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Alaska Salmon Research, 1999

ALASKA SALMON PROGRAM

T. QUINN, R. STEEN, D. SCHINDLER, W. LEW, R. HILBORN, AND D. ROGERS

Annual Report

to

Bristol Bay Processors

ACKNOWLEDGMENTS

This program was supported by the contributions of 10 salmon processing companies: Trident Seafoods, Peter Pan Seafoods, Wards Cove Packing, Nelbro, Ocean Beauty, Norquest, Snopac, UniSea, Yardarm Knot Fisheries, and American Seafoods.

The contributions of graduate students to our program are important. Sayre Hodgson was again involved in the field research and is in the final stages of completing her thesis, studying run timing of salmon along the North American coast. In 1999, two new graduate students were added to the Bristol Bay program: Greg Buck is working on stock identification techniques of Bristol Bay sockeye, and Ian Stewart will be studying the dynamics between different sockeye spawning populations in the Kvichak system. Additionally, Chris Boatright, who just began his thesis research working on the Alaska Peninsula and Mark Scheuerell, who is working with Daniel Schindler studying freshwater ecosystem dynamics, assisted with the program sampling protocols. Other University of Washington students working on the program in 1999 were Jennifer Bahrke, Brandon Chasco, Michael Morris, Kristi Overberg, Chris Sarver, Tom Wadsworth, Arni Magnusson, Sarah Chamberlain, and Phil Roni. Thomas O'Keefe and Scott Bechtold (University of Washington School of Fisheries) assisted with stream surveys at Lake Nerka. Tom Rogers oversaw maintenance activities and was assisted by Cindy Williams. Dan Gray (ADF&G) provided preliminary length and weight statistics for 1999. Brenda Rogers counted all the zooplankton samples, aged all otoliths collected from the Wood River and Kvichak systems, and provided valuable logistical support during the field season.

KEY WORDS

Bristol Bay, escapements, forecasts, growth, Kvichak, Nushagak predation, spawning, sockeye salmon, Wood River Lakes

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INTRODUCTION

The University of Washington School of Fisheries' Alaska Salmon Program (ASP) (formerly "Fisheries Research Institute" [FRI]) was established in 1946 with the financial support of the major Alaska salmon (*Oncorhynchus* spp.) processors to investigate the causes of the declines in production that had occurred in most stocks since the 1930s, work with the government management agency to increase our knowledge of the biology of salmon and the effects of the fisheries on the stocks, and assist salmon processors by providing a second opinion on matters of salmon fisheries management. With the high levels of production since the 1980s, our primary objectives now have been to determine how to maintain this high production (i.e., understand what has caused year-to-year variation) and provide information so that the salmon can be harvested and processed most efficiently (e.g., accurately forecast the run and facilitate even distribution of fishing throughout the run).

We presently have salmon research projects in Bristol Bay, the Alaska Peninsula, and Chignik that are funded in part or entirely by the industry. In addition, we have a federally funded high-seas salmon project that was focused on the oceanic distribution of salmon and the vulnerability of North American stocks to foreign fisheries, but is now focusing on ocean carrying capacity for salmon. In recent years, we have also worked in Kodiak, Southeast Alaska, and on the Yukon stocks. All these projects have been carried out in cooperation with the Alaska Department of Fish and Game (ADF&G) or the National Marine Fisheries Service (high seas), and we have also had cooperative research projects with salmon biologists from Japan and Russia.

This report is focused on our 1999 Bristol Bay research with emphasis on salmon forecasting and research relevant to escapement policies for maximizing production. Our Alaska Peninsula annual report will be completed in April and our Chignik report will be submitted in May.

FORECASTING

The 1999 total inshore run to Bristol Bay was 40 million sockeye (*O. nerka*) salmon. The run proved to be confounding to processors and managers alike as the fish remained in the bay during the early portion (due to very cold water temperatures) and came in at high abundance from July 1 to July 4. Our 1999 preseason forecast was 12% low using the traditional method and 28% low using the alternative method (Hilborn et al. 1998). The Port Moller inseason forecast predicted a run of 32.9 million on June 25 and 38.9 million on July 1.

Preseason Forecasts

Forecasts of the 2000 Bristol Bay sockeye salmon runs and catches were provided to participating processors at our November 1999 meeting (Hilborn et al. 1999). They are presented in Table 1 with the ADF&G forecasts and the past forecasts and runs beginning in 1990. The two river system forecasts (ASP and ADF&G) are based on the same data sources but different analytical methods have often been used. For the 2000 forecast, ASP and ADF&G used similar statistical methods that resulted in comparable forecasts (37.7 and 35.4 million, respectively; Link and Gray 2000). Both ASP and ADF&G primarily used sibling return relationships along with spawner return models to forecast the run. Forecasting for 2000 is complicated by the very strong return of 2-ocean fish in 1999 and the very weak return of jacks (salmon maturing after 1 year in the ocean). For example, a large return of 2-ocean fish in 1999 could indicate either a strong return of 3-ocean fish in 2000, due to high marine survival for the brood, or a dominant 2-ocean year maturation within this cohort. Comparatively, our forecast was a bit higher as we weighted the 2-ocean to 3-ocean sibling return relationship a bit heavier (notably for the Egegik system) than did ADF&G. We arrived at our final forecast by assigning probabilities to the results of different combinations of the sibling relationships between jacks and 2-ocean returns and 2-ocean and 3-ocean returns. The outlook for 2000 is for the run and catch to be almost equal to the recent years' average. However, the specter of the poor returns in 1997 and 1998 is still present and we cannot say with any certainty that it will not happen again.

The combined Naknek/Kvichak and Egegik districts are expected to produce nearly 70% of the Bristol Bay run in 2000. A recruits-per-spawner analysis for the Kvichak predicts a large return of 2.2s (~9 million), mainly due to the 1995 brood year escapement of 10 million. However, no jacks were counted in the Kvichak system and a sibling return model yields a very minimal forecast. We combined these methods to predict a 2.2 Kvichak run of 2.9 million. The uncertainty in this forecast is great and we could see a very small return of Kvichak 2.2s if the 1999 return of jacks proves to be an accurate indicator or a very large return if last year's poor jack return proves to be an anomaly. Our Egegik forecast is dominated by a strong return of 3-ocean fish, which should occur if the large 1999 return of 2-ocean fish indicates good marine survival. However, if last year's strong 2-ocean return occurred because a larger proportion of fish matured early, then the 2000 return of Egegik 3-ocean could be smaller than expected.

Port Moller Forecast

The Port Moller inseason test fishery was conducted by ADF&G during June and early July from 1968 through 1985, with a change in gear in 1985. There was no test fishery in 1986 and, beginning in 1987, ASP conducted the test fishery each year. The test fishery now employs a 200-f gillnet that is 60 meshes deep and has 5 1/8-in stretched mesh. The web is multistrand monofilament (center core). From 1994 to 1998, we used the fishing vessel *Cape Cross*. A new vessel, the *Sojourn*, was employed in 1999. Four stations (2, 4, 6, 8) have been routinely fished along a transect 33 to 63 nmi out from Port Moller (16 to 42 nmi from the nearest coastline). Additionally, in 1999, we made numerous sets at stations 10 and 12 and completed a number of duplicate sets. An almanac that provided statistics for forecasting the run was distributed to processors prior to the season (Rogers 1999). Beginning June 11, catch, mean length, and water temperature data were sent daily by radio to Port Moller and then faxed into Bristol Bay. Scales and length data were sent periodically to ADF&G (M. Link, King Salmon), where the scales were aged and the age compositions and average lengths by age were reported. From 1987 through 1996, the forecasts were very accurate. The runs differed from the forecasts made on June 25 and 30 by an average of 20%, and we were within an average of 12% on forecasts made about July 3 (Table 2). We have not done as well in forecasting the catch because river system forecasts and thus catches cannot be made until about July 3, when we have the first indication of where the salmon are going. In 1997 and 1998, we over-forecasted the inshore run. The weak runs in 1997 and 1998 still prove to be largely unexplained and we continue to devote time to researching various oceanographic conditions that may help to explain these anomalies.

In 1999, the Port Moller test fishery was forecasting a run of 34.3 (15% low) million from June 25 to June 30. On July 1, a run of 38.9 million (3% low) was predicted from the Port Moller information. Although the July 1 forecast was accurate, the fishery proved to be problematic for processors and managers because a disproportionately large number of fish entered the districts from July 1 to July 4. This was caused by extremely low water temperatures in the bay that forced the fish to remain outside the fishing districts until the water warmed. The peak for the run occurred on about average timing; however, the temporal pattern of the run was abnormally characterized by a large spike in early July with a gradual tapering off (Fig. 1). The distribution of the salmon as they passed Port Moller was ideal in 1999, as the fish were concentrated in the middle stations (i.e., 4 and 6; Fig 2). A significant number of fish were caught at stations 10 and 12; we will continue to fish this station routinely in 2000. Cloud cover conditions were typical in 1999 (with mostly overcast skies) but the water and air temperatures were well below the 1987–99 average (Table 3).

The ADF&G (M. Link, Anchorage, pers. comm.) provided preliminary length and weight statistics for 1999, and statistics from prior years were available (e.g., Yuen et al. 1981, Stratton and Crawford 1994) from which we could calculate mean lengths in the runs (Table 4). Both the 2- and 3-ocean sockeye salmon in the 1999 run were about equal to the recent 10-year average in length. This was a bit unusual for such a large run of 2-ocean fish, which in high abundance would be expected to be shorter than the average. Average weights in the Bristol Bay fishing districts in 1999 ranged from 5.4 lb (Nushagak) to 5.9 lb (Togiak) and were close to or slightly below recent years' averages (Tables 5 and 6). The percentage of 3-ocean fish was much lower than the recent years' averages for all districts owing to the strong return of 2-ocean fish.

Harvesting was slow for the first several days of fishing and then increased dramatically from July 1 to July 4 and exceeded processing capacity. Over-escapement occurred in all systems with the largest over-escapements occurring in the Wood, Egegik, and Ugashik systems (Table 7). The glut of fish produced from July 1 to July 4 forced processors to either refuse to buy fish or place fisherman on limits.

Lake Research

During summer 1999, we continued our long-term studies of spawner distribution, growth and abundance of fry, and the physical and biological environment for the sockeye salmon of the Wood River (Nushagak) and Kvichak lake systems. Most of our annual observations in the Wood River Lakes extend over more than 40 years and constitute the longest continuous biological and environmental record on any salmon stock in Alaska. In 1999, we also extended our studies of bear predation on spawning sockeye salmon and initiated an undergraduate class, "Aquatic Ecological Research in Alaska" for academic credit (see details below).

Kvichak System

Our 1999 field season in the Kvichak system (Lakes Iliamna and Clark) consisted of estimating the sockeye salmon escapement into the Newhalen River in late June and July; conducting spawning ground surveys in August, September, and October to collect otoliths for sockeye age determination; establishing transects on island beaches for index counts; and reestablishing limnological and townet sampling in Lake Iliamna.

Newhalen River Escapement

The annual escapements of sockeye salmon to the Kvichak lake system are estimated by ADF&G from expanded 10-min counts on each bank of the river near Igiugig at the outlet of Lake Iliamna. Since 1979, we have estimated escapements up the Newhalen River by expanding 20-min counts, for each of 10 daylight hours, on the northwest bank of the river at the town of Newhalen. We assume that fish use both sides of the river equally and that migration rate does not vary over the course of the day. The daily counts at Newhalen are compared with those of ADF&G at Igiugig to estimate a travel time. We calculate the daily proportions of the run at Igiugig that went up the Newhalen by lagging the Newhalen counts back the appropriate number of days (2 in 1999).

The cumulative daily escapements for the two rivers, timed to the Kvichak River, are given for 1993–99 (Table 8). In mid-July, milling fish often swim upriver along the banks of the Newhalen and are counted, only to drift back down in the middle of the river and return upstream to be counted again. This behavior inflates the counts for the escapement; therefore, we have used the average proportion of the Newhalen count for day 5 to day 16 (day 1 equals the first day of about 100,000 in the Kvichak) and the season's total Kvichak escapement to estimate the Newhalen/Lake Clark escapement. In 1999, we estimated that about 0.6 million of the Kvichak escapement of 6.2 million (about 10%) migrated to the Newhalen/Lake Clark system (Table 9). Due to turbid river conditions, ADF&G could not aerially survey the Newhalen River (Slim Morestad, ADF&G, pers. comm.); thus we cannot, by subtracting the Newhalen component, estimate the Lake Clark escapement as we have in the past.

Spawning Ground Surveys

Each year since 1956, we have collected scales or otoliths from spawned-out sockeye salmon from several major spawning grounds in the Kvichak River system. In 1999, we continued and expanded this work by sampling fish from all the sites we have sampled recently (Newhalen River, Copper River, Knutson Bay, Pedro Bay ponds, island beaches [Woody and Fuel Dump], Gibraltar Creek, Chinkelyes Creek and the Tazimina River). In addition, we reestablished sampling at several populations that had not been sampled for several years: a small creek (Mink Creek), an important system in the northwestern side of the lake (Lower Talarik Creek), and two other mainland beach populations (Finger Beach and Southeast Beach). Moreover, responding to persistent accounts from local people about late spawning fish in several sites, ASP and ADF&G staff returned in mid-October and obtained samples from the Pedro Ponds, Knutson Bay and from ponds in the Iliamna River system. Overall, the age pattern was similar to the composition of the entire lake system (Kvichak escapement). However, age 1.3 fish were scarce in beach and creek populations but quite abundant in the samples from the Gibralter and Copper rivers. Age 1.2 fish were most abundant in the other spawning populations—it was this age group that was most abundant in the Kvichak run in 1999 (Table 10). Preliminary analysis of the Knutson Bay stock indicates that the proportion of age 2.2 fish increased and that the proportion of age 1.3 fish decreased in the fall for both males and females.

In addition to the sampling for age composition, we continued to obtain samples for genetic analysis to be processed cooperatively by ADF&G and the University of Washington. We have now sampled most of the major populations around Iliamna Lake and hope to begin analysis of these samples in 2000. These data will be useful for stock identification work on adults and juveniles within the lake and in Bristol Bay.

We had conducted annual aerial surveys of the Kvichak spawning grounds from 1956 until 1988, after which ADF&G took over the surveys. The results of the 1999 survey were reported by Morestad (unpubl. data, 1999).

These are summarized for 29 selected spawning grounds (Table 11). Aerial counts accounted for 5.2% of the escapement into the Kvichak system. This percentage is slightly lower than the recent years' average, due in part to survey conditions and pilot availability. Most of the 6.2 million escapement in 1999 returned to the rivers in Lake Iliamna with very low numbers of spawners on the beaches.

Sockeye Fry Abundance and Size

We have sampled the sockeye fry (age 0) in the Kvichak system in August of each year since 1962 (1961 brood year) by townetting set stations in Lakes Iliamna and Clark at night (Table 12). However, the past few years have seen irregular sampling and some lack of consistency in stations. In 1999, we reestablished sampling that will be coordinated with limnological sampling (conducted cooperatively with ADF&G) to better understand the links between lake conditions, fry density, growth, and survival. The ADF&G limnology chief scientist, Jim Edmundson, visited the Porcupine Island camp to help instigate the joint limnology studies. Samples were taken at eight sites in the eastern end of Lake Iliamna during the summer and fall and, at time of writing, are awaiting analysis by ADF&G. We continue to work with ADF&G in planning a multi-year limnology study of Lake Iliamna.

Wood River System

The Bristol Bay research program of ASP began with spawning ground surveys in the Wood River Lakes in 1946 to determine where, when, and how many sockeye salmon spawned there. During the early 1950s, methods were established to enumerate and sample the commercial catches, escapements (using towers), and the number of smolts produced. By the late 1950s, we had established several important measurements, which we have maintained to the present to characterize each year's environment for spawning adults and rearing juveniles.

Environmental Observations

Ice breakup on Lake Aleknagik was 16 days later than normal in 1999 (Fig. 3, Table 13). As a result of the late spring, water temperatures were lower than normal during June, but were then about average for the rest of the summer. Except for a short period of warm and sunny weather in early July, solar radiation was substantially lower than average throughout the entire ice-free season (Table 13). Lake water level was approximately normal for all of the 1999 field season. The environmental conditions in 1999 when adult salmon were entering the lakes during late-June and early-July were not very different from the long-term average conditions observed in the Wood River system (Fig. 4, Table 13).

The standing crop of phytoplankton (chlorophyll) was lower than normal and zooplankton biovolume was substantially higher than the long-term average during summer 1999 (Fig. 5, Table 13). Zooplankters are the main source of food for juvenile sockeye salmon after they move offshore in late July. Because zooplankton are effective grazers of phytoplankton, we expect to see this inverse relationship between zooplankton and phytoplankton abundance. In 1999, abundance of most zooplankton species was near the recent years' average (Fig. 6). However, the abundance of the relatively small cyclopoid copepods was very high compared with recent years.

Insects (mainly pupal and adult midges) are the main source of food in the spring when the fry are inshore. In 1999, insect densities were similar to the long-term average in June but were then lower than average for the rest of the season (Table 14). Despite the fact that insect densities were lower than normal for most of the season, their emergence timing peaked at the standard time (late July/early August) and at normal "peak" densities. Water temperatures at the nearshore insect traps in 1999 were about 1°C below average.

Fry Abundance and Growth

In 1999, the sockeye salmon fry in Lake Aleknagik were of slightly less than average length in June—probably because of the cold water temperatures associated with the late spring. However, fry growth was higher than average during July and August, reaching about 60 mm by September 1 (Table 15). This rapid growth rate during these months could be attributed to the highly abundant food supply of cyclopoid copepods. Fry abundance as measured by townet sampling around September 1 was well below the long-term average. Threespine stickleback (*Gasterosteus aculeatus*) catches were also low in 1999 whereas their lengths and growth were higher than average. The adult sockeye salmon returns to Lake Aleknagik have generally been large since 1978 even though fry abundances have often been low. This suggests that recent large runs have been caused mainly by improved ocean survival.

The mean lengths of sockeye salmon fry in Lake Nerka indicated that, in 1999, growth was below average whereas townet catches were above average (Table 16). Juvenile sockeye salmon in the Wood River Lakes system exhibit density-dependent growth, and we are analyzing our long-term data sets to determine the relative effects of physical and biological factors in the lakes on the growth of the sockeye salmon fry. It appears that growth conditions for fry are not necessarily synchronized between lakes Aleknagik and Nerka, but are determined by fry densities in each of the lakes. In addition, we are examining year-to-year variation in zooplankton population composition along with annual variation in sockeye salmon fry and threespine stickleback abundance to determine the extent to which the fish alter their food resources. Lake productivity tends to be higher in lakes with sockeye salmon as a result of the nutrients brought in from the sea by adults (Reischauer 1996; Schindler unpubl. data). We hope the information from these studies will help explain the observed variability in the freshwater phase of the sockeye salmon.

Arctic Char Predation

Arctic char (*Salvelinus alpinus*) concentrate in the interconnecting rivers of the Wood River lake system to prey on sockeye salmon smolts during their seaward migration. We conducted several studies of this predation during the 1950s to 1970s, and since then, we have sampled the char in Little Togiak River on an opportunistic basis. In 1999, we sampled char during June 28–July 1 (Table 17). The average length of these fish was the largest recorded in the last 3 decades. Predation rates on sockeye smolts and fry were lower than normal during 1999, probably because our sampling was somewhat later than normal due to the late ice breakup.

Spawning Ground Surveys

Sockeye salmon spawning ground surveys have been conducted annually in the Wood River Lakes system since 1946; however, it was not until the early 1950s that all major spawning grounds were included. We collect otoliths from the major spawning grounds for age determination and make ground counts of the number of spawners in the small streams. The ADF&G estimates the numbers of spawners on the lake beaches and in the interconnecting rivers by aerial surveys. Thus, the total escapement to the lake system can be apportioned to the individual lakes or type of spawning ground (creek, river, and beach). The distribution of spawners among the lakes is used in forecasting the Wood River runs. Even escapement distributions tend to produce larger returns than uneven distributions.

Aerial surveys were conducted by ADF&G in 1999. The ground survey counts in 1999 for the major creek spawning grounds are given in Table 18. The creeks draining into Lake Aleknagik again contained relatively high counts of spawning salmon (a trend that has continued each year since 1987). Age compositions from our otolith sampling showed a high proportion of 2-ocean fish in the Wood River system (Table 19). The composition for female sockeye was comparable with ADF&G's sampling at the Wood River tower; however, our male sockeye sampling had a much higher percentage of 2-ocean fish than did the ADF&G tower sampling. Unsampled spawning grounds in the upper lakes (Beverley and Kulik) likely contained higher percentages of 2-ocean fish based on the samples from Moose Creek and Grant River.

Hansen Creek Daily Runs and Bear Predation

We completed the 10th year of our bear/spawning sockeye salmon interaction study in Hansen Creek, a small tributary of Lake Aleknagik (Table 20). The year 1999 was a record run to Hansen Creek, with a total of about 20,000 spawners in the 2-km creek. This creek now shows a clear cycle with a 4-year period, having had progressively larger runs in 1987, 1991, 1995 and 1999. Predation rate is density-dependent on an interannual basis, and the rate in 1999 was only about 20%. The predation in Hansen Creek and elsewhere in the system (e.g., Pick and Bear creeks) is size-selective; larger fish are more vulnerable than smaller fish. In addition, males are generally more likely to be killed than females. The detailed studies at Hansen Creek are being applied to the more extensive but less intensive sampling that we conduct in association with the annual creek surveys throughout the system. These reveal that the level of predation is a decreasing function of stream size (especially width) and the age structure and morphology of sockeye salmon are clearly related to habitat and predation. Larger rivers have more 3-ocean fish and fewer jacks, and the fish are more deep-bodied for their size than the fish in smaller creeks, with higher levels of size-selective predation. The level of predation among creeks is thus related to access by bears but the year-to-year pattern is related, in part, to fish density. Higher levels of escapement are associated with smaller percentages of the fish being killed.

The daily counts on Hansen Creek are not only important as a basis for studies of predation—they also provide us with percentage estimates of the total number of spawners counted on a single "peak survey" date and, thus, a means of adjusting our annual survey counts to equal the true number of spawners. Hansen Creek has been surveyed most often on August 6 in past years, but in 20% of the years, the survey was done on August 1 or earlier. The Hansen Creek sockeye salmon are about the earliest spawners in the lake system and the fish usually first enter the creek around July 22–25. On the basis of daily counts in 1990–99, if the surveys had been conducted on the single date of August 6, the peak survey counts would have been 67–89% of the totals; if the single surveys were done on August 1, the counts would have been 38–78% of the actual number of spawners (Table 21).

UNDERGRADUATE CLASS

The ASP has routinely employed undergraduate students as part of the field crew for years but until 1999 had no formal educational opportunity for them. In 1999 we initiated a class for academic credit at the University of Washington called "Aquatic Ecological Research in Alaska." Six students, selected from many who applied, received hands-on training at both the Aleknagik and Porcupine Island camps, had formal lectures, and collected data for independent research. Jointly taught by Drs. Tom Quinn, Daniel Schindler, and Ray Hilborn, the purpose of the class was to directly involve students in the research program and give them the kind of in-depth exposure to ecology and fisheries management that would be impossible back in Seattle. The class was very popular with the students and will be continued in the future. Funding was provided by the University of Washington, and the students helped the ASP program by assisting with the sampling. Several of them also worked for ASP either before or after the class, further cementing the connection between educational and research programs.

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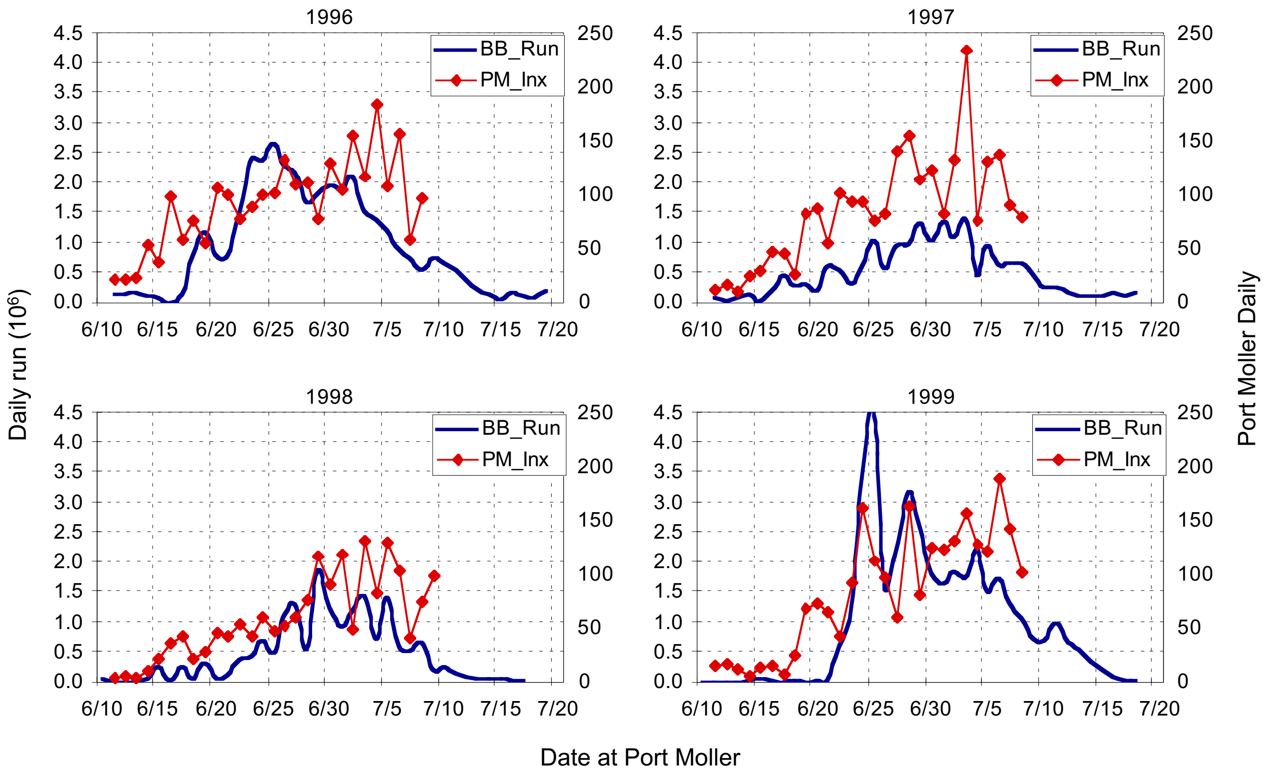

FIGURE 1. Daily Bristol Bay sockeye salmon runs reconstructed at Port Moller, 1996–99.

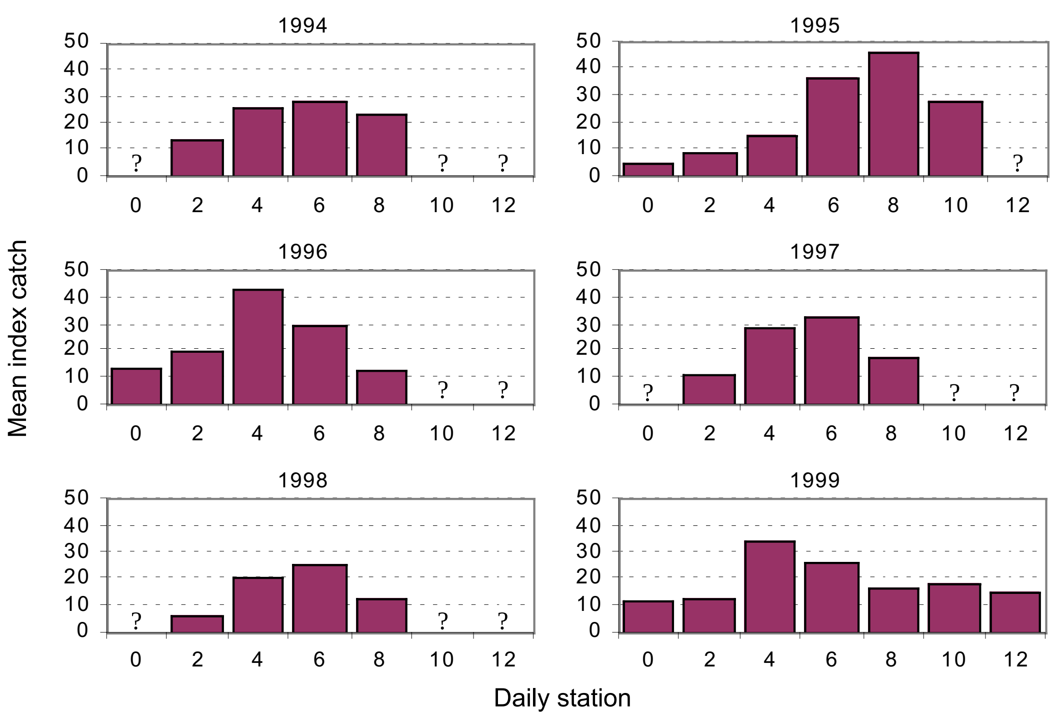

FIGURE 2. Average catches of sockeye salmon at Port Moller stations, June 11–July 10, 1994–99.

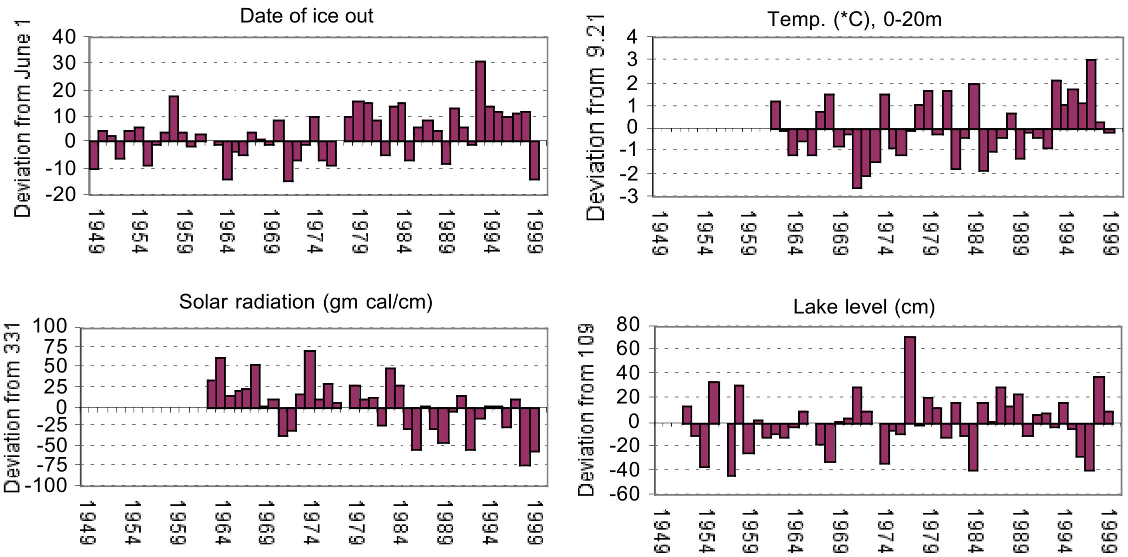

FIGURE 3. Annual deviations from averages of dates of ice out and summer averages of water temperature, solar radiation, and lake level in Lake Aleknagik.

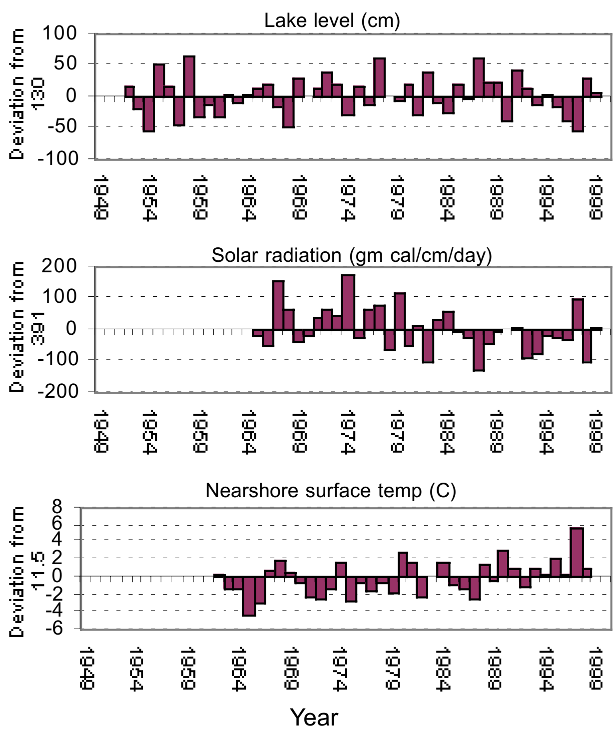

FIGURE 4. Annual deviations from averages of lake level, solar radiation, and surface temperatures during June 26–July 15.

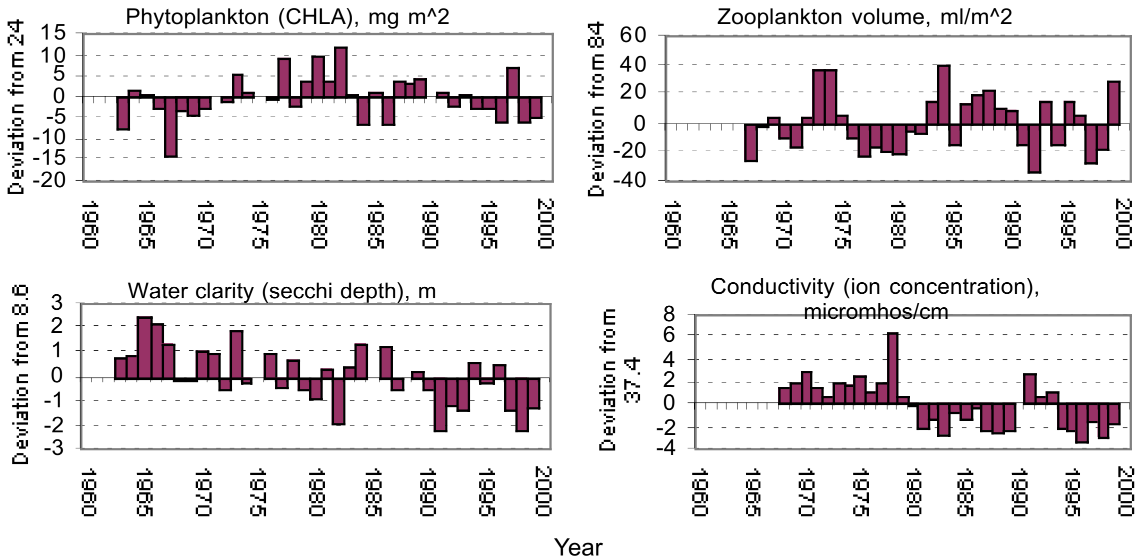

FIGURE 5. Annual deviations from averages of phytoplankton and zooplankton densities, water clarity, and conductivity in Lake Aleknagik.

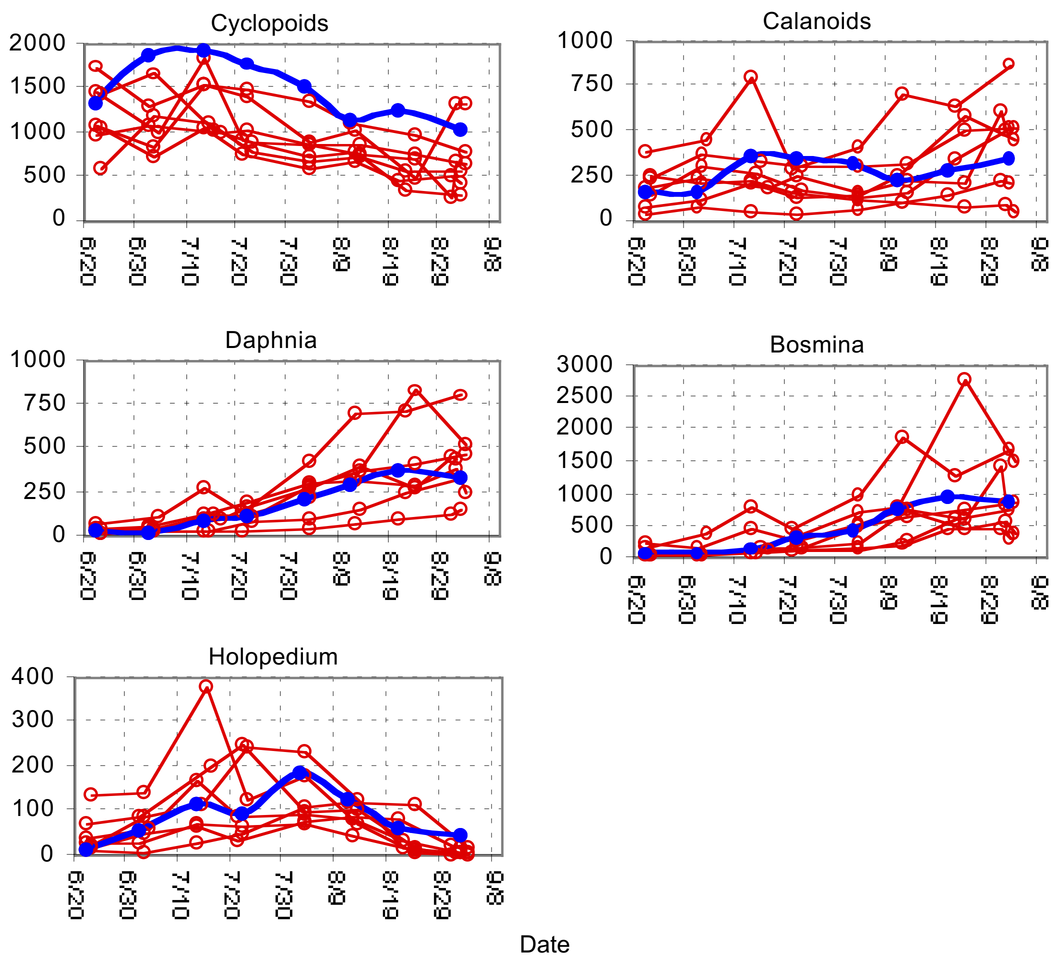

FIGURE 6. Summer densities of zooplankters in 1999 (heavier line) compared with densities in 1992–98.

TABLE 1. Preseason forecasts of the Bristol Bay sockeye salmon inshore runs (millions), 1990–2000.

Year	Forecast/Run	Nak/Kvi	Egegik	Ugashik	Nushagak	Total run	Catch	%Error
1990	FRI	14.9	6.6	3.0	4.6	29.8	19.0	-74
	ADFG	12.5	5.6	3.1	3.5	25.4	14.7	-125
	Actual run	25.8	12.3	2.9	5.7	47.6	33.1	
1991	FRI	16.6	8.9	3.6	6.9	36.7	25.0	-5
	ADFG	13.6	8.2	3.5	3.8	30.0	21.2	-24
	Actual run	18.1	9.6	5.5	7.7	42.1	26.2	
1992	FRI	13.4	10.4	4.0	4.3	33.0	22.0	-45
	ADFG	16.4	10.7	4.3	4.6	37.1	26.3	-22
	Actual run	15.4	17.6	5.5	5.2	45.3	32.0	
1993	FRI	12.7	18.2	5.5	6.0	43.3	31.9	-28
	ADFG	15.1	15.8	4.9	5.1	41.8	32.0	-27
	Actual run	14.0	23.3	5.7	7.6	51.9	40.8	
1994	FRI	22.6	16.2	3.6	5.3	48.8	34.1	-3
	ADF&G	21.7	18.8	5.6	5.4	52.4	39.6	11
	Actual run	25.0	12.6	5.4	5.8	50.1	35.2	
1995	FRI	29.7	12.1	5.0	5.3	53.1	34.4	-29
	ADF&G	30.4	13.1	5.4	5.3	55.1	40.3	-10
	Actual run	31.1	15.7	5.8	6.7	60.8	44.4	
1996	FRI	12.5	15.7	7.8	7.7	45.2	33.4	11
	ADF&G	13.2	16.9	6.2	5.8	43.4	34.6	14
	Actual run	10.4	11.9	5.1	8.3	36.9	29.7	
1997	FRI	11.1	13.9	2.9	5.9	35.1	25.4	52
	ADF&G	10.2	12.8	3.8	5.7	33.6	24.8	50
	Actual run	3.1	8.7	2.0	4.6	18.8	12.3	
1998	FRI	13.9	8.4	4.3	6.2	33.8	23.5	57
	ADF&G	12.3	8.6	3.2	5.3	30.2	20.6	51
	Actual run	5.9	4.7	1.6	5.4	18.2	10.0	
1999	FRI*	17.2	7.7	2.7	6.7	35.1/28.8	21.2/14.9	-18/-42
	ADF&G	14.3	3.6	1.4	4.9	24.9	13.8	-47
	Actual run	17.3	9.2	3.9	8.5	40.0	25.8	
2000	FRI	13.7	11.4	4.9	6.3	37.7	24.4	
	ADF&G	15.3	8.5	4.6	5.8	35.4	22.3	

Total run and catch include Branch River and Togiak District but exclude jacks (1-ocean age).
Percent error = error in forecasted catch (forecast-actual catch/forecast*100).

* FRI produced a forecast based on traditional methodology (35.1) and one based on an alternative methodology (28.8).

TABLE 2. Bristol Bay sockeye salmon runs and the predictions from the Port Moller test boat catches, 1987–99.

Bristol Bay			Run pred. on 6/25			Run pred. on 6/30			Final pred. (7/3-9)			Catch pred. (7/3-9)		
Year	Run	Catch	Pred.	R-P	%ofP	Pred.	R-P	%ofP	Pred.	R-P	%ofP	Pred.	C-P	%ofP
1987	27	16	27	0	0	27	0	0	26	1	4	15	1	7
88	23	14	15	8	53	15	8	53	22	1	5	12	2	17
89	44	29	50	-6	-12	37	7	19	42	2	5	28	1	4
90	48	33	42	6	14	56	-8	-14	39	9	23	25	8	32
91	42	26	48	-6	-13	37	5	14	37	5	14	21	5	24
92	45	32	49	-4	-8	45	0	0	41	4	10	29	3	10
93	52	41	61	-9	-15	57	-5	-9	56	-4	-7	44	-3	-7
94	50	35	37	13	35	41	9	22	43	7	16	29	6	21
95	61	44	47	14	30	49	12	24	50	11	22	33	11	33
96	37	30	45	-15	-33	44	-14	-32	41	-4	-10	34	-4	-12
97	19	12	39	-20	-51	41	-22	-50	26	-7	-27	17	-5	-29
98	18	10	29	-11	-38	31	-13	-42	20	-2	-10	11	-1	-9
99	40	26	33	7	19	35	5	14	41	-1	-2	28	-2	-7
Means	39	27	40	-2	-1	40	-1	0	37	2	3	25	2	6
absol.					25		8	22		5	12		4	17

Numbers in millions of fish.

R= run, P= predicted and C= catch.

absol. = absolute error, ignoring the sign.

%ofP= the percentage that the actual run differed from the prediction.

1993-97,99 forecasts on 6/25 & 6/30 are from Bristol Bay almanacs (not adjusted for run timing).

TABLE 3. Water surface and air temperatures taken from the Port Moller test fishery boat (~10 June–~10 July) in degrees Celsius, 1987–99.

Year	Water (surface)	Air
1987	5.7	8.2
1988	7.5	n/a
1989	6.4	8.5
1990	7.5	9.4
1991	5.8	6.5
1992	7.6	9.8
1993	7.9	9.5
1994	6.6	7.0
1995	7.3	8.1
1996	6.2	7.4
1997	9.9	11.1
1998	8.1	10.0
1999	4.5	6.8
Average	7.0	8.5

TABLE 4. Mean lengths (mid-eye to tail-fork, mm) of sockeye salmon in the Bristol Bay runs, 1958–99.

Year	BB run (millions)	2-ocean Male	2-ocean Female	2-ocean Combined	3-ocean Male	3-ocean Female	3-ocean Combined	Both age groups	Percent 3-ocean
1958	6	527	508	517	586	562	572	544	48
1959	13	522	502	512	585	562	571	522	16
1960	36	496	480	489	580	553	562	498	12
1961	18	525	512	519	583	562	572	554	66
1962	10	527	508	518	582	566	574	535	30
1963	7	529	512	520	594	570	580	546	44
1964	11	517	499	508	584	564	571	522	22
1965	53	506	487	497	574	552	561	502	8
1966	18	514	503	508	581	561	569	554	75
1967	10	534	518	526	592	570	579	544	34
1968	8	516	503	510	594	572	581	535	36
1969	18	524	510	517	591	571	580	525	22
1970	39	511	497	504	572	549	558	509	9
1971	16	530	516	522	584	563	572	552	60
1972	5	521	505	514	583	562	572	543	51
1973	2	522	513	518	601	575	587	575	82
1974	11	525	508	518	581	566	574	528	19
1975	24	518	499	509	587	564	574	523	21
1976	12	531	514	523	592	568	578	543	36
1977	10	533	517	525	597	573	584	556	53
1978	19	520	502	512	595	570	582	539	38
1979	40	537	524	530	586	567	576	538	18
1980	62	519	503	511	583	553	567	525	26
1981	34	536	523	529	588	566	577	555	54
1982	22	522	508	515	587	566	576	561	75
1983	46	530	514	521	574	557	565	529	17
1984	41	515	501	508	580	561	570	526	30
1985	37	527	512	520	583	567	575	543	41
1986	24	535	521	528	583	561	571	553	58
1987	27	521	506	513	590	567	577	538	39
1988	23	525	513	519	592	571	581	554	56
1989	44	525	507	515	586	564	575	538	27
1990	48	507	491	499	578	557	566	528	43
1991	42	508	493	500	573	547	560	536	60
1992	45	511	496	504	568	544	557	531	52
1993	52	530	515	522	582	560	570	547	52
1994	50	512	498	504	575	550	561	524	34
1995	61	520	502	511	578	555	567	526	27
1996	37	522	506	513	585	562	574	558	76
1997	19	519	503	511	585	565	576	540	45
1998	18	505	492	499	570	550	560	531	53
1999	40	516	500	508	587	556	569	539	22
Averages									
58-67	18	520	503	511	584	562	571	532	36
68-77	15	523	508	516	588	566	576	539	39
78-87	35	526	511	519	585	564	574	541	40
88-97	44	517	501	509	579	556	567	536	46

TABLE 5. Average weights of sockeye salmon (lbs) in commercial catches on the east side of Bristol Bay, 1988–99.

District	Year	Catch millions	2-ocean			3-ocean			All males	All females	All fish	Percent 3-ocean	Percent females
			Male	Female	Comb.	Male	Female	Comb.					
Nak/Kvi	88	3.5	5.3	4.5	4.9	7.4	6.5	6.9	6.3	5.6	5.9	52	52
	89	13.8	5.3	4.6	4.9	7.3	6.2	6.8	5.8	4.9	5.3	21	55
	90	17.1	5.0	4.5	4.7	7.3	6.2	6.7	5.9	5.3	5.6	43	54
	91	10.6	4.9	4.3	4.6	7.2	6.0	6.5	6.6	5.5	6.0	71	54
	92	9.3	5.0	4.5	4.7	6.7	5.7	6.2	6.0	5.2	5.6	60	48
	93	8.9	5.3	4.8	5.1	7.1	6.2	6.6	6.3	5.6	5.9	54	53
	94	16.3	5.0	4.5	4.7	7.0	5.5	6.1	5.4	4.7	5.0	18	58
	95	20.4	5.0	4.4	4.8	6.9	5.9	6.5	5.5	4.7	5.2	22	44
	96	8.2	5.5	4.5	4.9	7.4	6.3	7.0	7.1	5.9	6.7	83	39
	97	0.6	5.4	4.8	5.1	7.6	6.3	7.0	6.7	5.6	6.2	55	50
	98	2.6	5.3	4.7	5.1	6.8	6.0	6.5	6.2	5.6	5.9	60	44
	99	9.5	4.9	4.5	4.7	7.0	6.0	6.5	6.0	5.2	5.6	23	49
	Means	10.1	5.2	4.5	4.9	7.1	6.1	6.6	6.1	5.3	5.7	47	50
Egegik	88	6.5	5.4	4.9	5.2	7.5	6.7	7.2	6.6	6.0	6.3	57	45
	89	8.9	5.2	4.6	4.9	7.4	5.9	6.7	6.0	5.0	5.5	33	51
	90	10.1	5.3	4.9	5.1	7.3	6.1	6.6	6.3	5.6	5.9	54	52
	91	6.8	5.3	4.4	4.9	7.3	6.0	6.6	6.4	5.3	5.8	55	52
	92	15.7	4.7	4.1	4.5	6.6	5.8	6.2	5.6	5.0	5.4	51	44
	93	21.8	5.5	4.8	5.1	7.1	6.2	6.6	6.3	5.6	5.9	52	54
	94	10.8	4.6	4.1	4.4	7.0	5.6	6.2	5.6	5.0	5.3	51	53
	95	14.5	5.3	4.5	4.9	6.9	5.9	6.4	5.8	5.0	5.4	32	48
	96	10.8	5.5	4.7	5.1	7.6	6.2	6.8	7.0	5.8	6.4	73	54
	97	7.6	5.3	4.4	4.9	7.8	6.6	7.2	6.4	5.4	5.9	44	47
	98	3.6	4.7	4.5	4.7	6.5	5.8	6.2	6.0	5.6	5.8	75	47
	99	7.4	5.1	4.3	4.7	7.8	5.9	6.8	6.4	5.1	5.7	22	50
	Means	10.4	5.2	4.5	4.9	7.2	6.1	6.6	6.2	5.4	5.8	50	50
Ugashik	88	1.5	5.4	4.8	5.2	7.5	6.6	7.1	6.4	5.9	6.2	54	43
	89	3.1	5.5	4.7	5.1	7.7	6.5	7.2	5.9	5.0	5.5	19	45
	90	2.1	5.0	4.5	4.7	7.4	6.4	6.9	6.1	5.6	5.9	53	49
	91	3.0	5.3	4.5	4.9	7.0	5.8	6.3	6.2	5.3	5.8	59	52
	92	3.4	5.0	4.5	4.8	6.8	5.6	6.4	6.2	5.2	5.8	64	37
	93	4.3	5.7	4.6	5.2	7.7	6.7	7.2	6.7	5.7	6.2	52	52
	94	4.3	4.9	4.2	4.7	7.1	6.0	6.6	6.0	5.3	5.8	55	40
	95	4.5	5.2	4.3	4.8	6.9	6.1	6.5	5.7	4.9	5.3	30	42
	96	4.4	5.2	4.8	5.0	7.6	6.3	7.0	7.3	6.1	6.7	85	47
	97	1.4	5.5	4.6	5.1	7.7	6.3	7.0	6.5	5.4	6.0	47	47
	98	0.7	5.2	4.9	5.1	7.1	5.8	6.6	6.7	5.7	6.3	82	36
	99	2.3	5.2	4.3	4.8	7.4	6.0	6.7	6.3	5.2	5.7	15	44
	Means	2.9	5.3	4.5	5.0	7.3	6.2	6.8	6.3	5.5	5.9	51	45

TABLE 6. Average weights of sockeye salmon (lbs) in commercial catches on the west side of Bristol Bay, 1988–99.

District	Year	Catch millions	2-ocean Male	2-ocean Female	2-ocean Comb.	3-ocean Male	3-ocean Female	3-ocean Comb.	All males	All females	All fish	Percent 3-ocean	Percent females
Nushagak	88	1.7	4.9	4.3	4.7	7.8	6.2	7.0	7.1	5.9	6.5	79	49
	89	2.8	5.4	4.3	4.7	7.6	6.2	6.8	6.9	5.6	6.1	68	62
	90	3.6	4.5	4.1	4.4	7.6	5.9	6.7	6.6	5.5	6.0	71	50
	91	5.3	4.3	3.8	4.0	7.1	5.7	6.3	6.4	5.2	5.7	75	56
	92	2.8	4.7	4.0	4.4	6.5	5.4	6.0	5.7	5.0	5.4	61	45
	93	5.3	5.2	4.3	4.8	7.5	6.0	6.6	6.4	5.4	5.9	59	55
	94	3.4	4.3	4.0	4.2	6.9	5.9	6.2	6.3	5.8	6.0	87	60
	95	4.4	4.8	4.3	4.5	6.7	5.6	6.1	5.7	4.9	5.3	49	50
	96	5.8	5.0	4.1	4.5	7.3	5.9	6.5	6.5	5.4	5.8	68	57
	97	2.6	4.9	4.2	4.7	6.9	5.9	6.6	6.1	5.2	5.8	60	35
	98	3.0	4.3	3.7	4.0	6.9	5.3	6.2	5.4	4.2	4.7	34	54
	99	6.3	4.9	4.2	4.5	7.0	5.5	6.3	5.9	4.9	5.4	52	41
	Means	3.9	4.8	4.1	4.5	7.2	5.8	6.4	6.2	5.2	5.7	64	51
Togiak	88	0.7	6.3	5.1	5.6	8.8	7.2	7.9	8.7	7.1	7.8	97	54
	89	0.1	5.9	4.7	5.4	8.4	6.3	7.1	7.8	6.1	6.8	82	57
	90	0.2	5.4	4.8	5.0	8.1	6.3	7.1	7.7	6.1	6.8	85	57
	91	0.5	5.9	4.8	5.4	8.1	6.2	7.1	7.4	5.8	6.6	69	50
	92	0.6	5.4	4.8	5.1	8.7	6.3	7.6	8.2	6.1	7.2	85	47
	93	0.5	6.2	5.0	5.6	9.2	6.5	7.9	8.5	6.2	7.3	76	49
	94	0.3	6.4	5.2	5.7	8.1	6.3	7.1	8.0	6.2	7.0	91	53
	95	0.5	6.0	5.1	5.5	7.9	6.6	7.2	7.2	6.1	6.6	66	53
	96	0.4	6.3	5.1	5.8	8.5	6.6	7.5	8.3	6.5	7.4	90	52
	97	0.1	6.2	5.3	5.7	8.2	6.6	7.4	7.8	6.3	7.1	80	49
	98	0.2	5.9	4.5	5.1	7.6	6.0	6.6	7.4	5.8	6.5	88	58
	99	0.4	5.6	5.1	5.4	6.8	6.0	6.4	6.2	5.5	5.9	46	33
	Means	0.4	6.0	5.0	5.5	8.2	6.4	7.3	7.8	6.2	6.9	80	51

TABLE 7. Sockeye salmon escapements in excess of management goals for Bristol Bay rivers, 1990–99 (in millions).

River system	Escapement goals: Mid-point	Escapement goals: Upper range	90	91*	92	93	94	95	96	97	98	99
			Escapement in excess of mid-point									
Kvichak	variable	variable										
Branch												
Naknek***	1.00		1.09	2.57	.61	.54	.00	.11	.08	.03	.20	.53
Egegik***	1.00		1.19	1.79	.95	.52	.90	.27	.08	.10	.11	.63
Ugashik***	.70		.05	1.76	1.76	.71	.38	.60	.00	.00	.02	.62
Wood	1.00		.07	.16	.29	.18	.47	.48	.65	.51	.76	.51
Igushik	.20		.17	.56	.10	.21	.25	.27	.20	.00	.02	.24
Nush./Nuy.****	.24		.17	.00	.20	.21	.01	.00	.00	.00	.00	.07
Togiak	.15		.04	.13	.07	.04	.02	.06	.01	.00	.00	.08
Total			2.78	6.97	3.98	2.41	2.03	1.79	1.02	.64	1.11	2.68
Bristol Bay run			48	42	45	52	50	61	37	19	18	40
Catch			33	26	32	41	35	44	30	12	10	26
			Escapement in excess of upper range									
Naknek		1.40	.69	2.18	.21	.14	.00	.00	.00	.00	.00	.23
Egegik**		1.20	.99	1.59	.75	.32	.70	.00	.00	.00	.00	.33
Ugashik**		.90	.00	1.58	1.56	.51	.18	.10	.00	.00	.00	.45
Wood		1.20	.00	.00	.09	.00	.27	.28	.45	.31	.56	.31
Igushik		.25	.12	.51	.05	.16	.20	.22	.15	.00	.00	.19
Nush/Nuy		.76	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Togiak		.25	.00	.03	.00	.00	.00	.00	.00	.00	.00	.00
Total			1.80	5.89	2.66	1.13	1.35	.60	.60	.31	.56	1.51

*Strike in 1991 delayed the start of fishing except at Ugashik.
**Upper range of escapement goals for Egegik and Ugashik were increased to 1.4 and 1.2 million for 1995 and 1999.
***Mid point escapement goals for Naknek, Egegik, and Ugashik were increased to 1.1, 1.1, and 1.0 million for 1999.
****Nushagak escapement reduced to .235 million for 1999.

TABLE 8. Cumulative daily escapements of sockeye salmon in the Kvichak and Newhalen Rivers, 1994–99 (numbers in 1,000s and Newhalen escapements estimated from expanded counts lagged back 2 d for 1994–95, 3 d for 1996–97, and 1 d for 1998).

	1994		1995		1996		1997		1998		1999	
Date	Kvi	New	Kvi	New	Kvi	New	Kvi	New	Kvi	New	Kvi	New
6/22												
23	0											
24	0				0	0	0					
25	0		0		4	0	3		0			
26	1		41	7	25	1	6		0			
27	8		361	28	37	1	15	0	1		0	
28	24		724	48	40	1	42	1	3		0	
29	25		941	75	41	1	60	2	6		0	0
30	25		1113	109	42	2	67	4	16		17	0
7/1	26	0	1610	158	47	2	73	5	26	0	104	28
2	30	1	2338	255	90	2	76	8	32	0	336	36
3	254	1	2798	309	224	3	83	13	32	0	747	60
4	1550	321	3105	364	318	4	116	18	84	18	1085	105
5	2727	558	3346	398	361	6	158	30	233	37	1522	132
6	3518	775	3983	430	385	7	206	40	417	76	1826	155
7	4273	921	4937	482	420	7	299	50	597	230	2254	207
8	5132	1091	5930	581	468	8	439	63	753	256	2786	255
9	5821	1286	7020	687	568	15	637	105	833	338	3190	306
10	6473	1601	7683	805	669	22	797	132	980	592	3586	398
11	7058	1884	8005	1050	769	23	950	182	1366	937	3802	473
12	7268	2168	8169	1199	860	25	1053	224	1795	1137	4030	520
13	7330	2372	8430	1226	1035		1140	230	2071	1361	4330	600
14	7382	2450	8658	1378	1160		1200	239	2181	1450	4648	676
15	7495	2535	8878		1238		1291	253	2238	1573	4947	735
16	7540	2578	9017		1310		1349		2269	1680	5109	
17	7631		9131		1332		1382		2280	1723	5420	
18	7852		9248		1353		1412		2285		5849	
19	8099		9512		1397		1436		2291		6038	
20	8169		9703		1422		1456		2294		6108	
21	8193		9788		1436		1471		2295		6150	
22	8265		9876		1445		1486		2296		6175	
23	8338		9919		1451		1496				6196	
24			9954				1504					
25			9994									

TABLE 9. The Kvichak lake system escapements and the percentages going to the Newhalen River and Lake Clark, 1979–99.

Year	Kvichak system escapement (millions)	Newhalen/ Lake Clark escapement (millions)	Percent of Kvichak (%)	Newhalen River spawners (millions)	Lake Clark escape. (millions)	Percent of Kvichak (%)	Tazimina River aerial count (thousands)
1979	11.22	9.00	80	0.56	8.44	75	504
1980	22.51	7.50	33	2.64	4.86	22	128
1981	1.75	0.26	15	0.03	0.23	13	28
1982	1.14	0.34	30	0.13	0.21	18	31
1983	3.57	1.08	30	0.41	0.67	19	212
1984	10.49	3.20	31	0.67	2.53	24	366
1985	7.21	1.62	22	0.15	1.47	20	186
1986	1.18	0.29	25	0.01	0.28	24	7
1987	6.07	---	--	1.46	--	--	246
1988	4.06	2.41	59	0.29	2.12	52	83
1989	8.32	2.59	31	0.10	2.49	30	30
1990	6.97	1.09	16	*0.07*	--	--	4
1991	4.22	1.93	46	*0.10*	--	--	16
1992	4.73	1.05	22	<0.01	1.04	22	13
1993	4.03	1.55	38	<0.01	1.54	38	38
1994	8.34	2.34	28	0.01	2.33	28	93
1995	10.04	1.12	11	0.12	1.00	10	54
1996	1.45	0.04	2	<0.01	0.03	2	10
1997	1.50	0.27	18	<0.01	0.27	18	11
1998	2.30	1.38	60	0.01	1.37	60	24
1999	6.20	0.60	10	--	--	10	17

Newhalen River spawners estimated by two times the aerial survey estimate.

Italics = estimate of missing data.

TABLE 10. Age compositions of sockeye salmon on the Kvichak spawning grounds in 1999.

Spawning Ground	Sex	Sample size (n)	1.1	2.1	1.2	2.2	1.3	2.3	0.4
Chinkelyes Creek	F	100	0.0	0.0	15.0	72.0	12.0	0.0	0.0
	M	100	0.0	0.0	13.0	78.0	9.0	0.0	0.0
Copper River	F	97	0.0	0.0	23.7	48.5	9.3	17.5	0.0
	M	100	0.0	0.0	38.0	26.0	10.0	25.0	0.0
Finger beaches	F	106	0.0	0.0	81.1	10.4	7.5	0.9	0.0
	M	100	0.0	0.0	73.0	13.0	12.0	1.0	0.0
Fuel Dump Island beaches	F	50	0.0	0.0	86.0	10.0	4.0	0.0	0.0
	M	49	0.0	0.0	89.8	6.1	0.0	0.0	0.0
Gibraltar River	F	100	0.0	0.0	54.0	28.0	17.0	1.0	0.0
	M	100	0.0	0.0	57.0	25.0	15.0	3.0	0.0
Knutson Bay beach	F	100	0.0	0.0	39.0	43.0	15.0	3.0	0.0
	M	100	0.0	0.0	50.0	38.0	11.0	1.0	0.0
Knutson Bay beach (Oct)	F	100	0.0	0.0	43.0	52.0	4.0	1.0	0.0
	M	99	0.0	0.0	39.4	56.6	3.0	0.0	0.0
Lower Talarik Creek	F	105	0.0	0.0	94.3	1.9	3.8	0.0	0.0
	M	101	0.0	0.0	94.1	2.0	3.0	0.0	0.0
Mink Creek	F	64	0.0	0.0	25.0	60.9	10.9	0.0	0.0
	M	28	0.0	0.0	35.7	64.3	0.0	0.0	0.0
Newhalen River	F	109	0.0	0.0	22.0	48.6	29.4	0.0	0.0
	M	83	0.0	0.0	28.9	43.4	24.1	2.4	0.0
Pedro Ponds	F	100	0.0	0.0	49.0	22.0	27.0	0.0	0.0
	M	100	0.0	0.0	67.0	22.0	10.0	0.0	0.0
Pedro Ponds (Oct)	F	117	0.0	0.0	23.9	66.7	6.0	2.6	0.0
	M	28	0.0	0.0	35.7	57.1	0.0	3.6	0.0
Tazimina River	F	73	0.0	0.0	30.1	57.5	11.0	1.4	0.0
	M	100	0.0	0.0	28.0	64.0	6.0	0.0	0.0
Woody Island beaches	F	50	0.0	0.0	86.0	8.0	4.0	0.0	0.0
	M	50	0.0	0.0	94.0	6.0	0.0	0.0	0.0
Kvichak escapement	F	948	0.0	0.0	60.4	31.2	5.8	2.6	0.0
(ADF&G, Igiugig)	M	1430	0.0	0.0	59.4	29.5	7.7	3.4	0.0

TABLE 11. Estimates of sockeye salmon spawners on 29 selected spawning grounds in Lake Iliamna and the Newhalen River system, 1956–99.

	Aerial survey counts (1,000s)					Tower count	Aerial count/	
			Beaches			escapement	Escapement	Aerial
Year	Rivers	Creeks	Mainland	Island	Total	(1,000s)	(%)	observer
56	775	--	--	--		9443		1
57	170	--	--	--		2843		1
58	44	--	--	--		535		1
59	84	--	--	--		680		1
60	841	--	--	--		14630		1
61	246	40	50	127	463	3706	12.5	2
62	140	52	21	12	225	2581	8.7	2
63	31	13	5	7	56	339	16.5	2
64	36	38	3	21	98	957	10.2	2
65	734	538	261	1352	2885	24326	11.9	2
66	248	153	134	46	581	3776	15.4	2
67	370	63	85	16	534	3216	16.6	3
68	131	64	14	64	273	2557	10.7	3
69	192	168	40	102	502	8394	6.0	3
70	790	574	216	506	2086	13935	15.0	3
71	177	194	27	50	448	2387	18.8	3
72	89	50	15	9	163	1010	16.1	3
73	35	18	6	6	65	227	28.6	3
74	294	269	72	122	757	4433	17.1	3
75	936	440	225	412	2013	13140	15.3	3
76	144	55	19	45	263	1965	13.4	3
77	124	20	88	28	260	1341	19.4	3
78	510	100	42	6	658	4149	15.9	3
79	1424	372	252	81	2129	11218	19.0	3
80	2189	317	77	201	2784	22505	12.4	3
81	187	85	16	20	308	1754	17.6	3
82	255	68	27	9	359	1135	31.6	3
83	743	123	75	9	950	3570	26.6	3
84	1902	359	597	84	2942	10491	28.0	4
85	672	296	260	247	1475	7211	20.5	4
86	57	16	12	5	90	1200	7.5	5
87	1313	111	397	123	1944	6100	31.9	5
88	481	123	116	15	735	4065	18.1	6
89	386	88	31	8	513	8318	6.2	6
90	138	50	19	26	233	6970	3.3	6
91	196	111	18	19	344	4223	8.1	7
92	198	151	35	19	403	4726	8.5	7
93	225	128	42	10	405	4025	10.1	7
94	506	231	41	30	808	8338	9.7	7
95	554	187	50	244	1035	10039	10.3	7
96	177	49	22	10	258	1451	17.8	7
97	255	69	87	11	422	1504	28.1	7
98	138	82	34	13	267	2296	11.6	7
99	224	46	28	23	320	6196	5.2	8
Means								
61-66	239	139	79	261	718	5948	12.5	2
67-83	505	175	76	99	856	5702	17.6	3
84-90	707	149	205	73	1133	6336	16.5	4,5,6
91-98	281	126	41	45	493	4575	13.0	7

TABLE 12. Mean townet catches (geometric means of 20-min tows) and lengths on Sept. 1 (live, mm) of sockeye salmon fry in Lakes Iliamna and Clark, 1961–99.

Brood year	Kvichak escapement (millions)	Lake Iliamna Mean catch	Lake Iliamna Mean length	Lake Clark Mean catch	Lake Clark Mean length
61	3.7	90	53	13	50
62	2.6	12	45	54	50
63	0.3	5	54	3	50
64	1.0	7	62	2	50
65	24.3	170	53	23	52
66	3.8	67	57	15	47
67	3.2	78	62	47	59
68	2.6	43	62	9	50
69	8.4	386	61	11	55
70	13.9	127	44	20	38
71	2.4	4	50	15	41
72	1.0	3	58	17	48
73	0.2	2	71	12	57
74	4.4	491	54	80	55
75	13.1	252	49	105	49
76	2.0	16	53	--	--
77	1.3	11	61	--	--
78	4.1	339	62	65	56
79	11.2	282	53	60	48
80	22.5	134	61	26	59
81	1.8	37	52	58	46
82	1.1	9	68	18	57
83	3.6	242	64	40	56
84	10.5	147	46	84	51
85	7.2	63	54	16	49
86	1.2	10	60	--	--
87	6.1	79	63	11	56
88	4.1	22	58	21	48
89	8.3	181	55	19	47
90	7.0	336	54	--	--
91	4.2	-	56	20	47
92	4.7	135	57	27	61
93	4.0	64	57	26	55
94	8.3	83	55	21	54
95	10.0	126	62	-	-
96	1.5	23	67	-	-
97	1.5	-	-	-	-
98	2.3				
99	6.2	38	44		

Lake Iliamna tows in areas 7 & 8 only.

TABLE 13. Summary of 1999 environmental and limnological measurements in Lake Aleknagik.

Measurement and first year measured	Dates	1999	All years Average	All years Range
1. Date of ice breakup, 1949-		6/15	5/29	5/01-6/16
2. Water temperature,	6/24	4.3	5.8	3.7, 9.2
0-20m (C)	7/13	10.1	8.4	5.7, 12.0
1958-	8/11	10.2	10.8	7.7, 14.0
	9/2	11.3	11.2	9.3, 13.0
3. Water transparency	6/22	6.1	7.9	5.3, 10.5
Secchi depth (m)	7/13	5.1	8.1	5.0, 10.9
1962-	8/2	8.3	9.2	6.3, 11.9
	9/2	9.6	9.1	5.8, 12.1
4. Water conductivity	6/22	35.3	37.9	31.1, 52.1
(micromhos/cm)	7/13	36.0	37.0	33.5, 42.6
1968-	8/2	36.0	36.7	32.5, 40.5
	9/2	36.0	37.8	32.2, 47.9
5. Average daily	June 1-15	224	401	305, 588
solar radiation	June 16-30	370	403	265, 572
(gm/cal/cm)	July 1-15	394	383	277, 543
1963-	July 16-31	289	347	192, 485
	Aug. 1-15	218	294	203, 402
	Aug. 16-31	236	255	164, 421
	Sept. 1-15	189	204	114, 282
6. Lake level (cm)	June 1-15		144	84, 227
of Lake Nerka	June 16-30	160	151	97, 218
1952-	July 1-15	128	131	74, 199
	July 16-31	94	105	52, 172
	Aug. 1-15	88	85	34, 173
	Aug. 16-31	84	82	30, 184
	Sept. 1-15	79	82	29, 161
7. Chlorophyll "a",	6/22	25	28	10, 45
0-20m (mg/m2)	7/2	14		
1963-	7/13	20	26	10, 43
	7/22	26		
	8/2	13	21	6, 36
	8/11	17		
	8/21	17		
	9/2	18	23	12, 37
8. Zooplankton volume	6/22	44	52	20,168
0-60m (ml/m2)	7/2	60		
1967-	7/13	112	85	45-162
	7/22	121		
	8/2	187	117	43-226
	8/11	168		
	8/21	136		
	9/2	86	60	26-107

TABLE 14. Five-day averages of catches of emergent midges and water temperatures at 3 stations on Lake Aleknagik, 1999.

	Catch per day							Water temperature (°C)						
5-day	1999				1969-99			1999				1969-99		
period	W	H	B	Mean	Mean	Min	Max	W	H	B	Mean	Mean	Min	Max
6/1-5					2	0	3					3.8	0.0	9.8
6-10					9	0	70					5.3	0.0	10.4
11-15					12	1	53					7.1	0.0	12.1
16-20	3	6	36	15	15	1	168	6.0	7.3	10.0	7.8	8.6	3.9	12.7
21-25	8	7	17	10	6	0	42	7.0	7.8	10.5	8.4	9.2	4.8	12.8
26-30	13	4	1	6	4	0	12	6.0	9.0	11.5	8.8	10.2	6.0	13.9
7/1-5	8	1	1	3	6	1	16	12.5	11.8	13.0	12.4	11.5	7.7	15.5
6-10	4	2	1	2	11	2	61	9.3	12.0	14.8	12.1	12.2	9.3	16.0
11-15	9	2	2	4	13	1	34	8.5	13.0	14.3	11.9	12.6	9.2	17.9
16-20	2	4	3	3	14	2	36	9.2	12.3	12.7	11.4	12.5	8.5	17.0
21-25	5	3	3	3	19	2	74	11.0	12.5	13.3	12.3	13.0	7.9	17.2
26-30	7	0	56	21	26	5	59	13.0	12.5	13.5	13.0	13.5	8.9	16.1
31-4	9	32	39	27	26	4	77	9.0	12.3	13.0	11.4	13.6	10.2	17.5
8/5-9	9	15	25	16	18	3	80	11.3	12.0	13.8	12.3	13.6	10.4	17.1
10-14	11	6	11	9	14	1	54	11.3	12.3	13.8	12.5	13.6	9.5	18.8
15-19	15	3	4	7	12	1	70	11.8	13.7	14.7	13.4	13.6	11.0	16.2
20-24					5	0	28					13.7	9.7	15.4
25-29					5	1	11					13.5	11.3	14.7
3-7	5	4	1	3	5	1	13	12.0	11.5	12.0	11.8	12.8	10.6	14.2

W = Whitefish Bay; H = Hansen Bay; and B = Bear Bay.

TABLE 15. Average catches, lengths and growth rates for sockeye fry and age 1 threepine stickleback in Lake Aleknagik, 1958–99.

	Sockeye salmon fry					Sockeye	Threepine stickleback					
Year	Mean beach seine catch	Mean length on 6/24 (mm)	Mean length on 9/2 (mm)	Growth rate (mm/ day)	Mean tow net catch	Escape-ment in year-1 (1000s)	Mean beach seine catch	Mean length on 6/24 (mm)	Mean length on 9/2 (mm)	Growth rate (mm/ day)	Mean tow net catch	Age 0 tow net catch
58	-	-	62.1	-	14	88	-	-	44.6	-	36	<1
59	-	-	62.7	-	13	63	-	-	46.7	-	136	10
60	-	-	55.5	-	111	205	-	-	43.4	-	53	2
61	-	-	58.4	-	103	85	-	-	42.0	-	38	<1
62	334	31.7	54.1	.31	54	153	317	31.0	43.5	.17	139	5
63	-	-	62.1	-	24	48	-	-	46.4	-	46	1
64	227	31.1	60.4	.42	24	31	352	31.2	43.1	.17	272	1
65	549	31.2	53.6	.32	103	155	202	29.1	39.5	.15	182	1
66	395	30.2	47.5	.25	219	220	258	27.1	39.4	.18	150	0
67	339	30.7	43.4	.18	49	287	426	28.2	41.3	.19	61	5
68	46	31.8	57.9	.37	10	92	212	30.8	43.4	.18	268	169
69	96	31.7	61.4	.43	78	177	215	33.4	44.2	.16	81	<1
70	164	31.4	59.0	.40	43	160	156	32.1	44.8	.18	87	<1
71	408	30.6	54.6	.35	17	302	261	29.6	43.4	.20	3	<1
72	126	30.6	54.8	.35	10	182	45	28.0	44.4	.24	12	1
73	30	29.0	66.7	.54	3	98	62	29.3	49.5	.29	8	1
74	47	35.3	62.8	.39	44	162	125	33.1	50.1	.24	119	<1
75	111	29.1	55.3	.39	8	242	69	32.5	42.4	.15	132	<1
76	178	30.1	49.8	.29	394	457	279	27.7	39.6	.17	30	<1
77	223	30.1	48.0	.27	25	314	184	29.3	40.8	.17	36	<1
78	34	32.8	62.7	.43	6	152	64	31.7	47.5	.23	21	1
79	312	31.6	51.5	.28	130	612	82	33.2	42.3	.13	50	18
80	46	31.0	56.4	.35	3	354	32	31.0	44.9	.19	24	<1
81	423	32.4	51.3	.27	6	1230	217	34.7	45.5	.15	12	<1
82	53	30.0	52.2	.33	131	454	63	30.2	43.2	.19	12	0
83	43	32.1	63.9	.45	22	337	12	30.9	48.4	.25	64	12
84	16	36.2	64.2	.41	3	245	54	35.9	48.8	.19	200	155
85	102	31.0	56.3	.36	1	329	109	34.3	40.9	.09	2	0
86	32	32.2	58.4	.37	10	188	24	31.4	45.0	.19	11	0
87	69	29.7	57.5	.40	3	341	27	31.7	44.9	.19	67	<1
88	31	31.2	58.8	.40	2	362	42	32.4	48.5	.23	8	1
89	45	31.4	55.4	.34	18	285	26	32.6	47.0	.21	17	1
90	100	32.7	57.7	.36	20	477	129	31.2	48.1	.24	27	1
91	63	30.1	52.9	.33	14	393	108	31.3	42.2	.16	41	1
92	242	30.0	46.1	.24	52	788	200	27.9	39.4	.17	222	<1
93	34	33.7	56.4	.33	10	357	55	31.7	46.5	.22	3	<1
94	55	32.0	51.7	.29	121	417	31	30.3	46.6	.24	38	2
95	39	32.0	53.9	.31	24	483	33	31.5	46.0	.21	181	31
96	26	32.6	54.8	.32	100	470	43	32.6	47.1	.21	103	7
97	38	33.1	52.1	.27	8	625	164	34.2	41.4	.10	155	141
98	16	31.6	55.8	.35	3	404	26	30.6	45.3	.21	6	0
99	312	29.3	60.0	.44	5	401	182	31.4	52.8	.31	5	0
Means	146	31.4	55.8	0.35	47	336	132	31.2	44.7	0.19	76	21

1. Beach seine catches at 10 stations for four dates during 6/22-7/14.
2. Tow net catches for 5-min hauls, two at each of six stations during Sept. 1-5.
3. Lengths measured to nearest mm on preserved fish, means adjusted to live measurement.
4. Threespine stickleback catches are for all ages (0-4), but mean lengths for age 1 only.

TABLE 16. Average townet catches and mean lengths of sockeye fry (by lake area), number of parent spawners and average catches and mean lengths (age 1) of threepine stickleback for Lake Nerka, 1958–99.

	Sockeye salmon fry						Sockeye salmon spawners in year-1 (1000s)			Threespine stickleback	
	Mean tow-net catch			Mean length (mm) on 9/1							
Year	South	Central	North	South	Central	North	South	Central	North	Mean tow-net catch	Mean length (mm) on 9/1
58	4	4	10	62	60	61	73	57	52	26	44
59	17	9	4	66	61	61	163	58	188	35	43
60	62	42	42	58	55	51	564	332	395	11	42
61	108	57	64	59	56	54	231	137	214	8	41
62	2	7	26	64	59	59	49	50	143	6	47
63	58	18	55	62	60	62	97	73	126	9	48
64	3	7	44	57	55	64	56	65	110	8	45
65	15	8	93	57	54	54	110	159	161	9	40
66	4	7	70	57	54	54	60	77	184	6	44
67	8	18	58	64	58	59	149	141	246	12	46
68	4	11	8	68	64	65	44	64	114	25	48
69	15	4	27	65	61	60	46	103	150	14	46
70	2	5	21	64	65	63	51	56	266	5	43
71	3	9	197	54	52	58	141	132	229	4	42
72	2	11	8	57	55	55	68	73	178	8	45
73	1	3	11	61	61	61	37	82	109	4	45
74	5	4	34	69	64	64	19	29	83	107	50
75	7	15	9	59	55	53	236	141	242	60	44
76	1	9	40	52	49	45	128	69	297	17	40
77	19	50	143	55	54	51	77	69	176	17	42
78	<1	<1	4	56	61	63	67	65	173	18	46
79	3	17	50	64	54	58	151	181	460	61	47
80	1	14	37	52	49	47	246	142	287	33	41
81	3	16	13	59	55	55	219	224	566	6	46
82	1	6	38	54	56	54	89	169	348	24	45
83	2	4	4	66	63	63	29	43	396	1	48
84	1	11	2	72	61	63	66	84	243	14	50
85	1	2	123	61	56	55	57	89	371	2	45
86	2	16	12	50	54	64	50	106	492	2	42
87	1	7	21	57	56	55	34	64	253	4	43
88	<1	2	7	64	57	57	77	213	293	2	49
89	1	3	16	57	51	59	57	174	176	5	48
90	1	7	3	63	62	58	87	153	377	3	48
91	27	22	32	61	57	56	80	94	219	27	44
92	4	16	10	57	55	55	51	43	99	4	41
93	8	6	16	62	57	55	200	252	201	15	45
94	29	39	66	63	55	52	162	169	203	15	44
95	41	127	49	63	56	50	95	152	372	22	44
96	6	44		66	61		154	153	232	1	49
97	3	2	3	62	59	60	131	216	355	39	43
98	12	47	26	59	53	52	148	282	250	37	44
99	136	59	181	51	48	49	137	241	161	12	47
Means	16	19	41	60	57	57	114	126	243	18	45

TABLE 17. Occurrence and numbers of juvenile sockeye in stomachs of Arctic char collected by hook and line from Little Togiak River during 30 days after ice out, 1972–99.

Year	Date of ice out	Range in sampling dates	Number of char examined	Mean length (mm)	Percent of char with		Mean number per char		Sockeye escape. year-2
					Fry	Smolt	Fry	Smolt	
72	6/17	6/26-7/10	82	446	34	60	2.8	4.5	55
73	6/08	6/19-7/03	121	446	34	44	1.9	2.9	24
74	5/27	6/11-25	64	429	19	39	0.8	1.6	14
75	6/15	6/22-7/13	71	415	9	36	0.2	1.8	14
76	6/17	6/19-7/13	96	418	11	56	0.4	2.2	48
77	6/13	6/11-7/11	325	403	30	17	7.0	0.4	30
78	6/02	6/07-25	316	437	7	42	0.2	1.5	18
79	5/24	6/06-22	178	438	32	25	1.8	1.2	26
80	5/27	6/09-25	278	459	27	81	1.4	9.4	45
81	5/28	6/12-25	124	415	3	31	0.1	1.4	44
82	6/15	6/17-7/05	105	450	18	61	1.8	6.4	81
83	5/27	6/19-7/03	78	424	0	14	0.0	0.3	60
84	5/26	6/20-7/02	56	408	0	18	0.0	0.4	36
85	6/17	6/15-7/06	60	437	22	30	1.6	1.2	29
86	6/04	6/16-7/05	61	437	21	56	0.4	2.7	15
87	6/01	6/14-7/05	51	451	6	78	0.1	4.9	20
88	6/05	6/16-29	43	431	7	26	0.1	0.8	24
89	6/17	6/20-7/15	105	388	37	38	2.2	1.3	15
90	5/28	6/07-24	72	391	35	11	1.8	0.3	16
91	6/07	6/20-7/07	48	415	4	35	0.9	3.2	13
92	6/13	6/15-7/11	79	425	0	46	0.0	1.9	29
93	5/12	6/07-18	51	428	21	22	1.4	0.7	19
94	5/28	6/14-29	39	416	3	21	0.1	0.2	35
95	5/29	6/11-13	3	468	66	66	2.3	2.0	19
96	5/30	6/16-22	40	429	0	42	0.0	1.1	24
97	5/29	6/13-24	28	445	0	11	0.0	0.3	28
98	5/28	6/15-25	22	435	9	36	0.1	2.8	23
99	6/15	6/28-7/01	12	469	17	50	0.4	0.9	45
means	6/5		93	430	17	39	1.1	2.1	30

TABLE 18. Ground survey counts of sockeye spawners in the Wood River lakes, 1999.

Location	Date	Estimated off mouth	In creek Live	In creek Dead	In creek Natural	In creek Bear kill	Total
Aleknagik							
Yako	8/02	1000	4641	652	282	370	6293
Hansen	8/08		7607	6187	4527	1723	13794
Bear	8/06	800	3539	422	119	303	4761
Happy*	8/05	1500	5932	2645	1853	792	10077
Ice*	8/07		8879	785	499	286	9664
Eagle	8/09	500	1222	809	82	727	2531
Mission	8/15	375	3131	731	452	279	4237
Whitefish	8/14	400	1569	665	78	587	2634
Nerka							
Fenno	8/13	50	1130	3536	3282	254	4716
Pick	8/14	300	4549	481	90	391	5330
Lynx	8/23	100	691	293	75	218	1084
Hidden Lake	8/19	150	1839	839	500	339	2828
Elva	8/26	75	51	16	13	3	142
Little Togiak River	8/27		1813	8	6	2	1821
Stovall*	8/25	0	532	444	250	194	976
Pike	8/20	0	73	42	37	5	115
Teal	8/20	150	1022	1227	449	778	2399
Kema	8/27	0	985	1856	1229	627	2841
Little Togiak							
A Creek	8/21	0	18	0	0	0	18
C Creek	8/21	0	0	25	3	22	25
Beverley							
Moose	8/23		2205	831	529	302	3036
Kulik							
Grant R.	8/22		12680	1406	742	664	14086

* Partial count; entire stream not surveyed.

TABLE 19. Age compositions (%) of sockeye salmon spawners in the Wood River Lakes in 1999.

	Males						No.	Females						No.
Location	1.1	1.2	2.2	1.3	2.3	1.4	fish	1.1	1.2	2.2	1.3	2.3	1.4	fish
Hansen	0.0	97.1	2.9	0.0	0.0	0.0	110	0.0	97.3	0.0	2.7	0.0	0.0	105
Happy	0.0	68.4	0.0	30.6	1.0	0.0	98	0.0	66.7	0.9	32.4	0.0	0.0	108
Bear	0.0	89.1	0.0	10.9	0.0	0.0	110	0.0	91.0	0.0	9.0	0.0	0.0	100
Ice	0.0	46.8	0.0	53.2	0.0	0.0	109	1.0	34.3	0.0	64.7	0.0	0.0	102
Agulowak River	0.0	19.0	0.0	80.0	1.0	0.0	105	0.0	14.0	0.0	86.0	0.0	0.0	114
Wood River	0.0	88.7	0.0	11.3	0.0	0.0	97	0.0	87.5	0.0	12.5	0.0	0.0	104
Fenno	0.0	81.7	0.0	18.3	0.0	0.0	104	0.0	87.0	0.0	13.0	0.0	0.0	100
Stovall	0.0	69.4	0.0	30.6	0.0	0.0	108	0.0	70.4	0.0	29.6	0.0	0.0	125
Lynx	3.2	79.0	0.0	17.7	0.0	0.0	62	0.0	82.0	0.0	18.0	0.0	0.0	111
Kema	0.0	88.2	0.0	11.8	0.0	0.0	102	0.0	97.1	0.0	2.9	0.0	0.0	104
Pick	0.0	61.7	0.0	37.4	0.9	0.0	107	0.0	62.9	0.0	37.1	0.0	0.0	70
LT River	0.0	63.9	3.1	32.0	1.0	0.0	97	0.0	48.0	0.0	52.0	0.0	0.0	100
N4-N6 beach	0.0	69.2	0.0	30.8	0.0	0.0	104	0.0	84.0	0.0	16.0	0.0	0.0	106
Hidden Lake	0.0	91.8	0.0	8.2	0.0	0.0	98	0.9	88.7	0.9	9.4	0.0	0.0	106
Anvil Bay beach	0.0	75.5	0.0	24.5	0.0	0.0	102	0.0	93.6	0.0	6.4	0.0	0.0	109
Agulukpak River	0.0	8.8	0.9	89.5	0.9	0.0	114	0.0	2.8	0.9	96.3	0.0	0.0	107
LT beaches							0							0
ABC creeks							0							0
Moose	0.0	82.3	2.5	15.2	0.0	0.0	79	0.0	90.9	0.0	9.1	0.0	0.0	99
Grant River	0.0	69.9	1.9	28.2	0.0	0.0	103	0.0	79.0	2.0	19.0	0.0	0.0	100
Unweighted mean	0.2	69.5	0.6	29.5	0.3	0.0	1809	0.1	71.0	0.3	28.7	0.0	0.0	1870
Wood River ADFG tower	0.0	53.6	3.4	41.9	1.0	0.0	365	0.0	74.8	2.9	22.0	0.2	0.0	819

TABLE 20. Daily counts of sockeye salmon spawners in Hansen Creek, 1999.

	In creek			In ponds					Cumu-	Live+
		Natural	Bear		Natural	Bear	Total	Total	lative	cum.
Date	Live	dead	dead	Live	dead	dead	live	dead	dead	dead
Jul. 21	0	20	78	0	0	0	0	98	31	31
22	0	0	5	0	0	0	0	5	40	40
23	129	28	37	10	0	0	139	65	105	244
24	187	38	97	37	0	0	224	135	240	464
25	1561	90	117	74	0	0	1635	207	447	2082
26	838	168	167	104	0	0	942	335	782	1724
27	756	56	59	96	0	0	852	115	897	1749
28	1198	106	91	132	0	0	1330	197	1094	2424
29	1465	142	57	194	0	0	1659	199	1293	2952
30	2576	297	46	172	0	0	2748	343	1636	4384
31	2563	291	104	212	0	0	2775	395	2031	4806
Aug. 1	3151	257	24	196	0	0	3347	281	2312	5659
2	3521	305	64	228	2	0	3749	371	2683	6432
3	5112	558	64	244	3	0	5356	625	3308	8664
4	7066	297	150	749	6	0	7815	453	3761	11576
5	6774	423	147	440	9	0	7214	579	4340	11554
6	7374	347	135	440	15	0	7814	497	4837	12651
7	5809	457	124	600	0	0	6409	581	5418	11827
8	7124	577	156	483	35	1	7607	769	6187	13794
9	7119	408	65	480	15	0	7599	488	6675	14274
10	6410	678	173	480	21	1	6890	873	7548	14438
11	6990	785	226	600	24	0	7590	1035	8583	16173
12	6579	945	161	675	46	0	7254	1152	9735	16989
13	5928	1232	128	400	98	0	6328	1458	11193	17521
14	5642	717	76	300	34	0	5942	827	12020	17962
15	4716	926	154	285	25	0	5001	1105	13125	18126
16	3909	879	175	230	60	3	4139	1117	14242	18381
17	3513	725	113	200	51	7	3713	896	15138	18851
18	3046	732	190	280	53	2	3326	977	16115	19441
Totals		12464	3183		497	14				

Upper pond not counted

Dead fish removed on each survey.

TABLE 21. Summary of Hansen Creek spawning surveys, 1990–99.

Year	Date first fish entered	Survey date	Survey counts: Mouth	Survey counts: Live	Survey counts: Dead	Survey counts: Total	Total from daily surveys	Percent peak count of total	Mortalities: Natural dead	Mortalities: Bear-kill dead	Mortalities: Percent bear-kill
1990	7/28	8/1		3570	201	3771	6733	56	5139	1594	24
		8/6	25	4105	743	4873	6733	72			
1991	7/21	8/1		4460	1664	6124	16296	38	13671	2625	16
		8/6	500	8670	3735	12905	16296	79			
1992	7/18	8/1		4594	1085	5679	7292	78	5991	1301	18
		8/6	50	3518	2886	6454	7292	89			
1993	7/20	8/1		1359	685	2044	4212	49	2696	1516	36
		8/6	200	1482	1573	3055	4212	73			
1994	7/27	8/1		2314	718	3032	7413	41	3358	4055	55
		8/6	500	3205	1947	5652	7413	76			
1995	7/20	8/1	600	6509	2348	9457	17589	54	9854	7297	43
		8/6	100	7680	4425	12205	17589	69			
1996	7/18	8/1	1000	5076	1674	6750	9736	69	6476	2800	30
		8/6	200	3968	3345	7313	9736	75			
1997	7/18	8/1		1597	2183	3780	8845	43	3969	4831	55
		8/6	300	2163	3804	5967	8845	67			
1998	7/21	8/1		4336	2152	6488	12529	52	6040	5875	49
		8/6		4153	4525	8678	12529	69			
1999	7/21	8/1		3347	2312	5659	19441	29	12961	3197	20
		8/6		7374	4837	12651	19441	65			