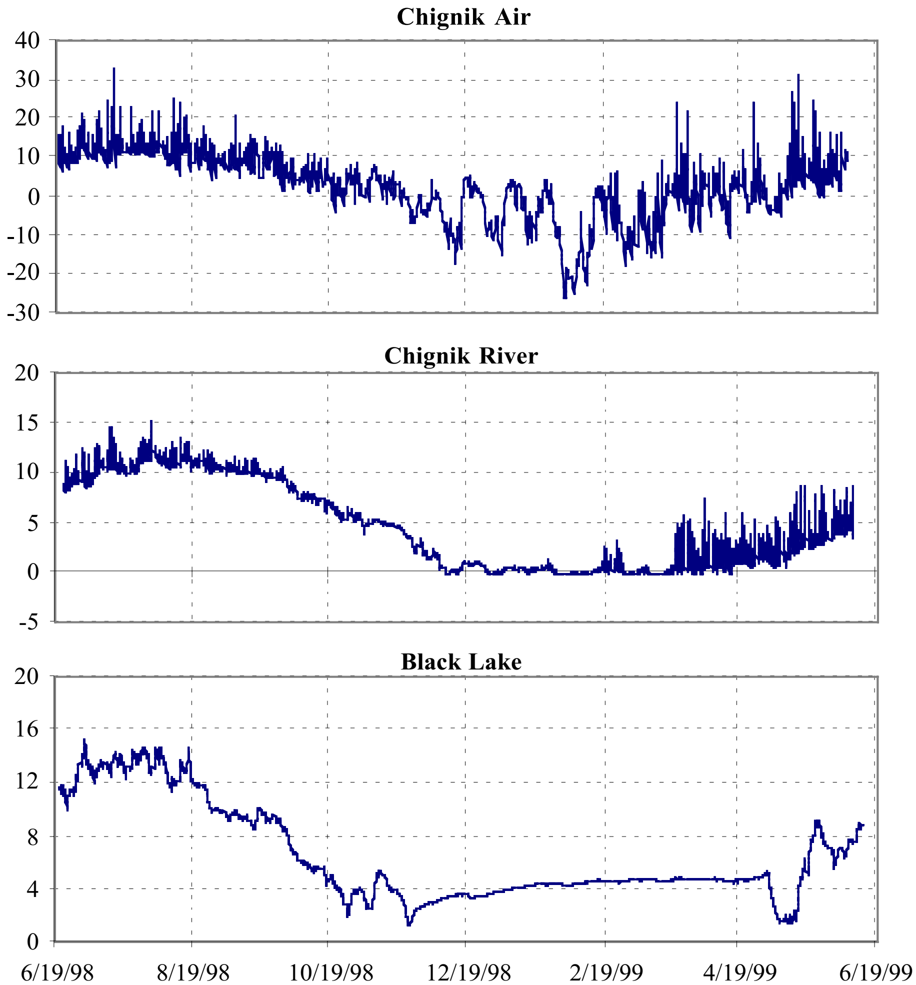


FIGURE 3. Daily temperatures (°C) measured year-round with automatic temperature loggers from Black Lake (water), Chignik River (water), and from our camp (air), 1998–99.

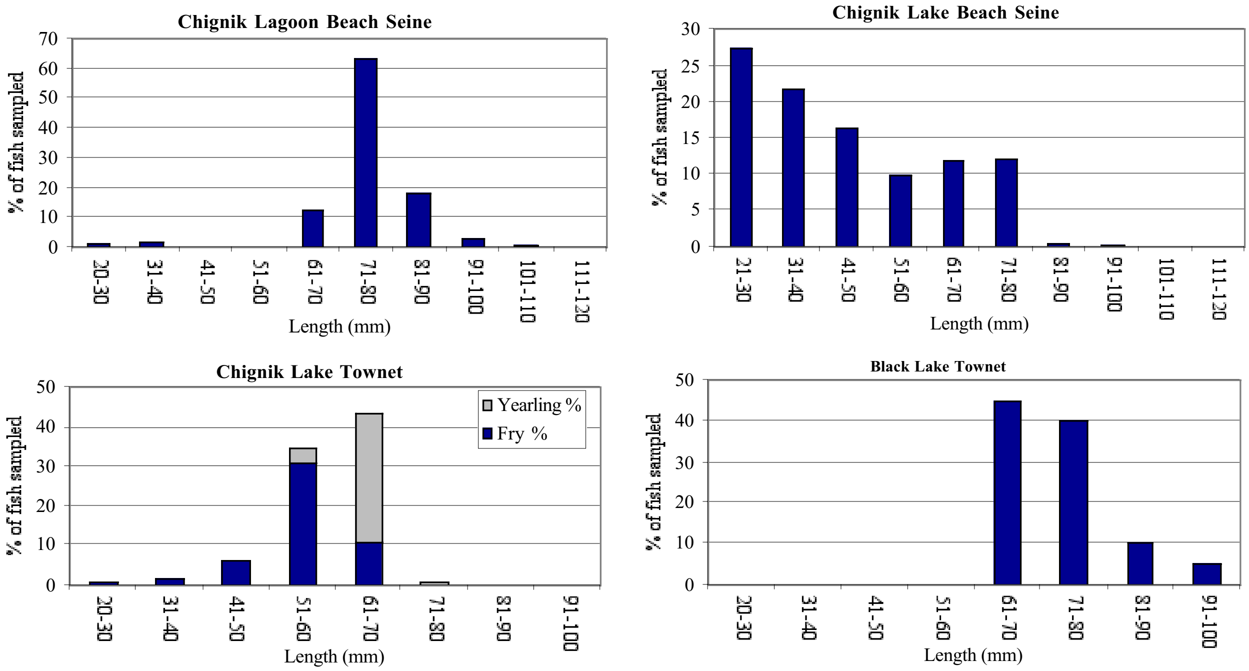


FIGURE 4. Length frequency distributions of juvenile sockeye sampled from beach seining (Chignik Lagoon and Chignik Lake) and townetting (Chignik and Black Lakes). Age distributions included for townet samples, 1999.

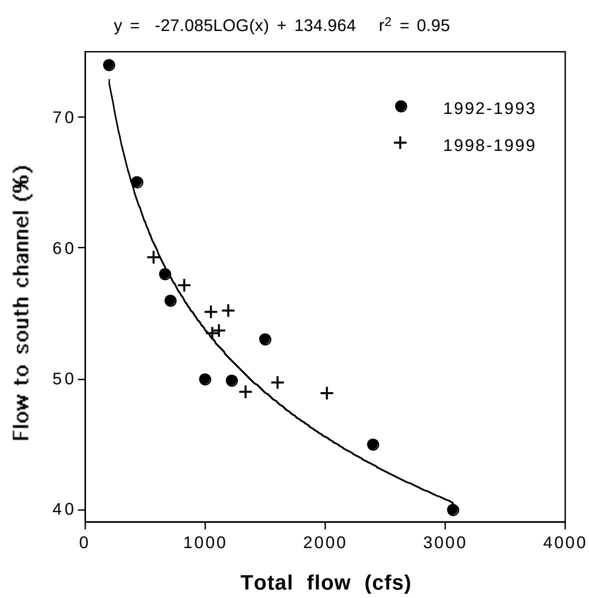


FIGURE 5. Percentage of Alec River flow entering the south channel in relation to total flow in Alec River during 1992–93 and 1998–99. Regression line represents 1992–93 data. On average, 1.2% more water was flowing through the south channel during 1998–99 than expected from the 1992–93 data.

TABLE 1. Limnological data from Black Lake, 1999.

| Date | Location | Secchi depth (m) | Surface temp. (°C) | Chlorophyll $a$ ($mg/m^3$) |
|---|---|---|---|---|
| 6/12 | Hydro Pt | 0.9 | 10.0 | 1.41 |
| | Alec Bay | 0.3 | 6.5 | 2.48 |
| | Outlet | 0.3 | 7.0 | 2.51 |
| 6/21 | Hydro Pt. | 1.0 | 11.5 | 2.48 |
| | Alec Bay | n/a | n/a | n/a |
| | Outlet | 1.5 | 11.0 | 2.82 |
| 6/26 | Hydro Pt | 1.5 | 12.0 | 4.69 |
| | Alec Bay | 1.0 | 10.8 | 2.41 |
| | Outlet | 1.5 | 8.5 | 1.92 |
| 7/5 | Hydro Pt. | 1.3 | 11.0 | 3.95 |
| | Alec Bay | 1.5 | 11.0 | 3.76 |
| | Outlet | 0.8 | 11.0 | 6.53 |
| 9/7 | Hydro Pt. | 1.5 | 10.0 | 3.92 |
| | Alec Bay | 1.8 | 9.5 | 6.29 |
| | Outlet | 1.3 | 10.0 | 2.65 |
| | 1999 means | 1.2 | 10.0 | 3.42 |

TABLE 2. Historical averages of limnological data from Black Lake, 1990–99.

| Date | | | Secchi depth | Surface water | Chlorophyll a |
|---|---|---|---|---|---|
| Mo | Day | Year | (m) | temp. (C) | $mg/m^3$ |
| 6 | 27 | 90 | 1.8 | 13.0 | 2.65 |
| 6 | 20 | 92 | n/a | n/a | 3.24 |
| 7 | 8 | 92 | n/a | n/a | 2.28 |
| 9 | 3 | 92 | n/a | n/a | 4.59 |
| 5 | 18 | 93 | 1.6 | 8.8 | 1.26 |
| 6 | 16 | 93 | 1.7 | 9.7 | 0.98 |
| 7 | 16 | 93 | 1.8 | 15.5 | 0.60 |
| 8 | 15 | 93 | 0.9 | 12.7 | 4.33 |
| 9 | 9 | 93 | 0.7 | 12.5 | 3.32 |
| 6 | 9 | 95 | 1.4 | 11.2 | 3.67 |
| 6 | 20 | 95 | 1.4 | 10.7 | 1.34 |
| 7 | 11 | 95 | 1.5 | 12.3 | 1.15 |
| 7 | 23 | 96 | 1.8 | 13.8 | 2.26 |
| 6 | 2 | 97 | 2.2 | 12.5 | 1.75 |
| 6 | 20 | 98 | 1.2 | 9.7 | n/a |
| 7 | 3 | 98 | 1.0 | 12.3 | 4.02 |
| 7 | 16 | 98 | 1.3 | 13.2 | 1.99 |
| 9 | 3 | 98 | 0.5 | 10.3 | n/a |
| 6 | 12 | 99 | 0.5 | 7.8 | 2.13 |
| 6 | 21 | 99 | 1.3 | 11.3 | 2.65 |
| 6 | 26 | 99 | 1.3 | 10.4 | 3.01 |
| 7 | 5 | 99 | 1.2 | 11.0 | 4.75 |
| 9 | 7 | 99 | 1.5 | 9.8 | 4.29 |

TABLE 3. Zooplankton densities in Chignik and Black lakes (1,000 m$^2$), 1999.

| Lake | Location | Date Mo | Day | Category Calanoids | *Cyclops* | *Daphnia* | *Bosmina* | *Chydoris* | Nauplii | *Asplanchna* | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chignik | Clark Bay | 6 | 8 | 45 | 830 | 51 | 23 | 0 | 102 | 9 | 1060 |
| | | 6 | 16 | 107 | 1073 | 112 | 51 | 0 | 166 | 9 | 1518 |
| | | 6 | 24 | 622 | 962 | 153 | 133 | 0 | 308 | 28 | 2206 |
| | | 7 | 6 | 478 | 620 | 140 | 140 | 7 | 586 | 96 | 2067 |
| | | 9 | 9 | 1053 | 194 | 133 | 111 | 4 | 165 | 4 | 1664 |
| Chignik | Delta | 6 | 8 | 144 | 1859 | 95 | 99 | 7 | 280 | 48 | 2532 |
| | | 6 | 16 | 227 | 1866 | 53 | 62 | 15 | 249 | 4 | 2476 |
| | | 6 | 24 | 446 | 929 | 344 | 267 | 0 | 280 | 13 | 2279 |
| | | 7 | 6 | 420 | 913 | 119 | 65 | 27 | 65 | 12 | 1621 |
| | | 9 | 6 | 878 | 553 | 269 | 481 | 62 | 344 | 16 | 2603 |
| Black | Hydro Pt. | 6 | 12 | 182 | 38 | 1 | 54 | 0 | 48 | 1 | 324 |
| | | 6 | 21 | 41 | 82 | 3 | 67 | 3 | 70 | 2 | 268 |
| | | 6 | 26 | 484 | 370 | 0 | 1152 | 38 | 410 | 8 | 2462 |
| | | 7 | 5 | 611 | 374 | 0 | 852 | 42 | 405 | 10 | 2294 |
| | | 9 | 7 | 10 | 41 | 0 | 932 | 28 | 10 | 0 | 1021 |
| Black | Alec Bay | 6 | 12 | 176 | 89 | 0 | 105 | 2 | 126 | 0 | 498 |
| | | 6 | 21 | 2 | 2 | 0 | 4 | 2 | 8 | 0 | 18 |
| | | 6 | 26 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 4 |
| | | 7 | 5 | 453 | 447 | 0 | 680 | 26 | 207 | 7 | 1820 |
| | | 9 | 7 | 9 | 9 | 1 | 24 | 0 | 18 | 0 | 61 |
| Black | Outlet | 6 | 12 | 27 | 11 | 1 | 24 | 0 | 20 | 0 | 83 |
| | | 6 | 21 | 97 | 81 | 2 | 176 | 12 | 164 | 4 | 536 |
| | | 6 | 26 | 13 | 7 | 0 | 17 | 4 | 4 | 0 | 45 |
| | | 7 | 5 | 73 | 42 | 0 | 107 | 8 | 36 | 0 | 266 |
| | | 9 | 7 | 23 | 122 | 0 | 1541 | 6 | 29 | 0 | 1721 |

Chignik Lake: From 40-m vertical hauls with a .5-m net of 153-µm mesh. Two hauls per date and station.

Black Lake: From 20-m horizontal hauls with a .5-m net of 153-µm mesh. Two hauls per date and station.

TABLE 4. Historical zooplankton densities (1000 $m^2$) in Black Lake, 1992–99.

| Year | Mo | Day | # sites | Calanoids | *Cyclops* | *Daphnia* | *Bosmina* | *Chydoris* | Nauplii | *Asplanchia* | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1992 | 6 | 20 | | 6 | 37 | 0 | 5 | 0 | 13 | 3 | 64 |
| 1993 | 5 | 17 | | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 5 |
| 1993 | 6 | 15 | | 13 | 1 | 0 | 21 | 0 | 0 | 0 | 35 |
| 1993 | 7 | 15 | | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 5 |
| 1993 | 8 | 14 | | 9 | 19 | 0 | 227 | 0 | 0 | 0 | 255 |
| 1993 | 9 | 8 | | 6 | 6 | 0 | 149 | 0 | 0 | 0 | 161 |
| 1995 | 6 | 9 | | 1 | 14 | 0 | 1 | 1 | 5 | 1 | 23 |
| 1995 | 6 | 20 | | 0 | 5 | 0 | 2 | 0 | 1 | 0 | 8 |
| 1995 | 7 | 11 | | 2 | 12 | 0 | 8 | 2 | 2 | 9 | 35 |
| 1995 | 9 | 5 | | 3 | 6 | 0 | 24 | 6 | 3 | 3 | 45 |
| 1998 | 6 | 20 | 2 | 2 | 8 | 0 | 1 | 0 | 3 | 1 | 15 |
| 1998 | 7 | 3 | 2 | 6 | 22 | 0 | 9 | 1 | 5 | 3 | 46 |
| 1998 | 7 | 16 | 2 | 5 | 5 | 0 | 14 | 0 | 6 | 1 | 31 |
| 1998 | 9 | 3 | 2 | 4 | 16 | 0 | 53 | 4 | 4 | 6 | 87 |
| 1999 | 6 | 12 | 3 | 128 | 46 | 1 | 61 | 1 | 65 | 0 | 302 |
| 1999 | 6 | 21 | 3 | 47 | 55 | 2 | 82 | 6 | 81 | 2 | 275 |
| 1999 | 6 | 26 | 3 | 166 | 126 | 0 | 390 | 14 | 138 | 3 | 837 |
| 1999 | 7 | 5 | 3 | 379 | 288 | 0 | 546 | 25 | 216 | 6 | 1460 |
| 1999 | 9 | 7 | 3 | 14 | 57 | 0 | 832 | 11 | 19 | 0 | 933 |

TABLE 5. Limnological data from Chignik Lake, 1999.

| Date | Clark Bay Secchi depth (m) | Clark Bay Depth (m) | Clark Bay Water temp. (°C) | Clark Bay Chlorophyll a mg/m³ | Delta Secchi depth (m) | Delta Depth (m) | Delta Water temp. (°C) | Delta Chlorophyll a mg/m³ |
|---|---|---|---|---|---|---|---|---|
| 6/8 | 3.5 | 0 | 4.5 | | 2.5 | 0 | 5 | |
| | | 1 | 4.5 | 3.20 | | 1 | 5 | 3.56 |
| | | 5 | 4.3 | 5.27 | | 5 | 5 | 1.25 |
| | | 10 | 4.2 | 3.18 | | 10 | 5 | 2.89 |
| | | 20 | 4.2 | 3.28 | | 20 | 5 | 3.20 |
| 6/16 | 3 | 0 | 7.5 | | 1.0 | 0 | 8.2 | |
| | | 1 | 7.5 | 8.06 | | 1 | 8.2 | 4.24 |
| | | 5 | 6 | 4.87 | | 5 | 8 | 2.52 |
| | | 10 | 6 | n/a | | 10 | 8 | 3.03 |
| | | *20 | 5.5 | 4.37 | | 20 | 7.5 | 2.03 |
| 6/24 | 2 | 0 | 7 | | 1.5 | 0 | 7 | |
| | | 1 | 7.5 | 3.11 | | 1 | 7 | 3.01 |
| | | 5 | 7.2 | 2.27 | | 5 | 7 | 4.00 |
| | | 10 | 7 | 3.29 | | 10 | 7 | 3.74 |
| | | 20 | 7 | 3.75 | | 20 | 7.2 | 3.82 |
| 7/6 | n/a | 0 | n/a | n/a | n/a | 0 | n/a | n/a |
| | | 1 | n/a | n/a | | 1 | n/a | n/a |
| | | 5 | n/a | n/a | | 5 | n/a | n/a |
| | | 10 | n/a | n/a | | 10 | n/a | n/a |
| | | 20 | n/a | n/a | | 20 | n/a | n/a |
| 9/6 | 0.75 | 0 | 10.2 | | 0.5 | 0 | 10.2 | |
| | | **1 | 10.2 | 2.68 | | 1 | 10.2 | 0.89 |
| | | **5 | 10.2 | 2.82 | | 5 | 10.2 | 3.34 |
| | | **10 | 10.2 | 3.43 | | 10 | 10.2 | 5.13 |
| | | 20 | 10.2 | n/a | | 20 | 10.2 | 2.06 |
| 1999 means | 2.3 | | 7.0 | 3.8 | 1.4 | | 7.6 | 3.0 |

*Chlorophyll sampled on 6/19.

**Chlorophyll sampled on 9/9.

TABLE 6. Historical averages of limnological data from Chignik Lake, 1988–99.

| Date | | | Secchi depth (m) | Averages over 1-20 m | |
|---|---|---|---|---|---|
| Mo | Day | Year | | Temp. (C) | Chlorophyll a ($mg/m^3$) |
| 6 | 16 | 88 | n/a | n/a | 4.13 |
| 7 | 14 | 88 | n/a | n/a | 2.92 |
| 6 | 24 | 89 | 2.4 | 9.2 | 3.38 |
| 6 | 24 | 90 | 1.8 | 8.6 | 2.40 |
| 6 | 21 | 91 | n/a | 8.3 | 2.55 |
| 6 | 23 | 92 | 1.8 | 9.6 | 3.27 |
| 7 | 11 | 92 | 2.6 | 9.9 | 2.68 |
| 9 | 3 | 92 | n/a | 10.8 | 5.42 |
| 5 | 10 | 93 | 2.2 | 4.3 | 7.96 |
| 6 | 17 | 93 | 1.4 | 9.1 | 0.88 |
| 7 | 26 | 93 | 0.6 | 12.4 | 0.81 |
| 8 | 18 | 93 | 0.8 | 11.7 | 1.49 |
| 9 | 10 | 93 | 0.8 | 11.6 | 1.71 |
| 6 | 8 | 95 | 1.7 | 7.5 | 4.89 |
| 6 | 17 | 95 | 1.6 | 9.0 | 3.23 |
| 6 | 29 | 95 | 2.5 | 9.1 | 2.61 |
| 7 | 7 | 95 | 2.4 | 10.1 | 1.85 |
| 7 | 17 | 95 | 2.7 | 11.1 | 2.91 |
| 6 | 17 | 96 | 2.0 | 9.0 | 3.22 |
| 7 | 4 | 96 | 2.7 | n/a | 1.50 |
| 7 | 12 | 96 | 2.6 | 9.6 | 2.03 |
| 7 | 30 | 96 | 2.8 | 12.3 | 1.94 |
| 8 | 8 | 96 | 4.2 | 11.2 | 1.92 |
| 5 | 26 | 97 | 3.2 | 7.0 | 2.93 |
| 6 | 11 | 97 | 2.3 | 9.2 | 3.64 |
| 8 | 15 | 97 | 1.6 | 13.1 | 1.73 |
| 8 | 28 | 97 | 2.1 | 12.3 | 2.10 |
| 6 | 22 | 98 | 1.6 | 8.2 | n/a |
| 7 | 4 | 98 | 2.4 | 10.1 | 2.80 |
| 7 | 14 | 98 | 2.5 | 11.0 | 2.00 |
| 9 | 5 | 98 | 1.9 | 11.2 | n/a |
| 6 | 8 | 99 | 3.0 | 4.7 | 3.23 |
| 6 | 16 | 99 | 2.0 | 7.2 | 4.16 |
| 6 | 24 | 99 | 1.8 | 7.1 | 3.37 |
| 7 | 6 | 99 | n/a | n/a | n/a |
| 9 | 6 | 99 | 0.6 | 10.2 | 2.91 |

TABLE 7. Historical zooplankton densities in Chignik Lake (1,000 m²), 1968–99.

| Year | Month | Day | # sites | Depth (m) | Cala-noids | *Cyclops* | *Daphnia* | *Bosmina* | *Chydoris* | Nauplii | *Asplan-chia* | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1968 | 6 | 25 | 5 | 30 | 12 | 25 | 1 | 2 | 3 | 0 | 0 | 43 |
| 1968 | 7 | 20 | 5 | 30 | 15 | 11 | 3 | 11 | 8 | 0 | 0 | 48 |
| 1968 | 8 | 4 | 5 | 30 | 41 | 32 | 13 | 51 | 7 | 0 | 0 | 144 |
| 1968 | 8 | 29 | 5 | 30 | 98 | 24 | 110 | 67 | 5 | 0 | 0 | 304 |
| 1969 | 6 | 29 | 5 | 44 | 5 | 364 | 4 | 7 | 2 | 0 | 0 | 382 |
| 1969 | 7 | 27 | 5 | 47 | 13 | 329 | 11 | 22 | 2 | 0 | 0 | 377 |
| 1969 | 8 | 15 | 5 | 42 | 26 | 161 | 34 | 45 | 3 | 0 | 0 | 269 |
| 1969 | 8 | 30 | 5 | 44 | 33 | 28 | 42 | 51 | 2 | 0 | 0 | 156 |
| 1970 | 6 | 28 | 4 | 30 | 24 | 83 | 5 | 3 | 1 | 0 | 0 | 116 |
| 1970 | 7 | 27 | 4 | 30 | 39 | 37 | 10 | 20 | 2 | 0 | 0 | 108 |
| 1970 | 8 | 29 | 4 | 30 | 99 | 32 | 31 | 59 | 7 | 0 | 0 | 228 |
| 1971 | 7 | 3 | | 45 | 0 | 126 | 4 | 2 | 0 | 0 | 0 | 132 |
| 1971 | 7 | 28 | | 45 | 3 | 263 | 18 | 10 | 0 | 0 | 0 | 294 |
| 1971 | 8 | 29 | | 42 | 1 | 132 | 27 | 70 | 0 | 0 | 0 | 230 |
| 1972 | 7 | 14 | | 15 | 12 | 19 | 1 | 5 | 7 | 0 | 0 | 44 |
| 1972 | 8 | 6 | | 15 | 3 | 82 | 3 | 5 | 4 | 0 | 0 | 97 |
| 1972 | 8 | 31 | | 15 | 0 | 17 | 3 | 7 | 0 | 0 | 0 | 27 |
| 1973 | 7 | 21 | | 45 | 11 | 659 | 40 | 35 | 14 | 0 | 55 | 814 |
| 1987 | 6 | 5 | 5 | 40 | 10 | 56 | 2 | 3 | 0 | 0 | 4 | 75 |
| 1988 | 6 | 16 | 5 | 40 | 15 | 277 | 3 | 11 | 2 | 0 | 2 | 310 |
| 1988 | 7 | 14 | 5 | 40 | 7 | 35 | 3 | 39 | 2 | 0 | 3 | 89 |
| 1989 | 6 | 22 | 5 | 40 | 19 | 212 | 3 | 16 | 14 | 2 | 4 | 270 |
| 1990 | 6 | 11 | 1 | 40 | 6 | 650 | 1 | 1 | 0 | 0 | 8 | 666 |
| 1990 | 6 | 24 | 2 | 40 | 14 | 189 | 10 | 9 | 0 | 0 | 56 | 278 |
| 1991 | 6 | 27 | 5 | 40 | 21 | 41 | 1 | 19 | 0 | 0 | 31 | 113 |
| 1992 | 5 | 19 | 5 | 40 | 1 | 488 | 29 | 1 | 0 | 11 | 7 | 537 |
| 1992 | 6 | 6 | 3 | 40 | 2 | 292 | 12 | 1 | 0 | 6 | 19 | 332 |
| 1992 | 6 | 23 | 5 | 40 | 17 | 251 | 18 | 4 | 0 | 11 | 66 | 367 |
| 1992 | 7 | 11 | 5 | 40 | 22 | 199 | 34 | 16 | 0 | 9 | 231 | 511 |
| 1992 | 8 | 31 | 5 | 40 | 285 | 177 | 206 | 338 | 0 | 133 | 37 | 1176 |
| 1993 | 5 | 9 | 2 | 40 | 74 | 144 | 2 | 4 | 0 | 0 | 0 | 224 |
| 1993 | 6 | 19 | 2 | 40 | 48 | 77 | 0 | 22 | 0 | 0 | 0 | 147 |
| 1993 | 7 | 26 | 2 | 40 | 380 | 239 | 16 | 423 | 0 | 0 | 0 | 1058 |
| 1993 | 8 | 16 | 2 | 40 | 82 | 67 | 35 | 120 | 0 | 0 | 0 | 304 |
| 1993 | 9 | 9 | 2 | 40 | 17 | 26 | 82 | 109 | 0 | 0 | 0 | 234 |
| 1995 | 6 | 8 | 2 | 40 | 9 | 115 | 7 | 7 | 2 | 24 | 6 | 170 |
| 1995 | 6 | 17 | 2 | 40 | 5 | 124 | 6 | 7 | 3 | 20 | 10 | 175 |
| 1995 | 6 | 29 | 2 | 40 | 7 | 155 | 16 | 20 | 4 | 16 | 38 | 256 |
| 1995 | 7 | 7 | 2 | 40 | 15 | 205 | 25 | 56 | 7 | 44 | 68 | 420 |
| 1995 | 7 | 16 | 2 | 40 | 39 | 258 | 32 | 107 | 3 | 52 | 78 | 569 |
| 1995 | 9 | 5 | 2 | 40 | 356 | 224 | 537 | 498 | 18 | 108 | 43 | 1784 |

TABLE 7—cont.

| Year | Month | Day | # sites | Depth (m) | Cala-noids | *Cyclops* | *Daphnia* | *Bosmina* | *Chydoris* | Nauplii | *Asplan-chia* | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996 | 6 | 17 | 2 | 40 | 33 | 69 | 4 | 19 | 11 | 20 | 59 | 215 |
| 1996 | 7 | 4 | 2 | 40 | 51 | 131 | 4 | 27 | 24 | 78 | 116 | 431 |
| 1996 | 7 | 12 | 2 | 40 | 286 | 258 | 10 | 97 | 34 | 215 | 152 | 1052 |
| 1996 | 7 | 29 | 2 | 40 | 108 | 96 | 10 | 62 | 34 | 13 | 176 | 499 |
| 1996 | 8 | 8 | 2 | 40 | 182 | 117 | 36 | 159 | 17 | 62 | 159 | 732 |
| 1997 | 5 | 26 | 2 | 40 | 21 | 1866 | 24 | 55 | 19 | 304 | 11 | 2300 |
| 1997 | 6 | 11 | 2 | 40 | 77 | 1892 | 55 | 29 | 55 | 135 | 0 | 2243 |
| 1997 | 8 | 15 | 2 | 40 | 1449 | 422 | 2342 | 1951 | 6 | 825 | 399 | 7394 |
| 1997 | 8 | 28 | 2 | 40 | 677 | 509 | 1079 | 1642 | 13 | 299 | 223 | 4442 |
| 1998 | 6 | 23 | 2 | 40 | 16 | 128 | 4 | 8 | 108 | 21 | 1 | 286 |
| 1998 | 7 | 4 | 2 | 40 | 24 | 93 | 7 | 18 | 222 | 20 | 1 | 385 |
| 1998 | 7 | 14 | 2 | 40 | 41 | 65 | 8 | 12 | 212 | 19 | 1 | 358 |
| 1998 | 9 | 5 | 2 | 40 | 154 | 98 | 73 | 181 | 7 | 88 | 5 | 606 |
| 1999 | 6 | 8 | 2 | 40 | 95 | 1345 | 73 | 61 | 4 | 191 | 29 | 1798 |
| 1999 | 6 | 16 | 2 | 40 | 167 | 1470 | 83 | 57 | 8 | 208 | 7 | 2000 |
| 1999 | 6 | 24 | 2 | 40 | 554 | 946 | 249 | 200 | 0 | 294 | 21 | 2264 |
| 1999 | 7 | 6 | 2 | 40 | 449 | 767 | 130 | 103 | 17 | 326 | 54 | 1846 |
| 1999 | 9 | 6 | 2 | 40 | 966 | 374 | 201 | 296 | 33 | 255 | 10 | 2135 |

TABLE 8. Sockeye fry emergence rates during June, 1999 (fry per $m^2$ per 30 days) on Chignik Lake beaches.

| Year | South Hatchery north | Delta | Average |
|---|---|---|---|
| 1986 | 26.3 | 12.8 | 19.6 |
| 87 | 40.3 | 25.1 | 32.7 |
| 88 | 43.5 | 40.4 | 42.0 |
| 89 | 2.9 | 15.8 | 9.4 |
| 90 | 6.2 | 12.3 | 9.3 |
| 91 | 13.4 | 2.7 | 8.1 |
| 92 | 5.0 | 6.3 | 5.7 |
| 93 | 2.6 | 2.1 | 2.4 |
| 94 | | | n/a |
| 95 | 7.5 | 20.3 | 13.9 |
| 96 | 70.4 | 2.9 | 36.7 |
| 97 | 31.4 | 19.4 | 25.4 |
| 98 | 5.1 | 6.4 | 5.8 |
| 99 | 5.2 | 7.4 | 6.3 |
| 1986-1998 Averages | 21.2 | 13.9 | 17.6 |

Calculations based on Ruggerone et al. 1993,1994.

1998 and 1999 numbers could be underestimates as sampling occı

TABLE 9. Historical average tow net catches for Chignik Lake (10 min. tows), 1960–99.

| Date | | No. of | Species | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Sockeye salmon | | Juvenile | Juvenile | Pond | Stickleback | |
| Mo | Year | tows | Fry | Yearling | coho | chinook | smelt | 3-spine | 9-spine |
| 6 | 60 | 15 | 6 | 33 | 0 | 0 | 0 | 0 | 1 |
| 7 | 60 | 42 | 5 | 25 | 0 | 0 | 0 | 1 | 3 |
| 8 | 60 | 9 | 74 | 83 | 0 | 0 | 0 | 1 | 9 |
| 9 | 60 | 1 | 6 | 12 | 0 | 0 | 0 | 0 | 0 |
| 7 | 61 | 14 | 1 | 136 | 0 | 0 | 0 | 1 | 12 |
| 8 | 61 | 65 | 308 | 286 | 0 | 0 | 0 | 13 | 50 |
| 9 | 61 | 1 | 278 | 103 | 0 | 0 | 1 | 6 | 10 |
| 7 | 62 | 17 | 46 | 648 | 1 | 0 | 0 | 2 | 12 |
| 8 | 62 | 80 | 55 | 238 | 0 | 0 | 0 | 32 | 14 |
| 9 | 62 | 11 | 14 | 58 | 0 | 0 | 3 | 121 | 6 |
| 6 | 63 | 4 | 66 | 76 | 2 | 1 | 1 | 2 | 11 |
| 7 | 63 | 22 | 28 | 147 | 1 | 0 | 1 | 5 | 26 |
| 8 | 63 | 44 | 56 | 87 | 0 | 0 | 4 | 26 | 15 |
| 9 | 63 | 13 | 230 | 171 | 0 | 0 | 16 | 39 | 16 |
| 7 | 64 | 13 | 5 | 28 | 0 | 0 | 0 | 2 | 7 |
| 8 | 64 | 38 | 61 | 83 | 0 | 0 | 1 | 10 | 15 |
| 9 | 64 | 15 | 251 | 79 | 0 | 0 | 0 | 30 | 15 |
| 7 | 65 | 14 | 65 | 152 | 1 | 2 | 0 | 1 | 15 |
| 8 | 65 | 27 | 91 | 410 | 0 | 0 | 4 | 3 | 24 |
| 7 | 66 | 6 | 60 | 319 | 1 | 1 | 1 | 1 | 3 |
| 8 | 66 | 16 | 419 | 144 | 0 | 0 | 0 | 1 | 3 |
| 9 | 66 | 15 | 137 | 34 | 0 | 0 | 0 | 4 | 5 |
| 6 | 67 | 11 | 145 | 74 | 0 | 1 | 0 | 0 | 4 |
| 7 | 67 | 18 | 1338 | 177 | 0 | 0 | 3 | 1 | 76 |
| 9 | 67 | 18 | 295 | 53 | 0 | 0 | 1 | 45 | 9 |
| 6 | 68 | 2 | 86 | 100 | 2 | 2 | 53 | 0 | 5 |
| 7 | 68 | 18 | 138 | 163 | 1 | 0 | 1 | 1 | 3 |
| 8 | 68 | 26 | 36 | 64 | 0 | 0 | 3 | 18 | 5 |
| 6 | 69 | 10 | 48 | 0 | 4 | 0 | 0 | 2 | 2 |
| 8 | 69 | 20 | 124 | 26 | 0 | 0 | 1 | 4 | 6 |
| 9 | 69 | 14 | 910 | 13 | 0 | 0 | 9 | 20 | 7 |
| 6 | 70 | 10 | 67 | 440 | 10 | 0 | 2 | 3 | 1 |
| 7 | 70 | 10 | 59 | 120 | 0 | 0 | 1 | 3 | 18 |
| 8 | 70 | 15 | 14 | 52 | 0 | 0 | 0 | 21 | 2 |
| 7 | 71 | 20 | 183 | 63 | 1 | 0 | 0 | 4 | 7 |
| 9 | 71 | 15 | 247 | 18 | 0 | 0 | 4 | 28 | 4 |
| 7 | 72 | 10 | 25 | 27 | 3 | 0 | 0 | 1 | 2 |
| 8 | 72 | 30 | 131 | 41 | 0 | 0 | 0 | 9 | 15 |
| 7 | 73 | 10 | 78 | 76 | 0 | 0 | 0 | 1 | 5 |
| 8 | 73 | 20 | 156 | 168 | 0 | 0 | 1 | 2 | 11 |
| 7 | 80 | 20 | 52 | 50 | 0 | 0 | 20 | 2 | 8 |
| 7 | 82 | 5 | 8 | 1 | 2 | 0 | 0 | 1 | 1 |
| 6 | 83 | 5 | 33 | 87 | 0 | 0 | 0 | 0 | 1 |
| 7 | 83 | 10 | 173 | 101 | 0 | 0 | 1 | 0 | 1 |
| 9 | 92 | 9 | 65 | 9 | 0 | 0 | 5 | 2 | 3 |
| 8 | 93 | 7 | 61 | 23 | 0 | 0 | 39 | 47 | 11 |
| 9 | 93 | 8 | 44 | 18 | 0 | 0 | 108 | 19 | 16 |
| 9 | 95 | 5 | 38 | 17 | 0 | 0 | 17 | 8 | 3 |
| 9 | 96 | 6 | 16 | 24 | 0 | 0 | 4 | 58 | 4 |
| 9 | 97 | 5 | 95 | 200 | 0 | 0 | 58 | 59 | 24 |
| 9 | 98 | 5 | 53 | 156 | 0 | 0 | 6 | 1618 | 12 |
| 9 | 99 | 5 | 13 | 9 | 0 | 0 | 90 | 27 | 5 |

TABLE 10. Historical average tow net catches for Black Lake (10 min. tows), 1960–99.

| Date | | No. of | Species | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Sockeye salmon | | Juvenile | Juvenile | Pond | Stickleback | |
| Mo | Year | tows | Fry | Yearling | coho | chinook | smelt | 3-spine | 9-spine |
| 6 | 60 | 12 | 5 | 1 | 0 | 0 | 9 | 18 | 2 |
| 7 | 60 | 8 | 11 | 0 | 0 | 0 | 0 | 19 | 2 |
| 7 | 61 | 10 | 2096 | 0 | 1 | 0 | 11 | 872 | 94 |
| 8 | 61 | 9 | 1057 | 0 | 0 | 0 | 113 | 3439 | 227 |
| 9 | 61 | 10 | 567 | 0 | 0 | 0 | 43 | 206 | 14 |
| 7 | 62 | 10 | 570 | 0 | 4 | 0 | 0 | 2387 | 136 |
| 8 | 62 | 65 | 279 | 0 | 0 | 0 | 45 | 697 | 52 |
| 6 | 63 | 4 | 369 | 0 | 1 | 0 | 198 | 188 | 5 |
| 7 | 63 | 14 | 182 | 3 | 1 | 0 | 90 | 61 | 27 |
| 8 | 63 | 22 | 304 | 3 | 2 | 0 | 229 | 267 | 55 |
| 7 | 64 | 28 | 313 | 3 | 1 | 0 | 12 | 121 | 16 |
| 8 | 64 | 8 | 385 | 5 | 1 | 0 | 65 | 824 | 27 |
| 9 | 64 | 13 | 221 | 4 | 1 | 0 | 258 | 588 | 64 |
| 7 | 65 | 10 | 1426 | 6 | 2 | 0 | 31 | 75 | 21 |
| 8 | 65 | 21 | 1001 | 2 | 0 | 0 | 36 | 396 | 36 |
| 8 | 66 | 22 | 585 | 2 | 1 | 0 | 56 | 64 | 13 |
| 6 | 67 | 21 | 1798 | 12 | 1 | 0 | 38 | 13 | 37 |
| 7 | 67 | 13 | 968 | 8 | 1 | 0 | 473 | 146 | 80 |
| 8 | 67 | 3 | 338 | 1 | 1 | 0 | 213 | 1139 | 373 |
| 9 | 67 | 5 | 294 | 1 | 0 | 0 | 117 | 250 | 109 |
| 7 | 68 | 15 | 614 | 1 | 2 | 0 | 51 | 100 | 24 |
| 8 | 68 | 13 | 60 | 1 | 1 | 0 | 170 | 394 | 91 |
| 9 | 68 | 7 | 102 | 1 | 0 | 0 | 62 | 197 | 74 |
| 6 | 69 | 1 | 772 | 0 | 6 | 0 | 172 | 2 | 2 |
| 7 | 69 | 6 | 1265 | 2 | 5 | 0 | 138 | 35 | 26 |
| 8 | 69 | 21 | 615 | 0 | 1 | 0 | 59 | 193 | 29 |
| 6 | 70 | 8 | 126 | 3 | 2 | 0 | 0 | 4 | 3 |
| 7 | 70 | 8 | 573 | 1 | 1 | 0 | 8 | 36 | 22 |
| 8 | 70 | 20 | 332 | 1 | 1 | 0 | 19 | 139 | 60 |
| 7 | 71 | 14 | 637 | 1 | 1 | 0 | 11 | 26 | 17 |
| 8 | 71 | 13 | 141 | 0 | 1 | 0 | 200 | 32 | 35 |
| 7 | 72 | 8 | 144 | 7 | 1 | 0 | 8 | 11 | 10 |
| 8 | 72 | 8 | 406 | 0 | 1 | 0 | 6 | 80 | 21 |
| 9 | 72 | 12 | 379 | 0 | 0 | 0 | 127 | 10 | 8 |
| 9 | 73 | 8 | 291 | 0 | 4 | 0 | 905 | 486 | 54 |
| 11 | 73 | 8 | 20 | 0 | 0 | 0 | 61 | 42 | 31 |
| 9 | 92 | 7 | 347 | 0 | 1 | 0 | 110 | 70 | 78 |
| 6 | 93 | 2 | 3260 | 0 | 0 | 0 | 148 | 10 | 30 |
| 7 | 93 | 1 | 478 | 0 | 0 | 0 | 13 | 0 | 0 |
| 8 | 93 | 9 | 143 | 0 | 11 | 0 | 729 | 910 | 1148 |
| 9 | 93 | 4 | 126 | 0 | 23 | 0 | 1914 | 565 | 269 |
| 6 | 95 | 6 | 28 | 4 | 0 | 0 | 19 | 4 | 2 |
| 9 | 95 | 5 | 176 | 1 | 0 | 0 | 49 | 15 | 12 |
| 9 | 96 | 3 | 82 | | (All other fishes released) | | | | |
| 9 | 97 | 3 | 80 | 0 | 3 | 0 | 173 | 217 | 64 |
| 9 | 98 | 5 | 303 | 0 | 15 | 0 | 92 | 219 | 128 |
| 9 | 99 | 4 | 114 | 0 | 23 | 0 | 208 | 95 | 126 |

TABLE 11. Historical average beach seine catches for Chignik Lake, 1956–99.

| Date | | No. | Species | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | of | Sockeye salmon | | Juvenile | Juvenile | | Stickleback | | | Pygmy |
| Mo | Year | sets | <45 mm | >45 mm | coho | chinook | Char | 3-spine | 9-spine | Sculpin | whitefish |
| 5 | 56 | 5 | 0 | 94 | | | | | | | |
| 7 | 56 | 4 | 53 | 65 | | | | | | | |
| 8 | 56 | 10 | 28 | 57 | | | | | | | |
| 5 | 57 | 3 | 0 | 167 | | | | | | | |
| 6 | 57 | 4 | 6 | 109 | | | | | | | |
| 7 | 57 | 6 | 11 | 92 | | | | | | | |
| 8 | 57 | 6 | 1 | 98 | | | | | | | |
| 5 | 59 | 4 | 5 | 81 | | | | | | | |
| 6 | 59 | 1 | 0 | 98 | | | | | | | |
| 6 | 61 | 1 | 4 | 309 | 120 | 0 | 0 | 248 | 0 | 0 | 90 |
| 7 | 61 | 2 | 1 | 149 | 20 | 0 | 0 | 70 | 0 | 0 | 52 |
| 8 | 61 | 4 | 17 | 283 | 19 | 0 | 3 | 441 | 140 | 1 | 54 |
| 9 | 61 | 3 | 16 | 216 | 0 | 0 | 0 | 86 | 7 | 3 | 35 |
| 6 | 62 | 2 | 0 | 0 | 0 | 0 | 22 | 291 | 5 | 0 | 29 |
| 7 | 62 | 5 | 0 | 0 | 4 | 0 | 39 | 114 | 4 | 1 | 83 |
| 8 | 62 | 3 | 7 | 208 | 26 | 0 | 3 | 30 | 2 | 59 | 4 |
| 9 | 62 | 2 | 1 | 527 | 19 | 0 | 3 | 20 | 0 | 4 | 1 |
| 6 | 63 | 4 | 27 | 81 | 35 | 0 | 2 | 18 | 6 | 1 | 2 |
| 7 | 63 | 4 | 3 | 81 | 3 | 0 | 2 | 1 | 2 | 1 | 0 |
| 8 | 63 | 4 | 8 | 114 | 0 | 0 | 0 | 124 | 0 | 0 | 0 |
| 9 | 63 | 3 | 8 | 291 | 0 | 0 | 0 | 61 | 0 | 0 | 0 |
| 6 | 64 | 9 | | 49 | 2 | 0 | 2 | 22 | 3 | 5 | 32 |
| 7 | 64 | 10 | | 83 | 7 | 0 | 15 | 69 | 5 | 13 | 2 |
| 8 | 64 | 9 | | 264 | 26 | 24 | 26 | 667 | 72 | 2 | 95 |
| 6 | 65 | 4 | 138 | 162 | 3 | 2 | 2 | 27 | 2 | 4 | 7 |
| 7 | 65 | 10 | 74 | 27 | 29 | 6 | 14 | 12 | 1 | 4 | 9 |
| 8 | 65 | 2 | 51 | 227 | 16 | 5 | 3 | 546 | 50 | 4 | 28 |
| 6 | 67 | 4 | 13 | 155 | 97 | 97 | 66 | 23 | 8 | 8 | 3 |
| 6 | 68 | 4 | 24 | 3 | 2 | 0 | 0 | 42 | 1 | 6 | 27 |
| 6 | 69 | 4 | 22 | 4 | 11 | 22 | 23 | 7 | 23 | 20 | 3 |
| 6 | 70 | 4 | 23 | 41 | 1 | 0 | 0 | 3 | 0 | 1 | 32 |
| 7 | 70 | 5 | 0 | 0 | 8 | 0 | 25 | 45 | 17 | 22 | 22 |
| 8 | 70 | 7 | 0 | 0 | 25 | 0 | 64 | 55 | 0 | 3 | 10 |
| 6 | 71 | 10 | 408 | 36 | 7 | 0 | 3 | 112 | 27 | 6 | 3 |
| 7 | 71 | 5 | 1 | 6 | 8 | 0 | 2 | 53 | 4 | 15 | 4 |
| 6 | 72 | 6 | 87 | 380 | 3 | 0 | 1 | 9 | 6 | 13 | 4 |
| 7 | 72 | 6 | 19 | 3 | 58 | 0 | 36 | 92 | 25 | 29 | 18 |
| 6 | 80 | 5 | 47 | 0 | 2 | 0 | 7 | 16 | 1 | 28 | 0 |
| 7 | 80 | 12 | 52 | 9 | 3 | 1 | 2 | 22 | 1 | 16 | 1 |
| 5 | 85 | 10 | 113 | 189 | 103 | 2 | 6 | 3317 | 53 | 12 | 2 |
| 6 | 85 | 18 | 15 | 71 | 112 | 3 | 36 | 1031 | 136 | 18 | 28 |
| 7 | 85 | 17 | 9 | 217 | 30 | 4 | 104 | 399 | 28 | 11 | 6 |
| 8 | 85 | 6 | 20 | 183 | 9 | | | | | | |
| 9 | 85 | 6 | 0 | 2 | 7 | 0 | 18 | 943 | 18 | 25 | 6 |
| 5 | 86 | 33 | 33 | 85 | 48 | 8 | 10 | 499 | 33 | 22 | 7 |
| 6 | 86 | 49 | 49 | 3 | 31 | 8 | 17 | 111 | 15 | 14 | 7 |
| 7 | 86 | 46 | 46 | 4 | 12 | 2 | 12 | 162 | 9 | 13 | 5 |
| 8 | 86 | 12 | 2 | 15 | 6 | 2 | 24 | 154 | 5 | 14 | 11 |
| 5 | 87 | 12 | 1048 | 714 | 136 | 7 | 25 | 639 | 54 | 13 | 19 |
| 6 | 87 | 54 | 6 | 230 | 113 | 9 | 65 | 260 | 6 | 13 | 15 |
| 7 | 87 | 58 | 16 | 51 | 17 | 0 | 8 | 44 | 5 | 14 | 3 |
| 6 | 92 | 15 | 10 | 15 | 13 | 0 | 7 | 123 | 22 | 13 | 2 |
| 7 | 92 | 6 | 9 | 2 | 20 | 2 | 23 | 192 | 16 | 7 | 7 |
| 5 | 93 | 6 | 1 | 173 | 57 | 0 | 13 | 224 | 7 | 9 | 41 |
| 6 | 93 | 6 | 1 | 20 | 6 | 0 | 15 | 24 | 0 | 8 | 13 |
| 6 | 95 | 21 | 27 | 9 | 11 | 1 | 13 | 244 | 26 | 18 | 8 |
| 7 | 95 | 21 | 16 | 13 | 13 | 1 | 10 | 49 | 6 | 17 | 6 |
| 6 | 96 | 7 | 12 | 121 | 39 | 1 | 15 | 117 | 3 | 22 | <1 |
| 7 | 96 | 21 | 9 | 47 | 30 | 0 | 24 | 215 | 9 | 7 | 19 |
| 8 | 96 | 7 | 3 | 16 | 41 | 0 | 22 | 82 | 7 | 1 | 9 |
| 5 | 97 | 6 | 77 | 324 | 15 | 7 | 19 | 1367 | 24 | 61 | 0 |
| 6 | 97 | 6 | 5 | 125 | 7 | 0 | 6 | 14 | 3 | 6 | 2 |
| 6 | 98 | 11 | 140 | 436 | 104 | 43 | 58 | 4488 | 214 | 74 | 16 |
| 7 | 98 | 9 | 31 | 359 | 307 | 11 | 374 | 4106 | 219 | 79 | 17 |
| 6 | 99 | 18 | 36 | 28 | 55 | 9 | 77 | 527 | 16 | 8 | 2 |

TABLE 12. Mean lengths and number of sockeye fry per stomach for juvenile coho sampled from Chignik Lake beach seine, 1999.

| Date | Location | Mean # of sockeye per coho | Average coho length (mm) | # of coho captured, >70 mm |
|---|---|---|---|---|
| 6/20 | Clark Bay | 3.0 | 93 | 18 |
| | S. Hatchery | 1.0 | 103 | 18 |
| | Delta | 1.6 | 96 | 30 |
| | N. Cucumber | 0.0 | 101 | 20 |
| | Outlet | 0.5 | 111 | 5 |
| | N. Hatchery | 1.5 | 85 | 7 |
| 6/27 | Clark Bay | 1.8 | 99 | 8 |
| | S. Hatchery | 1.2 | 109 | 4 |
| | Delta | 0.7 | 90 | 16 |
| | N. Cucumber | 0.7 | 98 | 21 |
| | Outlet | 0.4 | 98 | 24 |
| | N. Hatchery | 1.1 | 90 | 11 |

TABLE 13. Beach seine data collected from Chignik Lagoon, 1999.

| | average # fish per set | | | Sockeye smolt | | Juvenile coho | |
|---|---|---|---|---|---|---|---|
| | Sockeye | | Juvenile | | | | |
| Date | Fry | Smolt | Coho | ave. length (mm) | ave. weight (g) | ave. length (mm) | ave. weight (g) |
| 6/9 | 0 | 27 | 0 | 73.9 | 4.4 | n/a | n/a |
| 6/10 | 0 | 6 | 0 | 79.4 | 5.6 | n/a | n/a |
| 6/22 | 2 | 22 | 14 | 76.9 | 5.2 | 129.6 | 27.5 |
| 7/4 | 167* | 37 | n/a | 79.1 | 5.1 | n/a | n/a |

*Approximately 500 sockeye emergent fry were captured and released on one set in the lower river st

TABLE 14. Percentage of juvenile sockeye smolts containing prey at three locations in Chignik Lagoon, 1999.

| Date | Location | Fish sampled | Immature insects | Adult insects | Amphipods | Fish larvae | Rocks | Other | % fullness |
|---|---|---|---|---|---|---|---|---|---|
| 10-Jun | lagoon spit | 36 | 14 | 0 | 75 | 8 | 0 | 8 | 45.4 |
| | hume pt. | 4 | 50 | 25 | 75 | 0 | 25 | 0 | 60.0 |
| | lower river | 51 | 10 | 2 | 100 | 0 | 0 | 2 | 24.8 |
| | | 91 | | | | | | | |
| 23-Jun | lagoon spit | 29 | 59 | 0 | 62 | 10 | 0 | 3 | 49.5 |
| | hume pt. | 30 | 33 | 0 | 93 | 0 | 0 | 7 | 46.3 |
| | lower river | 19 | 47 | 11 | 84 | 0 | 0 | 0 | 60.5 |
| | | 78 | | | | | | | |
| 5-Jul | lagoon spit | 25 | 8 | 0 | 100 | 0 | 0 | 0 | 76.8 |
| | hume pt. | 54 | 44 | 2 | 98 | 0 | 0 | 0 | 46.1 |
| | lower river | 15 | 27 | 0 | 73 | 0 | 0 | 0 | 30.7 |
| Grand total | | 263 | 32 | 4 | 85 | 2 | 3 | 2 | 49 |

TABLE 15. Estimates of bank erosion along the upper reach of the south channel of Alec River, 1990–99.

| Stake | Location | Minimum distance from stake to river bank (m) | | | | | | | | | Present | Total | Change per |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | condition | change (m) | year (m) |
| Wye Pt | | | | | | | | | | | | | |
| 1 | Wye Pt. | | | 4.00 | 3.40 | 3.40 | 2.96 | 2.80 | 1.20 | 1.20 | sunken | -2.80 | -0.47 |
| 2 | | | | 4.40 | 3.10 | 3.00 | 2.60 | 2.53 | 1.70 | 1.60 | sunken | -2.80 | -0.47 |
| 3 | (near S. channel) | | | 3.25 | 3.00 | 3.00 | 2.20 | 1.78 | 0.80 | 0.80 | sunken | -2.45 | -0.41 |
| | | | | | -0.72 | -0.03 | -0.55 | -0.22 | -1.14 | -0.03 | | -2.68 | -0.45 |
| Straight channel | | | | | | | | | | | | | |
| 1 | (rebar) | 3.3 | 3.10 | 2.85 | *2.53* | 2.20 | 1.10 | 1.08 | 0.60 | 0.60 | | -2.70 | -0.34 |
| 2 | Discharge area | | 2.37 | 2.30 | 1.95 | 1.30 | 0.90 | 0.90 | 0.90 | 0.13 | active | -2.24 | -0.32 |
| | | | | -0.16 | -0.34 | -0.49 | -0.75 | -0.01 | -0.24 | -0.39 | | -2.47 | -0.33 |
| River bend | | | | | | | | | | | | | |
| 1 | upriver | | 8.30 | 7.65 | 7.60 | 5.40 | 5.32 | 5.32 | 5.35 | 5.35 | slough | -2.95 | -0.42 |
| 2 | | | 10.30 | 9.95 | *9.08* | 8.20 | 7.80 | 7.80 | 7.10 | 6.65 | active | -3.65 | -0.52 |
| 3 | | | 10.30 | 9.75 | 9.70 | 9.70 | 9.50 | 9.45 | 8.90 | 8.60 | undercut | -1.70 | -0.24 |
| 4 | | | 15.10 | 13.95 | 13.70 | 13.40 | 13.40 | 12.15 | 12.15 | 12.15 | slough | -2.95 | -0.42 |
| 5 | | | 12.50 | 12.50 | 11.55 | 11.40 | 11.00 | 10.70 | 10.50 | 10.15 | | -2.35 | -0.34 |
| 6 | | | 9.20 | 8.75 | 8.70 | 7.60 | 7.35 | 7.40 | 6.75 | 6.75 | | -2.45 | -0.35 |
| 7 | down river | | 6.70 | 6.60 | *6.43* | 6.25 | 5.90 | 5.80 | 6.10 | 3.50 | | -3.20 | -0.46 |
| | | | | -0.46 | -0.34 | -0.69 | -0.24 | -0.24 | -0.25 | -0.53 | | -2.75 | -0.39 |
| Left bank Pt. | | | | | | | | | | | | | |
| 1 | Lt. bank Pt. | 2.5 | 2.50 | 2.20 | 1.90 | 1.80 | *1.70* | *1.40* | 1.15 | 1.10 | | -1.40 | -0.18 |
| | | | *0.00* | *-0.30* | *-0.30* | *-0.10* | *-0.10* | *-0.30* | *-0.25* | *-0.05* | | | |

# Appendix: Chignik Sockeye Salmon Forecast, 2000

GREG RUGGERONE
APRIL 4, 2000

## RECAP OF 1999 SOCKEYE SALMON RUN

The 1999 sockeye salmon run of approximately 4.46 million sockeye salmon to the Chignik Lakes (including interception harvests) was the fourth highest run since 1922. Only runs in 1947 (5.9 million), 1932 (4.8 million), and 1984 (4.5 million) were larger. Approximately 2.49 million sockeye were destined for Black Lake spawning grounds and approximately 1.97 million were bound for Chignik Lake spawning grounds.

I was not asked to develop a forecast of the 1999 run, but I did note at the preseason Chignik Regional Aquaculture Association (CRAA) meeting at Chignik Bay that the Black Lake run would be larger than the Chignik Lake run (based on winter and spring sampling). In contrast, ADFG forecasted a somewhat larger Chignik Lake run (1.3 million) compared with Black Lake run (1.0 million) in 1999.

The large size of both runs is surprising because large runs to both lakes have not occurred since the record run in 1947. During the 1950s and 1960s, runs to both lakes were small. Larger total runs began in the mid-1970s but never to both lakes. I have suggested that this inverse relationship is due to the lowering of Black Lake water level in the late 1960s, resulting in greater emigration of Black Lake juveniles to Chignik Lake. Since 1970, the relatively large young-of-the-year Black Lake sockeye appeared to have an adverse effect on the somewhat small Chignik yearlings. Apparently this relationship did not significantly affect smolts that migrated to sea in 1996.

Documentation of conditions leading to the large return in 1999 is important:

- Parent spawning escapement to Black Lake was very high (770,000 fish) and slightly above average in Chignik Lake (333,000 fish).
- Chignik and Black Lake smolts were exceptionally large during winter and spring 1996.
- Zooplankton counts in Chignik Lake during fall 1995 (preceding the smolt year) were high, spring was early, water temperature was somewhat high, and lake transparency was high throughout the summer and fall.
- Black Lake contained high oxygen levels during winter 1996 although lake level was somewhat low.
- Fisheries Research Institute was not funded by CRAA in 1994, so fry emergence data were not available.
- Smolt counts in Chignik R. were very low, but concerns were raised regarding trap efficiency and possible early migration in 1996.

In retrospect, I suspect that sockeye abundance in the lakes during the previous two years was below average (e.g., see fry emergence rates, winter conditions, adult returns). Low fish abundance in prior years may have allowed zooplankton populations to rebound, thereby enabling significant growth of both Black Lake and Chignik Lake stocks rearing in Chignik Lake during 1995. High oxygen levels in Black Lake apparently enabled successful migration/survival of the Black Lake stock during the 1995/96 winter (more Black Lake than Chignik Lake sockeye were observed in Chignik Lake during winter). Ocean conditions were likely favorable for sockeye returning in 1999. These factors likely contributed to the large run to Chignik in 1999.

## SOCKEYE SALMON FORECAST FOR 2000

| | |
|---|---|
| Black Lake run: | 2.1 to 2.7 million |
| Chignik Lake run: | 1.2 to 1.5 million |
| Total run[1]: | 3.3 to 4.2 million |

I developed the Black Lake forecast primarily from the large return of age 1.2 sockeye in 1999, but I also considered parent year escapement (below average), winter conditions in Black Lake (moderate), age composition of sockeye sampled in Chignik Lake during winter and spring (mostly age 2.x sockeye), moderately large smolt migration in 1997, and length of age-1.2 sockeye returning to Black lake in 1999 (largest since 1978). The large size of age-1.2 sockeye in 1999 suggests that many fish may have matured early, implying that a forecast based on numbers of age-1.2 sockeye may be high. During the 1997 winter study, I estimated that most juveniles rearing in Chignik Lake were age-2, which often indicates Chignik Lake origin. However, after reviewing age composition of adults returning to both lakes in 1999, I suspect many of these age-2 juveniles (1997) had originated from Black Lake. Thus, the somewhat larger migration of age-2 versus age-

[1]Values include Cape Igvak and southeastern mainland interceptions)

1 smolts in 1997 does not translate to a larger Chignik Lake run compared with Black Lake run in 2000. The lower end of the forecasted range (2.1–2.7 million) reflects the possible adverse effect that early maturity might have on the Black Lake forecast. This forecast is well above the average since 1980 (1.5 million sockeye).

The Chignik Lake run is more difficult to forecast because we do not have a relatively precise statistical model for this run. However, the Chignik Lake run also varies less from year to year compared with the Black Lake run. I developed the Chignik Lake forecast from the number of jacks in 1999 (moderate number) and the projected run to Black lake in 2000 (large), but I also considered the small parent escapement (197,000 fish), age composition of juveniles during winter and spring 1997, fall zooplankton abundance (moderate), smolt abundance in 1997 (somewhat large), and fry emergence in Chignik Lake (moderate in 1995 v. low in ’92 and ’93). The Chignik Lake forecast is similar to the average run since 1980 (1.3 million sockeye).

ADFG forecasted an exceptional run of 4.99 million sockeye salmon in 2000 (3.9 million to Black Lake, 1.09 million to Chignik Lake, including interception harvests). This run would be the second largest run since 1922, if it materializes. The Black Lake forecast exceeds the largest run to Black Lake by 200,000 fish. When reviewing historical runs, I found that sockeye run size following runs exceeding 3.5 million sockeye (e.g., 1999 run) were below average (avg. 1.6 million total). This simple approach suggests that back-to-back runs of 4 million or more sockeye is less likely.