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# Chignik Salmon Studies Investigations of Salmon Populations, Hydrology, and Limnology of the Chignik Lakes, Alaska, During 2005–2006

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Annual Report to the National Marine Fisheries Service

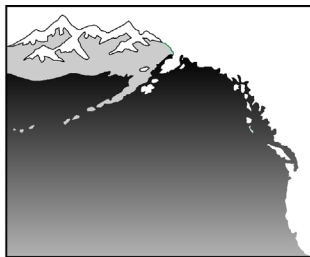
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Introduction.....	2
Limnology .....	3
Methods.....	3
Results .....	3
Biotic.....	3
Abiotic.....	4
Seasonal temperatures .....	4
Tow net sampling.....	5
Methods.....	5
Results .....	5
Beach seining .....	5
Methods.....	6
Results .....	6
Chignik Lake.....	6
Alec River Hydrology .....	6
Methods.....	6
Results .....	7
Discharge.....	7
2006 salmon forecast.....	7
Acknowledgements .....	8
Key Words .....	8
References .....	9
Figures.....	11
Tables .....	23

## Introduction

The University of Washington Fisheries Research Institute (FRI) has been conducting research on the anadromous and resident (i.e. non-anadromous) fishes of the Chignik lakes system since the 1950s. The Chignik Lake system is situated on the south side of the Alaska Peninsula (56° 16'N Lat., 158° 50'W), and produces the vast majority of the sockeye in the region. The system consists of two interconnected lakes draining into the Gulf of Alaska (Fig. 1). Chignik Lake is small (22 km<sup>2</sup>), relatively deep (64 m), and is surrounded by precipitous mountains. In contrast, the upper lake, Black Lake, is larger (41 km<sup>2</sup>) and extremely shallow (3 m maximum depth) and turbid, resting in a shallow tundra depression. Black Lake drains via the Black River into Chignik Lake. The outlet of Chignik Lake flows into a semi-enclosed estuary, Chignik Lagoon, and eventually into the Gulf of Alaska (Narver 1966, Dahlberg 1968, Ruggerone 1989b). Funding for FRI's work has come from both the Federal Government through the Anadromous Fish Conservation Act (Public Law 89-304), and the Chignik fishermen through the Chignik Regional Aquaculture Association (CRAA). These institutions have supported FRI with the goal of maintaining the health of the sockeye runs in the Chignik lakes. Both parties feel that the maintenance of FRI's unique long-term data set provides an invaluable tool with which we can better understand the structure and functioning of the ecosystem. Ultimately, this understanding allows better management of the salmon resources of the area and facilitates analysis of how physical changes in the environment have potentially altered the fish community.

A key concern among Chignik fishermen, residents and biologists has been the rapid habitat evolution of Black Lake since the late 1960s. These physical changes, largely the result of rerouting of downstream tributaries of the Black River, include substantial loss of water volume, increased summer water temperatures, migration of inflow of the Alec River, and creation of a sandspit that currently extends approximately 80% across the lake (Papanicolaou et al. 2006). These changes are correlated with greater premature out-migration of Black Lake sockeye fry (young of the year) to Chignik Lake (Ruggerone et al. 1993, Ruggerone 1994). Large emigrations of fry appear to reduce growth of juvenile sockeye salmon rearing in Chignik Lake, leading to significant adverse effect on adult returns to Chignik Lake (Ruggerone 1996). The exceptionally low water volume and low dissolved oxygen during some winters appears to reduce survival of juvenile sockeye in Black Lake and influence large annual fluctuations in adult returns (Ruggerone 2003).

The overarching goals of the long-term data collection are 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 ecological studies conducted by Alaska Department of Fish and Game (Bouwens & Finkle 2003) and past winter ecology studies (Ruggerone 1999). The resulting long-term database provides a basis from which to 1) evaluate changes in the production of adult sockeye salmon from the Chignik Lakes and 2) evaluate potential habitat restoration projects that are being considered by CRAA. This report describes data collected during the 2005 field season and discusses the 2006 forecast for adult returning fish to the Chignik system and the harvest prospects for the coming season.

The specific objectives of the 2005-2006 research at Chignik were to continue the monitoring of biological and physical characteristics that were monitored in past years and to conduct three additional projects: 1) quantify patterns of sockeye fry and resident fish emigration out of Black Lake, 2) compare the size and weight of sockeye that were leaving Black Lake to those that stay, 3) use otolith microstructure to examine fine scale differences in growth rates between fish leaving Black Lake and those that stay. The results of these three objectives will not be discussed in this report, but will be discussed in a forth coming report to summarize all work completed during the three year NOAA grant. The 2005 fieldwork was completed during 101 days, between May and September. In addition to the specific projects previously mentioned, the following watershed monitoring tasks were completed:

- Temperature, water transparency (Secchi depth), phytoplankton (chlorophyll *a*), and zooplankton densities were measured to assess conditions that affect the growth of juvenile sockeye.
- Beaches were seined weekly at six established stations on Chignik Lake to assess the relative near-shore abundance of juvenile sockeye salmon and associated species.
- Tow netting was conducted in Chignik Lake and Black Lake during early September to assess the relative abundance and lengths of juvenile sockeye salmon in the pelagic region.

## Limnology

### Methods

Water temperature, water transparency, phytoplankton, and zooplankton samples were collected on both Black Lake and Chignik Lake (see Fig. 2 and Table 1 for GPS coordinates of sampling locations). Water clarity was estimated with a Secchi disk. Water temperatures were taken with a pocket thermometer on the surface of Black Lake and from water taken at several depths (1, 5, 10, and 20m) with a van Dorn bottle at Chignik Lake. Additionally, temperature data were collected from automatic, year-round thermographs (iB Cod (Z), Alpha Mach Inc.), deployed out of the water at the FRI cabin at the outlet of Chignik Lake, and in the water at two locations in Black Lake and one location in Chignik Lake. After the data from the logger were downloaded, it was reset to record continuously until retrieval next summer. Water samples for temperature and chlorophyll estimates were taken immediately below the surface for Black Lake, which is shallow and well mixed, and at 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 (0.48 $\mu$ ); 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 153 $\mu$  mesh, 0.5-m diameter net (1:3 ratio, 1000 mL collecting bucket) in Chignik Lake by hauling the net 40-m vertically through the water. In Black Lake, zooplankton were collected by hauling the 153 $\mu$  net horizontally along the lake surface for approximately 20-m. Additional details on sampling methodology are described in the FRI field manual (Rogers et al. 2002).

### Results

#### Biotic

Total zooplankton abundance in Chignik Lake is high compared to sockeye lakes in central and southeast Alaska ( $228,000 \pm 48,000 \text{ m}^{-2}$ ) (Kyle 1991) and western Alaska ( $250,000 \text{ m}^{-2}$  for 60 m haul) (D.E. Rogers, unpublished data). However, size of Chignik zooplankton tends to be small, indicating intense grazing pressure (Ruggerone 1994). Zooplankton in Chignik Lake during the past decade have displayed a seasonal pattern of relatively high abundance of *Cyclops* spp. during early summer followed by an increase in numbers of cladocerans (*Daphnia*, *Bosmina*, *Chydorus*) and Calanoids during late summer and fall. Abundances of zooplankton in Chignik Lake were found in densities higher than the long term average (Table 2). Rotifers (*Asplanchnia* sp.) were observed in extraordinarily high densities early in the season, followed by an exponential decline in their numbers by mid-summer. Copepods were observed in numbers lower than average early in the season, however, cladoceran abundances were higher than average. Seasonal patterns of species composition in 2005 are plotted in Fig. 3, (other than the high early season abundance of rotifers) followed the typical seasonal trend.

Interestingly, zooplankton density and total abundance in Black Lake was also extraordinarily high. Densities for all species were orders of magnitudes larger than the 2004 summer season, and densities of the cladoceran *Bosmina* were unprecedented (Table 3). Heavy grazing pressure by planktivorous fishes in Black Lake has the potential to reduce the densities of zooplankton, thus a reduction in this pressure may allow zooplankton to flourish. Although the relative abundance of sockeye was low (see tow netting below), other fishes in Black

Lake were high in 2005 indicating that a true lack of grazing pressure was unlikely. In contrast to a top down effect of grazing pressure causing the observed patterns in zooplankton abundance a plausible alternative is bottom up effects. An intriguing hypothesis is that volcanic eruptions from Mt. Veniaminof fueled an increase in primary productivity, which in turn supported the high abundances of zooplankton. Volcanic eruptions in Japan have been linked to increases in primary productivity in marine environments (Uematsu et al. 2004), and thus it is possible eruptions of Mt. Veniaminof in the winter of 2005 (AVO 2006) provided a large influx of nutrients to the system via sediment and ash. Although the mechanisms underlying the observed high abundances of zooplankton in Chignik Lake system are unclear, what is clear from the long term monitoring of FRI is that conditions in the system are continuing to change.

## Abiotic

Secchi depth (water clarity) in Chignik Lake is influenced by the standing crop of phytoplankton (indexed by chlorophyll *a*) and seasonal inflow of glacial melt from the West Fork River. Secchi depth typically declines from spring through summer, due to increase in amount of glacial melting and intense fish grazing on zooplankton, which allows more phytoplankton to bloom. Secchi depths in 2005 followed this general pattern and declined throughout the season (Table 3). No thermal stratification was observed in 2005 and surface waters were much cooler in general compared to the summer of 2004 (Westley et al. 2005). Chlorophyll *a* samples have not yet been analyzed.

Temperatures in Black Lake during 2005 were warm throughout the season, although there was clear variation in temperatures among sites. However, no site was consistently the warmest or coolest (Table 5). Surface temperatures in August approached 20 degrees. Secchi readings in Black Lake are influenced by both phytoplankton and suspended sediments caused by windstorms. The general pattern of declines in secchi depths during spring and summer is a result of the trophic cascade between planktivorous fishes, zooplankton, and phytoplankton. As the season progresses grazing of the zooplankton by sockeye and other planktivorous fishes increases and as a result the standing crop of phytoplankton, chlorophyll *a*, increases in Black Lake, thereby decreasing Secchi depths. We observed this pattern in 2005 with Secchi depths declining from 1.7 m in June to 0.80 m in September (Table 6).

## Seasonal temperatures

Chignik experienced a mild winter and warm spring in 2005, indicated by temperatures in excess of 20°C in April and extended periods of above freezing temperatures throughout the winter (Fig. 4). These observations were affirmed by local residents, who report that neither Chignik Lake nor Black Lake froze for any substantial period (Mr. Ron Lind, Chignik Lake, personal communication).

Water temperatures in Black Lake varied significantly throughout the summer, and revealed interesting patterns. Water temperatures were assessed every 15 minutes throughout the summer in two locations in Black Lake, one in the shallow outlet area (average depth ~1.5 m) and in the deepest part of the lake near Hydro Point (depth ~3 m). It was hypothesized that water temperatures in the shallow outlet area would, for any given time period, be warmer than the water near Hydro Point, simply due to the additional volume of water found at this site. However, contrary to expectations, the Outlet was not always warmer than Hydro Point (Fig. 5). Interestingly, the variations in the outlet area are much greater than at Hydro Point presumably because the shallow water will respond more quickly to air temperature changes, and daily fluctuation of over 3 degrees were recorded. The maximum daily fluctuation in water temperatures at Hydro Point was approximately 2 degrees. It is plausible too that cold water entering the outlet area of Black Lake serves to buffer the increase in temperature that would have occurred in a similarly shallow area with no cold water input. Additionally, we regressed the recorded temperature in the outlet to the temperature at Hydro Point and found a highly significant relationship ( $F=4294$ ,  $p<0.001$ ), indicating that when temperatures were high in the outlet they were high at Hydro Point. However, the temperature at the outlet described only 68% of the variation in temperature at Hydro Point (Fig. 6.),

indicating that these locations are responding differently to environmental factors (e.g. air temperature, cold water inputs).

As expected, water temperatures in Chignik Lake were cooler for a given date than temperature in Black Lake. Additionally, variations in water temperature were minor in Chignik Lake compared to Black Lake (Fig. 7.)

## **Tow net sampling**

Tow-net hauls were made annually in the Chignik Lakes from 1960 to 1973 (Rogers et al. 1996). Tow net operations provide a means to estimate size and relative abundance of juvenile sockeye salmon near the end of the growing season. During 1973 to 1991, tow netting was sporadic due to the lack of consistent funding. However, since funding has stabilized (provided by CRAA and NOAA) we have sampled both lakes since 1992, except for 1994<sup>1</sup> and 2004 (Chignik Lake only due to engine problems).

## **Methods**

Tow net catches were standardized to 10 min (Parr 1972) and arithmetic means were calculated. Towing typically begins at the north end of the lake and continues south toward the outlet, but may vary depending on weather conditions and wind direction. Locations of townetting stations are shown in Fig.2. and GPS coordinates are provided in Table 1. Tows have not been made in the outlet of Black Lake since the late 1980s because the outlet has become too shallow. For a complete description of the methods for tow netting see the FRI operations manual (Rogers et al. 2002).

## **Results**

The relative abundance of sockeye salmon in the fall townet survey of Chignik Lake was the lowest since 1999, and well below the historical average (Table 7, 8). Abundances of sticklebacks were similar to past years, indicating the net was still fishing effectively. Interestingly, the abundance of pond smelt was lower than past years, and drastically lower than 2004 (Westley et al. 2005). Length frequency distributions for 2005 are presented in figures 8-10.

Townetting was conducted in July and September in Black Lake. Relative abundance of sockeye in July was high compared to resident fishes (i.e. sticklebacks and pond smelt), but low in September. Sockeye catches in September were comparable to past years (Table 9).

## **Beach seining**

Beach seining was first conducted in Chignik Lake in 1956 and continued with consistency until 1972 and the resumed since the mid-1980s (Ruggerone 1989c, Rogers et al. 1996). The overall goal of the beachseining it to, like the townetting, quantify the relative abundance and size of fish in the system. Beachseines sample the littoral zone of the lakes and provide insight into habitat preferences of different species. For example, juvenile coho salmon are usually more abundant in beach seine catches than in townet catches, which reflects their preference for the nearshore habitat (Ruggerone 1989a). An intensive study of coho predation on sockeye salmon during the mid-1980s showed that coho consumed approximately 24 to 78 million sockeye salmon fry depending on year or approximately 59% of the emerging sockeye population (Ruggerone & Rogers 1992).

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<sup>1</sup> Sampling by ADFG in 1994 using a net towed by a single boat produced only a few sockeye per tow.

## **Methods**

Beach seining of Chignik Lake was conducted during June, July, and August 2005. For a complete description of the methods for beach seining see the FRI operations manual (Rogers et al. 2002).

## **Results**

### **Chignik Lake**

Beach seine sampling may not reflect abundance of Chignik Lake sockeye; especially fry, because fry are readily consumed by juvenile coho that are abundant nearshore and because fry rapidly move offshore apparently to avoid predation (Ruggerone 1989). The numbers of fish captured in 2005, like 2004, were well above average for sockeye, threespine sticklebacks, and coho compared to the past several years (Table 10, 11). The fish lengths from historical beach seine data are still being compiled, which precludes comparisons in length among years; however, length distributions from 2005 for the most commonly captured species are shown in figures 11-15.

### **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). 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<sup>2</sup>. 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 & Denman 1990) and in 1993 and 1999 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 most recent study indicates that the flow in the Alec River has potentially slowed its progression towards the outlet, although without additional years of sampling it will ultimately remain unclear.

## **Methods**

Measurements of flow were made on both channels by stretching a cable across the river at locations maintained by FRI (Fig.16). Depth is measured in centimeters, and flow is measured using a flow meter with an accuracy of 0.1 m/s.

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<sup>2</sup> 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 that it will likely lead to additional lowering of Black Lake water elevation.

We use an arcsin transformation of the percentage and log transformation of the total flow when modeling the relationship. We treat total flow and percentage to the south channel as continuous variables, and year as a continuous variable. Our generalized linear model (GLM) tests for the significance year and total flow, and any interaction between the three.

## **Results**

### **Discharge**

With the addition of data collected in 2002 to the linear model, the year predictor became statistically significant. For the next 2 subsequent years, this term remained significant and appeared to be becoming more significant. However, with the addition of data collected in 2005 the year predictor became highly insignificant ( $p=0.761$ ). Examination of the plot of percent of the total flow going down the south channel as a function of the total flow reveals several interesting observations. First, the range of observations in 2005 fell along a very narrow range of total flow values, which increase the influence of these points on the model fit. Second, for a given value of total discharge, the amount going down the south channel in 2005 was less than previous years (Fig. 17). Through personal observations in 2004 and 2005 it appeared as if the area downstream of the large wye at the junction of the north and south channels was eroding and more water was rejoining the North Channel. These results indicate that the system may be reaching some equilibrium or even beginning the process of reverting to the previous regime of preponderance of flow to the North Channel. Data collection in 2006 and subsequent years will be important for understanding how the Alec River system is continuing to evolve.

### **2006 salmon forecast**

We provide independent forecasts for Black Lake and Chignik Lake for the 2006 fishery. We have two models for producing the forecasts which operate on slightly different principles. Both models only used data from 1977 to 2005 to make predictions.

The first, and more familiar, method involves using sibling returns. Forecasts of five-year-old fish are made based on the number of four-year-old fish that returned last year (i.e. the sibling of the five-year-old fish this year). We assume the historic relationship between the siblings to be linear. Previously we chose only one age class to predict subsequent age classes. For instance, 2.2 are traditionally best predicted by the relationship with 1.2, and we ignored any information provided by the 1.1 or 2.1 from the same brood year. Our current method uses model averaging which allows us to use information from all of the pertinent sibling age classes for making forecasts. The forecasts from models that have poor fits to the data are down-weighted and thus provide less information in the overall forecast. Predicted returns to the Chignik system, estimated using this model, are summarized in Table 12.

Our second method is known as the recruits-per-spawner model (Adkison & Peterman 1999). The basic tenet is that forecasts for a particular age class can be made based on the signature age composition of a system, and information about the average recruits-per-spawner. The disadvantage of this method is that it only predicts the number of fish returning based on their total age, not based on their freshwater and saltwater age. This makes the age specific comparisons between the two models difficult. The advantage of this, however, is that we are able to produce Bayesian probability intervals for our estimates. Additionally, we can incorporate autocorrelation into model scenarios, which takes into account model performance for a specified amount of time in the past (e.g. how has the model performed in the past 2 years) and weights predictions accordingly. That is, if the model has been consistently under estimating returns the model will increase predicted returns, and the opposite is true if the model has been overestimating returns. Results of the recruits-per-spawner model run with no autocorrelation, 3 years of autocorrelation, and 5 years of autocorrelation are presented in Table 13.

Like with the sibling model, we conducted a retrospective analysis to investigate the performance of this model from 1983 to 2005. A retrospective analysis was completed to explore model performance. In general this model did a fair job at forecasting returns between the years examined (1983-2005) and we will continue to use this model for future forecasts (Fig. 18).

## **Acknowledgements**

The 2005 research at Chignik was funded by the National Marine Fisheries Service, Anadromous Fish Act Funds, and by the Chignik Regional Aquaculture Association. We wish to thank the Alaska Department of Fish and Game for their cooperation, especially Ken Bouwens, Patti Nelson, and Mark Witteveen. A number of residents of the Chignik Lake village provided valuable logistic support, including Johnny Lind, Willard Lind, Ron Lind, Doris Lind, and Eddie Slaton and Julie Slaton. Jon Moore, Joseph Anderson, Mark Henderson, and Donna Hauser helped conduct much of the data collection

## **Key Words**

Alec River, beach seine, Black Lake, Chignik Lake, escapement goals, forecast, hydrology, limnology, *Oncorhynchus nerka*, sockeye salmon, townet

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## Figures

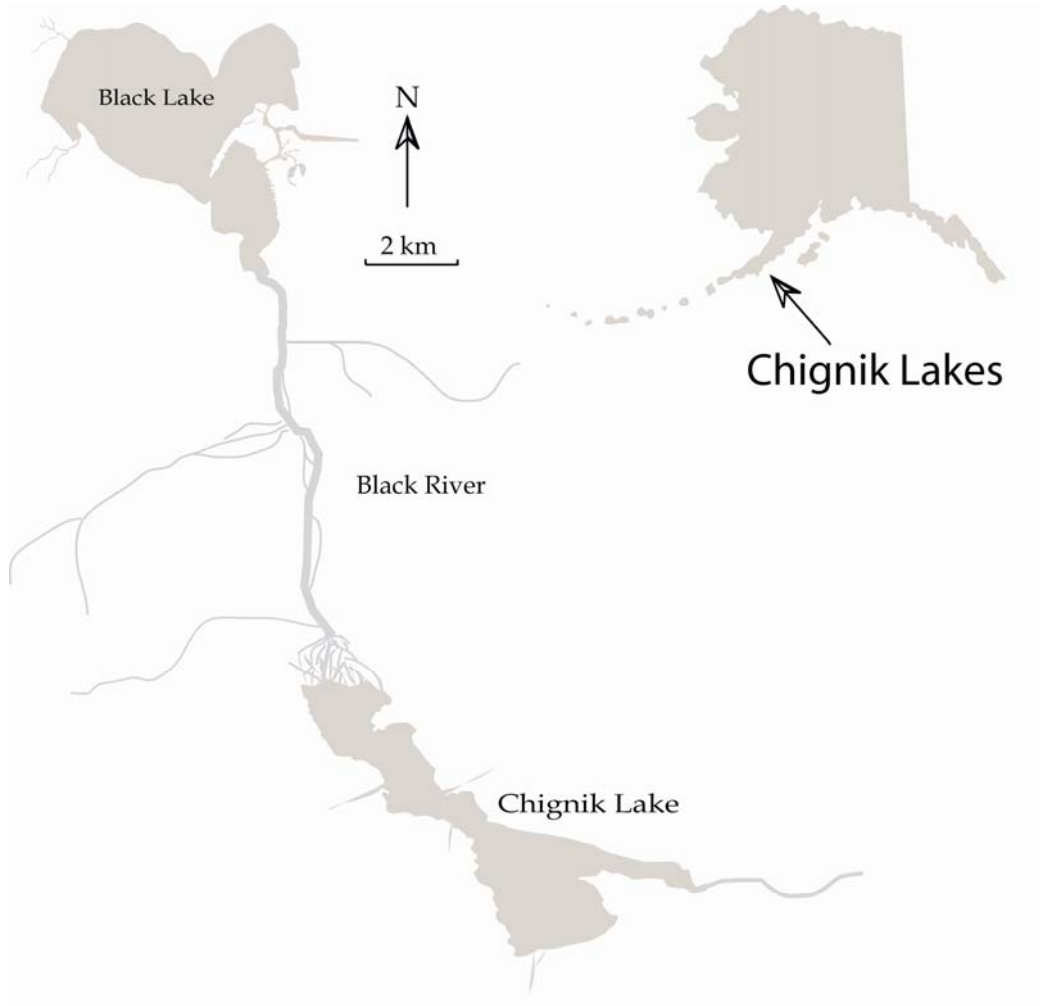


Fig.1. Map of the Chignik Lake system, with approximate location shown on inset of Alaska state map.

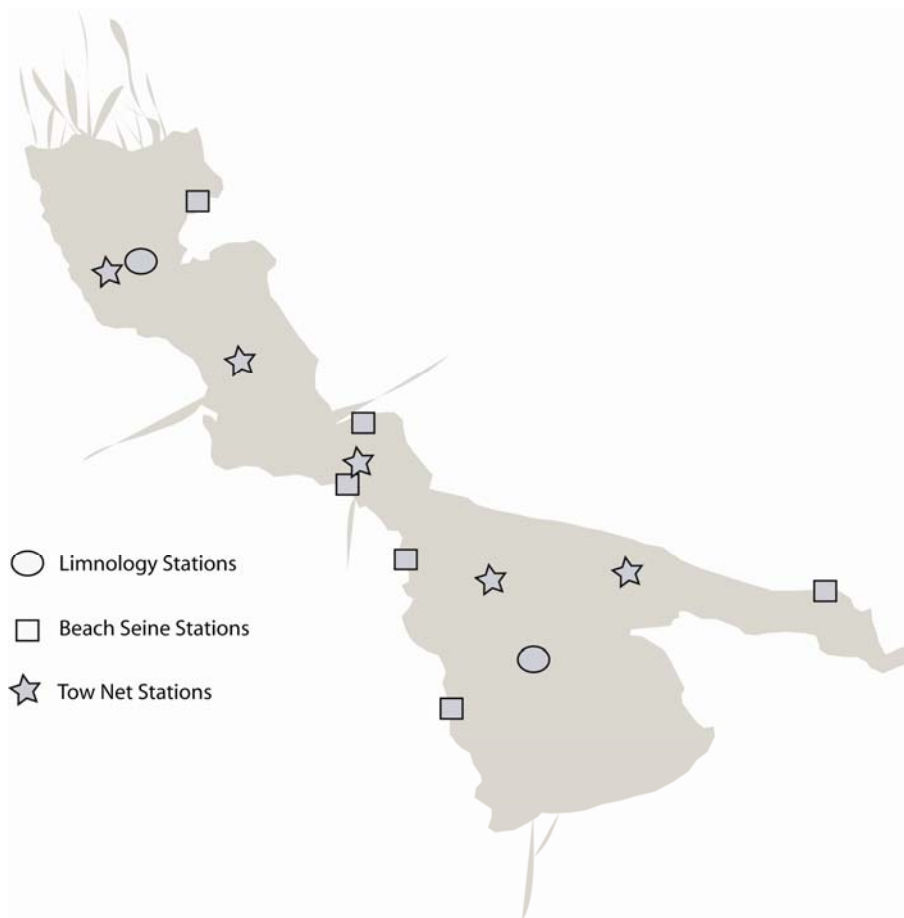
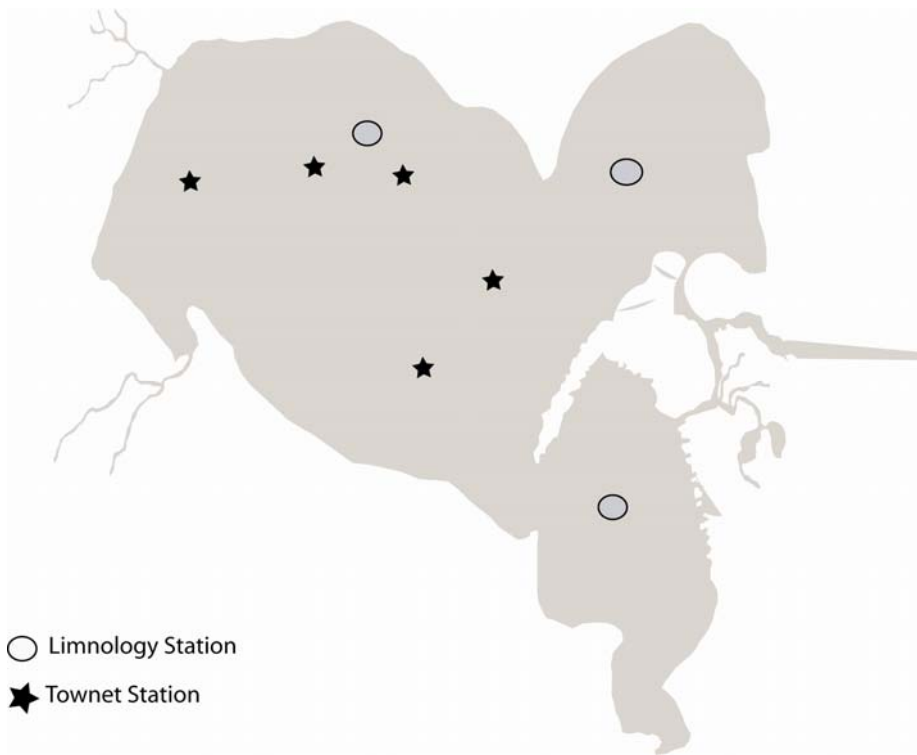


Fig.2. Maps of Black Lake (top) and Chignik Lake (bottom) shown with the locations of FRI limnology, beachseining, and townet stations.

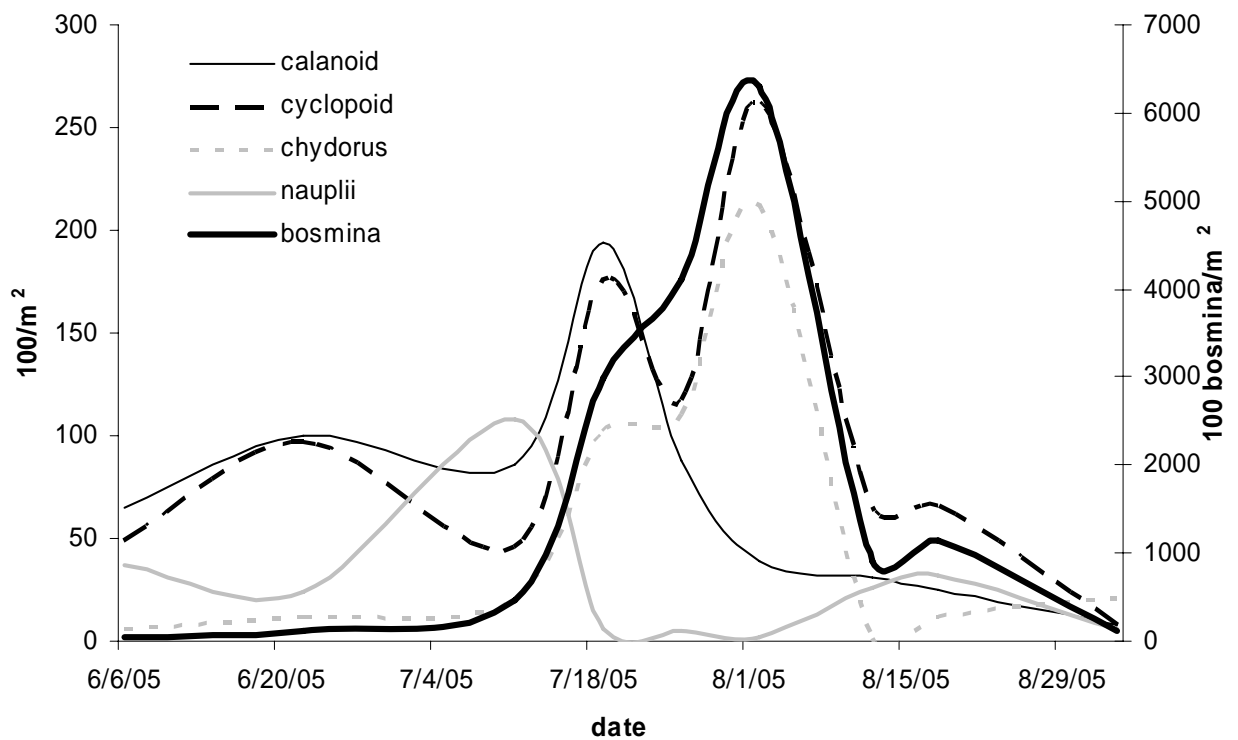
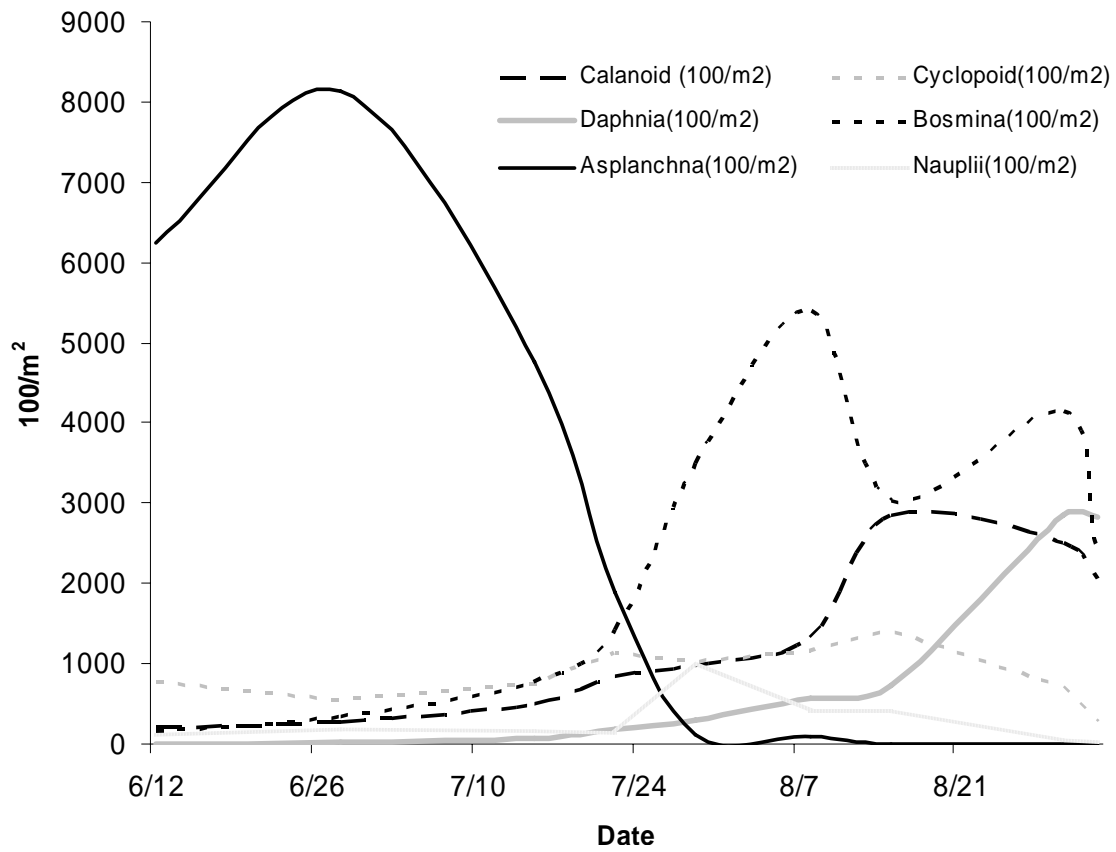


Fig. 3. Densities of zooplankton in Chignik Lake (top) and Black Lake (bottom) throughout the 2005 summer season.

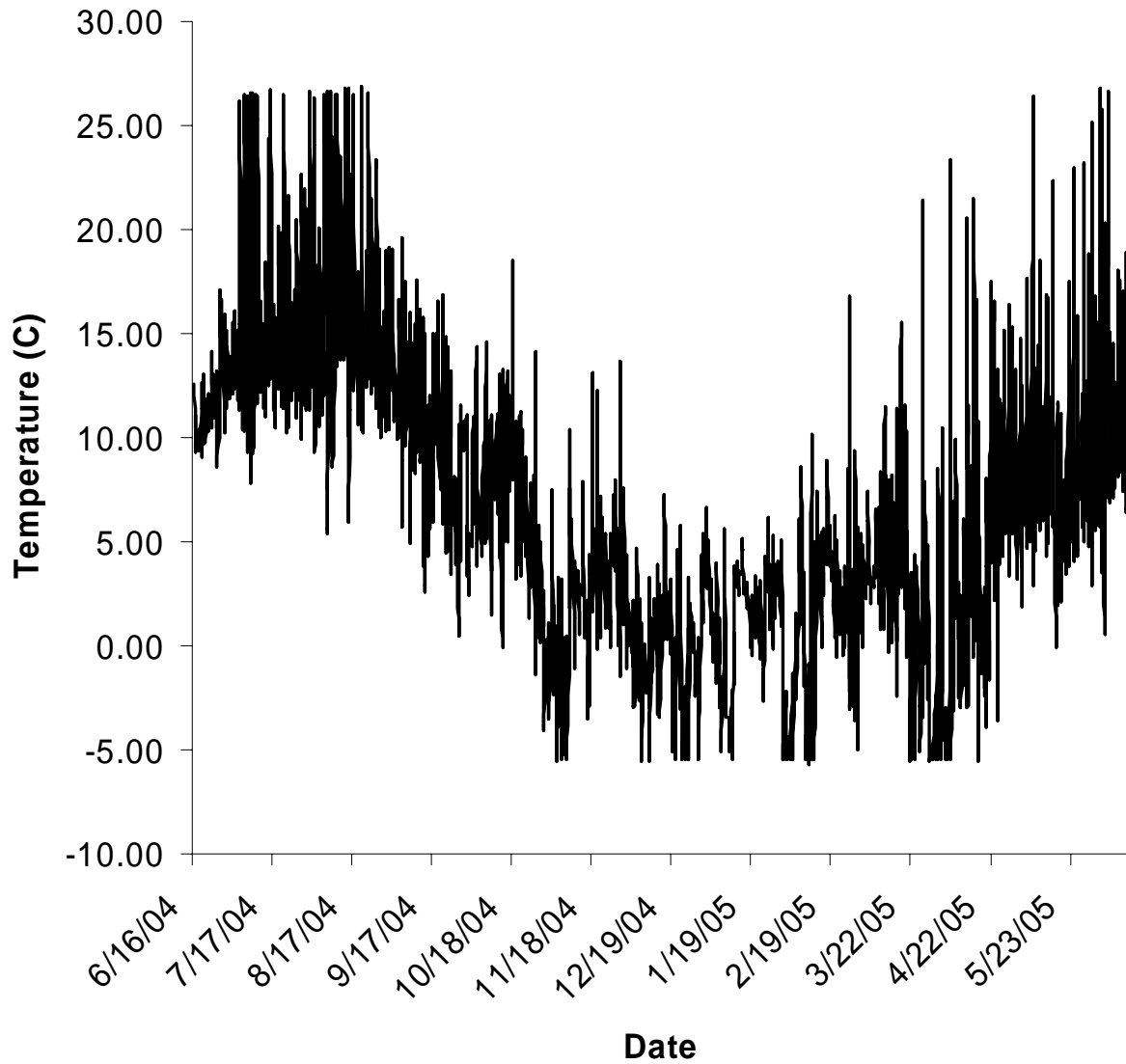


Fig. 4. Air temperature (Celsius) recorded at the FRI cabin at the outlet of Chignik Lake every 8 hours between 14 June 2004 and 14 June 2005.

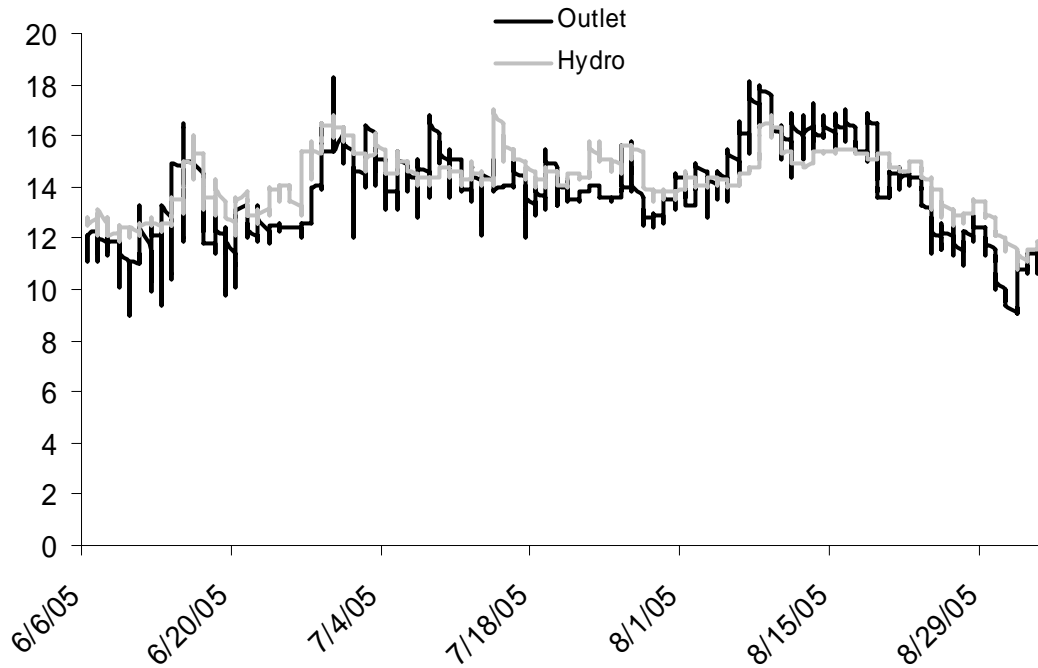


Fig. 5. Water temperatures (Celsius) recorded in 15 minute intervals at two locations in Black Lake, one near the outlet (black line) and another near Hydro Point (grey line)

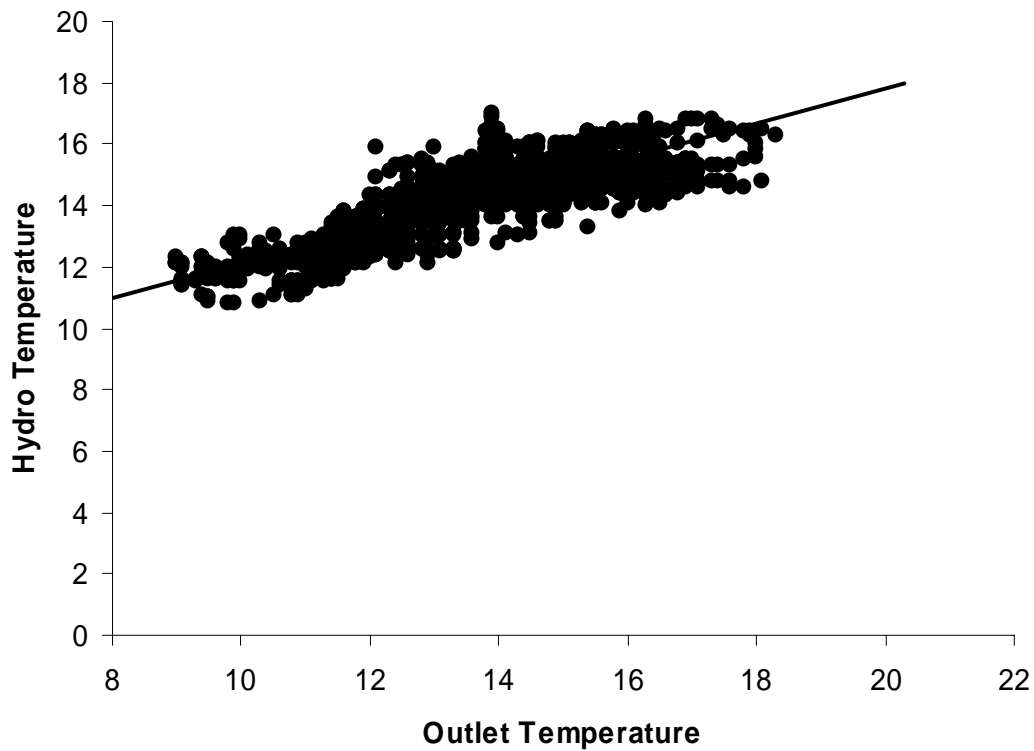


Fig. 6. Relationship between water temperature in the outlet area and at Hydro Point in Black Lake. There is a highly significant relationship among areas ( $p < 0.001$ ); however, the relationship was quite variable ( $r^2 = 0.68$ ).

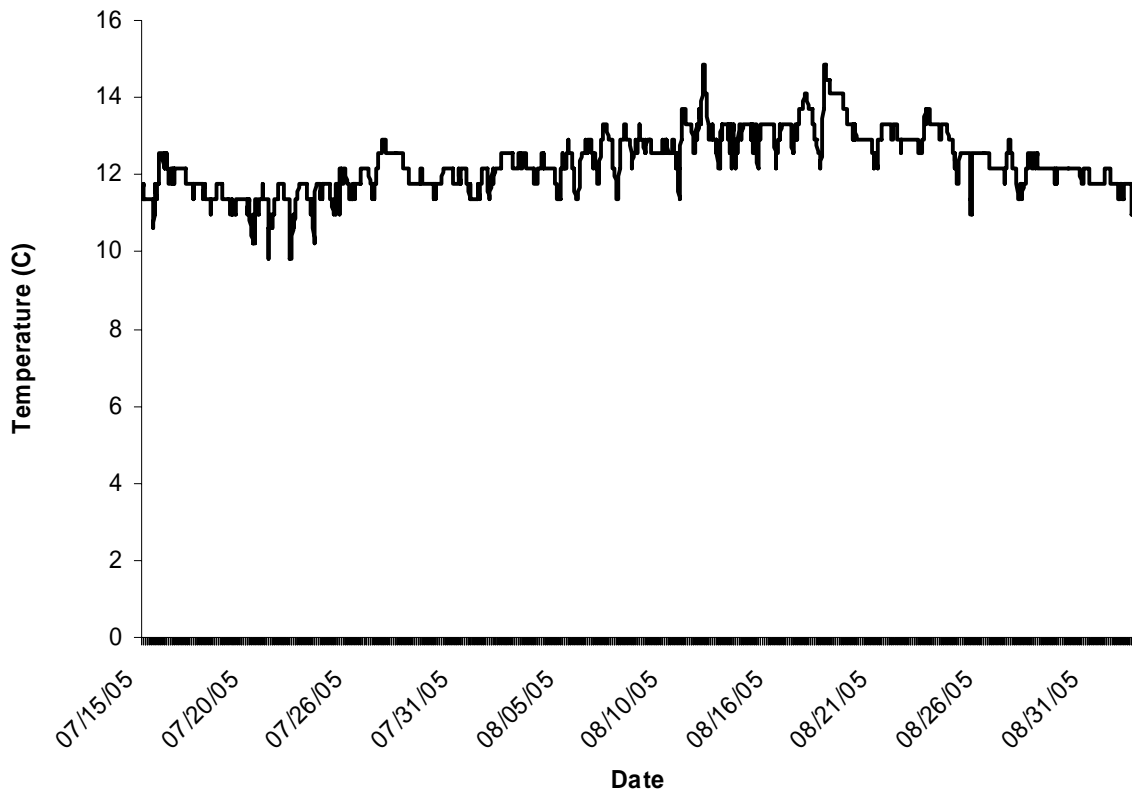


Fig. 7. Water temperature recorded every 15 minutes in Chignik Lake from 15 July 2005 to 2 September 2005.

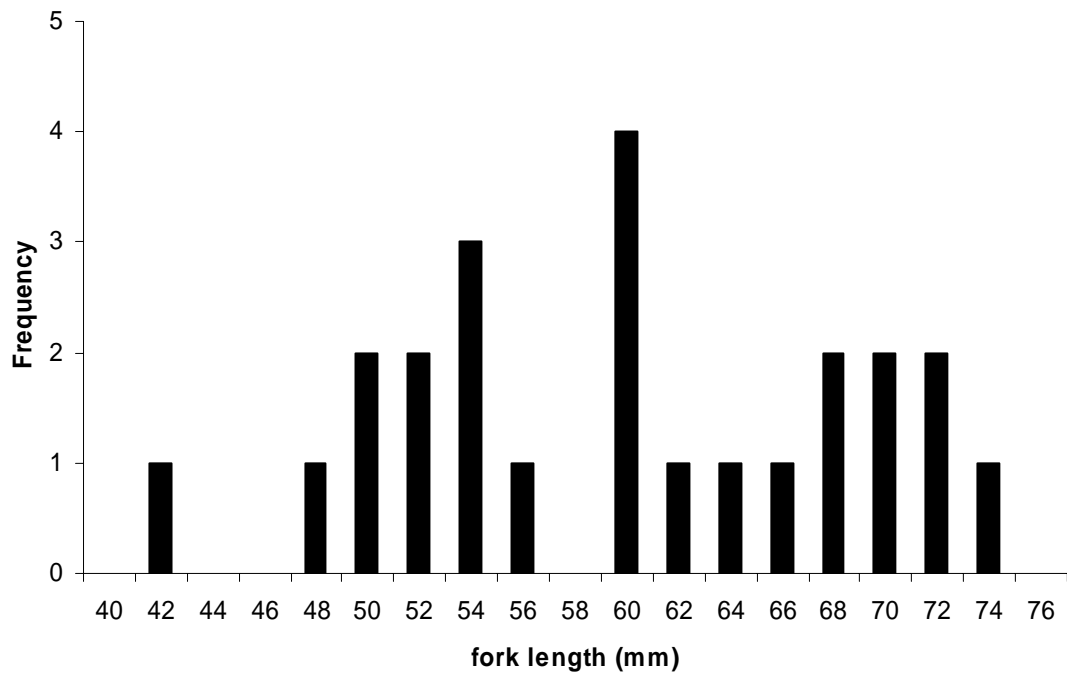


Figure 8. Fork length (mm) of sockeye salmon caught via tow netting in Chignik Lake during FRI's 2005 summer field season.

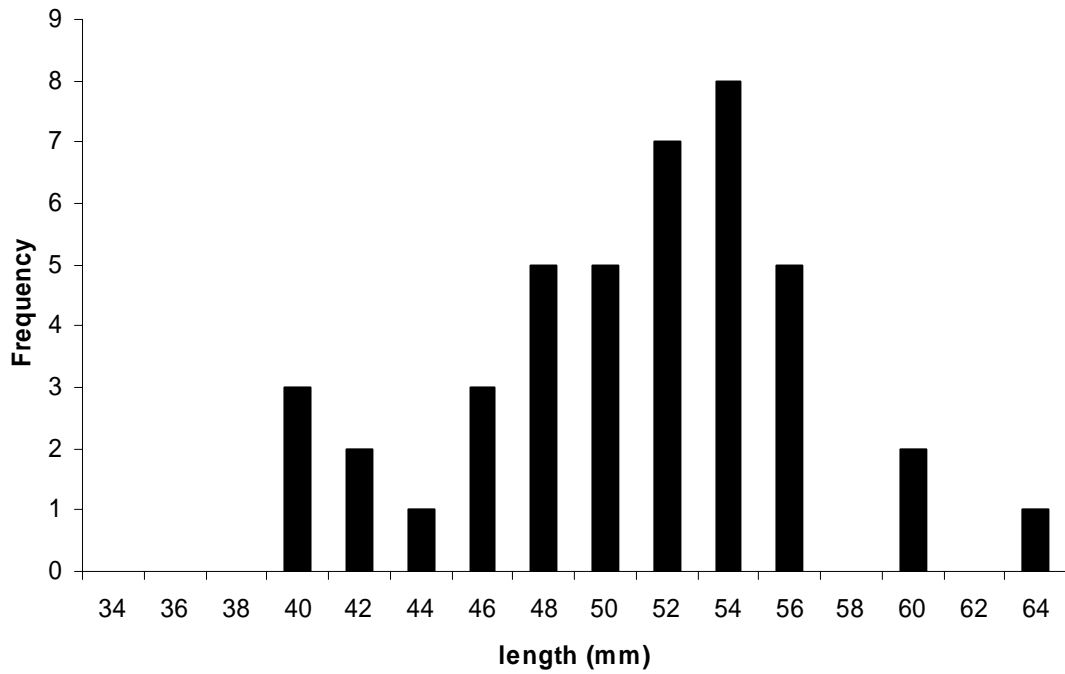


Figure 9. Length (mm) of ninespine sticklebacks caught via tow netting in Chignik Lake during FRI's 2005 summer field season.

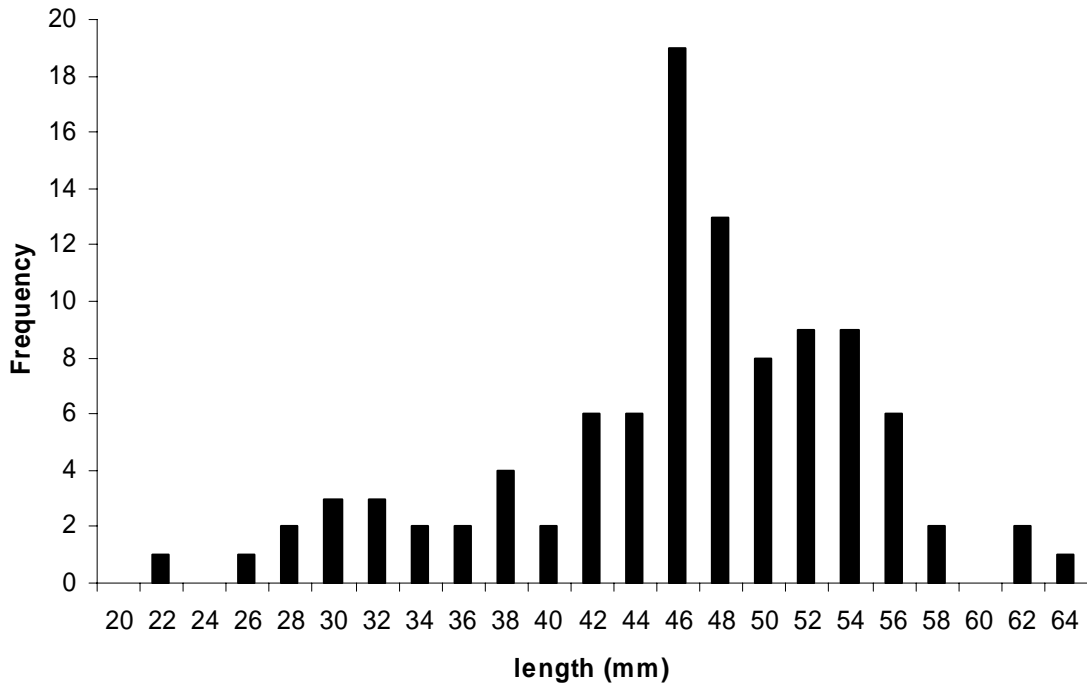


Figure. 10. Length (mm) of threespine sticklebacks caught via tow netting in Chignik Lake during FRI's 2005 summer field season.

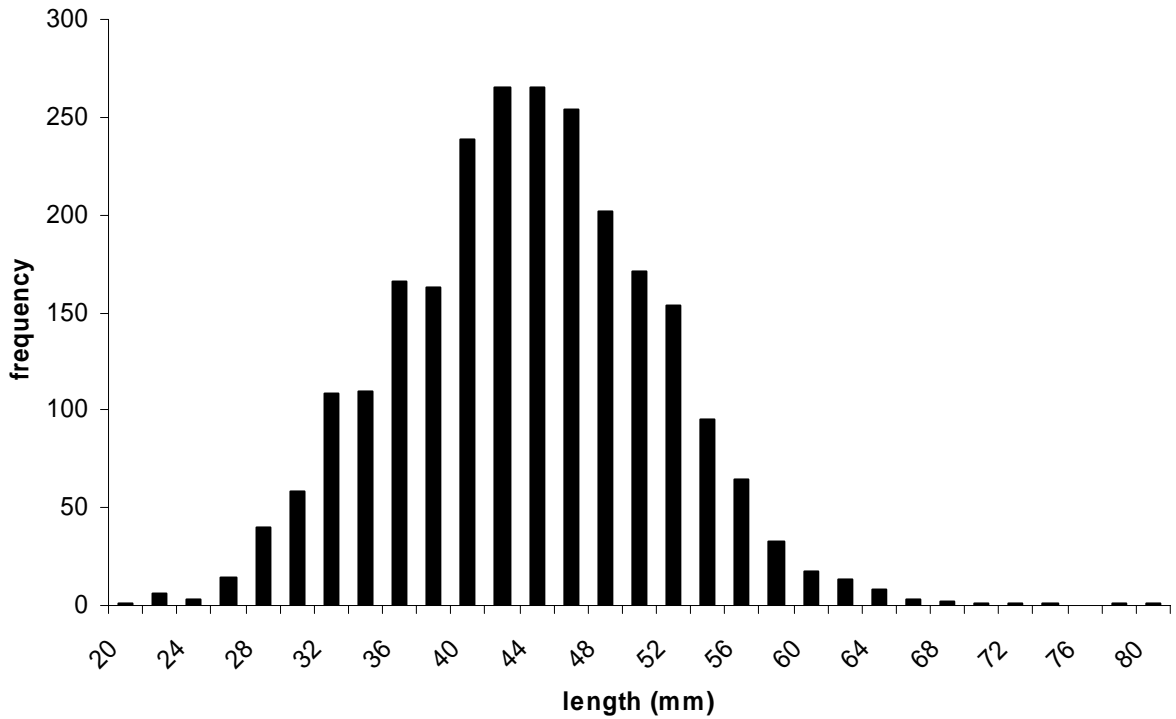


Figure. 11. Length (mm) of threespine sticklebacks caught via beach seining in Chignik Lake during FRI's 2005 summer field season.

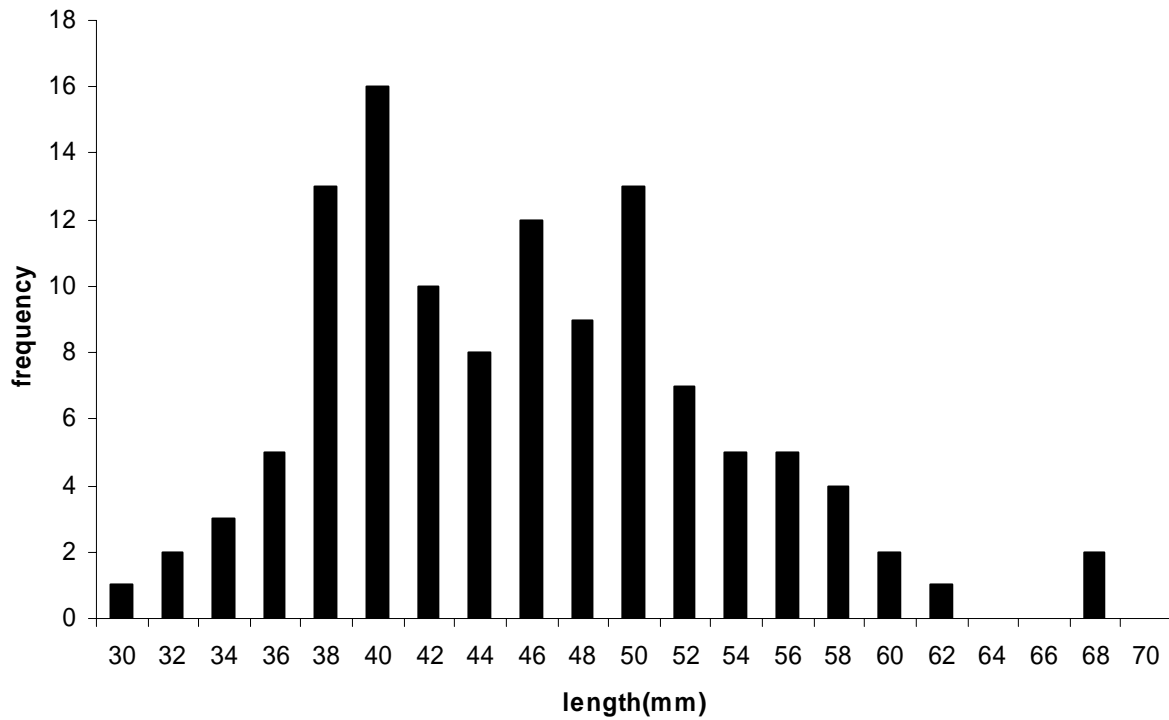


Figure. 12. Length (mm) of ninespine sticklebacks caught via beachseining in Chignik Lake during FRI's 2005 summer field season.

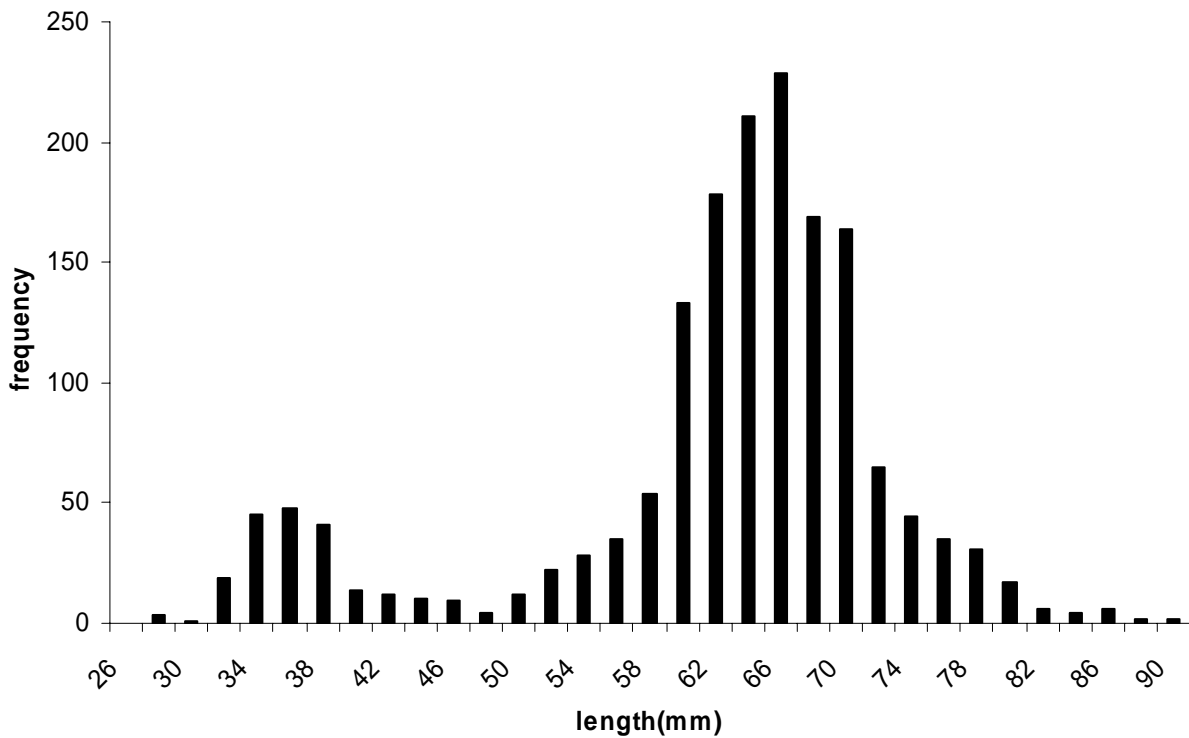


Figure. 13. Length (mm) of sockeye salmon caught via beachseining in Chignik Lake during FRI's 2005 summer field season.

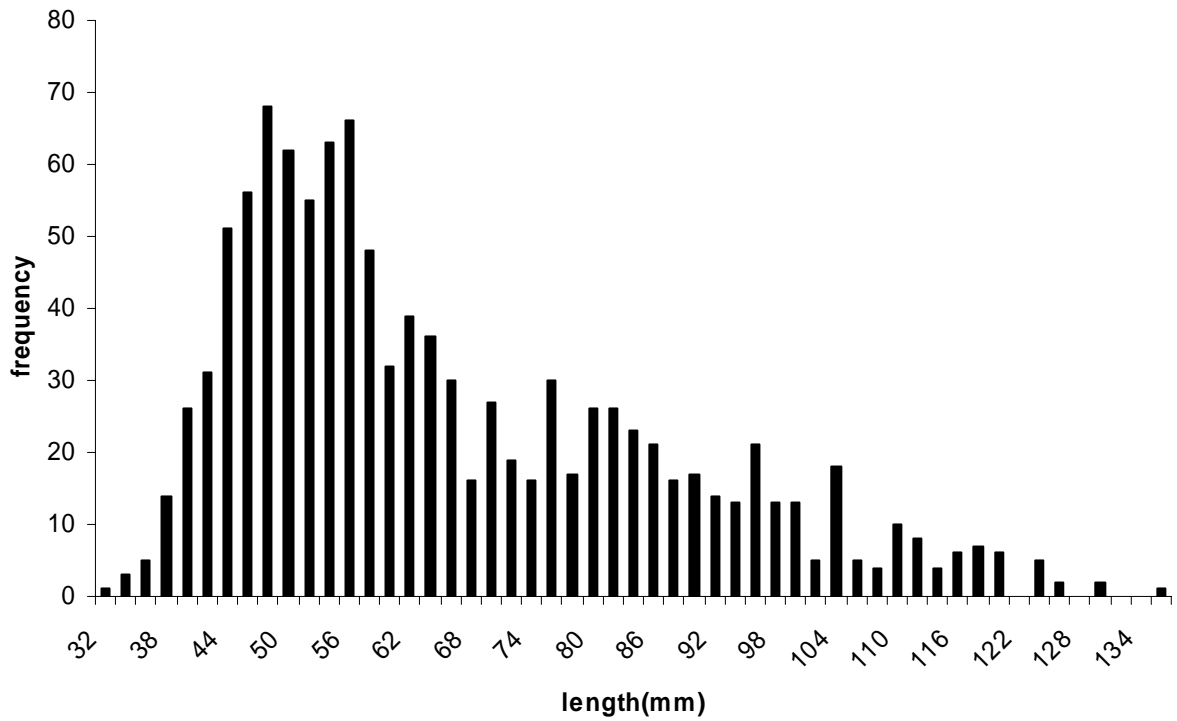


Figure. 14. Length (mm) of coho salmon caught via beachseining in Chignik Lake during FRI's 2005 summer field season.

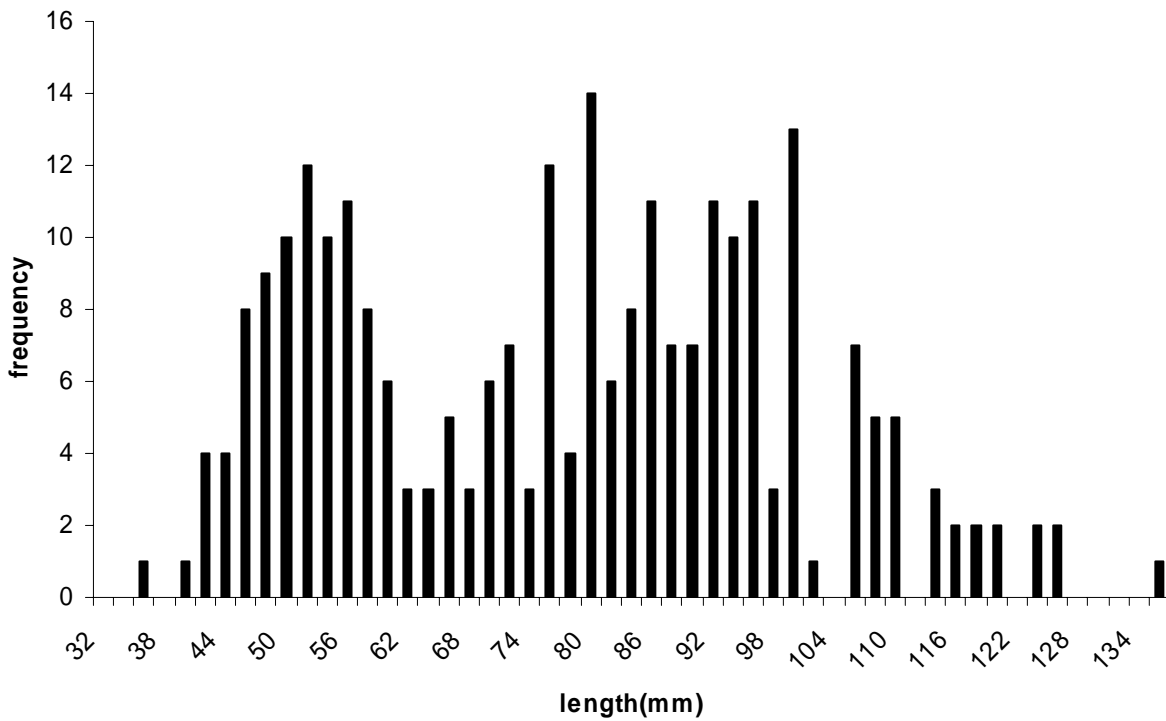


Figure. 15. Length (mm) of pygmy whitefish caught via beachseining in Chignik Lake during FRI's 2005 summer field season.

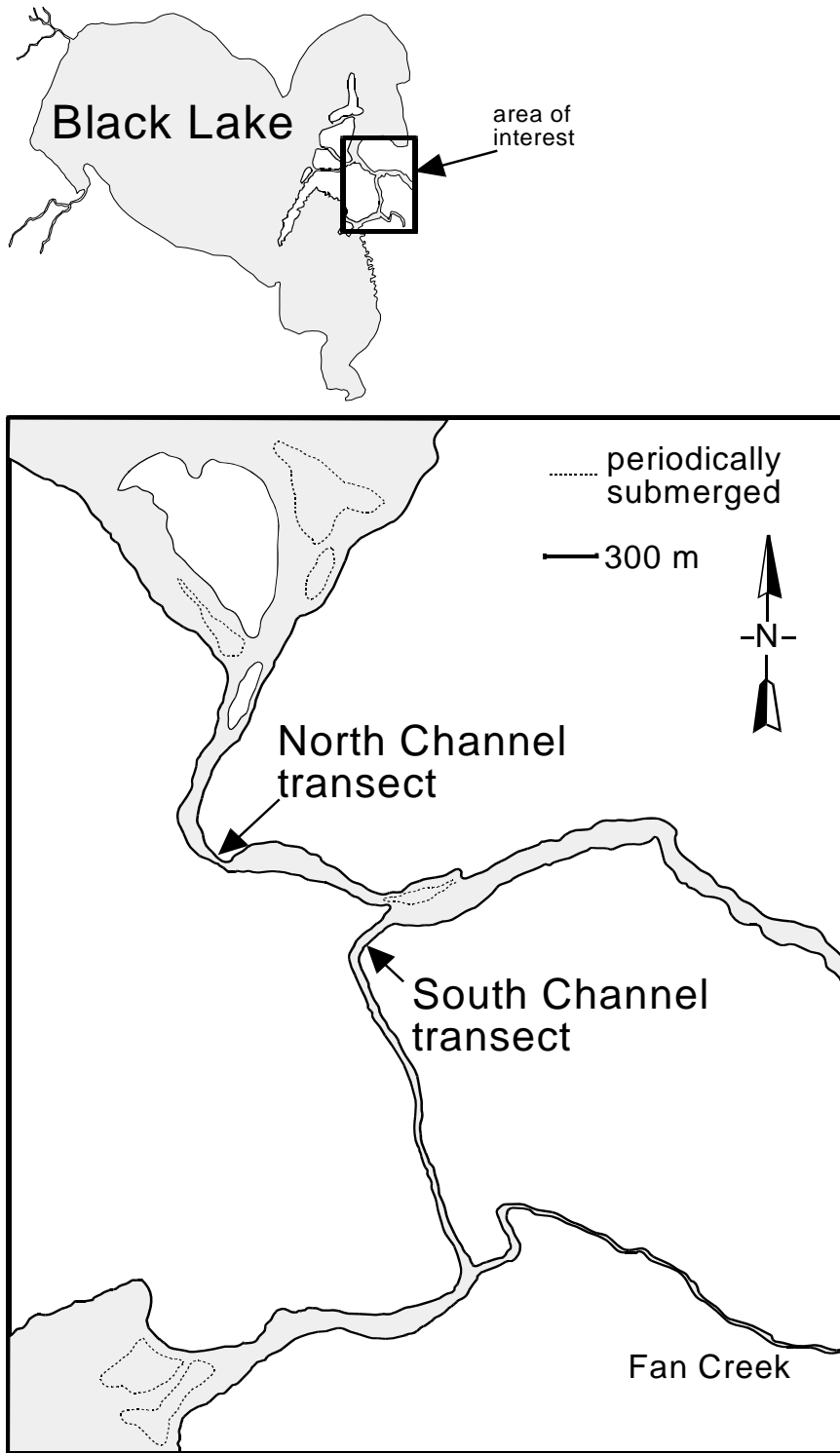


Figure 16. Alec River hydrology transects (dashed areas represent delta or sandbars).

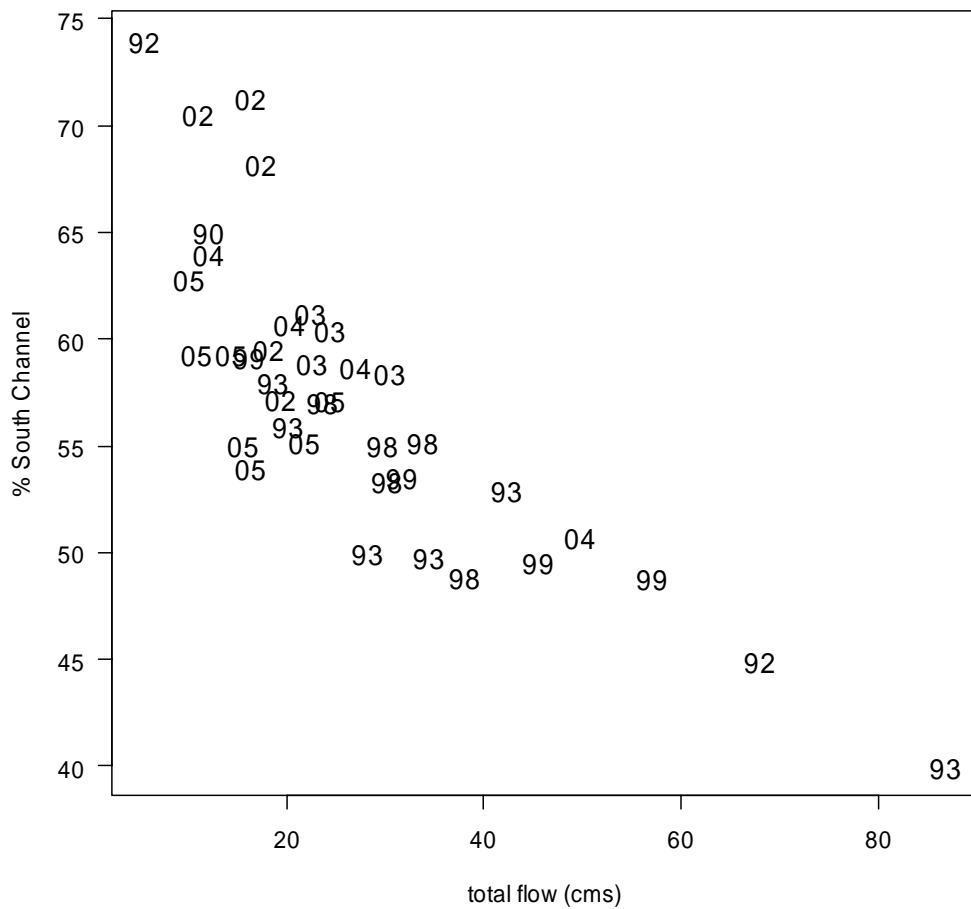


Figure 17. Plot of the relationship between total flow and percentage flowing to the south

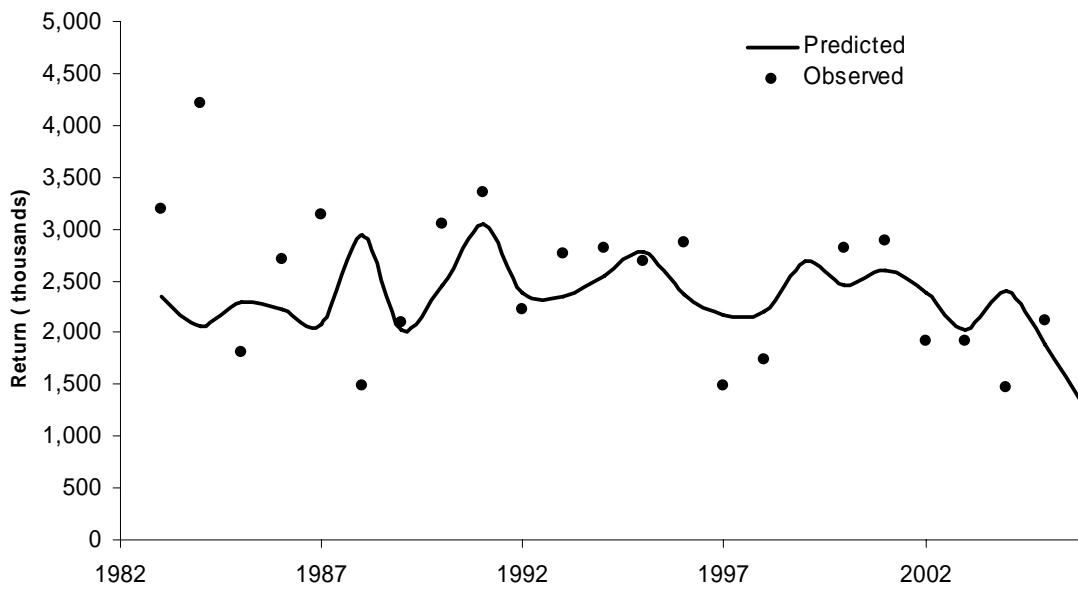


Figure 18. Retrospective analysis showing the fit of the spawner-recruit forecast model to the observed total return to the Chignik system.

## Tables

Table 1. General locations (Black or Chignik lakes), GPS coordinates, and description of sampling conducted at 15 sites in the Chignik Lake system.

Site	General Location	Beachseine/Townet	GPS Coordinates
Chig Tow 1	Chignik Lake	Townet	56.29399 N, 158.89902 W
Chig Tow 2	Chignik Lake	Townet	56.27373 N, 158.86969 W
Chig Tow 3	Chignik Lake	Townet	56.26611 N, 158.84737 W
Chig Tow 4	Chignik Lake	Townet	56.25521 N, 158.82951 W
Chig Tow 5	Chignik Lake	Townet	56.26008 N, 158.79295 W
BL Tow 1	Black Lake	Townet	56.45415 N, 158.97363 W
BL Tow 2	Black Lake	Townet	56.46781 N, 158.98912 W
BL Tow 3	Black Lake	Townet	56.47452 N, 158.00244W
BL Tow 4	Black Lake	Townet	56.47430 N, 159.01530 W
BL Tow 5	Black Lake	Townet	56.47271 N, 159.02577 W
Clark Bay	Chignik Lake	Beachseine	56.24045 N, 158.83083 W
South Hatch	Chignik Lake	Beachseine	56.26261 N, 158.84460 W
North Hatch	Chignik Lake	Beachseine	56.26917 N, 158.87996 W
Delta	Chignik Lake	Beachseine	56.28237 N, 158.86645 W
Cucumber	Chignik Lake	Beachseine	56.26070 N, 158.76961 W
Outlet	Chignik Lake	Beachseine	56.43457 N, 158.94599 W

Table 2. Historical zooplankton densities (1000/m<sup>2</sup>) in Chignik Lake from 1968-2005.

Year	Month	Day	# Sites	Depth (m)	Categories							Total
					Calanoids	<i>Cyclops</i>	<i>Daphnia</i>	<i>Bosmina</i>	<i>Chydoris</i>	Nauplii	<i>Asplanchnia</i>	
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

Historical Chignik Lake zooplankton--cont.

Year	Month	Day	# Sites	Depth (m)	Categories							Total
					Calanoids	Cyclops	Daphnia	Bosmina	Chydoris	Nauplii	Asplanchnia	
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
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	2	187	2	6	2	30	1	230
1997	6	11	2	40	8	189	6	3	6	14	0	224
1997	8	15	2	40	145	42	234	195	1	83	40	739
1997	8	28	2	40	68	51	108	164	1	30	22	444
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	10	135	7	6	0	19	3	180
1999	6	16	2	40	17	147	8	6	1	21	1	200
1999	6	24	2	40	55	95	25	20	0	29	2	226
1999	7	6	2	40	45	77	13	10	2	33	5	185
1999	9	6	2	40	97	37	20	30	3	26	1	214
2000	6	9	2	40	23	143	3	11	1	33	1	215
2000	6	18	2	40	27	123	4	22	1	20	2	199
2000	6	26	2	40	28	668	3	26	3	26	3	757
2000	7	05	2	40	42	109	2	37	5	17	2	214
2000	7	11	2	40	71	122	2	47	8	5	9	264
2000	9	05	2	40	170	79	22	193	13	41	54	572
2001	6	29	2	40	63	63	3	10	0	11	2	152
2001	7	7**	2	40	83	88	2	40	0	11	2	223
2001	7	13	2	40	122	39	1	58	0	23	14	258
2001	8	30	2	40	196	39	11	121	0	53	28	447
2002	6	27	2	40	30	97	2	12	3	6	99	247
2002	7	3	2	40	35	96	5	19	8	10	267	439
2002	7	8	2	40	21	141	7	21	6	26	305	526
2002	7	13	2	40	64	92	3	40	8	50	173	428
2002	7	22	2	40	107	94	11	72	6	41	43	372
2002	9	1	2	40	262	96	171	167	3	77	1	776
2004	6	25	2	40	68	85	66	64	19	17	28	347
2004	6	29	2	40	59	60	12	22	7	39	5	204
2004	7	5	2	40	50	108	14	80	12	26	13	303
2004	7	11	2	40	83	129	16	59	12	13	32	344
2004	9	3	2	40	25	68	211	151	2	28	79	564
2005	6	12	2	40	22	77	0	17	1	12	625	753
2005	6	28	2	40	26	54	3	34	4	17	813	951
2005	7	15	2	40	50	76	8	78	1	15	476	704
2005	7	22	2	40	84	115	17	141	4	14	189	564
2005	7	29	2	40	98	103	29	349	6	101	12	697
2005	8	8	2	40	133	116	57	541	11	40	9	907
2005	8	15	2	40	284	140	73	302	7	41	1	848
2005	8	30	1	40	250	70	285	415	5	6	1	1,032
2005	9	2	2	40	204	28	283	230	3	2	0	752

\*\*Due to high winds, samples for the half the samples on the delta were taken on June 6th. The results reflect the two day average.

Table 3. Historical zooplankton abundance in Black Lake from 1992-2005

Year	Month	Day	# Sites	Category							Total
				Calanoids	<i>Cyclops</i>	<i>Daphnia</i>	<i>Bosmina</i>	<i>Chydoris</i>	Nauplii	<i>Asplanchnia</i>	
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	13	5	0	6	0	7	0	30
1999	6	21	3	5	6	0	8	1	8	0	28
1999	6	26	3	17	13	0	39	1	14	0	84
1999	7	5	3	38	29	0	55	3	22	1	146
1999	9	7	3	1	6	0	83	1	2	0	93
2000	6	10	3	2	9	0	14	2	9	0	35
2000	6	18	3	6	10	0	19	4	16	0	54
2000	6	26	3	0	0	0	7	0	0	0	7
2000	7	05	3	9	9	0	25	4	4	0	51
2000	7	11	3	5	5	0	24	1	3	0	38
2000	9	05	3	14	40	0	294	48	2	0	399
2001	6	27	3	91	21	0	62	0	10	0	184
2001	7	7	3	73	23	0	200	1	17	0	314
2001	7	10	3	23	12	0	85	0	10	0	130
2001	7	13	3	24	10	0	38	0	14	0	86
2001	9	4	3	0	0	0	0	0	0	0	0
2002	6	28	3	20	39	1	27	4	19	17	126
2002	7	3	3	15	25	0	48	1	8	16	113
2002	7	19	3	10	26	0	84	20	4	2	146
2002	8	30	3	15	30	0	200	10	4	8	267
2004	6	27	3	2	3	0	20	2	1	0	28
2004	6	30	3	2	1	1	1	1	1	5	12
2004	7	12	3	33	12	0	57	7	5	0	114
2004	9	4	3	7	7	0	58	11	2	2	86
2005	6	6	3	65	49	0	53	6	0	37	210
2005	6	22	3	100	97	0	126	12	9	24	367
2005	7	11	3	86	46	0	465	20	15	108	740
2005	7	19	3	194	176	0	2989	102	1	6	3467
2005	7	26	3	88	117	0	4113	110	3	5	4436
2005	8	2	3	39	262	1	6304	212	3	2	6822
2005	8	12	3	31	65	0	908	1	9	26	1040
2005	8	18	3	25	66	0	1141	12	30	32	1306
2005	9	3	3	8	8	13	123	21	11	6	189

Table 3. Historical averages of limnological data from Chignik Lake, 1988-2005.

Date			Secchi depth (m)	Averages over 1-20 m	
Mo	Day	Year		Temp. (C)	Chlorophyll a (mg/m <sup>3</sup> )
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
6	9	00	2.2	6.2	9.50
6	18	00	1.3	7.0	7.00
6	26	00	1.6	8.0	6.00
7	5	00	1.5	9.1	5.50
7	11	00	2.0	10.5	3.30
9	5	00	1.0	11.0	10.90

Table 3--continued

Date			Secchi depth (m)	Averages over 1-20 m	
Mo	Day	Year		Temp. (C)	Chlorophyll a (mg/m <sup>3</sup> )
6	27	01	2.8	10.0	2.00
7	2	01	2.6	9.2	2.42
7	13	01	2.6	10.3	2.65
8	30	01	2.1		
6	28	01	2.4	10.0	2.14
7	3	01	2.5	9.2	2.46
7	13	01	1.8	10.3	2.67
9	1	01	2.9		
6	25	04	1.9	9.2	1.02
6	29	04	2.4	9.3	1.62
7	5	04	2.0	9.8	0.79
7	11	04	1.8	14.2	n/a
9	3	04	1.4	12.5	n/a
6	12	05	2.8	8.1	n/a
6	28	05	2.5	10.5	n/a
7	15	05	2.8	11.4	n/a
7	29	05	2.0	12.0	n/a
8	8	05	2.5	13.4	n/a
8	15	05	2.0	13.5	n/a
8	22	05	2.3	13.0	n/a
9	2	05	2.3	12.0	n/a

Table 4. Results of limnology sampling in Chignik Lake from two locations (Clark Bay, and Delta) during 2005

Date	Clark			Delta		
	Secchi (m)	Depth (m)	Temp (C)	Secchi (m)	Depth	Temp (C)
6/12	3.00	0	8.5	2.50	0	8
		1	8.5		1	8
		5	8.5		5	8
		10	8.5		10	7.5
		20	8		20	7.5
6/28	2.50	0	11.5	2.50	0	11
		1	11		1	11
		5	11		5	11
		10	10.5		10	10
		20	9		20	9
7/15	3	0	11	1.5	0	10
		1	11		1	10
		5	11		5	10
		10	11		10	9.5
		20	10		20	9
7/29	2.50	0	12	1.50	0	12
		1	12		1	12
		5	12		5	12
		10	12		10	12
		20	12		20	12
8/8	2.75	0	13	2.25	0	14
		1	13		1	14
		5	13		5	14
		10	13		10	14
		20	12		20	14
8/15	2.50	0	13.5	1.50	0	12.5
		1	13.5		1	12
		5	13.5		5	12
		10	13.5		10	12
		20	12.5		20	12
8/22	2.00	0	13	1.75	0	14
		1	13		1	14
		5	13		5	14
		10	13		10	13.5
		20	13		20	12.5
9/2	2.00	0	12	2.50	0	12
		1	12		1	12
		5	12		5	12
		10	12		10	12
		20	12		20	12
averages	2.53		11.6	2.00		11.5

Table 5. Results of limnology sampling in Black Lake from three locations (Outlet, Hydro, and Alec) during 2005

Date	Location	Secchi depth (m)	Surface Temp. (C)
6-Jun-05	Outlet	1	11
	Hyrdo	1.25	12
	Alec	0.75	12
22-Jun-05	Outlet	2	13
	Hyrdo	1	12.5
	Alec	2	12
11-Jul-05	Outlet	2	13
	Hyrdo	1.25	14
	Alec	1.3	13.5
19-Jul-05	Outlet	1.5	13
	Hyrdo	0.75	12.5
	Alec	1	13.5
26-Jul-05	Outlet	1	15
	Hyrdo	1.5	15
	Alec	0.75	15
2-Aug-05	Outlet		
	Hyrdo	1.25	14
	Alec	1.5	14
12-Aug-05	Outlet	1.25	18
	Hyrdo	1.25	17
	Alec	1.25	19
18-Aug-05	Outlet	1.75	16.5
	Hyrdo	1.5	16
	Alec	2	16
25-Aug-05	Outlet	0.5	12.5
	Hyrdo	0.5	12.5
	Alec	0.75	12.5
3-Sep-05	Outlet	1	11
	Hyrdo	1	11
	Alec	0.5	10.5
2005 averages		1.2	13.7

Table 6. Historical averages of limnological data from Black Lake, 1990-2005

Date			Secchi depth (m)	Surface water temp. (C)	Chloro- phyll a mg/m <sup>3</sup>
Mo	Day	Year			
6	27	1990	1.8	13.0	2.65
6	20	1992	n/a	n/a	3.24
7	8	1992	n/a	n/a	2.28
9	3	1992	n/a	n/a	4.59
5	18	1993	1.6	8.8	1.26
6	16	1993	1.7	9.7	0.98
7	16	1993	1.8	15.5	0.60
8	15	1993	0.9	12.7	4.33
9	9	1993	0.7	12.5	3.32
6	9	1995	1.4	11.2	3.67
6	20	1995	1.4	10.7	1.34
7	11	1995	1.5	12.3	1.15
7	23	1996	1.8	13.8	2.26
6	2	1997	2.2	12.5	1.75
6	20	1998	1.2	9.7	n/a
7	3	1998	1.0	12.3	4.02
7	16	1998	1.3	13.2	1.99
9	3	1998	0.5	10.3	n/a
6	12	1999	0.5	7.8	2.13
6	21	1999	1.3	11.3	2.65
6	26	1999	1.3	10.4	3.01
7	5	1999	1.2	11.0	4.75
9	7	1999	1.5	9.8	4.29
6	10	2000	1.3	10.0	9.50
6	19	2000	1.3	9.0	7.03
6	27	2000	2.0	n/a	6.00
7	6	2000	1.7	12.0	5.47
7	13	2000	2.0	15.3	3.27
9	7	2000	0.7	9.5	10.94
6	27	2001	1.8	12.5	n/a
7	7	2001	0.6	10.6	n/a
7	10	2001	1.6	12.3	n/a
7	13	2001	1.8	10.9	n/a
9	4	2001	0.7	n/a	n/a
6	28	2002	1.67	16.5	2.32
7	3	2002	1.75	13.6	4.01
7	19	2002	1.58	n/a	2.53
8	30	2002	1.42	14.17	
6	27	2004	1.5	12.7	n/a
6	30	2004	1.7	11.3	n/a
7	12	2004	1.7	17.7	n/a
9	4	2004	0.8	12.8	n/a
6	6	2005	1.0	11.7	n/a
6	22	2005	1.7	12.5	n/a
7	11	2005	1.5	13.5	n/a
7	19	2005	1.1	13.0	n/a
7	26	2005	1.1	15.0	n/a
8	2	2005	1.3	15.3	n/a
8	12	2005	1.4	17.5	n/a
8	18	2005	1.3	14.8	n/a
8	25	2005	0.8	12.0	n/a
9	3	2005	0.8	10.8	n/a

Table 7. Numbers of fish (by species) caught during the annual FRI fall townet in Chignik Lake

Location	Species					
	3 Spine	9 Spine	Coho	Pond	Sculpin	Sockeye
Chig Tow 1	56	14	0	7	0	10
Chig Tow 2	5	2	0	1	0	1
Chig Tow 3	9	20	0	1	0	2
Chig Tow 4	11	0	0		0	5
Chig Tow 5	20	6	0	4	0	6
Totals	101	42	0	13	0	24

Table 8. Historical townet catches in Chignik Lake from 1960-2005

Date		No. of tows	Species							
Mo	Year		Sockeye salmon			Juvenile coho	Juvenile chinook	Pond smelt	Stickleback	
			Fry	Yearling	Total				3-spine	9-spine
6	60	15	6	33	39	0	0	0	0	1
7	60	42	5	25	30	0	0	0	1	3
8	60	9	74	83	157	0	0	0	1	9
9	60	1	6	12	18	0	0	0	0	0
7	61	14	1	136	137	0	0	0	1	12
8	61	65	308	286	594	0	0	0	13	50
9	61	1	278	103	381	0	0	1	6	10
7	62	17	46	648	694	1	0	0	2	12
8	62	80	55	238	293	0	0	0	32	14
9	62	11	14	58	72	0	0	3	121	6
6	63	4	66	76	142	2	1	1	2	11
7	63	22	28	147	175	1	0	1	5	26
8	63	44	56	87	143	0	0	4	26	15
9	63	13	230	171	401	0	0	16	39	16
7	64	13	5	28	33	0	0	0	2	7
8	64	38	61	83	144	0	0	1	10	15
9	64	15	251	79	330	0	0	0	30	15
7	65	14	65	152	217	1	2	0	1	15
8	65	27	91	410	501	0	0	4	3	24
7	66	6	60	319	379	1	1	1	1	3
8	66	16	419	144	563	0	0	0	1	3
9	66	15	137	34	171	0	0	0	4	5
6	67	11	145	74	219	0	1	0	0	4
7	67	18	1338	177	1515	0	0	3	1	76
9	67	18	295	53	348	0	0	1	45	9
6	68	2	86	100	186	2	2	53	0	5
7	68	18	138	163	301	1	0	1	1	3
8	68	26	36	64	100	0	0	3	18	5
6	69	10	48	0	48	4	0	0	2	2
8	69	20	124	26	150	0	0	1	4	6
9	69	14	910	13	923	0	0	9	20	7
6	70	10	67	440	507	10	0	2	3	1
7	70	10	59	120	179	0	0	1	3	18
8	70	15	14	52	66	0	0	0	21	2
7	71	20	183	63	246	1	0	0	4	7
9	71	15	247	18	265	0	0	4	28	4
7	72	10	25	27	52	3	0	0	1	2
8	72	30	131	41	172	0	0	0	9	15
7	73	10	78	76	154	0	0	0	1	5
8	73	20	156	168	324	0	0	1	2	11
7	80	20	52	50	102	0	0	20	2	8

Historical Chignik Lake tow net catches--cont'd

Date		No. of tows	Species							
			Sockeye salmon			Juvenile coho	Juvenile chinook	Pond smelt	Stickleback	
Mo	Year		Fry	Yearling	Total				3-spine	9-spine
7	82	5	8	1	9	2	0	0	1	1
6	83	5	33	87	120	0	0	0	0	1
7	83	10	173	101	274	0	0	1	0	1
9	92	9	65	9	74	0	0	5	2	3
8	93	7	61	23	84	0	0	39	47	11
9	93	8	44	18	62	0	0	108	19	16
9	95	5	38	17	55	0	0	17	8	3
9	96	6	16	24	40	0	0	4	58	4
9	97	5	95	200	295	0	0	58	59	24
9	98	5	53	156	209	0	0	6	1618	12
9	99	5	13	9	22	0	0	90	27	5
6	00	3			* 116	0	0	0	134	26
7	00	3			* 38	1	0	0	54	3
9	00	5			* 347	0	0	198	14	2
7	01	1			*13	0	0	0	2	0
8	01	5			*603	0	0	25	9	4
9	02	5			*83	0	0	5	13	2
8	03	5			*347	0	0	199	2	25
9	04	5			*362	6	0	862	155	30
9	05	5			24	0	0	13	101	42

\* Juvenile scales are no longer read to determine the ages

Table 9. Historical townet catches in Black Lake (10 min tows), 1960-2005

Date		No. of tows	Species						
			Sockeye salmon		Juvenile coho	Juvenile chinook	Pond smelt	Stickleback	
Mo	Year		Fry	Yearling				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
6	00	3§	73	0	0	0	0	0	0
7	00	4§	30	0	0	0	1	0	0
9	00	4§	1591	0	0	0	438	51	153
7	01	1§	700	0	0	0	20	0	0
9	01	5§	251	0	0	0	960	1	3
8	02	4	488	0	0	0	69	84	25
8	03	4	10	0	2	0	24	113	567
7	05	3	504	0	0	0	18	2	32
9	05	5	78	0	18	0	215	290	320

§ Tows were made during the day due to strong winds and adverse conditions

Table 10. Historical beachseine catches in Chignik Lake, 1956-2005

Date		No. of sets	Species								
Mo	Year		Sockeye salmon		Juvenile coho	Juvenile chinook	Dolly Varden	Stickleback		Sculpin	Pygmy whitefish
			< 45mm	> 45mm				3-spine	9-spine		
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

Historical Chignik Lake beachseine catches--con't

Date		No. of sets	Species								
Mo	Year		Sockeye salmon		Juvenile coho	Juvenile chinook	Dolly Varden	Stickleback		Sculpin	Pygmy whitefish
			< 45mm	> 45mm				3-spine	9-spine		
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
6	00	12	33	17	13	0	17	317	7	10	9
7	00	6	32	6	4	0	1	110	3	1	1
6	01	6	10	38	12	0	20	94	6	2	0
7	01	6	17	26	2	2	22	18	3	2	3
6	02	6	50	0	13	0	17	317	7	10	10
7	02	6	46	14	18	3	57	315	16	24	6
6	03	12	1	7	10	0	10	43	2	4	1
7	03	12	3	5	5	0	3	167	2	2	2
6	04	15	24	29	35	17	8	2161	32	14	13
7	04	18	209	771	167	4	36	5083	129	59	46
6	05	11	222	1026	265	0	31	3257	70	47	201
7	05	23	257	2077	1879	0	238	8060	127	130	190
8	05	16	1	205	919	15	99	1851	91	22	153

Table 11. Relative abundances of fishes in the littoral zone of Chignik Lake during 2005

Date	Beachseine site	threespine stickleback	ninspine stickleback	Dolly Varden	Chinook salmon	coho salmon	pond smelt	pygmy whitefish	sculpin	sockeye salmon	starry flounder
6/12/2005	Chignik Lake Clark Bay	30	2	0	0	9	0	0	5	73	2
	Chignik Lake Delta	56	4	10	0	102	0	0	12	12	0
	Chignik Lake North Hatchery	28	1	0	0	3	0	0	9	13	0
	Chignik Lake Outlet	2151	38	17	0	81	0	193	0	401	0
6/30/2005	Chignik Lake South Hatchery	2	2	0	0	0	0	0	14	43	0
	Chignik Lake Clark Bay	30	3	3	0	13	0	0	3	104	2
	Chignik Lake Cucumber	0	0	0	0	1	0	0	0	1	0
	Chignik Lake Delta	666	0	0	0	16	92	4	4	392	0
	Chignik Lake North Hatchery	0	0	0	0	0	0	1	0	5	0
7/5/2005	Chignik Lake Outlet	292	20	0	0	20	0	2	0	188	0
	Chignik Lake South Hatchery	2	0	1	0	20	0	1	0	16	0
	Chignik Lake Clark Bay	174	16	0	0	22	0	0	10	264	0
	Chignik Lake Cucumber	28	1	3	0	17	1	2	10	139	0
	Chignik Lake Delta	970	0	0	0	4	0	26	4	68	1
7/16/2005	Chignik Lake North Hatchery	7	1	2	0	7	0	30	12	58	0
	Chignik Lake Outlet	587	56	0	0	48	0	0	8	400	8
	Chignik Lake South Hatchery	0	0	1	0	12	0	1	28	51	0
	Chignik Lake Clark Bay	10	0	0	0	30	0	0	0	147	0
	Chignik Lake Cucumber	2	0	2	0	37	0	1	3	0	0
7/23/2005	Chignik Lake Delta	576	0	4	0	8	0	0	12	448	0
	Chignik Lake North Hatchery	0	0	2	0	13	0	0	4	11	0
	Chignik Lake Outlet	668	0	0	0	52	0	0	0	92	2
	Chignik Lake South Hatchery	4	0	9	0	30	0	13	0	80	0
	Chignik Lake Clark Bay	164	2	6	0	74	0	6	2	56	3
7/31/2005	Chignik Lake Cucumber	621	0	20	0	248	0	8	0	8	0
	Chignik Lake Delta	1112	0	0	0	48	0	0	0	112	0
	Chignik Lake North Hatchery	84	4	48	0	112	0	4	0	84	0
	Chignik Lake Outlet	554	28	0	0	96	0	0	0	116	0
	Chignik Lake Clark Bay	126	0	0	0	15	0	5	0	10	0
8/9/2005	Chignik Lake Cucumber	941	7	0	0	343	0	0	0	35	0
	Chignik Lake Delta	4	0	30	0	60	0	10	0	69	2
	Chignik Lake North Hatchery	1017	0	99	0	468	0	63	27	68	0
	Chignik Lake Outlet	347	12	12	0	126	0	0	0	18	0
	Chignik Lake South Hatchery	64	0	0	0	9	0	21	10	0	0
8/16/2005	Chignik Lake Clark Bay	73	0	4	0	26	3	4	4	2	0
	Chignik Lake Delta	62	5	2	0	44	0	4	2	88	0
	Chignik Lake North Hatchery	5	1	5	0	46	0	1	0	2	0
	Chignik Lake Outlet	529	25	25	0	245	5	20	0	5	0
	Chignik Lake South Hatchery	2	0	8	0	78	0	45	2	18	0
8/23/2005	Chignik Lake Clark Bay	42	0	1	0	33	1	5	0	9	0
	Chignik Lake Delta	5	4	0	0	29	0	14	0	19	0
	Chignik Lake North Hatchery	1	0	3	0	28	0	1	5	1	0
	Chignik Lake Outlet	922	40	16	0	215	0	0	0	27	0
	Chignik Lake South Hatchery	2	0	12	0	40	0	7	2	5	0
8/23/2005	Chignik Lake Clark Bay	3	0	3	0	23	0	2	0	4	0
	Chignik Lake Cucumber	8	0	1	0	15	0	1	0	6	0
	Chignik Lake Delta	127	14	1	10	53	0	36	1	14	0
	Chignik Lake North Hatchery	8	0	3	1	12	0	2	2	0	0
	Chignik Lake Outlet	52	2	0	1	7	0	6	2	3	0
	Chignik Lake South Hatchery	10	0	15	3	25	0	5	2	3	0
<b>2005 Totals</b>		<b>13168</b>	<b>288</b>	<b>368</b>	<b>15</b>	<b>3063</b>	<b>102</b>	<b>544</b>	<b>199</b>	<b>3788</b>	<b>20</b>

Table 12. Results of the sibling returns model for forecasting the 2006 returns of the Black Lake, Chignik Lake, and total stock to the Chignik fishery

Stock	Forecast	Forecast Range
Black Lake	735,424	668,000-1,683,000
Chignik Lake	855,123	698,000-1,247,000
Total	1,559,547	1,365,000-2,930,000

Table 13. Results of the recruits per spawner model for forecasting the 2006 returns of the Black Lake, Chignik Lake, and total stock to the Chignik fishery

Model	Stock								
	Black Lake			Chignik Lake			Total		
	Probability Intervals								
	25%	50%	75%	25%	50%	75%	25%	50%	75%
no autocorrelation	393,400	486,200	604,100	421,000	472,400	536,400	814,400	958,600	1,140,500
3yr autocorrelation	478,300	596,600	721,500	664,300	708,000	774,700	1,142,600	1,304,600	1,496,200
5yr autocorrelation	366,300	451,000	539,000	528,700	557,900	596,400	895,000	1,008,900	1,135,400