Fishery Management Report No. 07-40

Salmon Spawning Ground Surveys in the Bristol Bay Area, Alaska, 2006

by

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Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

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

Mathematics, statistics

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

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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF APPENDICES (Continued)

ABSTRACT

The salmon spawning ground report is compiled annually to report the results of spawning ground surveys conducted by the Division of Commercial Fisheries staff in Bristol Bay. The report describes the conditions under which salmon were observed and other factors affecting escapement data. Although data have been collected for more than 20 years in most cases, appendix tables contain only information from the last 20 years to give the data context.

Key Words: Bristol Bay Management, commercial fisheries, escapement, spawning, sockeye salmon, Chinook salmon, chum salmon, coho salmon, pink salmon, Naknek, Kvichak, Egegik, Ugashik, Wood, Nushagak, Igushik, Togiak.

INTRODUCTION

Aerial surveys of salmon spawning streams have been conducted in the Bristol Bay area of Alaska (Figure 1) for many years. Surveys provide biologists with subjective information regarding the abundance and distribution of sockeye salmon *Oncorhynchus nerka*, Chinook salmon *O. tshawytscha*, chum salmon *O. keta*, pink salmon *O. gorbuscha*, and coho salmon *O. kisutch* escapements. This information is important to fishery managers for several reasons. It supplements data gathered at counting towers on the mainstem rivers, provides data from rivers where counting towers are not utilized, and provides data for time periods and species not covered by counting tower operations. Collected information can contribute to the: (1) evaluation of escapement goals and of escapement/return relationships, (2) forecast of future returns, (3) identification of possible management problems relating to escapements, (4) development of strategies designed to alleviate escapement problems and (5) evaluation of changes in spawning distribution. Readers must use caution when interpreting these data. Aerial surveys can be good indicators of general trends in fish distribution and abundance but are not good for developing concrete estimates. Generally, aerial survey information is used to supplement more concrete data for developing these finite estimates. In this report, we summarize the 2006 salmon spawning ground surveys conducted in the Bristol Bay area.

BACKGROUND INFORMATION BY DISTRICT

Naknek/Kvichak District

The Naknek-Kvichak District is comprised of 3 major rivers: (1) the Kvichak River, issuing from Iliamna Lake and its tributaries, (2) the Alagnak or Branch River flowing from Kukaklek and Nonvianuk Lakes, and (3) the Naknek River emanating from Naknek Lake and its tributaries (Figure 2). All of these systems flow into Kvichak Bay.

Since 1955, Kvichak River sockeye salmon annual escapement has been estimated using counting towers located on the Kvichak's mainstem, approximately one-quarter mile downstream of Lake Iliamna's outlet. Spawning ground survey information for the Kvichak River by means other than counting towers is also compiled (Morstad 2002). From 1957 to 1976, Alagnak River sockeye salmon annual escapement was estimated using a counting tower located near the upper extent of tidal influence. Since 1977, Alagnak sockeye annual escapement has been estimated using aerial surveys. In 2002, a counting tower was established upriver from the old site, and beginning in 2007 it will provide the measure of escapement used to assess the spawning goal. Clark (2005) explored the relationship between historical tower counts and aerial surveys to standardize the time series of escapement in terms of tower counts. From 1950 to 1957, annual sockeye escapement to the Naknek River system was counted using a

weir on the mainstem of the river just upstream of the tidal influence. From 1958 to the present, escapement has been estimated using counting towers near the Naknek River 'Rapids' downstream of the outlet of Naknek Lake.

Egegik District

The Egegik River system contains 2 major watersheds: (1) the Egegik River, flowing from Becharof Lake and nearby coastal lowlands, and (2) the King Salmon River, issuing from runoff from the Kejulik Mountains and southern portions of Katmai National Park (Figure 3). Both rivers flow into Egegik Bay near the village of Egegik.

From 1952 through 1956, a weir was used in the Egegik River to count sockeye salmon escapement. The weir was located near the bottom of the Egegik River rapids. From 1957 to the present, counting towers, situated between the outlet of Becharof Lake and Egegik Lagoon, have been used to estimate sockeye escapement. Escapements for other salmon species have been estimated using aerial surveys.

Ugashik District

The Ugashik River system is comprised of four major watersheds: (1) the Ugashik River, flowing from Lower Ugashik Lake and nearby coastal lowlands, (2) the Dog Salmon River, emanating from glacial melt and runoff from peaks in the Aleutian Range, (3) the King Salmon River, issuing from Mother Goose Lake and 3 major runoff tributaries, and (4) Dago Creek, issuing from a large lowland coastal area (Figure 4). All of these systems flow into the intertidal reaches of Ugashik River and Ugashik Bay.

From 1949 to 1956, a weir located downstream from the outlet of Lower Ugashik Lake was used to count sockeye salmon escapement. From 1957 to the present, sockeye escapement has been estimated using counting towers located between the outlet of Lower Ugashik Lake and Ugashik Lagoon. Escapements for other salmon species have been estimated using aerial surveys.

Nushagak District

The Nushagak watershed is comprised of 4 major rivers: (1) the Wood River, draining Grant, Kulik, Beverley, Nerka, and Aleknagik lakes, (2) the Nushagak River, draining Tikchik Lakes and the Nuyakuk, upper Nushagak, and Mulchatna rivers, (3) the Igushik River, draining Ualik and Amanka lakes, and (4) the Snake River, draining Lake Nunavaugaluk (Figures 5–8). All of these systems empty into Nushagak Bay.

Abundance and age composition of annual sockeye salmon escapement into the Wood River Lake system has been estimated annually from counting towers at the outlet of Lake Aleknagik since 1953.

Sockeye salmon distribution in the Wood River Lake system is an important element in establishing escapement goals and measuring success in achieving escapement goals for this system. Interconnecting rivers between the large lakes in the system are primarily used by 3-ocean sockeye salmon for spawning, while the lake beaches and tributary streams are used more by 2-ocean sockeye salmon.

Periodically, Alaska Department of Fish and Game (ADF&G) personnel conduct aerial surveys to assess sockeye salmon spawner distribution within the Wood River Lake system. Personnel from the University of Washington, Fisheries Research Institute, also conduct ground surveys on

major creeks and some rivers of the system (Table 10). Surveys of the actual spawning distribution within the creeks, rivers, and beaches of the system examine the distribution of spawning fish from year to year.

Salmon escapement in the Nushagak River is estimated by a sonar project, located on the Nushagak River below Portage Creek, approximately 32 km (20 miles) upstream from the river mouth. The Nushagak River sonar project has been used since 1980 to estimate annual escapements for all salmon species in the entire Nushagak drainage (McKinley 2003). In 2006, budget cuts reduced the operation of the sonar camp by a month, eliminating the coho and pink salmon enumeration portion of the sonar project. Prior to the advent of the sonar project, annual Nushagak River sockeye escapement was estimated by a counting tower project on the Nuyakuk River (1959–1988) and aerial surveys of the Nushagak-Mulchatna system (beginning in 1966). Initial aerial surveys provided escapement estimates for Chinook and chum salmon, while surveys, since 1977, were used to estimate sockeye abundance.

ADF&G staff continued to survey the upper Nushagak and Mulchatna areas after the development of the sonar project to provide a comparison with sonar estimates and document spawner distribution for all species except coho salmon. Chum salmon surveys were discontinued in the Nushagak District in 1980, and surveys of the Nushagak-Mulchatna Rivers for all other species were discontinued in 1991 due to the success of the sonar project and limited funding. The Nuyakuk tower project was halted after the 1988 season due to budget cuts, but was reinitiated for the 1995 season and has been operated since that time. Aerial surveys of the Nushagak and Mulchatna systems have been conducted sporadically since 1991 providing infrequent information on spawning sockeye distribution in the Nushagak River.

Aerial surveys were conducted sporadically in the Tikchik Lakes system from 1954 to 1987 to assess spawner distribution of sockeye salmon. Surveys of the Tikchik Lakes have been conducted, although infrequently, since 1990 to document an apparent change in spawner distribution, evidenced by changes observed in the age composition of Nushagak River sockeye escapement, and supported by reports of low numbers of spawners in the Tikchik Lake system. These changes were first noticed in 1990 when surveys documented lower than expected numbers of spawners in the Tikchik Lakes system, based on sonar estimates in the lower Nushagak River and historical distribution patterns (Russell et al. 1991). However, few corresponding surveys were conducted in the Nushagak and Mulchatna drainages to completely assess distribution. In fact, due to funding cuts, no aerial surveys of the Upper Nushagak and Mulchatna drainages have been performed since 1991. Average Nuyakuk River escapement for the 20 years before tower operations ceased was 369,506 sockeye salmon (excluding 1980, the "strike year"). When tower counts resumed in 1995, escapement was low and has remained low with an average per year of 150,211 sockeye salmon despite overall strong escapements in the Nushagak River. Therefore, any information that can be gained about this system is advantageous.

Sockeye escapement is measured in the Igushik Lakes system at a counting tower located at the outlet of Amanka Lake. Spawner distribution has not been documented annually, and surveys have not been conducted on the Igushik system for sockeye salmon and other species since 1991 (Russell et al. 1992). Spawning escapement and distribution of sockeye salmon in the Snake Lake system was estimated annually prior to 1998 by aerial surveys, but with the closure of the Snake River section and funding shortages in recent years, these surveys have not been continued.

Togiak District

Two major river drainages flow into the Togiak District: (1) the Togiak River, draining Togiak, Gechiak, Pungokepuk, and Ongivinuk lakes and Nayorurun and Kemuk rivers (Figure 9), and (2) the Kulukak River, draining Kulukak Lake (Figure 10). Various smaller systems within the district include the Kanik River draining Tithe Creek Ponds and the Quigmy, Matogak, Osviak, Slug, Negukthlik, and Ungalikthluk rivers. Kulukak River and the Kanik River flow into Kulukak Bay, located in the eastern portion of the district. The Togiak and Quigmy rivers flow into Togiak Bay, located in the middle of the district, and the Matogak, Osviak, and Slug rivers flow into Hagemeister Straits and coastal waters in the western portion of the district (Figure 1).

Sockeye salmon escapement is estimated for the Togiak Lake system from counting towers operated at the outlet of Togiak Lake. Abundance and distribution of spawning populations of sockeye salmon in the Togiak River and tributaries below the counting towers, as well as other systems within the Togiak District, are estimated by aerial surveys. Abundance and distribution of Chinook, chum, pink, and coho salmon spawning in Togiak District watersheds are also estimated entirely from aerial surveys.

Since 1991, the operational budget has not had sufficient funds to conduct spawning ground aerial surveys in the Togiak District. The U.S. Fish and Wildlife Service Togiak National Wildlife Refuge (USFWS/TNWR) has provided funding for aircraft charters for aerial surveys, and has assisted with aerial surveys in the Togiak District to monitor salmon populations within drainages on the refuge.

METHODS

Survey flights are conducted from any of the following aircraft: small fixed-wing, high-wing, wheeled aircraft (Super Cub, Cessna 180, Cessna 185, or Cessna 206) or helicopter (Robinson R-22) chartered from local air charter companies and flown by experienced survey pilots. ADF&G or USFWS biologists familiar with the streams and target species counted salmon. USFWS pilots and aircraft flew several of the surveys in the Togiak National Wildlife Refuge. Counts were made from low altitudes (200 to 400 feet) at air speeds of 50 to 90 mph. Polarized sunglasses and aircraft positioning were used to minimize effects of glare off the water. Surveys were scheduled to coincide as closely as possible to the historic peak of spawning for the target species, taking into account weather, water conditions, and aircraft availability. Peak of spawning was defined as that point when the greatest number of spawning salmon are occupying redds. Counts were registered on a hand tally counter or on a tape player. This information was transferred to survey data forms either sometime during the survey or upon returning to the office.

Aerial surveys account for only a portion of the known spawning populations (Evzerof 1975; Nielson and Green 1981; Rogers 1984; ADF&G 2005). At the time of each survey, some of the salmon have yet to reach the spawning grounds, some have already spawned and died, some are still schooled, and some are either misidentified or not seen. Methods used to interpret aerial survey counts are described below for each commercial fishing district.

Naknek/Kvichak District

Aerial surveys were flown during late summer and fall to assess escapements of sockeye and Chinook salmon in portions of the Naknek/Kvichak District. Salmon counts for these drainages are indices of the total number of each species present in the spawning area at the time of the

survey. In the Alagnak drainage, only 2 surveys were flown over the course of the season. On August 5, the lower Alagnak was flown for Chinook salmon. For the Naknek drainage, all major Chinook spawning areas were surveyed under poor conditions, thus no estimates are available. Similar to previous years, counting towers were used to estimate total sockeye escapement to the Kvichak, Alagnak, and Naknek rivers. ADF&G Commercial Fisheries Division staff made all aerial survey counts in the district.

Egegik District

No system-wide aerial surveys were flown for sockeye salmon in 2006. An aerial survey of known Chinook and chum salmon spawning areas in both the Egegik and King Salmon rivers was flown on August 5 and 6. An aerial survey was flown on selected index streams within the Egegik system on September 27 to estimate coho salmon escapement. All aerial survey counts in the Egegik drainage are of the actual numbers of salmon sighted and should be considered a minimum indication of abundance. As in previous years, a counting tower was used to estimate total sockeye escapement to the Egegik River. ADF&G Commercial Fisheries Division staff made all aerial survey counts in the district.

Ugashik District

Salmon counts in the Ugashik District reflect only the actual numbers of salmon sighted on the spawning grounds. Aerial surveys of known Chinook and chum salmon spawning areas in the Ugashik drainage were flown on August 6. With funding provided by the USFWS, Becherof National Wildlife Refuge, an aerial survey was flown on September 28 to estimate coho salmon escapement. Aerial survey counts should be considered a minimum indication of abundance. As in previous years, a counting tower was used to estimate total sockeye escapement to the Ugashik River. ADF&G, Commercial Fisheries Division staff made all aerial survey counts in the district.

Nushagak District

In conjunction with the University of Washington Fisheries Research Institute (FRI), ADF&G staff flew aerial surveys of the Wood River Lake system in 2006. Surveys were flown in a fixed-wing aircraft with 2 observers on the same side of the aircraft. Survey dates were August 18 and September 3. Observers recorded individual estimates of sockeye salmon on the lakeshore either spawning or holding off stream mouths. Also, surveys were made of streams connecting lakes. The individual observations were reconciled later and one estimate was generated. In addition, FRI obtained estimates for most of the small streams in the Wood River lake system by conducting foot surveys (Table 10). As in previous years, counting towers were used to estimate total sockeye escapement to the Wood and Igushik rivers. Sonar is used to estimate escapement of Chinook, sockeye, and chum salmon on the Nushagak River. ADF&G Commercial Fisheries Division staff made all aerial survey counts in the district.

Togiak District

Survey and data analysis methods used in the Togiak District were similar to those described by Nelson (1979), Bucher (1981), and Russell et al. (1990). This year, surveys were flown on August 8 and September 12 (Tables 11–14). Poor weather posed a severe limitation to survey completion this year as did pilot availability. The only surveys that were performed this year were a cooperative effort between USFWS/TNWR staff and ADFG staff. The Osviak and Matogak rivers were surveyed for Chinook and chum salmon and the Kulukak River was

surveyed for coho salmon. As in previous years, a counting tower was used to estimate total sockeye escapement to the Togiak River. ADF&G Commercial Fisheries Division staff made all aerial survey counts in the district.

Total escapement was estimated for sockeye salmon in systems without counting towers (i.e. Kulukak River, mainstem and tributaries of the Togiak River below the towers) by multiplying peak aerial counts by an expansion factor between 1.5 and 3.0 depending on survey and water conditions (Tables 11–14 list expansion factors by stream for each species). Expansion factors are used only in the Togiak system because management goals have been set that can only be assessed with aerial surveys. Because budget constrains result in generally one survey a year, expansion factors are used to account for less than ideal survey conditions or timing. Since 1980, total escapement for Chinook salmon in the Togiak District has been calculated by aerial counts using a multiplier of 2.5 if the survey was timed properly relative to the spawning peak and visibility conditions were average. In 2006, an expansion factor of 2.0 was used for Chinook surveys in all systems except the Neguthluk (expansion factor of 3.0). The same expansion factors were used for chum salmon in the same systems. An expansion factor of 3.0 has been used for coho salmon in all areas of the Togiak District since the initiation of coho surveys in 1980. Expansion factors have been subjectively adjusted based on weather conditions, visibility, and survey timing with respect to the peak spawning activity.

RESULTS AND DISCUSSION

Naknek/Kvichak District

Aerial surveys of sockeye salmon escapement into the Alagnak River and its tributaries were flown on two occasions. The peak count for each of the systems is represented in Table 1 and the total aerial survey count was 900,000 (Table 1). The tower on the lower Alagnak ran from June 27 until July 18 and estimated 1,773,966 sockeye salmon, for the Naknek River, the tower was in operation from June 20 until July 17 counting 1,953,228. The Kvichak River tower near Igiugig village began counting on June 21 and ceased July 24 counting 3,068,226 sockeye. There were no aerial surveys flown on either the Naknek or Kvichak rivers in 2006.

Aerial surveys of Chinook salmon escapements into the Naknek River drainage were flown in 2006 however, due to the poor conditions no estimate was possible (Appendix A2). Alagnak River drainage Chinook salmon escapement was surveyed on August 5, one week before the typical peak. The observed total was 4,278 (Table 2). From 1986–2005, Alagnak Chinook salmon counts have ranged from a low of 1,720 in 1990 to a high of 15,210 in 1997 (Appendix A3). There were no aerial surveys conducted on the Kvichak River for Chinook, chum and coho salmon in 2006 (Appendix A3–A5).

Egegik District

The 2006 Egegik River sockeye escapement past the counting towers totaled 1,465,158 fish, or 33% above the midrange objective of 1.1 million. The BEG range for Becharof Lake is 800 thousand to 1.4 million.

Aerial survey counts of known Chinook salmon spawning areas in the Egegik drainage yielded a total count of 276 (Table 3). No additional Chinook salmon were counted at the Egegik River counting towers. This total was 74% below the average count of 1,051 (Appendix A6). The commercial Chinook harvest in the Egegik District totaled approximately 918 fish, 26% below the 1986 to 2005 average harvest of 1,240. Since 1998, fishing time has been reduced to 3 days

per week between June 1 and June 16. Using gillnets with larger than five and one half-inch mesh in the commercial fishery from June 1 to July 1 has also been prohibited. All of these factors probably contributed to the reduced commercial harvest of Chinook salmon, but in general, recent Chinook salmon runs to Egegik have been small.

The chum salmon escapement index was 957 fish (Table 4), 81% below the 20-year average of 5,018 (Appendix A7). The 2006 commercial chum harvest from the Egegik District totaled approximately 161,000 fish, or 194% above the 1986 to 2005 average catch of 82,000. Escapement indices of less than 2,000 chum salmon have been recorded in eight of the last ten years, but aerial surveys for chum salmon are not reliable indicators and it is believed that chum escapement indices have greatly underestimated chum salmon escapements. In 1999, comparing the Gertrude Creek Weir count of 16,000 and an aerial survey count on August 6 showed that the aerial count was only about 2% of the weir count.

The coho salmon escapement was documented with an aerial survey conducted on September 27 (Table 5 and Appendix A8). A total of 21,100 coho salmon were counted in the Egegik River and in several tributaries (the main coho salmon producing areas) of Becharof Lake. The aerial counts were focused on major coho salmon producing areas, which are listed in Table 5. The commercial harvest totaled 26,785 fish, which was about 14% below the 20-year (1986–2005) average of 31,243.

Ugashik District

The 2006 Ugashik sockeye salmon escapement tower count was 978,718 fish, or 15% above the midrange objective of 850,000. System-wide aerial surveys were conducted in early August and approximately 24,000 additional sockeye salmon were observed in the Dog Salmon River (Table 6). Environmental conditions impacted all surveys conducted in the King Salmon River system (see below).

Chinook salmon escapement surveys of Dog Salmon, King Salmon, and Ugashik rivers were flown on August 6 and approximately 2,500 Chinook were observed (Table 7). The 20-year average is approximately 4,100 Chinook salmon (Appendix A9). The Ugashik District's commercial catch of approximately 2,549 Chinook salmon was 47% above the 20-year average harvest of 1,736.

Aerial surveys of Dog Salmon, King Salmon, and Ugashik rivers for chum salmon were also flown on August 6 (Table 8; Appendix A10). The District's commercial chum salmon harvest of approximately 129,000 fish is 77% higher than the 20-year average of 73,000.

An aerial survey for coho salmon was again made this year in the Ugashik drainage thanks to funding provided by US Fish and Wildlife Service, Becherof National Wildlife Refuge. A total of 25,000 coho salmon were observed on the September 26 flight (Table 9). Most of the count came from the Lower Ugashik Lake. Historical coho salmon escapement data are recorded in Appendix A11.

Environmental Conditions

An unusual event occurred in the Mother Goose Lake drainage during the spring or early summer of 2005. An event known as a lahar took place on Mt. Chiginigak, a semi-active volcano from which the headwaters of Volcano and Indecision creeks flow. These creeks

provide water to Mother Goose Lake which in turn is the source for the King Salmon River, a tributary that empties into Ugashik Bay.

A lahar is basically a runoff event, and while the mechanics or timing in this case is not clear, the effects were fairly dramatic. Sometime in the spring or early summer of 2005, an event took place on or within Mt. Chiginigak that caused the snow on and within the summit crater to melt and runoff into the Mother Goose Drainage and an unnamed tributary on the Pacific side of the Alaska Range. This runoff was extremely acidic in nature and large enough in volume to lower the pH of Mother Goose Lake and the King Salmon River to between 3.0 and 3.5. This condition persisted through most of the summer and into the fall and prevented salmon and other anadromous fish from migrating into the upper reaches of the system. Chinook and chum salmon were observed during aerial survey flights in 2 tributaries in the lower reaches of the King Salmon River, Pumice and Old creeks, but no fish were observed in the King Salmon River mainstem or Painter Creek, a tributary with a confluence just below Mother Goose Lake, or in Volcano or Indecision creeks. Painter Creek is a major spawning area for Chinook salmon in the Ugashik system.

Long-term ramifications from this event could be significant. At least 2 and possibly 3 age classes of salmon were impacted, depending on the timing of the event. The juvenile classes of 2004, which hatched in the spring of 2005, and the 2005 return were definitely affected, but depending on the timing of the lahar, the outgoing age class of the 2003 spawning event (smolts) could have outmigrated before the river was impacted by the acidic runoff. If the runoff ceases or diminishes over the winter, then while impacted, the watershed would become more habitable for all species. If the pH continues to stay at low levels, the ability of the system to support aquatic life will be diminished.

In terms of impacts to the fisheries, estimation of escapement in the King Salmon/Mother Goose system is done via aerial surveys and the historical range of estimates is approximately 4,000 to 30,000 sockeye salmon, with the latest 20-year average at about 15,000. This is a small number when compared to the overall Ugashik District. For Chinook salmon the system can contribute a significant percentage of the Chinook in the Ugashik District, but the latest 20-year average is only about 2,100 fish in the commercial fishery. A more significant impact would be felt by the sport fishing community since Painter Creek is one of the larger contributors to that fishery within the Ugashik District.

In the spring of 2006, a spot check was conducted by John Kent, owner of the Painter Creek lodge, using litmus paper to check the pre-breakup pH of the system. The results showed that the condition had persisted over the winter of 2005–2006. Aerial surveys flown in early August did not reveal any fish in the upper reaches of King Salmon River but showed the lower 2 tributaries (Pumice and Old creeks) to be well populated with Chinook, chum, and a few sockeye salmon. A single small fish of unknown species was observed in Painter Creek. USGS personnel did a more thorough examination in mid August and found that the pH was still low but not as low as in the summer of 2005.

Significant rainfall occurred during August of 2006 and during an aerial survey for coho salmon in September, salmon were observed in Painter Creek and the mainstem King Salmon River. John Kent confirmed the presence of chum salmon in Painter Creek in late August. Whether these observations indicate that conditions have abated or if the seasonal flush of rain was

enough to temporarily dilute the acidic water remains to be seen but the fact that fish did make it part way up the system is encouraging.

It is unknown at this time how long the acidic water will be produced and runoff into the King Salmon River/ Mother Goose Lake complex and there is no way to remedy the situation. Staff from the Volcano Observatory Group, the USFWS Alaska Peninsula National Wildlife Refuge, and ADF&G will continue to monitor the river and document impacts to the watershed through time.

Nushagak District

The sonar project at Portage Creek produced apportioned estimates of 124,683 Chinook salmon, 548,409 sockeye salmon, and 661,003 chum salmon in the Nushagak River for 2006. A counting tower was operated on the Nuyakuk River again this year enumerating 170,760 sockeye salmon.

Spawning escapement of sockeye salmon in the Wood River system was estimated, by tower count, to be 4,008,102 fish and the Igushik River tower count was 305,268 sockeye. Wood River escapement was almost four times the 1.1 million midrange escapement goal while the Igushik escapement was slightly above the 300,000 upper end of the escapement goal range. Two-ocean sockeye comprised approximately 83% of the Wood River escapement while 3-ocean sockeye contributed 17% of the escapement. The distribution of sockeye in the Wood river system is documented in Table 10 and Appendix A12. The total count of sockeye by aerial survey and foot survey was 1,354,891, about one third of the escapement documented by the tower count. No surveys were done in the Nushagak or Igushik systems.

Togiak District

This year's survey season was characterized by poor weather and conditions throughout the season. On the few days when the weather would clear, no pilot was available. No surveys for any species of salmon were performed in the Togiak River drainage this year.

Throughout the course of the Togiak River escapement project, 312,126 sockeye were counted past the towers below Togiak Lake (Table 11). The spawning escapement of sockeye salmon in the Kulukak Section, including the Kulukak River, Kulukak Lake, and Tithe Creek Ponds, was not assessed this year (Appendix Tables 13, 14, and 15).

Only the Quigmy, Osviak, and Matogak rivers were surveyed for Chinook salmon. On August 8, surveys of the Quigmy, Osviak, and Matogak rivers led to expanded estimates of 30, 1,360, and 280 Chinook salmon observed, respectively (Table 12; Appendix A16 and A17). This is abnormally high escapement in these systems. With no escapement information on the Togiak drainage, it is impossible to determine if the escapement goal for Chinook salmon in the Togiak Drainage of 10,000 fish was met. However, with strong catch rates and low effort, it is likely that escapement in the Togiak District was also strong.

Chum salmon counts were conducted coincidentally with the Chinook salmon surveys. On August 8, surveys of the Quigmy, Osviak, and Matogak rivers led to expanded estimates of 10,400, 9,060 and 7,440 chum salmon observed, respectively (Table 13 and Appendix A18). For the Osviak and Matogak rivers, the number of chum salmon observed corresponds with the 20-year mean. However, for the Quigmy River, this number is abnormally high, almost doubling the 20-year mean (Appendix A19).

Only one aerial survey was performed for coho salmon in 2006. Total coho escapement for Togiak River and tributaries therefore, was not estimated (Appendix 20). On September 12, a survey of the Kulukak River led to an expanded estimate of 3,078 coho salmon observed (Table 14). This number is approximately 32% of the 20-year average, however data has only been collected in 11 of the last 20 years (Appendix A21). As in other recent years, there was very little commercial harvest of coho salmon reported in 2006 because of poor market conditions.

ACKNOWLEDGEMENTS

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TABLES AND FIGURES

Table 1.–Aerial survey counts of sockeye salmon, Alagnak River system, 2006.[a]

Location	Number of Fish	Percent of Total
Nonvianuk River	0	0.0
Nonvianuk Lake		0.0
Kulik River	120,000	13.3
Kulik Lake		0.0
Alagnak River	0	0.0
Kukaklek Lake	40,000	4.4
Nanuktuk Creek	120,000	13.3
Battle River	100,000	11.1
Battle Lake	20,000	2.2
Moraine/Spectacle Creek	400,000	44.4
Funnel Creek	100,000	11.1
Total	**900,000**	**100.0**

Note: Blank cells represent no data.

[a] Aerial surveys were conducted with fixed-wing aircraft.

Table 2.–Aerial survey counts of Chinook, chum, pink, and coho salmon, Naknek-Kvichak District, 2006.

	Survey	Number of Salmon			
Location	Date	Chinook	Chum	Pink	Coho
Kvichak River		No survey	No survey	No survey	No survey
Alagnak River	5-Aug	4,278	No count	No count	No survey
Naknek River : [a]					
Paul's Creek	5-Aug	No count	No count	No count	No survey
King Salmon Creek	5-Aug	No count	No count	No count	No survey
Big Creek					
Mainstem Naknek River	No Survey	No count	No count	No count	No count
Total		**4,278**			

Note: Blank cells represent no data.

[a] Naknek River drainage flown under poor conditions no estimate possible.

Table 3.–Aerial survey peak counts of Chinook salmon escapement, Egegik District, 2006.

Location	Survey Date	Chinook Salmon Counted
Egegik River	August 5/6	0[a]
Shosky Creek	August 5/6	1
Whale Mountain Creek	August 5/6	0
Mossy Creek	August 5/6	1
Mink Creek	August 5/6	1
Gertrude Creek	August 5/6	66
Kaye's Creek	August 5/6	80
Takayoto Creek	August 5/6	50
Angle Creek	August 5/6	27
Contact Creek	August 5/6	50
Mainstem King Salmon River	August 5/6	[b]
Total		**276**

Note: Blank cells represent no data.

[a] Tower count.

[b] No count.

Table 4.–Aerial survey peak counts of chum salmon escapement, Egegik District, 2006.

Location	Survey Date	Chum Salmon Counted
Egegik River	August 5/6	0[a]
Shosky Creek	August 5/6	20
Whale Mountain Creek	August 5/6	340
Mossy Creek	August 5/6	9
Mink Creek	August 5/6	4
Gertrude Creek	August 5/6	450
Kaye's Creek	August 5/6	4
Takayoto Creek	August 5/6	0
Angle Creek	August 5/6	0
Contact Creek	August 5/6	130
Mainstem King Salmon River	August 5/6	[b]
Total		**957**

[a] Tower count.

[b] No count.

Table 5.–Aerial survey counts of coho salmon escapement, Egegik District, 2006.

Location [a]	Survey Date	Coho Salmon Counted	Comments
Egegik River Rapids	September 27	5,100	
Stream 115.8 (Featherly Creek)	September 27	150	100 along the lake shore at mouth of the creek, 50 in creek.
Stream 107.6 (Burl's Creek)	September 27	600	500 along the lake shore at mouth of the creek, 100 in creek.
Stream 90.3 (Salmon Creek)	September 27	5,200	5000 along the lake shore at mouth of the creek, 200 in creek.
Stream 89.8 (Ruth Creek)	September 27	300	All observed in the creek
Stream 87.0 (Bear Creek)	September 27	1,500	All observed along the shore in front of the creek.
Stream 73.5 (Becharof Creek)	September 27	3,600	1,400 along the lake shore at mouth of creek, 2,100 in creek.
Stream 48.1 (Kejulik River)	September 27	1,950	Includes Margaret Cr., Albert Cr. and mainstem. Poor visibility.
Total		**21,100**	**Sum includes 2700 in Cabin Creek**

[a] Streams tributary to Becharof Lake are designated by the number of miles between their mouth and the outlet of Becharof Lake (Egegik River) as one travels around the lake in a clockwise fashion from the Becharof lake outlet. This is the same system of designation used for years by previous investigators.

Table 6.–Aerial survey peak counts of sockeye salmon escapement, King Salmon and Dog Salmon River, Ugashik District, 2006.

Location	Survey Date	Sockeye Salmon Counted
King Salmon River System:		
Goose Lake and outlet	Aug. 6	[a]
Needle Lake	Aug. 6	[a]
Volcano Creek	Aug. 6	[a]
Painter Creek	Aug. 6	[a]
Indecision Creek	Aug. 6	[a]
Sub-total		
Dog Salmon River System:		
Figure-Eight Creek	Aug. 6	19,000
Goblet Creek	Aug. 6	70
Oldham Creek	Aug. 6	5,000
Wandering Creek	Aug. 6	230
Mainstem Dog Salmon River	Aug. 6	140
Subtotal		24,440
Total		**24,440**

[a] See Ugashik District text for results explanation.

Table 7.–Peak survey counts of Chinook salmon escapement, Ugashik District, 2006.

Location	Survey Date	Chinook Salmon Counted
King Salmon River System		
Old Creek	Aug. 6	201
Pumice Creek	Aug. 6	2,100
Painter Creek	Aug. 6	[a]
Mainstem King Salmon River	Aug. 6	[a]
Indecision Creek	Aug. 6	[a]
Volcano Creek	Aug. 6	[a]
Subtotal		2,301
Dog Salmon River System		
Figure-Eight Creek	Aug. 6	150
Goblet Creek	Aug. 6	45
Oldham Creek	Aug. 6	0
Wandering Creek	Aug. 6	0
Mainstem Dog Salmon River	Aug. 6	0
Subtotal		195
Ugashik River System		
Mainstem Ugashik River	Aug. 6	20
Grassy Creek	Aug. 6	33
Subtotal		53
Total		**2,549**

[a] See Ugashik District text for results explanation.

Table 8.–Peak survey counts of chum salmon escapement, Ugashik District 2006.

Location	Survey Date	Chum Salmon Counted
King Salmon River System		
Old Creek	Aug. 6	830
Pumice Creek	Aug. 6	15,150
Painter Creek	Aug. 6	[a]
Mainstem King Salmon River	Aug. 6	[a]
Needle Lake	Aug. 6	[a]
Indecision Creek	Aug. 6	[a]
Volcano Creek	Aug. 6	[a]
Subtotal		15,980
Dog Salmon River System		
Figure-Eight Creek	Aug. 6	520
Goblet Creek	Aug. 6	100
Oldham Creek	Aug. 6	300
Wandering Creek	Aug. 6	20
Mainstem Dog Salmon River	Aug. 6	0
Subtotal		940
Ugashik River System		
Mainstem Ugashik River	Aug. 6	140
Grassy Creek	Aug. 6	0
Subtotal		140
Total		**17,060**

[a] See Ugashik District text for results explanation.

Table 9.–Aerial survey counts of coho salmon escapement, Ugashik District, 2006.

Location	Survey Date	Coho Salmon Counted	Comments
Upper Ugashik Lake			
Crooked Creek	September 28	2,000	900 at mouth and 1,100 in creek.
Deer Creek	September 28	2,600	600 at mouth and 2,000 in creek.
Lower Ugashik Lake			
"E" Creek	September 28	3,800	2,300 at mouth and 1,500 in creek.
South Creek	September 28	4,400	2,500 at mouth and 1,900 in creek.
Ugashik Outlet	September 28	1,400	Below counting towers.
King Salmon River Tributaries			
Pumice Creek	September 28	0	High muddy water no visibility.
Old Creek	September 28	0	High muddy water no visibility.
Painter Creek	September 28	4,300	In creek.
Dog Salmon River Tributaries			
Figure Eight Creek	September 28	6,500	In creek.
District Total		**25,000**	

Table 10.–Peak aerial counts of live sockeye salmon and total escapement estimates, Wood River system, 2006.

Location	Date	Aerial/ Foot Count	Observed Distribution
Wood River[a]	18-Aug	42,000	**3.1%**
Lake Aleknagik		**58,024**	**4.3%**
Eagle Creek[b]	17-Aug	597	
Hansen Creek[b]	07-Aug	7,294	
Happy Creek[b]	08-Aug	16,673	
Bear Creek[b]	07-Aug	2,881	
Yako Creek[b]	16-Aug	5,654	
Whitefish Creek[b]	20-Aug	2,775	
Ice Creek[b]	05-Aug	12,663	
Mission Creek[b]	18-Aug	2,411	
Sunshine Creek	04-Aug	1,976	
Youth Creek			
Northshore Beaches	18-Aug	1,000	
Southshore Beaches	18-Aug	3,300	
Yako Beaches	18-Aug	800	
Agulowok River & lower River Bay	18-Aug	**395,000**	**29.2%**
Lake Nerka		**68,873**	**5.1%**
Fenno Creek[b]	10-Aug	6,744	
Pike Creek[b]	23-Aug	1,533	
Stovall Creek[b]	27-Aug	3,432	
Bear Creek	14-Aug		
Teal Creek[b]	16-Aug	915	
Pick Creek[b]	13-Aug	7,274	
Elva Creek[b]	24-Aug	88	
Kema Creek[b]	11-Aug	4,409	
Hidden Lake Creek[b]	22-Aug	823	
Lynx Creek[b]	26-Aug	479	
Sam Creek[b]	08-Aug	2,007	
Joe Creek[b]	09-Aug	1,169	
Upper River Bay Beaches, NW	18-Aug	3,000	
Upper River Bay Beaches, SE	18-Aug	600	
Allan Cr. - Ross Cr. Beaches	18-Aug	2,000	
N6 - River Bay Beach	18-Aug		
Pick Creek Beach[b]	30-Aug	300	
Elva Creek Beach	18-Aug	500	
Amakuk Arm Beaches	18-Aug	500	
Amakuk Arm - Ott's Bay Beach	18-Aug	1,800	
Ott's Bay Beach	18-Aug	1,000	

-continued-

Table 10.–Page 2 of 2.

Area	Date	Aerial Count	Observed Distribution
Anvil Bay Beaches	18-Aug	18,800	
Anvil Bay - Elbow Pt. Beach	18-Aug	4,200	
Elbow Pt. - Lynx Cr. Beach	18-Aug	4,500	
Lynx Cr. - Teal Cr. Beach	18-Aug	300	
Kema Lake Beaches	18-Aug		
Hidden Lake Beaches	18-Aug		
Lynx Lake Beaches	18-Aug	2,500	
Little Togiak River[b]	**28-Aug**	**3,980**	**0.3%**
Little Togiak Lake	**18-Aug**	**9,800**	**0.7%**
Northshore Beaches	18-Aug	4,000	
Southshore Beaches	18-Aug	2,300	
D Slough Beaches	18-Aug	3,500	
Agulukpak River	**18-Aug**	**400,000**	**29.5%**
Lake Beverley		**233,614**	**17.2%**
Tsun Creek			
Moose Creek[b]	16-Aug	9,314	
Hope Creek			
Hardluck Bay Beaches	18-Aug	30,000	
Sam's Beach	03-Sep	25,000	
Golden Horn Beaches	03-Sep	5,200	
Silver Horn Beaches	03-Sep	103,000	
B12 & B9 Beaches	03-Sep	60,000	
B9-B1	18-Aug	0	
Other	18-Aug	1,100	
Hope Lake Beach			
Peace River	**18-Aug**	**20,000**	**1.5%**
Lake Mikchalk	**03-Sep**	**8,500**	**0.6%**
Narrows	03-Sep	1,700	
Northshore Beaches	03-Sep	4,300	
Southshore Beaches	03-Sep	2,500	
Wind River	**03-Sep**	**3,300**	**0.2%**
Lake Kulik		**111,800**	**8.3%**
K1 & K2 Creeks	18-Aug	0	
K5 Creek - Grant River Beaches	18-Aug	1,000	
Grant River - K2 Creek Beaches	18-Aug	96,000	
Southshore Beaches	18-Aug	14,800	
Grant River[b]	**21-Aug**		**0.0%**
Total		**1,354,891**	**100.0%**

[a] Total does not include tower count of 4,008,102 sockeye.

[b] Ground survey counts conducted by FRI, University of Washington.

Table 11.–Peak aerial counts of live sockeye salmon and total escapement estimates, Togiak District, 2006.

	Aerial Counts		Total Escapement Estimate	
Location	**Date**	**Number**	**Factor [a]**	**Number**
Togiak Section				
Togiak Tower				312,126
Togiak River mainstem		No Surveys Done	2.0	
Gechiak Lake System		No Surveys Done	1.5	
Pungokepuk Lake		No Surveys Done	1.5	
Nayorurun River		No Surveys Done	1.5	
Kemuk River		No Surveys Done	1.5	
Ongivinuk Lake System		No Surveys Done	1.5	
Subtotal				
Kulukak Section				
Kulukak River		No Surveys Done	2.0	
Kulukak Lake		No Surveys Done	2.0	
Tithe Creek Ponds		No Surveys Done	1.5	
Subtotal				
Matogak, Osviak, and Cape Pierce Sections				
Matogak River		No Surveys Done	3.0	
Osviak River		No Surveys Done	2.5	
Slug River		No Surveys Done	2.0	
Subtotal				
Other				
Quigmy River		No Surveys Done	2.5	
Negukthlik River		No Surveys Done	3.0	
Ungalikthluk River		No Surveys Done	2.0	
Subtotal				
Total				**312,126**

[a] Derived by expanding peak live count to reflect fish not counted due to variables such as schooled and dead fish, late or poor survey conditions, bad weather, etc.

Table 12.–Peak aerial counts of live Chinook salmon and total escapement estimates, Togiak District, 2006.

	Aerial Counts		Total Escapement Estimate	
Location	**Date**	**Number**	**Factor [a]**	**Number**
Togiak Section				
Togiak River mainstem				
A		No Surveys Done	2.0	
B		No Surveys Done	2.0	
C		No Surveys Done	2.0	
D		No Surveys Done	2.0	
E		No Surveys Done	2.0	
F		No Surveys Done	2.0	
Subtotal				
Gechiak River		No Surveys Done	2.0	
Pungokepuk River		No Surveys Done	2.0	
Nayorurun River		No Surveys Done	2.0	
Kemuk River		No Surveys Done	2.0	
Ongivinuk River		No Surveys Done	2.0	
Subtotal				
Togiak River Drainage Total				
Kulukak Section				
Kulukak River		No Surveys Done	2.0	
Matogak, Osviak, and Cape Pierce Sections				
Matogak River	08-Aug	140	2.0	280
Osviak River	08-Aug	680	2.0	1,360
Slug River		No Surveys Done	2.0	
Subtotal		820		1,640
Other				
Quigmy River	08-Aug	15	2.0	30
Negukthlik River		No Surveys Done	3.0	
Ungalikthluk River		No Surveys Done	2.0	
Subtotal		15		30
Total		**835**		**1,670**

[a] Derived by expanding peak live count to reflect fish not counted due to variables such as schooled and dead fish, late or poor survey conditions, bad weather, etc.

Table 13.–Peak aerial counts of live chum salmon and total escapement estimates, Togiak District, 2006.

	Aerial Counts		Total Escapement Estimate	
Location	**Date**	**Number**	**Factor** [a]	**Number**
Togiak Section				
Togiak River mainstem				
A		No Surveys Done	2.0	
B		No Surveys Done	2.0	
C		No Surveys Done	2.0	
D		No Surveys Done	2.0	
E		No Surveys Done	2.0	
F		No Surveys Done	2.0	
Subtotal				
Gechiak River		No Surveys Done	2.0	
Pungokepuk River		No Surveys Done	2.0	
Nayorurun River		No Surveys Done	2.0	
Kemuk River		No Surveys Done	2.0	
Ongivinuk River		No Surveys Done	2.0	
Subtotal				
Togiak River Drainage Total				
Kulukak Section				
Kulukak River		No Surveys Done	2.0	
Matogak, Osviak, and Cape Pierce Sections				
Matogak River	08-Aug	3,720	2.0	7,440
Osviak River	08-Aug	4,530	2.0	9,060
Slug River		No Surveys Done	2.0	
Subtotal		8,250		16,500
Other				
Quigmy River	08-Aug	5,200	2.0	10,400
Negukthlik River		No Surveys Done	2.0	
Ungalikthluk River		No Surveys Done	2.0	
Subtotal		5,200		10,400
Total		**13,450**		**26,900**

[a] Derived by expanding peak live count to reflect fish not counted due to variables such as schooled and dead fish, late or poor survey conditions, bad weather, etc.

Table 14.–Peak aerial counts of live coho salmon and total escapement estimates, Togiak District, 2006.

	Aerial Counts		Total Escapement Estimate	
Location	**Date**	**Number**	**Factor [a]**	**Number**
Togiak Section				
Togiak River mainstem				
A		No Surveys Done		
B		No Surveys Done		
C		No Surveys Done		
D		No Surveys Done		
E		No Surveys Done		
F		No Surveys Done		
Subtotal				
Gechiak River		No Surveys Done		
Pungokepuk River		No Surveys Done		
Nayorurun River		No Surveys Done		
Kemuk River		No Surveys Done		
Ongivinuk River		No Surveys Done		
Subtotal				
Togiak River Drainage				
Kulukak Section				
Kulukak River	12-Sep	1,539	2.0	3,078
Matogak, Osviak, and Cape Pierce Sections				
Matogak River		No Surveys Done	2.0	
Osviak River		No Surveys Done	3.0	
Slug River		No Surveys Done	3.0	
Subtotal				
Other				
Quigmy River		No Surveys Done	3.0	
Negukthlik River		No Surveys Done	3.0	
Ungalikthluk River		No Surveys Done	3.0	
Subtotal				
Total		**1,539**		**3,078**

[a] Derived by expanding peak live count to reflect fish not counted due to variables such as schooled and dead fish, late or poor survey conditions, bad weather, etc.

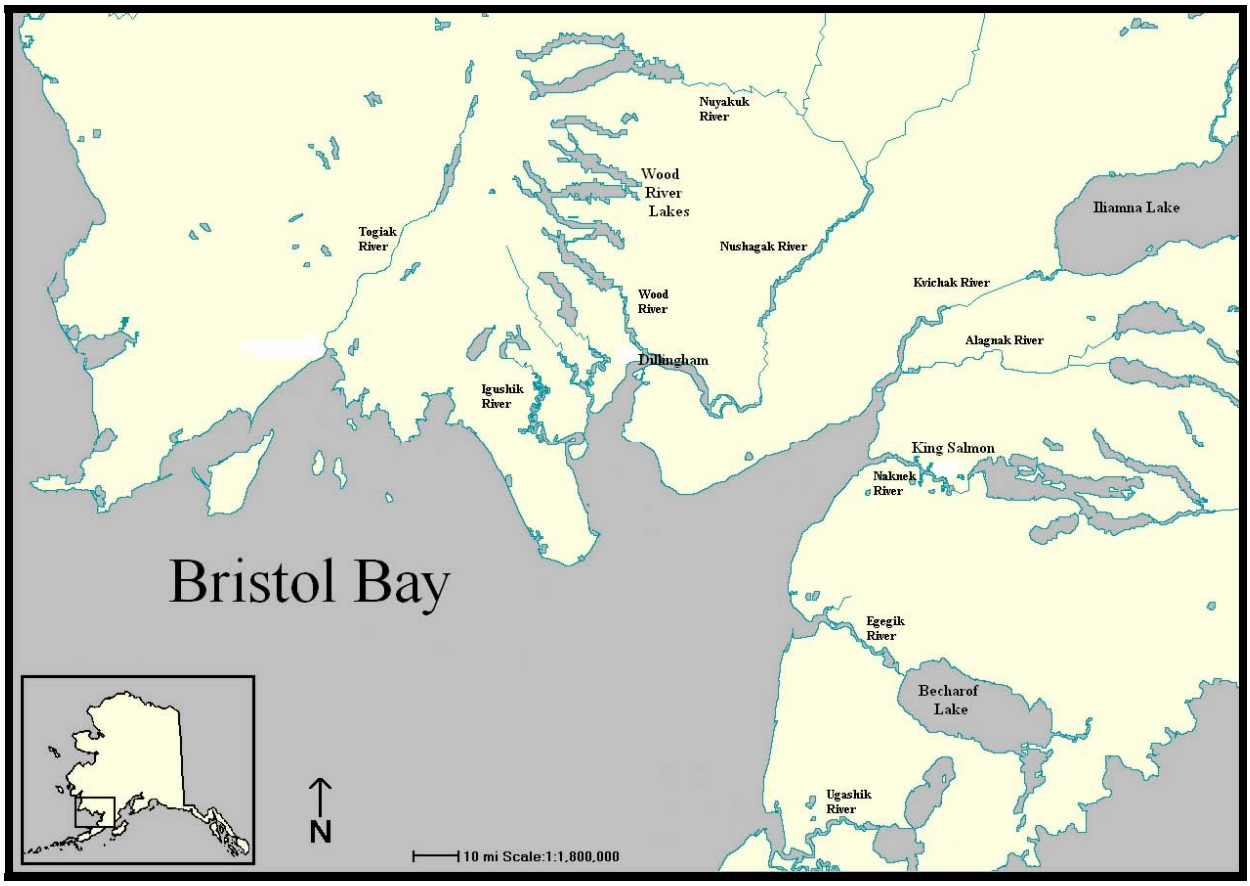

Figure 1.–Bristol Bay management area, Alaska.

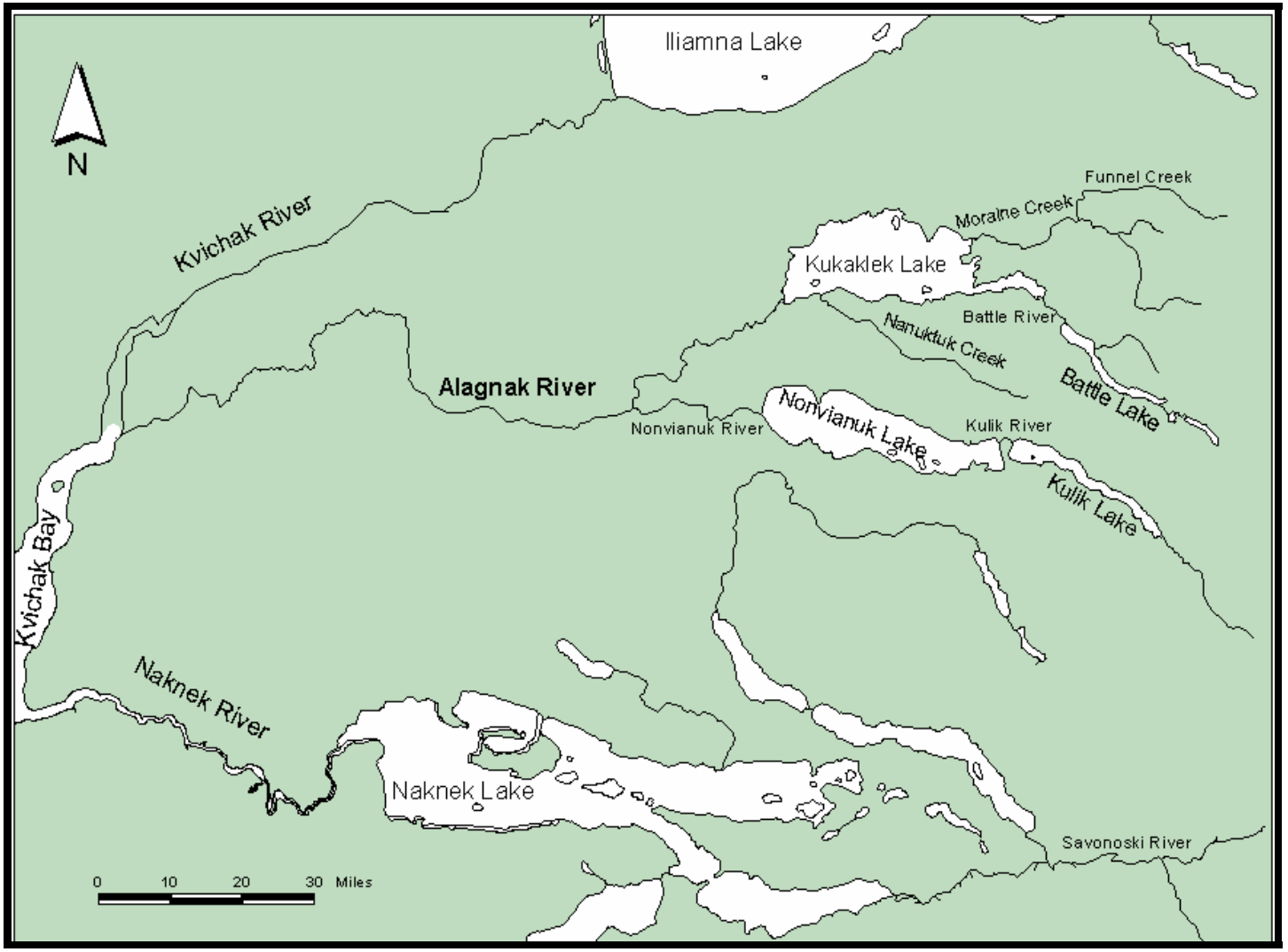

Figure 2.–Alagnak River drainage, Bristol Bay, Alaska.

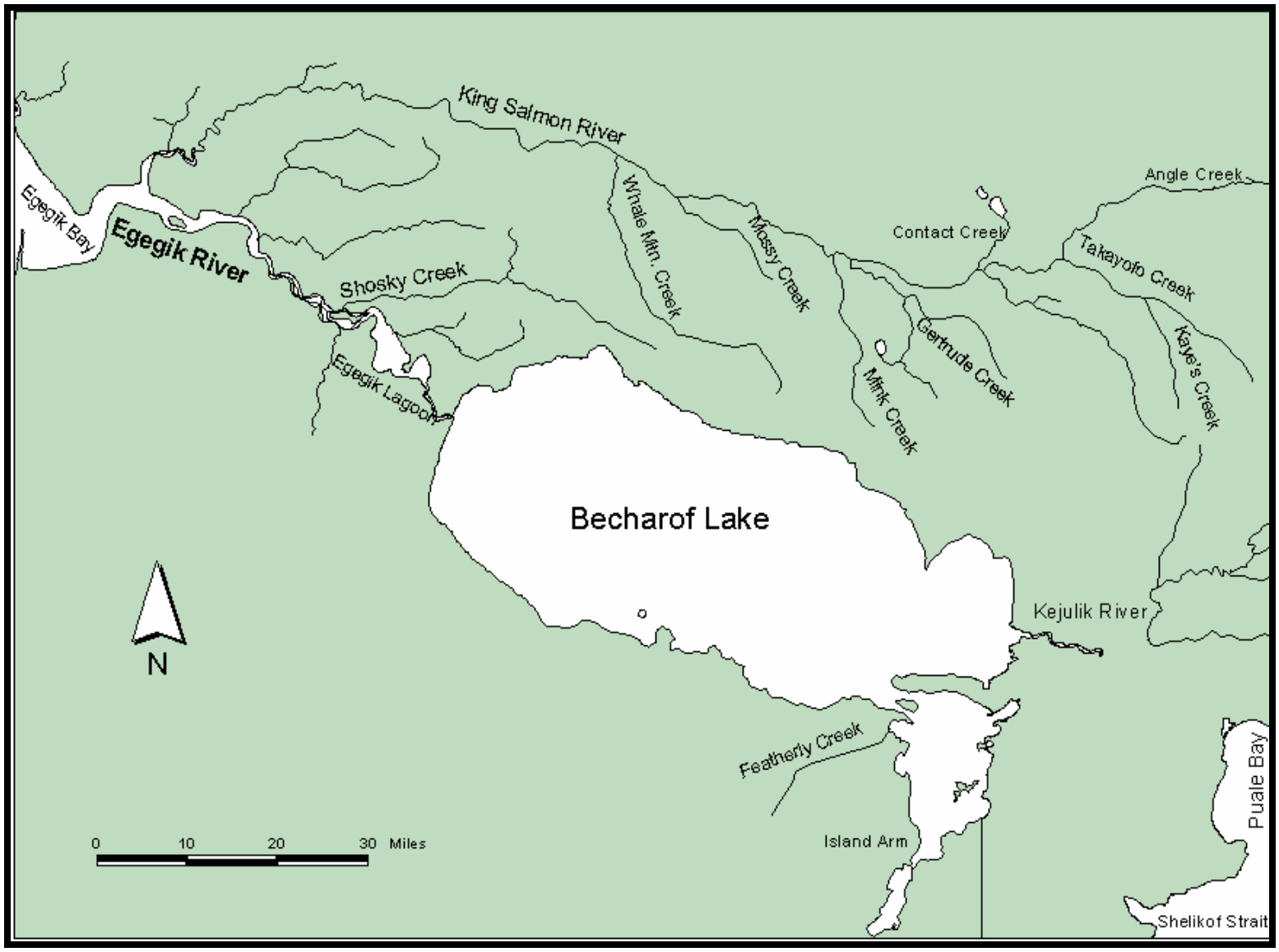

Figure 3.–Egegik River drainage, Bristol Bay, Alaska.

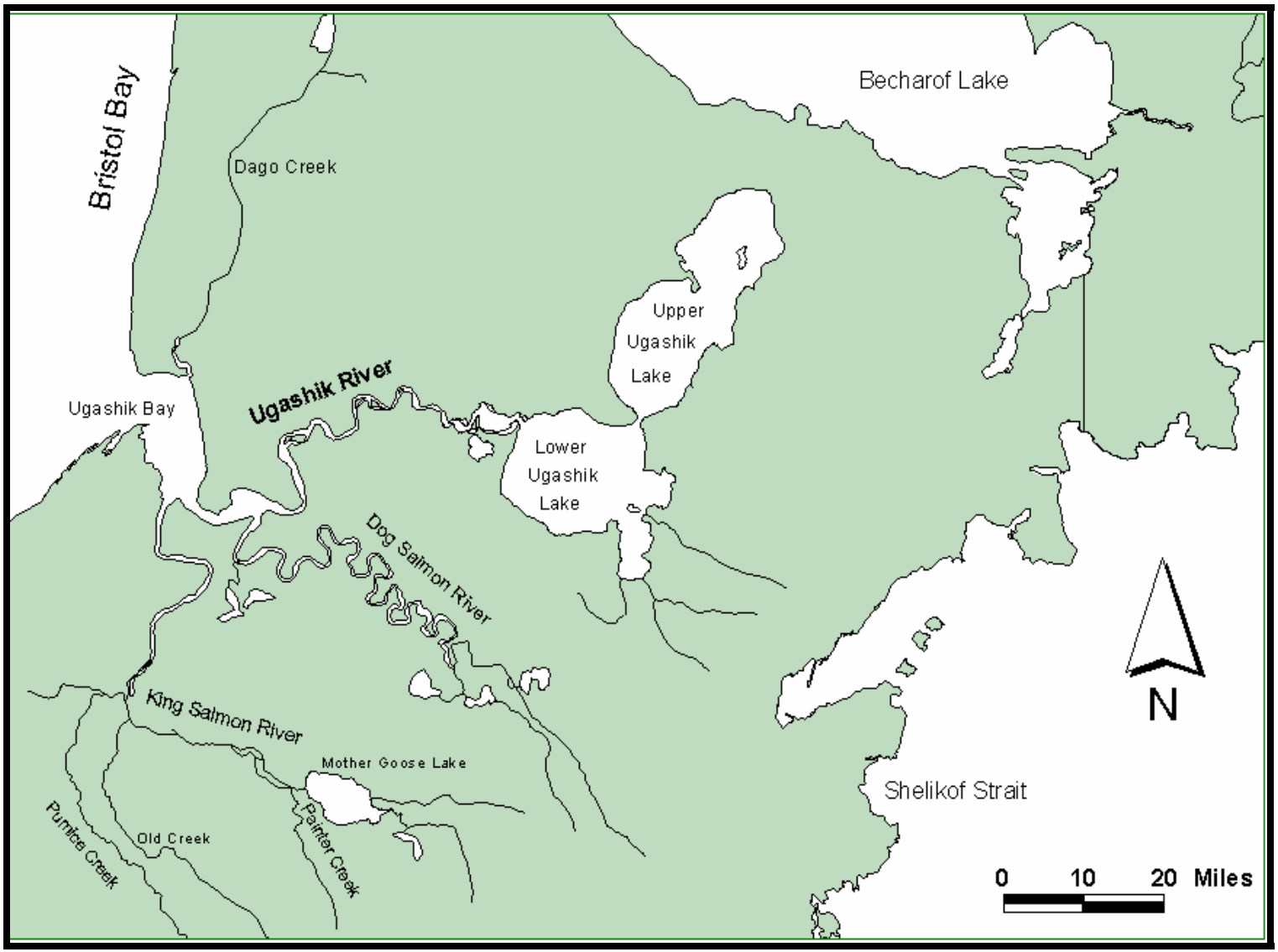

Figure 4.–Ugashik River drainage, Bristol Bay, Alaska.

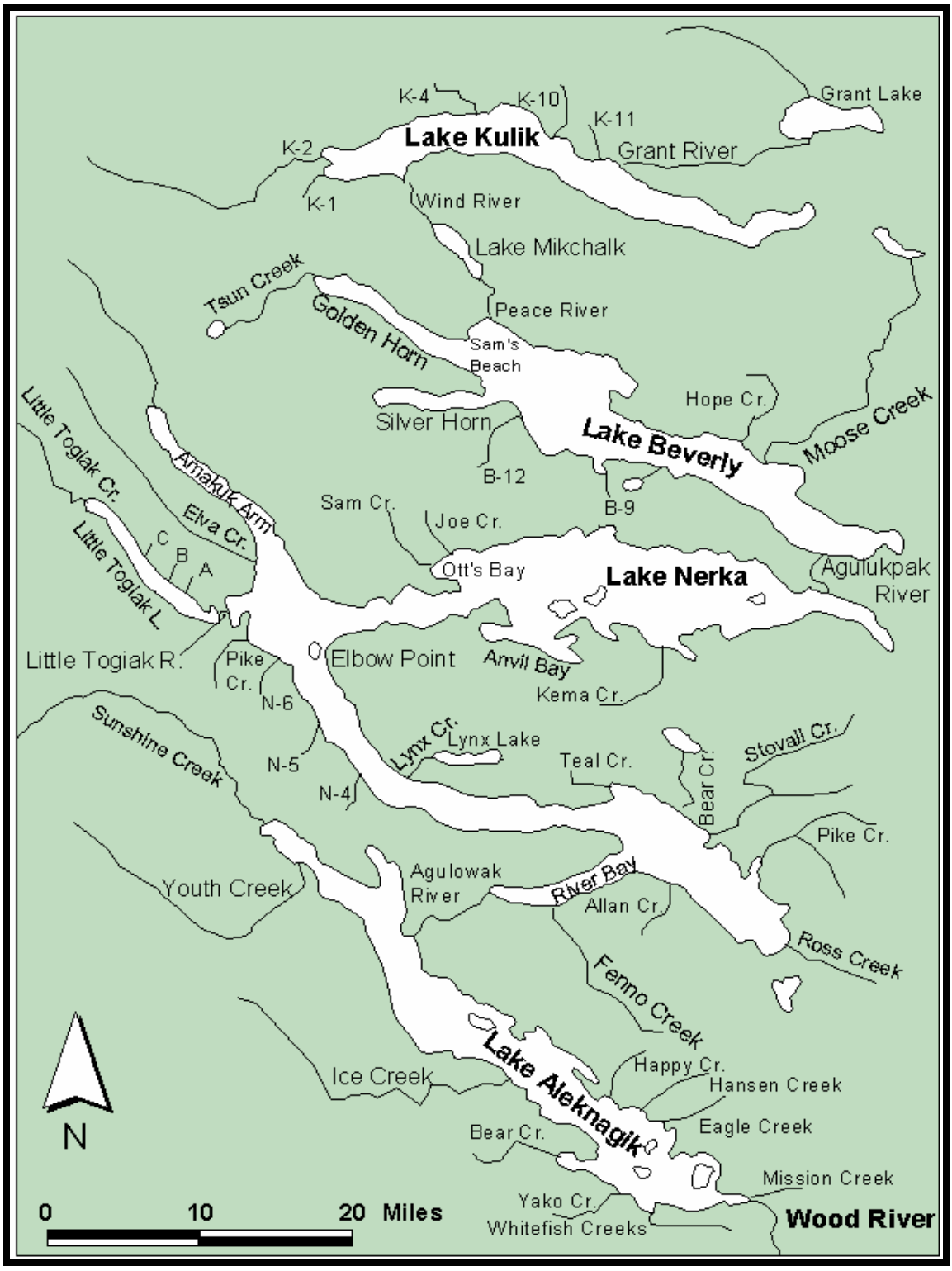

Figure 5.–Wood River Lakes system, Bristol Bay, Alaska.

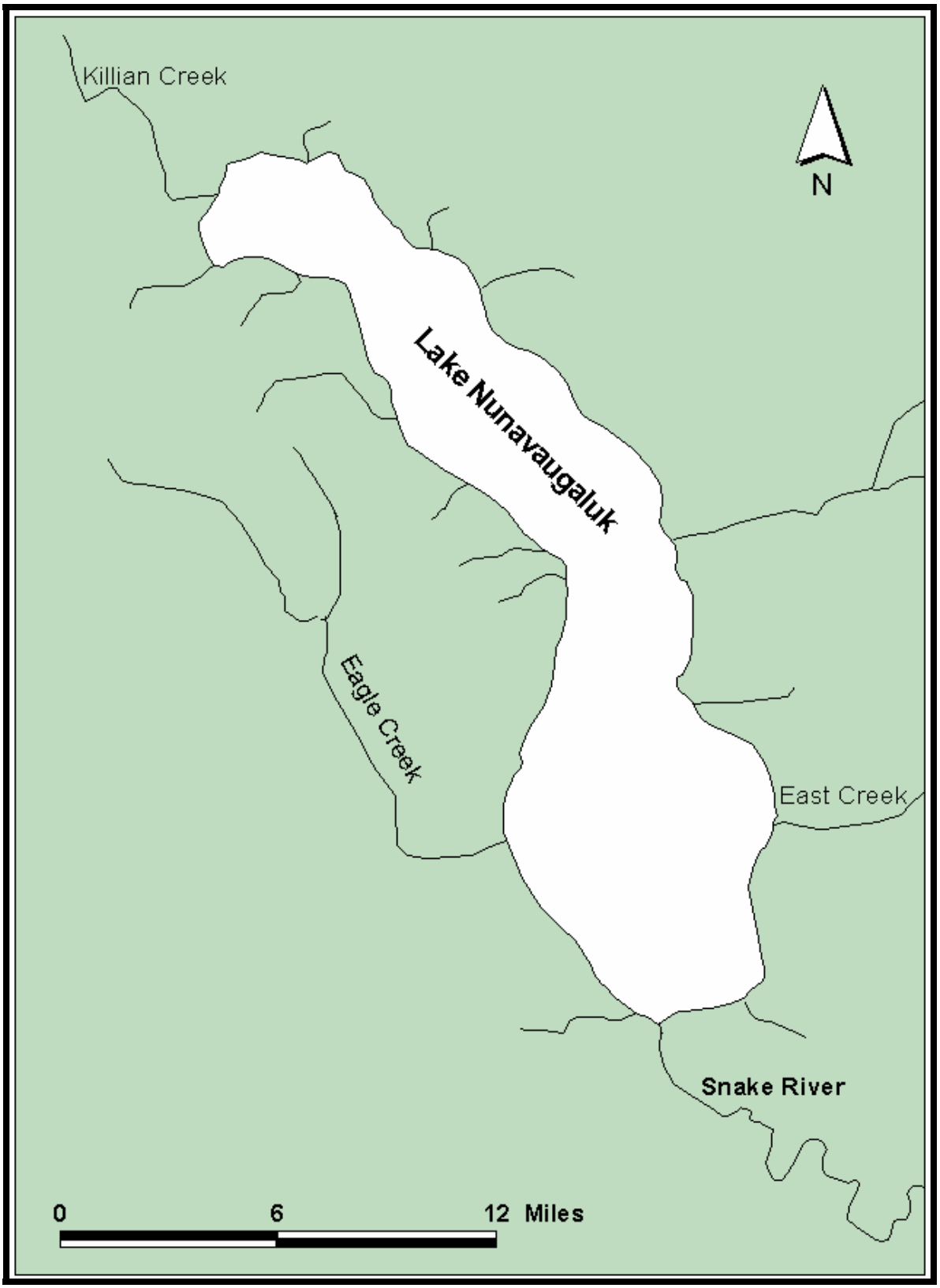

Figure 6.–Lake Nunavaugaluk system, Bristol Bay, Alaska.

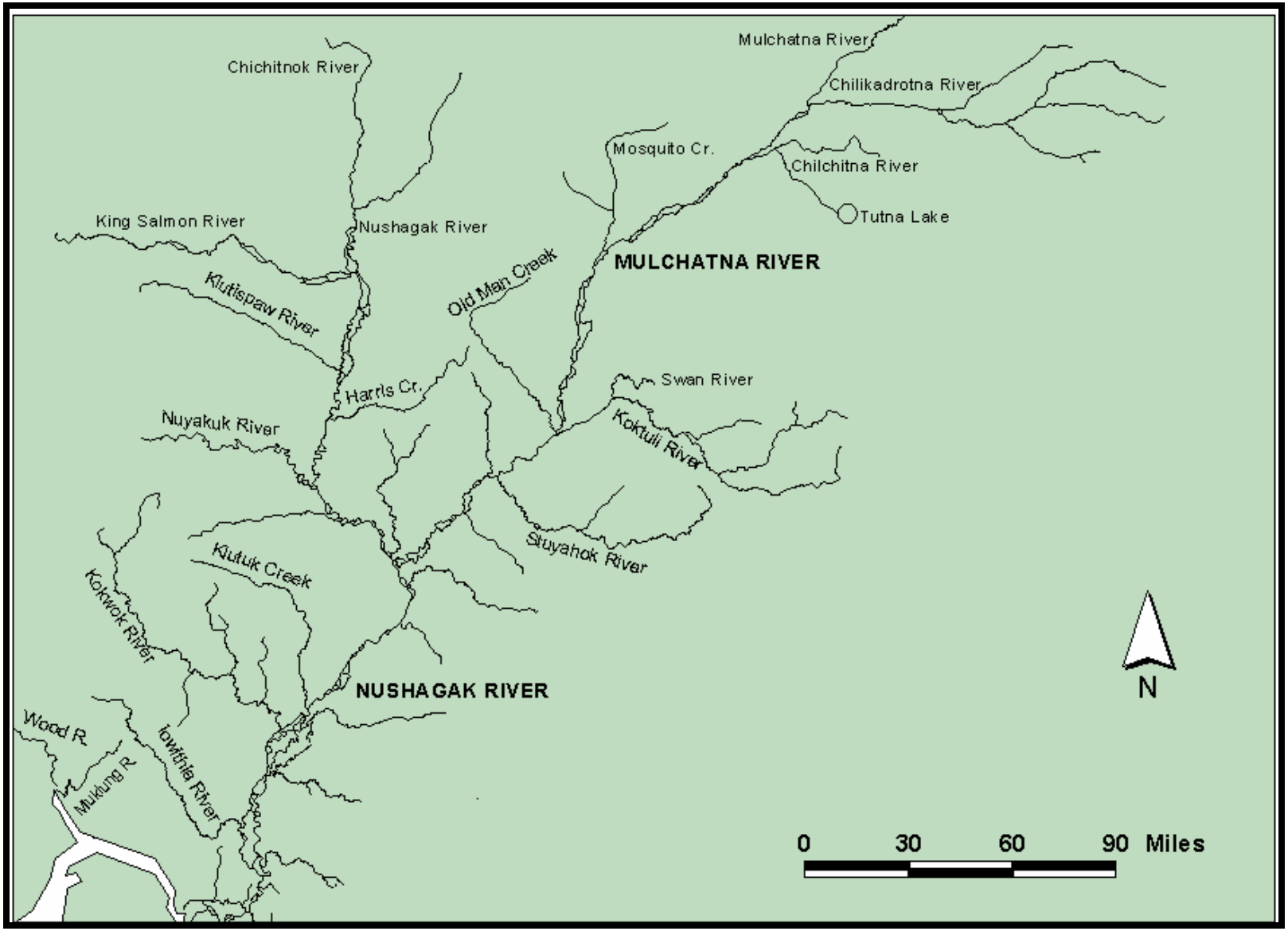

Figure 7.–Nushagak-Mulchatna River system, Bristol Bay, Alaska.

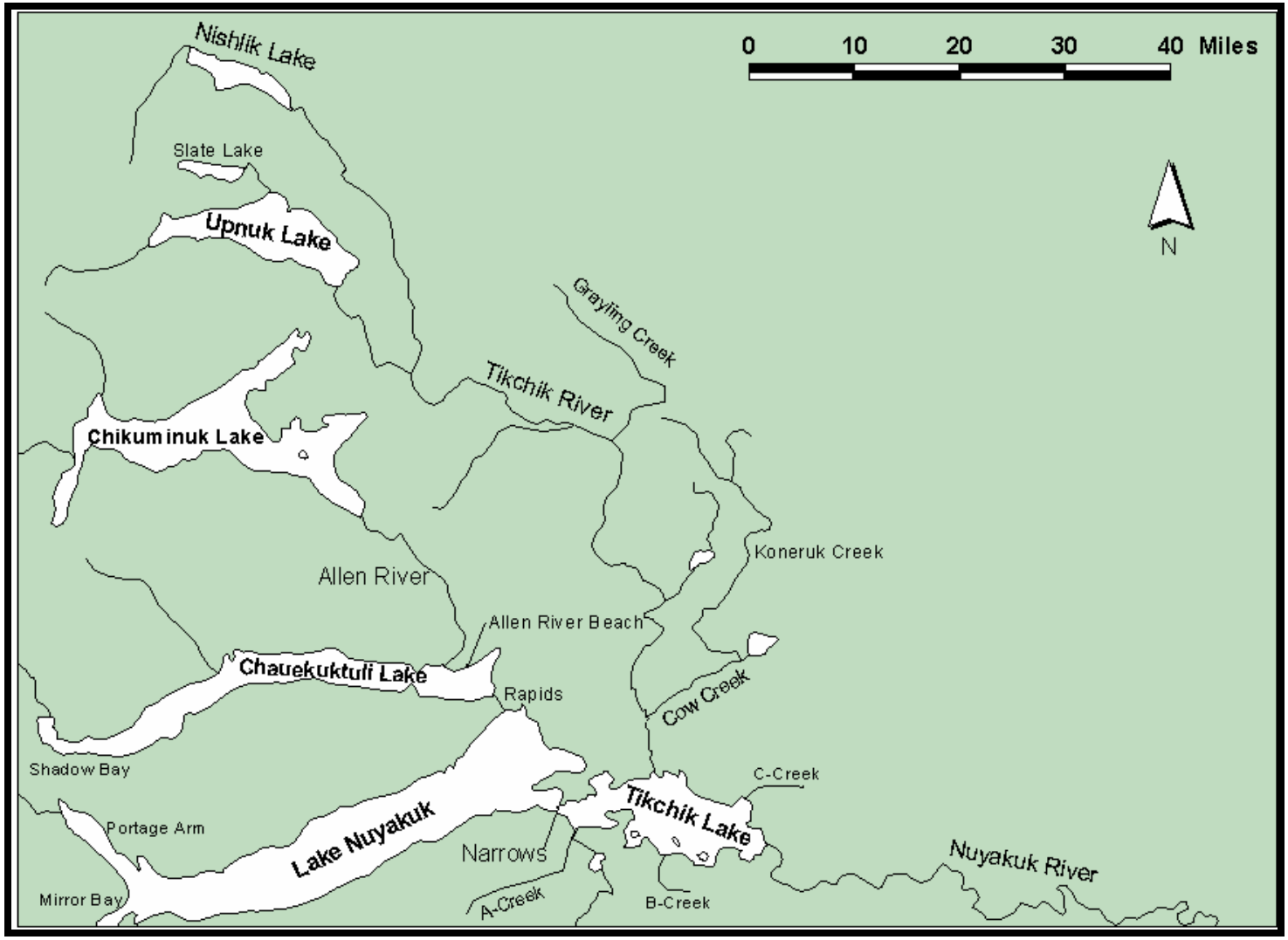

Figure 8.–Tikchik Lakes system, Bristol Bay, Alaska.

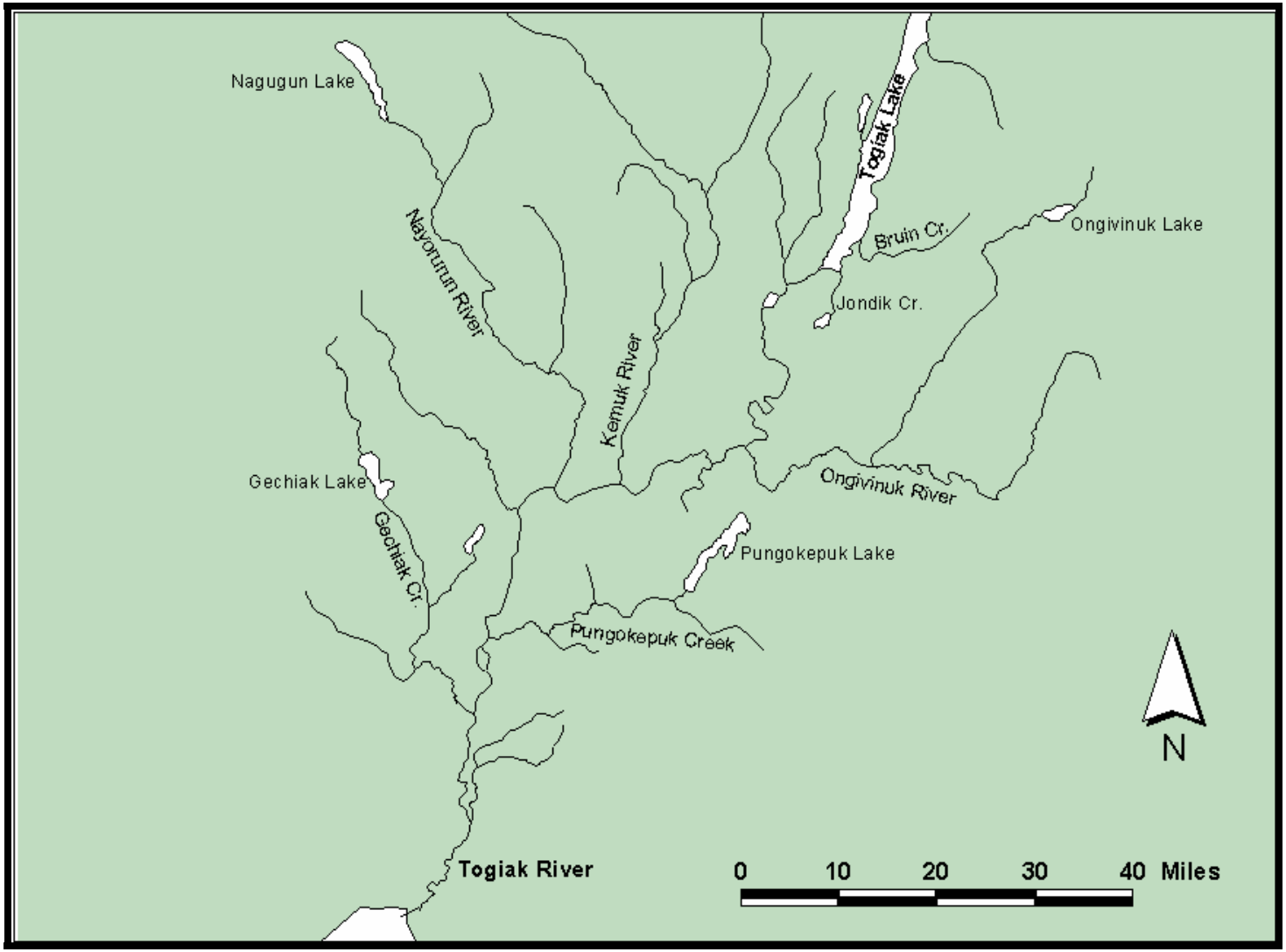

Figure 9.–Togiak River system, Bristol Bay, Alaska.

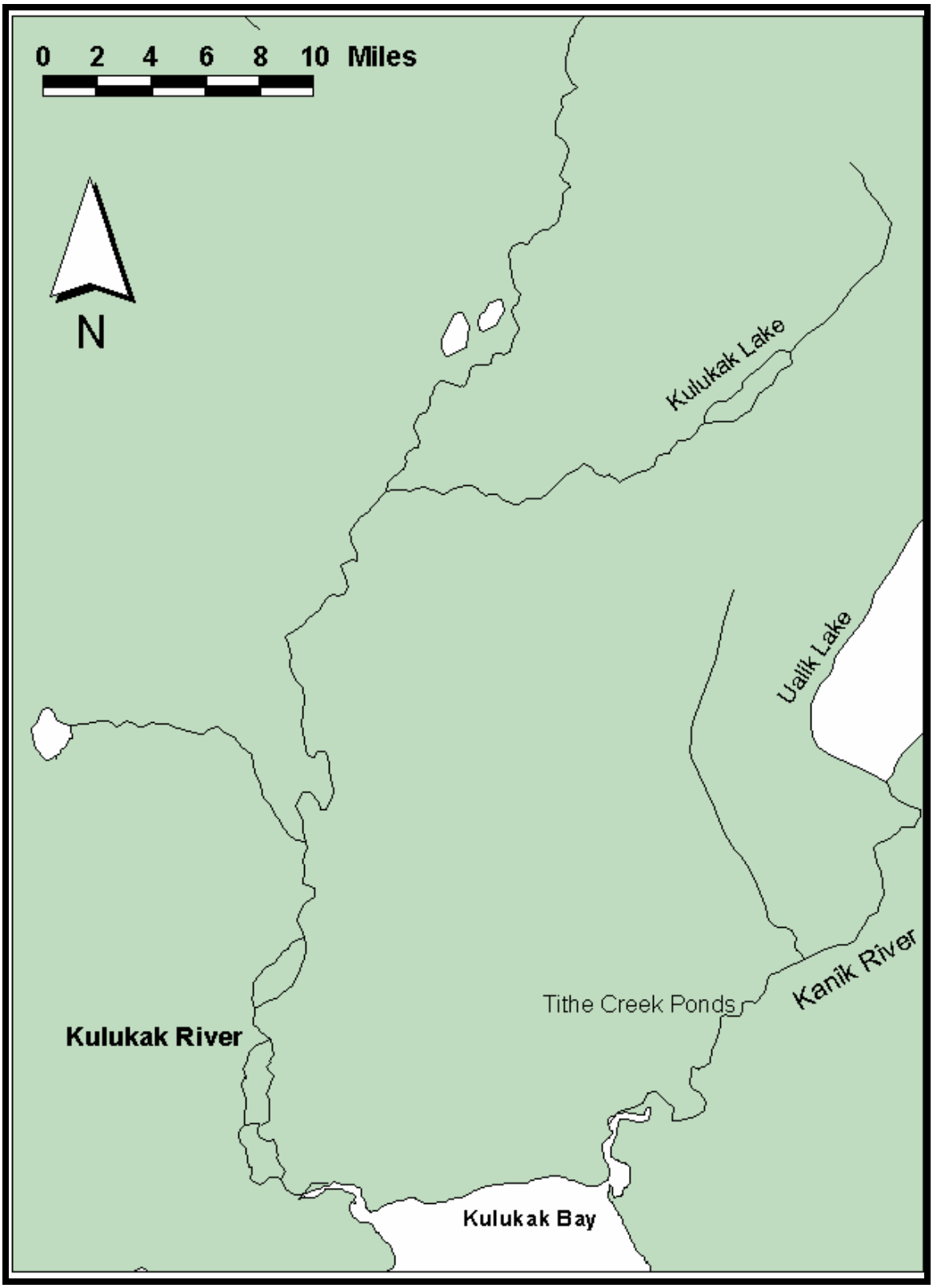

Figure 10.–Kulukak River system, Bristol Bay, Alaska.

APPENDIX A

Appendix A1.–Sockeye salmon total escapement estimates, Naknek-Kvichak District, 1986–2006.

Year	Kvichak	Naknek	Alagnak	Total	Alagnak % of Total
1986	1,179,322	1,977,645	230,180 [a]	3,387,147	7
1987	6,065,880	1,061,806	154,210 [a]	7,281,896	2
1988	4,065,216	1,037,862	194,630 [a]	5,297,708	4
1989	8,317,500	1,161,984	196,760 [a]	9,676,244	2
1990	6,970,020	2,092,578	168,760 [a]	9,231,358	2
1991	4,222,788	3,578,508	277,589 [a]	8,078,885	3
1992	4,725,864	1,606,650	226,643 [a]	6,559,157	3
1993	4,025,166	1,535,658	347,975 [a]	5,908,799	6
1994	8,337,840	990,810	242,595 [a]	9,571,245	3
1995	10,038,720	1,111,140	215,713 [a]	11,365,573	2
1996	1,450,578	1,078,098	306,750 [a]	2,835,426	11
1997	1,503,732	1,025,664	218,115 [a]	2,747,511	8
1998	2,296,074	1,202,172	252,200 [a]	3,750,446	7
1999	6,196,914	1,625,364	463,600 [a]	8,285,878	6
2000	1,827,780	1,375,488	451,300 [a]	3,654,568	12
2001	1,095,348	1,830,360	267,000 [a]	3,192,708	8
2002	703,884	1,263,918	282,100 [a]	2,249,902	13
2003	1,686,804	1,831,170	2,110,000 [a]	5,627,974	37
2004	5,500,134	1,939,374	5,396,592	12,836,100	42
2005	2,320,422	2,744,622	4,219,026	9,284,070	45
2006	3,055,128	1,953,228	1,773,966	6,782,322	26
Mean	**4,126,499**	**1,603,544**	**367,007** [b]	**6,541,130**	**8**

[a] Aerial survey counts.

[b] Mean of counts from 1986 to 2005.

Appendix A2.–Aerial survey counts of Chinook salmon escapements, Naknek River drainage, 1986–2006.

Year	Mainstem Naknek River	Paul's Creek	King Salmon Creek	Big Creek	Total
1986	2,200	73	102	1,542	3,917
1987	2,800	7	290	1,353	4,450
1988	7,380	150	600	3,600	11,730
1989	1,700	50	100	860	2,710
1990	4,500	150	350	2,000	7,000
1991	1,655	121	275	2,340	4,391
1992	1,550	88	158	895	2,691
1993	5,520	86	700	1,710	8,016
1994	5,970	203	974	2,531	9,678
1995	2,790	26	239	1,905	4,960
1996	2,965	157	312	1,576	5,010
1997	7,520	248	902	1,783	10,453
1998	2,150	210	1,060	2,085	5,505
1999	[a]	223	847	2,250	3,320
2000	1,900	43	178	1,112	3,233
2001	3,800	118	413	2,009	6,340
2002	4,240	314	934	2,015	7,503
2003	4,150	583	1,348	[a]	6,081
2004	6,900	315	1,582	4,081	12,878
2005 [a]					
2006 [a]					
Mean	**3,872**	**167**	**598**	**1,980**	**6,617**

[a] Counts unavailable due to poor conditions.

Appendix A3.–Chinook salmon escapement data, Naknek-Kvichak District, 1986–2006.

	Non-expanded Escapement Indices by Drainage [a]			
Year	**Naknek**	**Alagnak**	**Kvichak**	**Total**
1986	3,917	3,090		7,007
1987	4,450	2,420		6,870
1988	11,730	4,600	190	16,520
1989	2,710	3,650	100	6,460
1990	7,000	1,720	170	8,890
1991	4,391	2,531		6,922
1992	2,691	3,042	264	5,997
1993	8,016	10,170	115	18,301
1994	9,678	8,480	306	18,464
1995	4,960	6,860	96	11,916
1996	5,010	9,885	132	15,027
1997	10,453	15,210	103	25,766
1998	5,505	4,148	187	9,840
1999	3,320 [b]	2,178	1,200	6,698
2000	3,233	2,220	6	5,459
2001	6,340	5,458	36	11,834
2002	7,503	3,765		11,268
2003	6,081 [c]	8,209		14,290
2004	12,878	6,755		19,633
2005		5,084		
2006		4,278		
Mean	**6,043**	**5,474**	**223**	**11,492**

Note: Blank cells represent no data.

[a] Includes aerial indices from all streams surveyed in drainage.

[b] No index count for Naknek River.

[c] No index count for Big Creek.

Appendix A4.–Chum salmon escapement survey history, Alagnak River, 1990–2006.

Year	Count Dates	Surveyors	Aerial Index Estimate
1990	8/08	Bill	8,500
	8/18	Bill	48,800
1991	8/09	Regnart	43,000
	8/19	Regnart	64,300
1992	8/10	Regnart	114,000
1993	8/09	Regnart	4,600
1994	8/08	Regnart	62,900
1995	8/10	Regnart	132,000
1996	8/12	Regnart	145,000
1997	8/07	Regnart	37,800
1998	8/12	Anderson	3,150
1999	8/10	Morstad	11,800
2000	8/07	Morstad	10,120
2001	8/08	Morstad	70,800
2002	8/02	Morstad	157,800
2003	8/13	Morstad	78,000
2004			
2005	7/30	Morstad	20,300
2006			

Note: Blank cells represent no data.

Appendix A5.–Pink salmon escapement survey history, Naknek/Kvichak District 1986–2006.

		Non-expanded Escapement Indices by Drainage		
Year	**Survey Dates**	**Alagnak**	**Kvichak**	**Naknek**
1986	8/11	48,600	94,000	187,000
1988	8/12	415,000	25,300	
1990	8/08	45,100		
1990	8/18	240,500		
1992	8/10	15,000		
1994	8/08			
1996	8/12		7,000	10,000
1998	8/12	3,200		20,000
2000	8/07	30,000		
2002	8/02	127,500		
2004	8/17	650,000		
2006				
Mean		**135,711**	**42,100**	**125,750**

Note: Blank cells represent no data.

Appendix A6.–Aerial survey counts of Chinook salmon escapement, Egegik District, 1986–2006.

Year	Egegik River	Shosky Creek	Whale Mountain Creek	Mossy Creek	Mink Creek	Gertrude Creek	Kaye's Creek	Takayoto Creek	Angle Creek[a]	Contact Creek	King Salmon River	Total
1986	65	150	48	0	0	150	46	40		18	15	532[b]
1987	15	174	2	74	0	408	284	232	2	88		1,279
1988	50	151	0	12		248	120	177		110		868
1989	14	90	13	43	7	310	120	300		100		997
1990	24[c]	85	7	35	2	260	175	175		205		968
1991	0[c]	62	60	30	33	83	117	95		73		553
1992[d]	15	143	52	54	22	416	320	190		296		1,508
1993	80	58	6	38	6	350	170	200		235		1,143
1994[d]	66[c]	48	32	118	77	840	214	230		705		2,330
1995[d]	60[c]	32	10	53	103	456	248	130		275		1,367
1996	42[c]	102	8	38	20	230	74	123	6	203	[e]	846
1997	30[c]	39	2	18	10	260	173	374	[e]	740	[e]	1,646
1998	0[c]	29	45	55	[e]	320	165	120	[e]	329	[e]	1,063
1999	6[c]	75	10	51	[e]	165	6	115	[e]	145	[e]	573
2000	0[c]	4	0	16	[e]	85	41	73	[e]	341	[e]	560
2001	0[c]	32	0	35	[e]	116	120	153	[e]	299	[e]	755
2002	0[c]	24	4	0	[e]	277	220	149	[e]	238	[e]	912
2003	0[c]	35	0	20	10	297	180	313	[e]	197	[e]	1,052
2004	0	20	0	40	4	226	134	219	[e]	870	[e]	1,513
2005	0[c]	21	8	36	0	165	71	99	[e]	150	[e]	550
Average	23	69	15	38	21	283	150	175	4	281	15	1,051
2006	0[c]	1	0	1	1	66	80	50	27	50	[e]	276
Deviation		-99%	-100%	-97%		-77%	-47%	-71%		-82%		-74%

Note: Peak aerial counts unless otherwise noted. Data not expanded. Blank cells represent no data.

[a] Angle Creek is usually too turbid to survey.

[b] Survey 10–14 days later than normal.

[c] Tower count.

[d] Helicopter surveys.

[e] No count.

Appendix A7.–Aerial survey counts of chum salmon escapement, Egegik District, 1986–2006.

Year	Egegik River	Shosky Creek	Whale Mountain Creek	Mossy Creek	Mink Creek	Gertrude Creek	Kaye's Creek	Takayoto Creek	Angle Creek[a]	Contact Creek	King Salmon River	Total
1986	0	0	6,025			140	3	5	0	15	25	6,213[b]
1987	150	0	19,000	16	1,000	3,770	2,780	0		2,850		29,566
1988	500	50	4,400	100	50	5,200	1,600	0		3,200		15,100
1989	0	10	3,200	25	100	1,100	0	0		200	14	4,649
1990	72[c]	0	2,000	0	150	1,675	80	0		750		4,727
1991	0[c]	0	1,500	70	100	990	280	0		480		3,420
1992[d]	50	0	680	15	25	4,500	400	0		3,630	200	9,500
1993	100	0	1,020	8	1	1,075	0	0		100		2,304
1994[d]	42[c]	0	1,700	5	7	760	175	30		260		2,979
1995[d]	144[c]	2	395	15	30	560	162	5		600		1,913
1996	12	[e]	438	4	20	530	[e]	24	[e]	633	[e]	1,661
1997	0[c]	[e]	220	8	10	495	290	60	[e]	640	[e]	1,723
1998	17[c]	8	1,480	4	[e]	920	4	4	[e]	140	[e]	2,577
1999	6[c]	[e]	1,040	4	[e]	243	[e]	4	[e]	140	[e]	1,437
2000	0[c]	[e]	492	4[e]	[e]	475	32	6	[e]	180	[e]	1,189
2001	0[c]	[e]	424	6	[e]	494	40	30	[e]	1,240	[e]	2,234
2002	0[c]	[e]	284	5	[e]	302	16		[e]	150	[e]	757
2003	0[c]	0	540	70	50	690	0	0	[e]	3,800	[e]	5,150
2004	0[c]	0	260	50	20	610	50	0	[e]	750	[e]	1,740
2005	0[c]	0	300	10	14	770	30	0	[e]	390	[e]	1,514
Average	55	5	2,270	22	113	1,265	330	9	0	1,007	80	5,018
2006	0[c]	20	340	9	4	450	4	0	0	130	[e]	957

Note: Peak aerial counts unless otherwise noted. Data not expanded. Blank cells represent no data.

[a] Angle Creek is usually too turbid to survey.

[b] Survey 10–14 days later than normal.

[c] Tower count.

[d] Helicopter surveys.

[e] No count.

Appendix A8.–Aerial survey counts of coho salmon escapement, Egegik District, 1986–2006.

Year	Number of Surveys	Coho Salmon Count	Comments
1986	1	12,575	Surveyed August 19.
1987	6	6,930	Included King Salmon River & tributaries.
1988	6	13,715	Included King Salmon River & tributaries.
1989	9	4,485	Included Gertrude & Whale Mountain Creeks.
1990	7	13,400	Peak survey on August 17.
1991	0	220	Incidental observation made August 6.
1992 [a]	0	200	Incidental observation in Egegik River August 6.
1993	0	1,130	Incidental observation from Egegik River August 16.
1994 [a,b]	2	7,412	Included King Salmon River & tributaries.
1995 [c]	2	5,258	Included King Salmon River & tributaries.
1996 [d]	2	9,043	Included King Salmon River & tributaries.
1997	3	4,106	Gertrude Weir Count & selected Becharof Lake tributaries.
1998	1	6,075	Gertrude Weir Count & selected Becharof Lake tributaries.
1999	1	4,353	Gertrude Weir Count & selected Becharof Lake tributaries.
2000	1	4,870	Selected Becharof Lake tributaries.
2001	1	5,100	Selected Becharof Lake tributaries.
2002	1	7,050	Selected Becharof Lake tributaries.
2003	1	5,280	Selected Becharof Lake tributaries.
2004	1	41,400	Selected Becharof Lake tributaries.
2005	1	22,450	Selected Becharof Lake tributaries.
2006	1	21,100	Selected Becharof Lake tributaries.

[a] Helicopter surveys.

[b] The Egegik River Tower was maintained through September 11 and approximately 10,140 coho salmon were counted.

[c] The Egegik River Tower was maintained through August 30 and approximately 7,470 coho salmon were counted.

[d] The Egegik River Tower was maintained August 7 to September 11 and approximately 24,918 coho salmon were counted.

Appendix A9.–Aerial survey counts of Chinook salmon escapement, Ugashik District, 1986–2006.

Year	Ugashik River	Dog [a] Salmon River	King Salmon	Painter Creek	Pumice Creek	Old Creek	Total
1986	66 [b]	252	1,777	646	705	739	4,185
1987	54 [c]	751	981	1,051	1,602	1,155	5,594
1988	249 [d]	900	5,820	1,170	1,025	660	9,824
1989	226 [b,d]	848	1,670	1,030	510	520	4,804
1990	67 [c,d]	540	1,500	590	450	610	3,757
1991	131 [c,d]	449	700	365	375	420	2,440
1992[e]	260 [c,d]	821	1,260	855	750	815	4,761
1993	188 [c,d]	579	1,970	865	450	635	4,687
1994[e]	233 [c,d]	1,741	2,225	1,005	2,530	1,490	9,224
1995	149 [c,d]	882	440	366	501	505	2,843
1996	76 [c,d]	1,079	1,200	403	[f]	[f]	2,758
1997	839 [c,d]	906	802	525	536	558	4,166
1998	458 [c,d]	1,411	883	1,230	352	438	4,772
1999	237 [c,d]	535	[f]	166	340	213	1,491
2000	26 [c]	425	[f]	314	339	246	1,350
2001	346 [b,c,d]	929	828	563	646	530	3,842
2002	618 [b,c,d]	1,121	430	472	586	408	3,635
2003	469 [b,c,d]	1,053	334	490	596	351	3,293
2004	309 [b,c,d]	1,640	1176	1069	470	374	5,038
2005	[g]	[g]	[g]	[g]	124 [h]	54 [h]	178
Average	263	887	1,412	693	678	564	4,132
2006	53	195	[g]	[g]	2,100	201 [h]	2,549

[a] Includes Figure-Eight, Goblet, Oldham, and Wandering creeks.

[b] Tower count plus later aerial survey counts of main river.

[c] Tower counts.

[d] Survey included Grassy Creek (tributary downstream of Ugashik Lagoon).

[e] Helicopter surveys.

[f] No count.

[g] Flown but no estimate.

[h] New observer counts not reliable.

Appendix A10.–Aerial survey counts of chum salmon escapement, Ugashik District, 1986–2006.

Year	Ugashik River	Dog Salmon River [a]	King Salmon River	Painter Creek	Pumice Creek	Old Creek	Other	Total
1986	0 [b]	120	8,650	1,200	2,000	630	125	12,725
1987	130 [b]	340	9,750	2,290	10,340	2,090	40	24,980
1988	752 [b,c]	2,290	25,000	10,500	11,650	5,800	950	56,942
1989	600 [b,c]	1,005	7,500	3,700	2,200	2,010	625	17,640
1990	312 [b,c]	170	6,200	1,150	1,630	410	10	9,882
1991	315 [b,c]	240	7,400	750	2,550	2,525	130	13,910
1992[d]	510 [a,b,c]	1,210	8,525	4,000	14,000	15,000	0	43,245
1993	93 [b,c]	105	7,000	720	2,040	1,025	8	10,991
1994[d]	66 [b,e]	851	9,150	1,625	12,750	6,975	150	31,567
1995	6 [b,e]	160	3,900	1,370	2,600	1,800	0	9,836
1996	138 [e]	85	16,500	700	7,400	2,500	0	27,323
1997	100 [b,e]	450	10,500	4,200	5,300	9,480	115	30,145
1998	607 [b,e]	840	10,600	3,800	2,000	4,350	224	22,421
1999	278 [b,e]	400	[f]	650	1,660	2,020	50	5,058
2000	7 [e]	510	[f]	2,150	7,300	5,850		15,817
2001	78 [b,e]	1,140	8,100	6,000	13,500	7,800	200	36,818
2002	0 [b,e]	1,000	8,200	3,100	5,100	4,200	100	21,700
2003	142 [b,e]	1,130	5,500	8,000	4,000	3,000	50	21,822
2004	24 [b,e]	950	1,800	20,000	5,700	5,000	50	33,524
2005	[f]	[f]	[f]	[f]	1310 [g]	2030 [g]	[g]	3,340
Average	206	671	15,436	4,468	6,229	4,530	281	29,448 [h]
2006	140	940	[f]	[f]	15,150	830 [g]	[g]	17,060

Note: Blank cells represent no data.

[a] Includes Figure-Eight, Goblet, Oldham, and Wandering creeks.

[b] Survey included Grassy Creek (tributary downstream of Ugashik Lagoon).

[c] Included tower count plus later aerial survey count.

[d] Helicopter surveys.

[e] State tower counts, Federal tower count was 5,700 in 2001, 870 in 2002, and 630 in 2003.

[f] Flown but no estimate.

[g] New observer counts not reliable.

[h] Average of the sums of indices for all locations.

Appendix A11.–Aerial survey counts of coho salmon escapement, Ugashik District, 1986–2006.

Year	Number of Surveys	Coho Salmon Counts	Comments
1986	2	8,455	Surveyed on August 19 and 25.
1987	2	17,000	16,700 in King Salmon River on August 23.
1988	7	28,280	12,900 in King Salmon River on September 7.
1989	4	11,515	7,615 observed on August 14.
1990	5	12,610	
1991	0	400	Incidental observation made August 12.
1992[a]	0	790	Incidental observation made August 11.
1993	0	705	Incidental observation made August 16.
1994[a]	0	760	Incidental observation made August 11.
1995	0		
1996 [b]	1	8,275	Surveyed on September 27 and 28.
1997 [b]	2	9,400	Surveyed on September 30 and October 17.
1998 [b]	1	1,459	Surveyed on November 19.
1999[b]	1	10,210	Surveyed on October 14.
2000[b]	1	12,070	Surveyed on October 12.
2001[b]	1	4,540	Surveyed on September 27.
2002[b]	1	3,805	Surveyed on September 22.
2003[b]	1	19,670	Surveyed on September 21.
2004[b,c]	1	5,440	Surveyed on September 26.
2005	1	9,850	Surveyed on September 20.
2006	1	20,100	Surveyed on September 28.

Note: Blank cells represent no data.

[a] Helicopter survey.

[b] Surveys are of selected areas in the Ugashik Lakes, King Salmon, and Dog Salmon River drainages.

[c] In 2004, surveys of Painter, Old, and Pumice creeks could not be completed; 5,360 coho were counted from the Ugashik Lakes area and it was the second highest count for this area in 9 years.

Appendix A12.–Spawner distribution and total escapement estimates of sockeye salmon, Wood River system, 1986–2006.

	Spawner Distribution (%)			
Year	**Creeks**	**Beaches**	**Rivers**	**Total Escapement[a]**
1986	16.1	23.3	60.6	819,000
1987	27.6	56.1	16.3	1,337,000
1988	31.0	44.4	24.6	866,800
1989	19.6	28.9	51.5	1,186,400
1990				1,069,400
1991			19.0	1,159,900
1992	24.9	56.7	18.4	1,286,300
1993	40.9	34.1	25.0	1,176,100
1994	25.5	36.4	38.1	1,471,900
1995	33.5	52.9	13.6	1,482,200
1996	25.8	39.3	34.9	1,649,600
1997	15.6	60.8	23.6	1,512,400
1998	20.0	66.2	13.8	1,755,800
1999				1,512,400
2000				1,300,000
2001				1,458,700
2002				1,283,700
2003				1,459,800
2004				1,543,400
2005	39.8	46.6	13.6	1,496,600
Mean	26.7	45.5	27.2	1,341,370
2006	12.5	55.0	32.5	4,008,100

Note: Blank cells represent no data.

[a] Estimated from Wood River tower counts. Rounded to the nearest hundred.

Appendix A13.–Aerial estimates of sockeye salmon escapements, Togiak District, 1986–2006.

Year	Togiak River & Tributaries[a]	Kulukak Systems[b]
1986	35,000	42,800
1987	28,600	37,800
1988	32,400	31,700
1989	19,800	10,800
1990	47,100	49,600
1991	23,700	23,900
1992	16,500	26,400
1993	15,900	31,800
1994	19,400	29,700
1995	25,500	14,600
1996	30,200	19,000
1997	20,600	8,000
1998	21,900	13,000
1999	40,200	12,300
2000	40,300	22,400
2001[c]	6,700	17,000
2002	16,200	8,500
2003	[d]	8,000
2004	3,100	[d]
2005	3,470	[d]
1986–2005 Mean (20-Year)	22,329	20,365
1986–1995 Mean (10-Year)	26,390	29,910
1996–2005 Mean (10-Year)	18,267	10,820
2006 [d]		

Note: All counts are rounded to the nearest hundred.

[a] Estimates do not include fish spawning above the counting tower (Togiak Lake outlet); estimates for Ungalikthluk, Osviak, Matogak, and Slug rivers are not included in the 1977–1994 data as reported in Bristol Bay Data Reports 73 and 81.

[b] Includes Kulukak River, Kulukak Lake, and Tithe Creek Ponds.

[c] Togiak count includes only the Togiak mainstem and Ongivinuk Rivers.

[d] No aerial surveys performed due to inclement weather.

Appendix A14.–Peak aerial counts of live sockeye salmon, Togiak River drainage, 1986–2006.

Year	Togiak Mainstem	Gechiak River	Pungokepuk River	Narogurum River	Kashaiak River	Ongivinuk River	Total
1986	13,500						13,500
1987	5,200	3,600	600	0	0	4,900	14,300
1988	9,400	2,000	1,100	0	0	3,700	16,200
1989	7,600	1,500	630			150	9,880
1990	8,770	5,720	5,980	0	2,550	1,190	24,210
1991	7,990	1,640	1,220			1,010	11,860
1992	3,030	1,280	1,400			2,200	7,910
1993	2,300	1,270	540			2,950	7,060
1994	3,100	560	1,870			3,900	9,430
1995	3,260	1,745	1,000		4,200	2,330	12,535
1996	9,160	2,270	150	100	240	3,190	15,110
1997	8,200	1,600	450	50	650	2,800	13,750
1998	4,890	3,100	150	10	0	2,800	10,950
1999	5,400	11,275	1,475	100	75	6,700	25,025
2000	12,600	8,100	925	150	100	775	22,650
2001	3,260					100	3,360
2002	2,050	5,000	75	1,525	0	1,450	10,100
2003							
2004	3,050					50	3,100
2005	2,790	320	120	10	120	110	3,470
Mean	6,082	3,186	1,105	195	721	2,239	12,337 [a]
Percent	49.3	25.8	9.0	1.6	5.8	18.2	100.0
2006 [b]							

Note: Blank cells represent no data.

[a] Sum of means for all streams.

[b] No aerial surveys performed due to inclement weather.

Appendix A15.–Peak aerial counts of live sockeye salmon, Togiak District, 1986–2006.

Year	Togiak River [a]	Kulukak River [b]	Tithe Creek Ponds	Quigmy River	Matogak River	Osviak River	Slug River	Negukthlik River	Ungalikthluk River	Total	
1986	13,500	10,900	14,000							38,400	
1987	14,300	10,500	8,400							33,200	
1988	16,200	12,600	3,250	250	100	380	5,880	200	2,700	41,560	
1989	9,880	2,920	2,500					5,000		20,300	
1990	24,210	10,600	14,200	100	400	2,200	3,540	9,700	3,800	68,750	
1991	11,860	8,650	3,320	35	860	2,530	560	3,400	2,650	33,865	
1992	7,910	7,530	4,950	40	300	3,340	1,460	3,600	3,760	32,890	
1993	7,060	9,600	6,300					3,100	5,680	31,740	
1994	9,430	10,270	4,600	580	990	1,750	6,070	2,230	3,240	39,160	
1995	12,535	3,000	4,310	200	610	1,470	2,820	390	1,720	27,055	
1996	15,110	2,490	7,000		360	780	1,045	1,000		27,785	[c]
1997	13,750	2,300	3,000		360	780	1,045	1,000		22,235	
1998	10,950	2,175	4,300	20	900	2,600	5,010	2,300	240	28,495	
1999	25,025	3,250	3,200	1,100	2,400	750	1,400	1,625	625	39,375	
2000	22,650	6,100	5,075	125	526	1,512	1,201	2,175	575	39,939	
2001	3,360	5,140	3,500	160	370	210	4,620	740	2,340	20,440	
2002	10,100	2,375	1,875	660	1,450	1,705	371	160	0	18,696	[c]
2003		900	4,136	110	500	2,180	2,330	1,500	2,580	14,236	
2004	3,100			330	1,096	1,381	1,499	1,200	2,440	11,046	[c]
2005	3,470					1,485				4,955	[c]
Mean	12,337	6,183	5,440	285	748	1,566	2,590	2,313	2,311	29,706	[d]
Percent 2006 [e]	41.5	20.8	18.35	1.0	2.5	5.3	8.7	7.8	7.8	100.0	

Note: Blank cells represent no data.

[a] Includes all surveyed sections of Togiak River proper and all tributaries to the Togiak River.

[b] Includes surveys of Kulukak Lake. Counts prior to 1977 include Kulukak Lake only and are not included in the mean.

[c] Complete count not available.

[d] Sum of means for all streams.

[e] No aerial surveys performed due to inclement weather.

Appendix A16.–Peak aerial counts of live Chinook salmon, Togiak River drainage, 1986–2006.

	Togiak River Section [a]						Gechiak	Pungokepuk	Nayorurun	Kemuk	Ongivinuk	
Year	A	B	C	D	E	F	River	River	River	River	River	Total
1986	150	80	160	30	110	350						880
1987	20	70	170	120	200	480	610	180	100	120	320	2,390
1988	70	70	160	160	170	710	390	180	60	70	90	2,130
1989	10	30	370			940	190	80			40	1,660
1990	230	170	680	365	805	1,085	370	125	75	400	10	4,315
1991	505	165	475	225	520	455	460	105	90	100	150	3,250
1992	150	250	440	225	450	690	250	160	70	175	105	2,965
1993	170	120	220	160		1,810 [b]	595	240	130	65	440	3,950
1994				215	815	1,580	420	215	225	570	380	4,420
1995	120	220	750	255	800	800	715	140	425	520	295	5,040
1996	75	150	160	100	255	625	335	120	120	235	325	2,500
1997	100	350	1,300	600	820	1,000	275	180	150	275	100	5,150
1998	10	20	250	50	400	1,200	400	150	275	140	275	3,170
1999	150	210	540	510	225	480	365	90	240	305	270	3,385
2000	75	50	500	400	850	1,450	350	85	125	100	75	4,060
2001	610	500	500	200	300	950	700	270	550	1,050	160	5,790
2002	140	410	820	250	390	690	400	45	65	210	125	3,545
2003				180	265	495			115	100	135	1,290
2004	198	549	1,044	603	657	1,598	90	320	666	239	198	6,162
2005	117	414	927	576	635	1139	144	170	360	265	347	5,094
Mean	161	213	526	275	482	926	392	159	213	274	202	3,557 [c]
Percent	4.5	6.0	14.8	7.7	13.5	26.0	11.0	4.5	6.0	7.7	5.7	100.0
2006 [d]												

Note: Blank cells represent no data.

[a] Section A: Togiak Bay - Gechiak River
Section B: Gechiak River - Pungokepuk River
Section C: Pungokepuk River - Nayorurun River
Section D: Nayorurun River - Kashaiak River
Section E: Kemuk River - Ongivinuck River
Section F: Ongivinuck River - Togiak Lake

[b] Includes count for Section E.

[c] Sum of means for all streams.

[d] No aerial surveys performed due to inclement weather.

Appendix A17.–Peak aerial counts of live Chinook salmon, Togiak District, 1986–2006.

Year	Togiak River [a]	Quigmy River	Kulukak River	Matogak River	Osviak River	Slug River	Negukthlik River	Ungalikthluk River	Total
1986	880								880
1987	2,390		300	30	40		660	80	3,500
1988	2,130	10	490	0	40	0	650	170	3,490
1989	1,660		740				560		2,960
1990	4,315	30	635	75	60	0	930	25	6,070
1991	3,250	25	285	75	100		1,175	55	4,965
1992	2,965	15	485	40	105	30	490	35	4,165
1993	3,950		1,140	80	110	100	830	70	6,280
1994	4,420	20	835	40	60	10	540	190	6,115
1995	5,040	35	430	65	135	50	740	80	6,575
1996	2,500	35	698	35	71	30	402		3,771
1997	5,150	10	310	50	65	33		10	5,628
1998	3,170	45	375	92	58	39	75	25	3,879
1999	3,385	10	240	105	40	150	345	130	4,405
2000	4,060	26	340	65	42	6	1,100	226	5,865
2001	5,790	24	330	58	84	2	201	74	6,563
2002	3,545	28	860	54	62	7	1,203	161	5,920
2003	1,290	17	360	28	99	66	466	40	2,366 [b]
2004	6,162	4	594	17	63	15	720	60	7,635
2005	5,094	16	447	133	202	90	255	396	6,633
Mean	3,557	22	521	58	80	39	630	107	4,883 [c]
Percent	72.8	0.4	10.7	1.2	1.6	0.8	12.9	2.2	100.0
2006		15		140	680				835

Note: Blank cells represent no data.

[a] Includes all surveyed sections of Togiak River proper and all tributaries to the Togiak River.

[b] Partial aerial survey for Togiak District.

[c] Sum of means for all streams.

Appendix A18.–Peak aerial counts of live chum salmon, Togiak River drainage, 1986–2006.

	Togiak River Section [a]											
Year	A	B	C	D	E	F	Gechiak River	Pungokepuk River	Nayorurun River	Kemuk River	Ongivinuk River	Total
1986[b]												
1987	12,000	9,400	2,700	500	13,200	33,000	2,600	1,200	4,100	700	13,100	92,500
1988	10,000				4,900	3,800	3,700	5,000	3,500	200	3,800	34,900
1989		2,600	2,100		5,000	8,100	290	700			1,200	19,990
1990	2,200	1,275	1,350	400	650	4,200	3,150	1,150	3,400	250	125	18,150
1991	10,200	3,900	2,800	600	5,500	6,000	2,300	500	3,500	800	3,480	39,580
1992[c]	1,800	1,800	300	100	1,200	1,500	2,000	500	1,800	900	800	22,700[d]
1993	6,500	3,500	2,300	60		4,400[e]	1,950	450	4,380	620	3,500	27,660
1994				1,300	5,200	10,400	900	2,400	7,100	900	5,700	33,900
1995	15,700	7,100	4,700	1,800	6,800	5,900	4,800	1,900	9,700	2,700	8,200	69,300
1996	3,700	10,250	5,500	1,300	5,750	8,250	2,600	750	900	550	3,400	42,950
1997	3,900	3,100	3,800	2,750	7,100	4,550	3,200	800	4,750	1,800	3,900	39,650
1998	2,300	1,400	2,750	1,300	4,300	8,950	3,600	1,050	3,000	250	1,650	30,550
1999	3,975	1,950	2,375	1,300	1,725	2,200	1,840	440	4,230	480	2,540	23,055
2000[b]												
2001	9,400	6,500	5,250	1,000	3,500	9,850	7,800	2,850	200	21,450	6,000	73,800
2002	3,350	5,300	4,200	800	4,650	2,100	4,950	650	2,700	1,800	650	31,150
2003				25	675	1,000			175	1,125	1,125	4,125
2004	5,175	2,175	1,575	330	1,875	18,975	750	290	6,675	1,688	450	39,958
2005	720	730	450	105	445	638	765	60	420	120	780	5,233
Mean	6,366	4,227	2,989	905	4,454	7,783	2,825	1,262	3,671	2,215	3,506	36,850[f]
Percent	17.3	11.5	8.1	2.5	12.1	21.1	7.7	3.4	10.0	6.0	9.5	100.0
2006[b]												

Note: Blank cells represent no data.

[a] Section A: Togiak Bay - Gechiak River
Section B: Gechiak River - Pungokepuk River
Section C: Pungokepuk River - Narogurum River
Section D: Narogurun River - Kashaiak River
Section E: Kemuk River - Ongivinuck River
Section F: Ongivinuck River - Togiak Lake

[b] No aerial surveys conducted.

[c] Counts by section are not representative due to post-peak survey, and are notincluded in the mean.

[d] Preferred total estimate; management survey count conducted 7/15/92.

[e] Includes count for Section E.

[f] Sum of means for all streams.

Appendix A19.–Peak aerial counts of live chum salmon, Togiak District, 1986–2006.

Year	Togiak River [a]	Quigmy River	Kulukak River	Matogak River	Osviak River	Slug River	Negukthlik River	Ungalikthluk River	Total
1986									
1987	92,500	1,500	22,000	2,300	2,160				120,460
1988	34,900	10,800	35,000	12,000	17,400	7,600	400	11,300	129,400
1989	19,990	2,820	5,580	7,450	4,900		560		41,300
1990	18,150	555	5,550	1,475	2,300	3,650	750	1,300	33,730
1991	39,580	4,420	9,540	4,730	8,700		120	3,020	70,110
1992	22,700 [b]	600	4,800 [b]	4,400	7,100	1,700	100	4,000	45,400
1993	27,660		6,950	1,970	1,360	3,060	20	4,020	45,040
1994	33,900	890	10,700	1,630	2,000	4,360	230	1,090	54,800
1995	138,600	2,200	7,600	5,200	13,920	6,440	1,000	7,200	182,160
1996	42,950	960	7,560	560	810	2,670	40		55,550
1997	39,650	1,700	4,550	3,000	2,500	1,890			53,290
1998	30,550	2,630	2,700	4,980	3,870	1,060	150	1,300	47,240
1999	23,055	1,340	3,430	5,700	3,650	4,750	410	11,360	53,695
2000		2,870	4,950	9,090	10,880	4,150	200	5,520	37,660
2001	75,600	2,590	22,300	2,840	2,220	5,570	220	5,480	116,820
2002	31,150	3,300	15,400	7,600	6,360	800	530	6,940	72,080
2003	4,125[c]	720	3,425	1,340	3,480	1,030	30	4,970	14,995
2004	39,958	1,080	5,831	2,310	1,970	416	100	250	51,915
2005	5,233	8,100	790	17,200	15,300	1,350	1,760	4,440	54,173
Mean	39,785	2,726	9,403	5,041	5,836	3,156	389	4,813	67,359 [d]
Percent	59.1	4.0	14.0	7.5	8.7	4.7	0.6	7.1	100.0
2006		5,200		3,720	4,530				13,450

Note: Blank cells represent no data.

[a] Includes all surveyed sections of Togiak River proper and tributaries to the Togiak River.

[b] Preferred estimate from a management survey due to post-peak spawning ground survey.

[c] Partial aerial survey data.

[d] Sum of means for all streams.

Appendix A20.–Peak aerial counts of live coho salmon, Togiak River drainage, 1986–2006.

	Togiak River Section [a]						Mainstem	Gechiak	Pungokepuk	Narogurum	Kashaiak	Ongivinuk	
Year	A	B	C	D	E	F	Total	River	River	River	River	River	Total
1986			60	400	100	400	960					2,560	3,520
1987	340	500	250	200	240	530	2,060	1,020	70			1,060	4,210
1988	950	370		140	210	360	2,030	1,530				4,100	7,660
1989													
1990	1,650	390	400	0	540	660	3,640	920	450	260	130	1,730	7,130
1991	4,900	400	700	600	1,680	140	8,020					100	140 [b]
1992	4,420	1,120	1,180	540	2,940	3,080	13,280	5,240	1,440	780	1,500	4,460	26,700
1993													
1994								1,290 [b]	220 [b]	120 [b]	95 [b]	1,930	3,655
1995								1,450			200	1,180	2,830
1996	2,550	1,090	150	250	1,600	5,020	10,910	2,080	1,170	575	725	6,450	21,910
1997	600	200	400	100	400	1,800	3,500	1,000	650	350	475	900	6,875
1998	460	625	100	100	310	1,075	2,670	2,550	575	400	500	1,750	8,445
1999	250	75	50	25	100	75	575	275	35	100	25	175	1,185
2000													
2001													
2002													
2003													
2004													
2005													
Mean	1,791	530	336	236	812	1,314	4,765	1,736	576	369	456	2,200	7,855 [c]
Percent	22.8	16.7	4.7	3.0	10.3	16.7	60.7	22.1	7.3	4.7	5.8	28.0	100.0
2006 [d]													

Note: Blank cells represent no data.

[a] Section A: Togiak Bay - Gechiak River
Section B: Gechiak River - Pungokepuk River
Section C: Pungokepuk River - Narogurum River
Section D: Narogurum River - Kashaiak River
Section E: Kashaiak River - Ongivinuck River

[b] Timing of aerial surveys did not coincide with the period of peak spawning activity, and therefore, counts were not included in the mean or percent.

[c] Sum of means for all streams.

[d] No aerial surveys performed due to inclement weather.

Appendix A21.–Peak aerial counts of live coho salmon, Togiak District, 1986–2006.

Year	Togiak River [a]	Quigmy River	Kulukak River	Matogak River	Osviak River	Slug River	Negukthlik River	Ungalikthluk River		Total
1986	3,520									3,520
1987	4,210	30	910	440	120			130		5,840
1988	8,590	460	1,840	310	490	470	370	3,170		15,700
1989										
1990	7,130	1,029	5,195	2,675	1,491	810		4,153		22,483
1991	140		4,200							4,340 [b]
1992	26,700		12,640							39,340
1993										
1994										
1995		855	1,185	1,392	1,080	1,149		5,196	[c]	10,857
1996	21,660	1,211	10,290	3,062	2,805	1,944	851	5,917		47,740
1997	6,875	325	1,675	150	1,046	1,397		1,690		13,158
1998	8,445	390	3,650	1,785	2,001	523		2,770		19,564
1999	1,185	169	500	220	213	117	95	450		2,949
2000										
2001		149		372	370	418				1,309
2002		421		597	539	62		1,027		2,646
2003		680	1,610	1,620						3,910
2004										
2005										
Mean	8,846	520	3,972	1,148	1016	766	439	2,723	0	13,8112 [d]
Percent	64.0	3.8	28.8	8.3	7.4	5.5	3.2	19.7		100.0
2006			1,539							

Note: Blank cells represent no data.

[a] Includes all surveyed sections of Togiak River proper and tributaries to the Togiak River.

[b] Timing of aerial surveys did not coincide with the period of peak spawning activity, and therefore, counts were not included in the mean or percent.

[c] Negukthlik and Ungalikthluk rivers combined.

[d] Sum of means for all streams.