Fishery Management Report No. 06-40

The 2005 Spiridon Lake Sockeye Salmon Stocking Project and Related Monitoring Parameters

by

Robert T. Baer

July 2006

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

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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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by

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July 2006

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This document should be cited as:
Baer, R. T. 2006. The 2005 Spiridon Lake sockeye salmon stocking project and related monitoring parameters. Alaska Department of Fish and Game, Fishery Management Report No. 06-40, Anchorage.

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ABSTRACT

A sockeye salmon *Oncorhynchus nerka* enhancement stocking project was initiated at Spiridon Lake in the early 1990s to provide increased harvest opportunities for fishermen in the Kodiak Management Area. Because Spiridon Lake lies within the boundaries of the Kodiak National Wildlife Refuge (KNWR), the project is subject to U.S. Fish and Wildlife Service (USFWS) oversight and guiding principles. In an effort to ensure that the project remains compatible with the KNWR mission, the Alaska Department of Fish and Game (ADF&G) conducts monitoring projects and submits an annual summary to the USFWS.

As required in the Spiridon Lake Management Plan (SLMP), ADF&G monitored and examined specific water quality parameters, zooplankton characteristics, smolt outmigrations, stocking numbers and commercial salmon harvests in 2005. Specific parameters were evaluated and compared to criteria established as guidelines for the stocking project to ensure that the project does not adversely affect the Spiridon Lake system.

The 2005 water quality parameters measures resulted in: a total nitrogen to total phosphorus ratio of 296:1, a total ammonia level of 4.3 µg/L, and a chlorophyll *a* concentration of 0.60 µg/L. The zooplankton community parameters measured resulted in: *Diaptomus* to *Cyclops* ratio of 0.03:1, a copepod biomass of 2.7 mg/m^3, a *Bosmina* to *Daphnia* ratio of 1.56:1, a cladoceran biomass of 10.2 mg/m^3, and a *Bosmina* size (average length) of 0.50 mm. An estimated 1,409,374 sockeye salmon smolt emigrated from Spiridon Lake in the spring of 2005 while a total of 1,201,668 sockeye salmon juveniles were stocked in the summer and fall. A total of 59,494 adult sockeye salmon were harvested in the Spiridon Bay Special Harvest Area (SBSHA) and reported on commercial fish harvest tickets.

A portion of the data collected in 2005 to monitor the Spiridon Lake stocking project was not within the ranges specified in the SLMP. The total nitrogen to total phosphorus ratio exceeded the specified range in 2005 despite being below the range in 2003 and 2004. The copepod biomass was below the specified range in 2004 and 2005. The cladoceran biomass exceeded the range in 2005 for the fist time since 2002, and *Bosmina* were smaller than the specified size by .01 mm for the second year in a row. Results of the 2005 limnology data suggest fluctuating conditions in Spiridon Lake. Parameters falling outside of specified ranges for two or more consecutive years may prompt a reevaluation of the monitoring guideline in the SLMP and/or result in stocking project modifications.

Key words: Spiridon Lake, Telrod Cove, Special Harvest Area, *Oncorhynchus nerka*, sockeye salmon, stocking, Kodiak National Wildlife Refuge, U.S. Fish and Wildlife Service, Kodiak Regional Aquaculture Association, Special Use Permit, limnology.

INTRODUCTION

This report consolidates the 2005 and historical project data collected to monitor the Spiridon Lake sockeye salmon *Oncorhynchus nerka* stocking project. Spiridon Lake is located within the boundaries of the Kodiak National Wildlife Refuge (KNWR); therefore, the stocking project is subject to U.S. Fish and Wildlife Service (USFWS) and KNWR guiding principles and conditions. Such principles and conditions are described in the Spiridon Lake Management Plan (SLMP; Chatto 2000) and the project is permitted under the conditions described in the Spiridon Lake Special Use Permit (SLSUP). The intention of this report is to fulfill the Alaska Department of Fish and Game (ADF&G) reporting requirements as outlined in the SLMP and SLSUP.

Prior to stocking, Spiridon Lake did not support anadromous fish due to impassable falls that prevent lake access. The intent of the stocking project is to utilize the lake's freshwater rearing environment without upsetting the nutrient balance or forage base (macrozooplankton) of the lake (Honnold 1997). In addition to the utilization of the lakes forage, stocking a barren lake also provides researchers and managers with the opportunity to thoroughly assess the response of the macrozooplankton community to predation by juvenile salmon while reducing possible interactions with wild stocks by directing harvest of adults to a specified (terminal) area (Kyle 1996).

In 1990, ADF&G in cooperation with Kodiak Regional Aquaculture Association (KRAA) submitted proposals to the USFWS to stock sockeye salmon into Spiridon Lake in the Kodiak Unit of the KNWR (Chatto 2000). The KNWR prepared an environmental assessment (EA) for the proposed project, which resulted in a finding of no significant impact. A temporary 5-year Special Use Permit (SUP) for the Spiridon Lake project was issued to ADF&G by the KNWR in 1991, so the project could be thoroughly evaluated and additional baseline data could be gathered for a comprehensive management plan that would contain parameters specific to Spiridon Lake. In 1997, ADF&G consolidated existing information (excluding wildlife studies) from the Spiridon Lake stocking project into one document (Honnold 1997), which was then used for reference in writing the existing KNWR SLMP (Chatto 2000). The SLMP was authorized in June 2000 and the ADF&G was issued a 5-year renewable SLSUP to continue stocking and monitoring in the KNWR. Juvenile sockeye salmon have been stocked into Spiridon Lake annually since 1990 (Schrof and Honnold 2003). Since 1991, ADF&G has annually enumerated the smolt migrating out of Spiridon Lake and collected samples for age, size, and condition data. The returning adult sockeye salmon have been harvested in the Spiridon Bay Special Harvest Area since 1994 (SBSHA; Figure 1). ADF&G has annually monitored the fishery and sampled a portion of the sockeye salmon commercial catch for age, sex, and length data.

This report compares and contrasts the 2005 results from a series of concurrent ADF&G studies and monitoring programs to SLMP guidelines intended to assure compatibility with the KNWR purposes.

MANAGEMENT PLAN MONITORING GUIDELINES

The purpose of the SLMP is to document the various components of the lake stocking project, to outline how the project will be managed to remain compatible with the KNWR's mission, and to serve as a reference document to guide any proposed changes to project operations (Chatto 2000).

Monitoring guidelines were established from data collected at Spiridon Lake from 1987–1999. Criteria for specific limnological and fishery parameters were developed for comparison purposes. If measurements were outside the criteria specified in the Management Plan for any given parameter for two or more consecutive years, then the stocking project may need to be adjusted to meet the guidelines and purposes of the KNWR (Chatto 2000). Specific parameters monitored include lake nutrient concentrations (nitrogen, phosphorus, total ammonia, and chlorophyll *a*), zooplankton composition, density and biomass, juvenile stocking, smolt production, and adult harvest estimates (Table 1).

DESCRIPTION OF STUDY AREA

Spiridon Lake (57° 40' N lat., 153° 39' W long.) is located on the northwest side of Kodiak Island, approximately 74 km southwest of the city of Kodiak (Figure 1). The lake is 9.6 km long, up to 1.6 km wide, and has a surface area 9.2 km^2 (Figure 2; Schrof and Honnold 2003). Spiridon Lake is at an elevation of 136 m, has a mean depth of 34.7 m, and a maximum depth of 82.0 m. The Spiridon Lake outlet stream (Telrod Creek) is approximately 2.0 km long and empties into Telrod Cove. Telrod Creek has three waterfalls that are impassable to anadromous fish. Two waterfalls are located approximately 0.8 km downstream of the lake outlet, and a third waterfall, located near the stream terminus, blocks salmon from migrating further upstream.

Resident fish in Spiridon Lake include: rainbow trout *O. mykiss*, Dolly Varden char *Salvenlinus malma*, threespine stickleback *Gasterosteus aculeatus*, and freshwater sculpin *Cottus aleuticus* (Honnold 1997).

METHODS

LAKE LIMNOLOGY MONITORING

The SLMP outlines a range of values and parameters for specific water quality and biological characteristics that are used as guidelines to ensure that the Spiridon Lake sockeye salmon stocking project remains compatible with KNWR objectives (Chatto 2000). Parameters specified in the SLMP included total nitrogen (TN) to total phosphorus (TP) ratio, total ammonia (TA), chlorophyll *a* (Chl *a*), *Diaptomus* to *Cyclops* density ratio, copepod biomass, *Bosmina* to *Daphnia* density ratio, cladoceran biomass, and cladoceran (*Bosmina*) average size.

Lake Sampling Protocol

To obtain the limnology data, ADF&G personnel traveled to Spiridon Lake in a fixed-wing aircraft nine times from May–October at two-week intervals. Two sampling stations were established in the deepest basins of the lake using Global Positioning Satellite (GPS) equipment (Figure 1). Water samples were collected from the 1 m and 50 m depths and a 50 m vertical tow was hauled to collect zooplankton. Samples were collected following standard ADF&G sampling procedures which were adopted from Schrof et al. (2000; ADF&G 2005).

Water samples for general chemistry and nutrient analysis were collected during each survey at the epilimnion with a sample taken 1 m below the water surface. Sampling was done with a 6-L opaque Van Dorn sampler, and the samples were emptied into separate, pre-cleaned polyethylene carboys, which were kept cool and dark in the float of the plane until processed at the laboratory in Kodiak. Vertical zooplankton hauls were made at each station using a 0.2 m diameter conical net with 153 μm mesh. The net was pulled manually at a constant speed (~0.5 m sec^{-1}) from approximately 2 m off the lake bottom to the surface. The contents from each tow were emptied into a 125-ml poly-bottle and preserved in 10% neutralized formalin.

General Water Chemistry and Nutrients

For analysis of color and dissolved inorganic nutrients, a portion of each sample was filtered through a rinsed 47 mm-diameter Whatman GF/F cellulose fiber filter and stored frozen in phosphate free soap-washed poly bottles. Frozen filtered water was also used for analysis of total phosphorus (TP), total Kjeldahl nitrogen (TKN), and general water chemistry, and these measurements were also made for frozen unfiltered and refrigerated (4^{o} C) water stored in clean poly bottles (Koenings et al. 1987). The pH of water samples was measured with an Orion 499A meter, while alkalinity (mg L^{-1} as $CaCO_3$) was determined from 100-ml of water titrated with 0.02 N H_2SO_4 to a pH of 4.5 and measured with a pH meter (AHPA 1985).

Reactive silicon was determined using the method of ascorbic acid reduction to molybdenum-blue after Stainton et al. (1977). Total filterable phosphorus (TFP) and filterable reactive phosphorus (FRP) were determined by the molybdate blue-ascorbic acid method (Murphy and Riley 1962) modified by Eisenreich et al. (1975). TP was analyzed after potassium persulfate-sulfuric acid digestion using the FRP procedure (Eisenreich et al. 1975). Samples for nitrate + nitrite (NO_3^- + NO_2^-) and ammonia (NH_4^+) were analyzed on a Spectronic Genesys 5 Spectrophotometer using the cadmium reduction and phenylhypochlorite methods outlined in Stainton et al. (1977). Analysis of TKN was completed using the Macro-Kjeldahl/Phenate

methods described in Clesceri et al. (1998) in converting nitrogen to ammonia. This determines the concentrations of organic nitrogen and total ammonia. Total nitrogen (TN), the sum of TKN and nitrate + nitrite, was calculated for each sample in addition to the ratio of TN to TP (TN:TP).

Chlorophyll *a*

For chlorophyll *a* (chl *a*) analysis, 1.0 L of water from each sample was filtered through a Whatman GF/F filter under 15 psi vacuum pressure. Approximately 2 ml of magnesium chloride ($MgCO_3$) were added to the final 50 ml of water near the end of the filtration process. Filters were stored frozen and in individual plexiglass slides until analyzed. Filters were then ground in 90% buffered acetone using a mechanical tissue grinder, and the resulting slurry was refrigerated in separate 15-ml glass centrifuge tubes for 4 hours to ensure maximum pigment extraction. Pigment extracts were centrifuged, decanted, and diluted to 15 ml with 90% acetone (Koenings et al. 1987). The extracts were analyzed fluorometrically with a Turner 112 fluorometer equipped with a F4T5B lamp and calibrated with purified chl *a* (Sigma Chemical).

Zooplankton

For zooplankton analysis, cladocerans and copepods were identified according to taxonomic keys in Pennak (1989) and Thorp and Covich (1991). Zooplankton were measured in triplicate 1 ml subsamples taken with a Hansen-Stempel pipette and placed in a Sedgewick-Rafter counting chamber. Lengths from a minimum of 15 animals of each species or group (typically animals are grouped at the genus level) were measured to the nearest 0.01 mm, and the mean was calculated. Biomass was estimated from species-specific linear regression equations between length and dry weight derived by Koenings et al. (1987). Zooplankton data from the two stations were averaged for each survey.

STOCKING

Stocking densities for Spiridon Lake were determined by estimating the lake's rearing capacity based on in-season zooplankton biomass from May through July (Honnold and Byrne 2005). Saltery Lake sockeye salmon eggs were collected in early September of 2004 by Pillar Creek Hatchery (PCH) personnel using standard fish culture procedures (ADF&G 1994). Eggs were flown back to Kodiak, incubated and reared at PCH, and the juvenile salmon were then aerially released into Spiridon Lake via fixed-wing aircraft.

SMOLT MONITORING

A crew of two technicians were housed in a cabin (built in 2003) on the southwest bank of Telrod Creek to monitor, estimate, and sample the sockeye salmon smolt emigration from Spiridon Lake (Figure 2). Sockeye salmon smolt that emigrated from the lake were funneled into a counting tank, enumerated, and released into a bypass system that circumvented the barrier falls. The entire bypass system consisting of two Canadian fan traps and supporting frame work, de-watering tanks, troughs, and a diversion weir (Chatto 2000; ADF&G 2005) were installed in the Spiridon Lake outlet creek (Telrod Creek) next to the cabin. A 15-cm diameter black plastic pipeline provides smolt passage around the falls during smolt emigration to the ocean. The pipeline carries water and smolt approximately 0.75 km and drops about 90 m in elevation before it terminates and smolt exit into lower Telrod Creek. Timed counts were used, as in past years, to estimate the number of emigrating smolt (ADF&G 2005). A portion of the smolt emigration were sampled for age and size data (Honnold 1997; ADF&G 2005). Once smolt emigrations and trapping ceased, the bypass system was removed from the creek and stored on the stream banks.

HARVEST MONITORING

Harvest within the SBSHA was monitored by two ADF&G personnel stationed at a camp on the outer eastern shoreline of Telrod Cove (Figure 1; Chatto 2000). In 2005, the camp was operated from late June to early August. A weatherport tent erected on a wooden platform housed the crew.

The crew monitored the commercial fishery in the SBSHA by skiff. Monitoring activities included assessing sockeye salmon run strength, recording the fishing effort, estimating the commercial catch by species, and sampling a portion of the sockeye salmon catch for age, sex, and length data (Schrof and Honnold 2003; ADF&G 2005). The ADF&G fish ticket database was used to generate the end-of-season catch summaries and to confirm on-site estimates.

ESCAPEMENT MONITORING

The field crew conducted a foot survey of Telrod Creek during the commercial fishery to estimate sockeye salmon and pink salmon *O. kisutch* escapements. Live and dead salmon were enumerated by species. In an effort to monitor the chum salmon escapements of surrounding systems, aerial surveys of the Spiridon River drainage and Spiridon Bay were conducted twice, in early and late August, with fixed-wing aircraft.

RESULTS AND DISCUSSION

LAKE LIMNOLOGY MONITORING

Total Nitrogen to Total Phosphorus Ratio

The total nitrogen to total phosphorus ratio (TN:TP) in Spiridon Lake was 296:1 in 2005 (Table 2), which was above the desired range of 148:1 to 273:1, specified in the SLMP (Table 1). The 2005 TN:TP ratio was the highest recorded at Spiridon Lake. In contrast, the 2003 TN:TP ratio of 118:1 and the 2004 TN:TP ratio of 130:1 were the two lowest ratios recorded. The high 2005 TN:TP ratio was caused by a combination of a high average TKN level and a low average TP level. While phosphates were consistently low in all samples, there was a high variability in the TKN measurements ranging from a high of 456 µg/L on May 3 to a low of 9 µg/L on August 30. To assess whether the high TKN value in May was a legitimate high value or a data outlier, the ADF&G is currently processing an additional set of water samples from Station 2 in Spiridon Lake.

Total Ammonia

The 2005 seasonal mean concentration of total ammonia was 4.3 µg/L at 1 m in Spiridon Lake (Table 3). The standard deviation was fairly low, indicating little variability between sampling dates. The 2005 average ammonia concentration was lower than historical 1 m depth averages but was within the range of 1.6 - 11.2 µg/L specified in the SLMP (Table 1).

Chlorophyll *a*

Levels of Chl *a* in Spiridon Lake averaged 0.60 µg/L at the 1 m depth in 2005; results were averaged from water samples collected at two stations (Table 3). The average Chl *a* concentration was within the specified range of 0.1 - 1.0 µg/L (Table 1). Chl *a* concentrations showed little seasonal variability and were higher than the historical 1990 – 2004 mean (0.52 µg/L; SD = 0.23).

Total Zooplankton

The SLMP includes specific criteria to assess the lake's zooplankton (Table 1). In addition to the SLMP criteria, total biomass, density, and the cladoceran to copepod ratio are reported (Table 4).

The 2005 seasonal mean zooplankton density in Spiridon Lake was 4,964 No./m^3 and the biomass was 12.8 mg/m^3 (Table 4; Figure 2). Density and biomass in 2005 were below the mean values from 1990-2004 but above the 2004 values. Inter-annual variability of total zooplankton biomass has been high. The majority of the zooplankton in Spiridon Lake in 2005 were cladocerans, and the cladoceran to copepod ratio was the highest recorded. In the previous decade (1990-2000) the cladoceran to copepod biomass ratio was consistently less than 1 with one exception in 1997. From 2001 through 2005, the annual copepod biomass has been lower than cladoceran biomass.

Diaptomus to Cyclops Density Ratio

The *Diaptomus to Cyclops* density ratio was 0.03:1, which met the criteria range (0.01 – 0.54) specified in the SLMP (Table 5; Table 1). The average ratio from 1990-2004 was 0.11:1. Although the ratio of *Diaptomus to Cyclops* has been low in most years since 1992, it has met the specified criteria in all years.

Copepod Biomass

The average number of copepods in Spiridon Lake in 2005 was 1,671 No./m^3 and the average biomass was 2.7 mg/m^3, which was outside of the SLMP criteria range of 3.5 – 21.7 mg/m^3 (Table 5; Table 1). The average copepod density from 1990-2004 was 5,071 No./m^3 and the average biomass was 10.8 mg/m^3. Although copepod populations have been cyclical with large inter-annual variation, the 2004 and 2005 copepod biomass estimates were the lowest on record and should be closely monitored in the following years. The predominant copepod species in Spiridon Lake historically has been *Cyclops*, which continued to dominate the population in 2005.

Bosmina to Daphnia Density Ratio

The *Bosmina* to *Daphnia* density ratio of 1.56:1 was within the criteria range (0.22 – 1.73:1) specified in the SLMP (Table 6; Table 1). The average ratio from 1990-2004 was 0.96:1. The density of both *Bosmina* and *Daphnia* in 2005 was higher than all previous years.

Cladoceran Biomass

There were a record number of cladocerans in Spiridon Lake in 2005 (3,329 No./m^3; Table 6). The average biomass in 2005, of 10.2 mg/m^3, was nearly double the average biomass from 1990-2004 (5.5 mg/m^3), and was above the criteria range of 2.6 – 6.8 mg/m^3 (Tables 1 and 6). *Daphnia* and *Bosmina* prey primarily on phytoplankton and microbial plankton. The high Chlorophyll *a* and low ammonia concentrations are indicative of the high production rate in 2005. Both cladoceran species have likely benefited from this high production.

Cladoceran (Bosmina) Size

The cladoceran *Bosmina* averaged 0.50 mm in length, which was just slightly below the criteria ($\geq$ 0.51 mm) specified in the SLMP (Table 7; Table 1). The average size of *Bosmina* from 1990-2004 was 0.54 mm and the average size prior to the first stocking in 1990 was 0.58 mm. This is the second year in a row in which *Bosmina* have averaged 0.50 mm in length. The rationale for the minimal size requirement for *Bosmina* is that this species will decrease its reproductive size under increased predation pressure. As sockeye salmon grow, they target zooplankton of increasing size but are less efficient when feeding on smaller plankton organisms. Thus, stocking of larger juvenile sockeye salmon may be increasing predation pressure on both copepods and larger sized cladocerans, therefore causing *Bosmina* to adapt by reproducing and sustaining strong populations at a smaller size.

STOCKING

Juvenile sockeye salmon at different life stages were stocked into Spiridon Lake on two occasions in 2005. On June 23, approximately 693,176 fingerlings (average 0.75 g) were stocked into Spiridon Lake and on October 2-3, approximately 508,492 presmolt (average 9.50 g) were stocked, for a total of 1,201,668 juveniles (Table 8). The number of fish stocked in 2005 is the second lowest total since 1990, and substantially smaller than the average number of 3,565,340 sockeye salmon stocked from 1991-2004. The stocking numbers in the past five years have been below the 15-year average.

SMOLT MONITORING

Approximately 1,409,374 live sockeye salmon smolt emigrated from Spiridon Lake in 2005 (Table 9). The average emigration from 1992 – 2004 was 836,328 smolt. Smolt mortality occurring in the trapping/bypass system was considered minimal at 0.8% in 2005.

The age composition of the 2005 outmigration was predominately age 1. (96.3%), followed by age-2. (3.4%) and a small portion of age-3. (0.3%) smolt (table 9). The 13-year average (1992-2004) age composition was 77.7% age-1. followed by 22.2% age-2 and 0.2% age 3. smolt.

Age-1. smolt averaged 106 mm in length and weighed 9.6 g in 2005 (Table 10). Age-2. smolt averaged 178 mm and weighed 51.1 g. Very few (n=18) age-3. smolt were sampled; however their average size was 194 mm and 61.8 g. Average size of age 1. smolt declined in 2005 compared to the previous two years, but their average size was consistent with there average size of smolt from 1992 -2004, (109 mm and 10.9 g; Table 10).

HARVEST MONITORING

Commercial salmon harvests in the SBSHA occurred from June 21 through August 7 in 2005 (Table 11). Approximately 59,494 sockeye salmon, 0 coho salmon *O. kisutch*, 33,254 pink salmon *O. gorbuscha*, and 2,106 chum salmon *O. keta* were harvested. The 2005 harvest of the target species, sockeye salmon, was the second smallest harvest in the history of the special harvest area (Table 12). The number of non-targeted salmon species was notably less than in most years. The 2005 harvest of 33,254 pink salmon was the third lowest harvest after 1994 and 2004. Incidental pink salmon harvests are expected to remain low due to the advent of earlier closures of the SBSHA. The success of this management strategy was apparent by the lack of coho salmon harvested in the SBSHA in 2005.

Age-1.3 sockeye salmon comprised the majority (52.2%) of the harvest, while the age-1.2 fish comprised a smaller portion (38.3%) of the harvest (Table 13). Historically (1994-2004), the age-1.2 component represented slightly more of the harvest (58.1%) while the age-1.3 component represented slightly less (19.7%).

ESCAPEMENT MONITORING

A stream survey of Telrod Creek was conducted by onsite personnel downstream of the terminal falls on July 11, 2005. A total of 500 sockeye salmon and 100 pink salmon were observed (Table 14). Although the pink salmon escapement observation was the third lowest count in the 11 years, it was also the earliest the survey has been conducted. Historically the Telrod Creek surveys are typically conducted in mid-August, which more closely matches the run timing of pink salmon.

Two aerial stream surveys were conducted on the Spiridon River in 2005 (Table 15). Indexed peak pink salmon escapement counts were estimated to be 5,000 on August 8 and were only conducted on the upper river drainage under poor visibility conditions. Peak chum salmon escapement counts were estimated to be 15,500 on the second aerial survey on August 26. There were no coho salmon observed in either of the surveys, which was expected based on later run timing of coho salmon. Indexing the Spiridon River escapements using aerial survey methods is extremely difficult due to the heavily glaciated and turbid waters and estimates may not truly reflect the total abundance trends. The commercial fishery in the SBSHA was closed on August 7, resulting in few non-targeted species harvested in 2005. The Saltery Lake sockeye salmon brood stock used for stocking Spiridon Lake has an earlier run timing, which will continue to reduce the exploitation of pink and coho salmon bound for Spiridon River.

OUTLOOK FOR 2006

The five-year SLSUP for the Spiridon Lake project was renewed and is now scheduled to expire on December 31, 2010. The anticipated activities of the Spiridon Lake project at the smolt (Telrod Creek) and adult (Telrod Cove) camps are expected to be status quo for the 2006 field season.

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TABLES AND FIGURES

Table 1.-Spiridon Lake limnological and fishery monitoring parameters specified in the Spiridon Lake Management Plan (SLMP), and the 2005 results.

Parameter	Range Specified in the SLMP	2005 results
Lake Limnology Monitoring		
Total Nitrogen : Total Phosphorous Molar Ratio	148 - 273	296
Total Ammonia (μg/L)	1.6 - 11.2	4.3
Chlorophyl *a* (Chl *a*) (μg/L)	0.1 - 1.0	0.60
Diaptomus : *Cyclops* Density Ratio	0.01 - 0.54	0.03
Copepod Biomass (mg/m^3)	3.5 - 21.7	2.7
Bosmina : *Daphnia* Density Ratio	0.22 - 1.73	1.56
Cladoceran Biomass (mg/m^3)	2.6 - 6.8	10.2
Cladoceran (*Bosmina*) average size (mm)	$\geq$ 0.51	0.50
Stocking		
Sockeye		1,201,668
Smolt Monitoring		
Sockeye smolt outmigration estimate		1,409,374
Harvest Monitoring		
Telrod Cove (254-50)		
Sockeye		59,494
Coho		0
Pink		33,254
Chum		2,106
Escapement Monitoring		
Telrod Creek (254-403)		
Sockeye		500
Pink	>200	100
Spiridon River (254-401)		
Pink	15,000-45,000	5,000
Chum	10,000-30,000	15,500
Coho	4,000-12,000	0

Table 2.-Seasonal mean total kjeldahl nitrogen (TKN), nitrate+nitrite (No_3+No_2), total phosphorus (TP) concentrations, and total nitrogen to phosphorus ratio by weight (TN:TP) from the epilimnion (1 m) and hypolimnion (>25 m) of Spiridon Lake, 1988-2005.

Year	Depth	Station	TKN ($\mu g/L^1$)	No_3+No_2 ($\mu g/L^1$)	TP ($\mu g/L^1$)	TN:TP Ratio	Mean
1988	Epilimnion	1	102.8	220.5	3.8	187	
1988	Hypolimnion	1	94.9	256.9	3.8	205	
1988	Epilimnion	2	100.5	221.3	3.5	204	
1988	Hypolimnion	2	91.4	236.2	4.0	181	195
1989	Epilimnion	1	103.4	207.1	3.6	189	
1989	Hypolimnion	1	97.9	242.8	4.2	179	
1989	Epilimnion	2	114.8	197.9	6.1	114	
1989	Hypolimnion	2	104.0	209.8	7.3	95	151
1990	Epilimnion	1	92.5	203.4	3.5	188	
1990	Hypolimnion	1	85.3	228.5	3.0	233	
1990	Epilimnion	2	83.2	185.0	2.4	245	
1990	Hypolimnion	2	87.7	187.3	2.5	244	217
1991	Epilimnion	1	93.7	234.0	4.9	148	
1991	Hypolimnion	1	87.5	265.1	5.2	150	
1991	Epilimnion	2	91.8	237.0	3.6	201	
1991	Hypolimnion	2	88.6	267.7	3.8	209	175
1992	Epilimnion	1	89.6	239.5	3.7	196	
1992	Hypolimnion	1	87.0	258.7	4.9	158	
1992	Epilimnion	2	98.4	235.2	3.6	207	
1992	Hypolimnion	2	83.2	273.4	4.5	175	201
1993	Epilimnion	1	93.6	231.6	2.7	267	
1993	Hypolimnion	1	90.7	240.2	3.0	248	
1993	Epilimnion	2	97.0	230.3	2.9	253	
1993	Hypolimnion	2	85.4	247.7	2.5	293	260
1994	Epilimnion	1	101.8	204.3	3.2	212	
1994	Hypolimnion	1	97.5	218.1	3.9	178	
1994	Epilimnion	2	105.7	202.1	2.8	245	
1994	Hypolimnion	2	105.6	225.7	3.3	219	228
1995	Epilimnion	1	108.8	203.1	3.4	203	
1995	Hypolimnion	1	105.6	241.6	3.4	225	
1995	Epilimnion	2	125.2	213.4	3.9	194	
1995	Hypolimnion	2	108.2	243.1	3.2	244	199
1996	Epilimnion	1	113.4	183.6	2.7	242	
1996	Hypolimnion	1	90.5	210.8	3.0	222	
1996	Epilimnion	2	105.5	180.2	2.7	236	
1996	Hypolimnion	2	101.1	217.9	4.4	162	239

-continued-

Table 2.-Page 2 of 2.

Year	Depth	Station	TKN ($\mu g/L^1$)	No_3+No_2 ($\mu g/L^1$)	TP ($\mu g/L^1$)	TN:TP Ratio	Mean
1997	Epilimnion	1	103.6	147.4	3.0	184	
1997	Hypolimnion	1	90.5	191.0	2.8	223	
1997	Epilimnion	2	106.1	168.2	3.1	198	
1997	Hypolimnion	2	107.4	188.3	3.8	171	191
1998	Epilimnion	1	138.3	121.5	4.8	120	
1998	Hypolimnion	1	118.4	174.4	4.0	162	
1998	Epilimnion	2	124.6	148.3	3.9	155	
1998	Hypolimnion	2	122.9	171.9	4.0	163	137
1999	Epilimnion	1	93.0	188.0	4.0	155	
1999	Hypolimnion	1	92.0	211.4	3.2	213	
1999	Epilimnion	2	103.5	193.4	2.7	240	
1999	Hypolimnion	2	87.9	208.1	3.0	221	197
2000	Epilimnion	1	NA	195.5	7.0	NA	
2000	Epilimnion	2	NA	184.0	6.1	NA	
2001	Epilimnion	1	101.2	193.8	4.9	133	133
2001	Epilimnion	2	NA	189.2	6.7	NA	
2002	Epilimnion	1	96.7	136.5	3.3	156	156
2002	Epilimnion	2	NA	135.0	4.0	NA	
2003	Epilimnion	1	100.3	203.3	5.7	118	118
2003	Epilimnion	2	NA	201.3	3.5	NA	
2004	Epilimnion	1	97.6	208.1	5.2	130	130
2004	Epilimnion	2	NA	193.3	6.3	NA	
2005	Epilimnion	1	205.4	142.7	2.6	296	296
2005	Epilimnion	2	NA	NA	NA	NA	
Epilimnion mean 1988-1989:							173
Epilimnion mean 1990-2004:							184

NA – not analyzed

Table 3.-Summary of seasonal mean (including standard deviation -SD) nutrient and algal pigment concentrations by station and depth for Spiridon Lake, 1988-2005.

Year	Station	Depth (m)	Total-P (µg/L)	SD	Total Filterable-P (µg/L)	SD	Filterable reactive-P (µg/L)	SD	Total Kjeldahl nitrogen (µg/L)	SD	Ammonia (µg/L)	SD	Nitrate+nitrite (µg/L)	SD	Chlorophyll *a* (µg/L)	SD
1988	1	1	3.8	1.4	3.0	1.1	2.5	1.2	102.8	11.4	9.9	2.7	220.5	26.0	0.45	0.09
	1	50	3.8	0.6	2.2	0.6	1.7	0.5	94.9	9.0	11.2	5.5	256.9	9.6	0.16	0.06
	2	1	3.5	0.1	2.0	0.6	1.8	0.3	100.5	11.3	7.8	6.6	221.3	11.1	0.40	0.10
	2	50	4.0	0.6	1.9	0.6	1.8	0.5	91.4	9.9	8.6	4.4	236.2	27.5	0.29	0.12
1989	1	1	3.6	0.7	3.7	1.9	3.0	2.2	103.4	7.6	8.5	2.5	207.1	35.4	0.19	0.11
	1	50	4.2	1.0	3.2	1.2	2.4	0.4	97.9	18.6	11.5	7.3	242.8	54.9	0.32	0.18
	2	1	6.1	3.7	2.7	1.0	2.5	0.4	114.8	45.7	9.5	5.2	197.9	61.9	0.18	0.13
	2	50	7.3	7.8	2.7	0.7	2.7	0.7	104.0	40.1	12.5	11.0	209.8	50.4	0.37	0.28
1990	1	1	3.5	1.8	2.4	0.6	2.0	0.8	92.5	16.5	4.9	2.0	203.4	36.8	0.23	0.11
	1	50	3.0	0.7	2.8	0.5	2.0	0.6	85.3	10.9	6.3	2.5	228.5	24.8	0.34	0.21
	2	1	2.4	0.6	4.1	3.2	3.3	2.4	83.2	6.4	4.7	1.7	185.0	79.4	0.24	0.09
	2	50	2.5	0.8	2.8	1.1	2.9	1.9	87.7	12.3	6.6	2.8	187.3	80.1	0.24	0.12
1991	1	1	4.9	5.9	2.8	0.8	2.6	0.9	93.7	7.3	7.6	4.4	234.0	38.1	0.38	0.14
	1	50	5.2	3.7	3.3	2.0	2.8	1.4	87.5	12.9	9.4	4.8	265.1	20.9	0.20	0.09
	2	1	3.6	0.8	4.8	3.3	4.6	3.3	91.8	8.6	8.2	4.5	237.0	29.6	0.35	0.12
	2	50	3.8	1.5	3.6	3.3	3.4	3.2	88.6	7.4	11.3	5.8	267.7	7.7	0.25	0.14
1992	1	1	3.7	0.6	2.1	0.7	1.5	0.5	89.6	10.1	1.5	0.8	239.5	12.3	0.27	0.15
	1	50	4.9	1.4	4.2	3.1	3.7	3.0	87.0	8.0	4.6	3.3	258.7	16.9	0.22	0.07
	2	1	3.6	0.3	2.6	1.4	2.4	1.4	98.4	18.2	1.7	0.6	235.2	25.9	0.27	0.21
	2	50	4.5	0.8	3.1	2.8	2.0	1.1	83.2	24.8	5.3	3.7	273.4	7.7	0.23	0.11
1993	1	1	2.7	0.9	2.2	1.1	1.6	0.8	93.6	11.2	2.4	1.5	231.6	37.6	0.75	0.24
	1	50	3.0	0.9	3.0	4.0	1.8	1.8	90.7	10.8	5.2	3.4	240.2	22.8	0.42	0.20
	2	1	2.9	1.0	3.2	3.5	2.6	3.3	97.0	12.0	1.8	0.5	230.3	41.5	0.77	0.29
	2	50	2.5	0.1	3.2	2.5	2.8	2.5	85.4	3.8	5.4	3.7	247.7	30.6	0.40	0.22
1994	1	1	3.2	1.3	1.9	1.5	1.5	1.1	101.8	3.9	3.2	4.7	204.3	22.1	0.26	0.21
	1	50	3.9	2.0	1.2	0.2	1.1	0.4	97.5	16.1	6.7	3.6	218.1	18.3	0.21	0.13
	2	1	2.8	0.7	2.2	1.5	1.4	0.9	105.7	12.8	1.6	1.3	202.1	17.2	0.31	0.15
	2	50	3.3	1.2	2.2	1.3	1.9	1.1	105.6	13.2	5.8	2.5	225.7	20.6	0.20	0.07
1995	1	1	3.4	2.2	0.9	0.1	0.9	0.2	108.8	12.3	2.2	1.6	203.1	26.8	0.95	0.49
	1	50	3.4	1.3	1.5	0.3	1.4	0.4	105.6	20.4	3.5	2.4	241.6	6.6	0.58	0.44
	2	1	3.9	2.0	1.2	0.4	1.1	0.2	125.2	24.1	2.2	1.0	213.4	19.8	1.02	0.41
	2	50	3.2	0.9	0.9	0.2	0.9	0.1	108.2	18.6	4.5	3.0	243.1	9.1	0.58	0.45

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Table 3.-Page 2 of 2.

Year	Station	Depth (m)	Total-P (µg/L)	SD	Total Filterable-P (µg/L)	SD	Filterable reactive-P (µg/L)	SD	Total Kjeldahl nitrogen (µg/L)	SD	Ammonia (µg/L)	SD	Nitrate+nitrite (µg/L)	SD	Chlorophyll *a* (µg/L)	SD
1996	1	1	2.7	0.6	1.5	0.9	1.0	0.5	113.4	34.1	5.1	2.8	183.6	18.5	0.49	0.16
	1	50	3.0	1.1	1.3	0.7	1.0	0.4	90.5	18.5	9.3	5.0	210.8	9.0	0.51	0.23
	2	1	2.7	0.7	1.4	0.7	1.1	0.3	105.5	20.7	5.6	1.6	180.2	14.4	0.47	0.14
	2	50	4.4	1.7	1.5	0.7	1.5	1.3	101.1	16.9	10.2	4.1	217.9	2.4	0.57	0.33
1997	1	1	3.0	0.6	3.4	3.5	3.5	4.1	103.6	12.0	11.2	5.8	147.4	31.1	0.57	0.35
	1	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.58	0.37
	1	50	2.8	0.7	1.8	0.4	1.8	0.5	90.5	5.2	11.1	6.3	191.0	19.7	0.38	0.22
	2	1	3.1	0.9	3.2	3.3	3.1	3.2	106.1	11.3	11.2	6.4	168.2	25.2	0.59	0.35
	2	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.57	0.32
	2	50	3.8	1.5	3.1	1.0	3.2	1.0	107.4	30.3	10.7	6.2	188.3	17.5	0.44	0.24
1998	1	1	4.8	1.6	2.7	1.8	1.7	1.0	138.3	20.5	8.4	6.1	121.5	24.7	0.43	0.25
	1	50	4.0	0.4	1.6	0.8	1.3	0.5	118.4	10.1	10.2	5.4	174.4	19.6	0.14	0.04
	2	1	3.9	1.2	1.5	1.1	1.4	0.6	124.6	10.1	4.9	1.4	148.3	12.2	0.38	0.28
	2	50	4.0	1.7	1.5	0.9	1.5	0.7	122.9	12.0	9.6	4.5	171.9	26.4	0.21	0.12
1999	1	1	4.0	2.5	1.9	0.5	1.5	0.5	93.0	4.8	6.4	2.9	188.0	33.8	0.49	0.30
	1	50	3.2	0.4	1.7	0.7	1.2	0.5	92.0	2.7	6.9	3.8	211.4	6.1	0.15	0.05
	2	1	2.7	0.3	2.3	0.7	1.7	0.4	103.5	14.3	6.2	4.1	193.4	24.0	0.30	0.22
	2	50	3.0	0.6	2.3	1.6	1.7	1.4	87.9	15.3	11.2	6.0	208.1	10.1	0.25	0.14
2000	1	1	7.0	4.5	3.4	3.8	2.3	2.2	NA	NA	8.7	8.6	195.5	1.8	0.58	0.14
	2	1	6.1	8.7	3.3	4.6	2.0	2.0	NA	NA	7.5	8.0	184.0	15.7	0.77	0.18
2001	1	1	4.9	3.3	3.5	2.1	1.9	2.0	101.2	8.0	4.6	4.7	193.8	6.7	0.60	0.30
	2	1	6.7	5.1	3.5	3.3	2.7	3.5	NA	NA	2.1	1.3	189.2	7.3	0.60	0.10
2002	1	1	3.3	2.6	1.5	0.9	3.0	1.9	96.7	14.5	5.0	2.3	136.5	7.9	0.32	0.00
	2	1	4.0	1.9	1.3	1.3	1.9	1.0	NA	NA	3.4	1.7	135.0	21.2	0.45	0.18
2003	1	1	5.7	0.8	2.8	3.4	2.6	1.7	100.3	10.1	2.6	2.1	203.3	36.7	0.70	0.40
	2	1	3.5	0.7	1.4	1.1	3.6	0.8	NA	NA	1.9	2.0	201.3	22.1	0.60	0.30
2004	1	1	5.2	3.9	0.9	1.0	1.4	0.8	97.6	22.2	5.7	1.8	208.1	18.8	0.70	0.27
	2	1	6.3	5.3	3.2	5.1	2.1	0.4	NA	NA	6.8	1.2	193.3	23.4	0.70	0.29
2005	1	1	2.6	1.1	2.2	1.8	NA	NA	205.4	141.2	4.3	1.5	142.7	27.5	0.52	0.18
	2	1	NA	NA	1.1	1.2	NA	NA	NA	NA	NA	NA	NA	NA	0.68	0.06
Mean 1 m 1988-1989:			4.3	1.5	2.8	1.1	2.4	1.0	105.4	19.0	8.9	4.2	211.7	33.6	0.31	0.11
Mean 1 m 1990-2004:			4.0	2.1	2.4	1.9	2.1	1.4	102.7	13.6	5.0	3.0	193.0	24.4	0.52	0.23

SD - standard deviation; NA - not analyzed

Table 4.-Summary of the Spiridon Lake weighted mean density and biomass of Cladocerans and Copepods and their density ratio, 1988-2005.

	Cladoceran		Copepod		Total		Cladoceran to Copepod ratio[a]	
	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass
Year	No./m^3	mg/m^3	No./m^3	mg/m^3	No./m^3	mg/m^3	No./m^3	mg/m^3
1988	1,120	5.3	4,006	11.7	5,126	17.0	0.28	0.45
1989	1,308	4.9	9,826	15.8	11,134	20.7	0.13	0.31
1990	1,055	5.1	6,361	17.7	7,416	22.8	0.17	0.29
1991	834	3.4	8,862	18.8	9,696	22.2	0.09	0.18
1992	980	4.5	6,996	21.7	7,976	26.2	0.14	0.21
1993	878	2.9	5,616	10.3	6,494	13.2	0.16	0.29
1994	1,517	4.7	4,977	10.0	6,494	14.7	0.30	0.47
1995	1,589	6.4	4,538	12.0	6,127	18.4	0.35	0.53
1996	1,180	5.2	7,762	17.1	8,942	22.3	0.15	0.30
1997	1,531	6.7	2,477	6.3	4,008	13.0	0.62	1.06
1998	1,715	6.8	7,262	10.5	8,977	17.3	0.24	0.65
1999	726	2.6	1,450	3.5	2,176	6.1	0.50	0.74
2000	1,580	5.0	7,393	9.6	8,973	14.6	0.21	0.52
2001	1,752	7.6	1,421	4.4	3,173	11.9	1.23	1.73
2002	2,211	11.3	4,964	9.8	7,175	21.1	0.45	1.16
2003	2,785	6.8	3,779	6.7	6,564	13.4	0.74	1.01
2004	1,679	3.6	1,510	2.9	3,189	6.5	1.11	1.22
2005	3,329	10.2	1,635	2.7	4,964	12.8	2.04	3.77
mean 88-89:	1,214	5.1	6,916	13.8	8,130	18.9	0.18	0.37
mean 90-04:	1,467	5.5	5,025	10.8	6,492	16.2	0.29	0.51

[a] Means are not calculated; actual values based on mean density.

Table 5.-Spiridon Lake weighted mean Copepod density and biomass by species and the Diaptomus to Cyclops density ratio, 1988-2005.

		Epischura		*Diaptomus*		*Cyclops*		Totals		*Diaptomus*
	Number	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass	*to Cyclops*
Year	of Samples	No./m^3	mg/m^3	No./m^3	mg/m^3	No./m^3	mg/m^3	No./m^3	mg/m^3	density ratio[a]
1988	4	0	0.0	1,067	4.9	2,939	6.8	4,006	11.7	0.36
1989	5	0	0.0	2,199	6.7	7,627	9.1	9,826	15.8	0.29
1990	5	0	0.0	2,228	9.4	4,134	8.3	6,361	17.7	0.54
1991	7	0	0.0	2,276	7.5	6,587	11.3	8,862	18.8	0.35
1992	6	0	0.0	504	3.1	6,492	18.6	6,996	21.7	0.08
1993	6	5	0.0	221	1.1	5,395	9.2	5,621	10.3	0.04
1994	6	0	0.0	155	0.8	4,822	9.2	4,977	10.0	0.03
1995	6	0	0.0	266	2.5	4,272	9.5	4,538	12.0	0.06
1996	6	0	0.0	69	0.4	7,693	16.7	7,762	17.1	0.01
1997	6	0	0.0	64	0.5	2,413	5.8	2,477	6.3	0.03
1998	5	0	0.0	163	0.9	7,099	9.6	7,262	10.5	0.02
1999	5	0	0.0	97	0.5	1,353	3.0	1,450	3.5	0.07
2000	5	133	0.2	61	0.3	7,332	9.3	7,526	9.8	0.01
2001	5	46	0.1	95	0.9	1,326	3.4	1,467	4.4	0.07
2002	5	81	0.1	459	2.5	4,506	7.3	5,045	9.9	0.10
2003	4	381	0.4	593	2.6	3,186	4.1	4,160	7.1	0.19
2004	5	57	0.1	100	0.7	1,410	2.3	1,567	3.0	0.07
2005	5	36	0.0	45	0.2	1,590	2.5	1,671	2.7	0.03
Mean 1988-1989:	5	0	0.0	1,633	5.8	5,283	8.0	6,916	13.8	0.31
Mean 1990-2004:	5	47	0.1	490	2.2	4,535	8.5	5,071	10.8	0.11

[a] Means are not calculated; actual values based on mean density.

Table 6.-Summary of the Spiridon Lake weighted mean density and biomass of Cladocerans by species and the Bosmina to Daphnia density ratio, 1988-2005.

		Bosmina		*Daphnia*		*Holopedium*		Totals		*Bosmina* to
Year	Number of Samples	Density No./m^3	Biomass mg/m^3	Density No./m^3	Biomass mg/m^3	Density No./m^3	Biomass mg/m^3	Density No./m^3	Biomass mg/m^3	*Daphnia* density ratio[a]
1988	4	724	2.6	381	2.6	15	0.1	1,120	5.3	1.90
1989	5	759	2.2	441	1.9	108	0.8	1,308	4.9	1.72
1990	5	424	1.4	601	3.6	30	0.1	1,055	5.1	0.70
1991	7	144	0.4	662	2.9	28	0.1	834	3.4	0.22
1992	6	298	1.0	614	3.0	68	0.5	980	4.5	0.49
1993	6	324	0.9	479	1.4	75	0.6	878	2.9	0.68
1994	6	561	1.5	801	2.0	155	1.2	1,517	4.7	0.70
1995	6	599	1.5	591	1.6	399	3.3	1,589	6.4	1.01
1996	6	571	1.9	427	1.6	182	1.7	1,180	5.2	1.34
1997	6	652	1.8	526	2.2	353	2.7	1,531	6.7	1.24
1998	5	474	1.2	915	4.4	326	1.2	1,715	6.8	0.52
1999	5	374	1.2	216	0.7	136	0.7	726	2.6	1.73
2000	5	855	2.0	442	1.2	282	1.7	1,580	5.0	1.94
2001	5	664	1.9	793	2.5	294	3.2	1,752	7.6	0.84
2002	5	714	2.1	485	2.4	1,012	6.9	2,211	11.3	1.47
2003	4	1,671	3.2	826	1.7	288	1.9	2,785	6.8	2.02
2004	5	638	1.4	999	2.0	42	0.2	1,679	3.6	0.64
2005	5	1,745	4.1	1,122	1.9	462	4.2	3,329	10.2	1.56
Mean 1988-1989:	5	741	2.4	411	2.3	62	0.5	1,214	5.1	1.80
Mean 1990-2004:	5	598	1.6	625	2.2	245	1.7	1,467	5.5	0.96

[a] Means are not calculated; actual values based on mean density.

Table 7.-Seasonal weighted mean lengths (mm) of zooplankton taxa in Spiridon Lake, 1988-2005.

Year	*Diaptomus*	*Cyclops*	*Bosmina*	*Daphnia*	*Holopedium*
1988	1.02	0.81	0.61	1.20	0.73
1989	0.89	0.60	0.56	0.96	0.82
1990	0.99	0.76	0.59	1.10	0.69
1991	0.94	0.70	0.55	0.99	0.76
1992	1.13	0.91	0.60	1.01	0.91
1993	1.06	0.70	0.51	0.80	0.83
1994	1.09	0.75	0.55	0.75	0.85
1995	1.30	0.79	0.51	0.78	0.83
1996	0.99	0.78	0.58	0.92	0.91
1997	1.26	0.82	0.54	1.00	0.84
1998	1.09	0.63	0.52	0.90	0.58
1999	1.06	0.78	0.58	0.92	0.63
2000	1.14	0.61	0.51	0.79	0.76
2001	1.34	0.85	0.55	0.84	0.97
2002	1.12	0.69	0.55	1.01	0.80
2003	1.00	0.62	0.45	0.68	0.80
2004	1.14	0.70	0.50	0.72	0.68
2005	1.00	0.67	0.50	0.62	0.79
Mean 1988-1989:	0.95	0.71	0.58	1.08	0.77
Mean 1990-2004:	1.12	0.74	0.54	0.88	0.79

Table 8.-Sockeye salmon stocking numbers, life stage, size and release date by year into Spiridon Lake, 1990-2005.

Year	Fry			Fingerling			Presmolt			Total
	Date	Number	Weight (g)	Date	Number	Weight (g)	Date	Number	Weight (g)	Number
1990	n/a	249,346	n/a							249,346
1991	7-Jul	3,480,000	0.25							3,480,000
1992	20-Jun	2,200,000	0.20							2,200,000
1993	9-Jun	4,246,000	0.20							4,246,000
1994	24-May	4,400,000	0.16							
1994	9-Jun	1,276,000	0.20							5,676,000
1995	26-Jun	2,813,000	0.30	5-Jul	1,786,000	0.40				4,599,000
1996	21-May	1,100,000	0.18	26-Jun	3,744,000	0.35				4,844,000
1997	28-Jun	4,200,000	0.23							
1997	12-Jul	1,300,000	0.31	24-Jul	1,200,000	0.52				6,700,000
1998 [a]	18-Jun	784,000	0.35	7-Jul	2,556,000	0.70				3,340,000
1999 [b]	18-Jun	600,000	0.33	11-Jul	2,160,000	0.75				
1999 [c]				8-Aug	804,000	1.65				3,564,000
2000	25-May	535,000	0.30							
2000	11-Jun	3,355,000	0.40	23-Aug	507,100	3.00				4,397,100
2001 [d]				19-Jun	1,700,600	0.80				1,700,600
2002				30-Jul	366,000	1.20	4-Oct	586,900	8.50	952,900
2003				29-Jun	730,744	1.20	9-Oct	686,775	11.80	1,417,519
2004				19-Jun	2,008,205	0.48				
2004 [e]				16-Aug	288,219	4.10	6-Oct	501,220	11.50	2,797,644
2005 [f]				23-Jun	693,176	0.75	2-Oct	508,492	9.50	1,201,668
Mean 1991-2004:										3,565,340
Mean 1991-2001:										4,067,882
Mean 2002-2005:										1,592,433

[a] Fingerlings were stocked from 1 July - 13 July with average weights of 0.5 - 0.9 g.

[b] Fingerlings were stocked from 8 July - 29 July with average weights of 0.5 -1.0 g.

[c] Fingerlings were stocked from 2 August - 17 August with average weights of 0.5 -1.0 g.

[d] Fingerlings were stocked from 16 June - 21 June with average weights of 0.8 g.

[e] Presmolt were stocked from 5 October - 7 October with average weights of 11.5 g.

[f] Presmolt were stocked from 2 October - 3 October with average weights of 9.5 g.

Table 9.-Spiridon Lake sockeye salmon total and live smolt estimates by year and age 1992-2005.

Smolt Outmigration Year	Number and Relative Proportions of Smolt by Age Class			Total Smolt	Total Mortality	Number and Relative Proportions of Live Smolt by Age Class			Total Live Smolt
	1.	2.	3.			1.	2.	3.	
1992	1,466,995	17,826	0	1,484,821	87,169	1,380,321	17,331	0	1,397,652
	98.8%	1.2%	0.0%	100.0%	5.9%	98.8%	1.2%	0.0%	100.0%
1993	260,115	85,443	0	345,558	15,433	249,784	80,341	0	330,125
	75.3%	24.7%	0.0%	100.0%	4.5%	75.7%	24.3%	0.0%	100.0%
1994	599,717	244,360	6,271	850,348	3,123	597,502	243,464	6,259	847,225
	70.5%	28.7%	0.7%	100.0%	0.4%	70.5%	28.7%	0.7%	100.0%
1995	314,604	299,556	831	614,992	21,030	304,326	288,822	813	593,961
	51.2%	48.7%	0.1%	100.0%	3.4%	51.2%	48.6%	0.1%	100.0%
1996	918,540	135,414	1,232	1,055,186	23,120	897,762	133,097	1,207	1,032,066
	87.1%	12.8%	0.1%	100.0%	2.2%	87.0%	12.9%	0.1%	100.0%
1997	654,293	237,492	2,934	894,719	25,551	635,650	230,685	2,833	869,168
	73.1%	26.5%	0.3%	100.0%	2.9%	73.1%	26.5%	0.3%	100.0%
1998	529,726	216,923	301	746,950	21,321	514,606	210,731	292	725,629
	70.9%	29.0%	0.0%	100.0%	2.9%	70.9%	29.0%	0.0%	100.0%
1999	812,267	123,458	373	936,118	37,331	779,875	118,534	358	898,787
	86.8%	13.2%	0.0%	100.0%	4.0%	86.8%	13.2%	0.0%	100.0%
2000	792,029	493,529	5,133	1,290,692	4,384	788,909	492,275	5,122	1,286,306
	61.4%	38.2%	0.4%	100.0%	0.3%	61.3%	38.3%	0.4%	100.0%
2001	1,093,246	442,975	0	1,536,221	7,305	1,087,695	441,221	0	1,528,916
	71.2%	28.8%	0.0%	100.0%	0.5%	71.1%	28.9%	0.0%	100.0%
2002	441,964	92,484	0	534,448	12,523	431,542	90,384	0	521,925
	82.7%	17.3%	0.0%	100.0%	2.3%	82.7%	17.3%	0.0%	100.0%

-continued-

Table 9.-Page 2 of 2.

Smolt Outmigration Year	Number and Relative Proportions of Smolt by Age Class 1.	2.	3.	Total Smolt	Total Mortality	Number and Relative Proportions of Live Smolt by Age Class 1.	2.	3.	Total Live Smolt
2003	228,857	34,854	914	264,624	1,777	227,376	34,698	789	262,863
	86.5%	13.2%	0.3%	100.0%	0.7%	86.5%	13.2%	0.3%	100.0%
2004	540,748	36,884	1,272	578,904	1,249	539,582	36,804	1,269	577,655
	93.4%	6.4%	0.2%	100.0%	0.2%	93.4%	6.4%	0.2%	100.0%
2005	1,368,763	48,326	4,264	1,421,353	11,979	1,357,702	47,636	4,036	1,409,374
	96.3%	3.4%	0.3%	100.0%	0.8%	96.3%	3.4%	0.3%	100.0%
Average	665,623	189,323	1,482	856,429	20,101	648,841	186,030	1,457	836,328
1992-2004	77.7%	22.1%	0.2%	100.0%	2.3%	77.6%	22.2%	0.2%	100.0%

Table 10.-Mean length, weight, and condition coefficient by age of sockeye salmon smolt emigrating from Spiridon Lake, 1991-2005.

	Age-1.					Age-2.					Age-3.				
Year	*n* [a]	%	Length (mm)	Weight (g)	Condition (K)	*n* [a]	%	Length (mm)	Weight (g)	Condition (K)	*n* [a]	%	Length (mm)	Weight (g)	Condition (K)
1991	596/?	100.0	127	19.3	1.08	0/0	0.0				0/0	0.0			
1992	1393/1389	98.8	115	12.7	0.81	16/14	1.1	183	58.9	0.80	0/0	0.0			
1993	817/493	66.8	116	13.4	0.83	404/240	33.0	155	33.8	0.88	2/2	0.2	178	50.7	0.90
1994	1477/929	73.5	106	9.3	0.78	526/344	26.2	152	28.5	0.79	6/4	0.3	254	145.8	0.88
1995	1697/999	60.9	104	9.2	0.81	1081/667	38.8	138	25.1	0.95	6/5	0.2	244	102.8	0.84
1996	2224/1573	76.1	109	10.3	0.79	694/513	23.7	141	20.7	0.73	6/5	0.2	221	85.6	0.77
1997	1428/876	66.2	102	8.6	0.80	720/441	33.4	137	20.6	0.80	11/6	0.5	169	41.9	0.81
1998	2205/1496	77.4	93	6.3	0.76	727/414	22.5	127	15.4	0.75	3/0	0.1			
1999[b]	1452/799	73.6	95	7.0	0.80	518/336	26.3	122	14.1	0.78	2/1	0.1	126	15.0	0.75
2000	2263/1700	81.1	94	6.8	0.79	507/325	18.2	132	18.5	0.80	22/8	0.8	142	22.4	0.77
2001	2037/2037	80.1	104	8.8	0.78	506/506	19.9	136	20.2	0.79	0/0	0.0			
2002	1716/1716	86.6	118	12.7	0.77	266/266	13.4	155	30.2	0.80	0/0	0.0			
2003	1226/1197	80.0	131	20.4	0.89	288/277	18.8	165	42.4	0.87	19/19	1.2	168	42.7	0.84
2004	1325/1325	89.0	127	16.8	0.80	160/160	10.7	184	51.3	0.80	3/3	0.2	227	98	0.84
2005	1069/1069	88.6	106	9.6	0.79	119/119	9.9	178	51.1	0.83	18/18	1.5	194	61.8	0.84
mean 1992-2004:		77.7	109	10.9	0.80		22.0	148	29.2	0.81		0.3	192	67.2	0.82

[a] The first ‘n’ is the number of aged smolt / the second ‘n’ is the number of smolt sampled for length, weight, and condition.

[b] One smolt sampled was age 0. and was 96 mm; 6.6 g; 0.75 K.

Table 11.-Commercial harvest by species by day in the Spiridon Bay Special Harvest Area (statistical area 254-50), 2005.

Date	Sockeye	Coho	Pink	Chum
21-Jun	4,380	0	0	0
22-Jun	103	0	2	0
23-Jun	559	0	29	0
24-Jun	1,426	0	63	1
25-Jun	493	0	31	0
26-Jun	1,220	0	108	18
27-Jun	0	0	0	0
28-Jun	4,618	0	540	1
29-Jun	821	0	179	5
30-Jun	1,406	0	416	13
1-Jul	1,070	0	400	18
2-Jul	40	0	22	0
3-Jul	202	0	52	2
4-Jul	242	0	58	2
5-Jul	2,222	0	440	9
6-Jul	196	0	102	3
7-Jul	186	0	77	0
8-Jul	335	0	198	2
9-Jul	821	0	335	3
10-Jul	3,719	0	1,330	11
11-Jul	0	0	0	0
12-Jul	1,080	0	1,010	3
13-Jul	2,449	0	1,132	100
14-Jul	4,805	0	2,963	123
15-Jul	1,064	0	820	36
16-Jul	425	0	463	148
17-Jul	0	0	0	0
18-Jul	6,032	0	4,042	304
19-Jul	1,050	0	457	130
20-Jul	2,303	0	2,043	199
21-Jul	1,907	0	6,412	331
22-Jul	440	0	1,423	146
23-Jul	0	0	0	0
24-Jul	1,441	0	1,048	240
25-Jul	167	0	259	17
26-Jul	1,818	0	360	180
27-Jul	125	0	116	9
28-Jul	27	0	55	16
29-Jul	6,907	0	4,776	27
30-Jul	0	0	0	0
31-Jul	0	0	0	0
1-Aug	0	0	0	0
2-Aug	0	0	0	0
3-Aug	0	0	0	0
4-Aug	0	0	0	0
5-Aug	1,384	0	832	7
6-Aug	95	0	0	0
7-Aug	1,916	0	661	2
Total	59,494	0	33,254	2,106

Table 12.-Commercial harvest by species by year in the Spiridon Bay Special Harvest Area (statistical area 254-50), 1994-2005.

Year	Sockeye	Coho	Pink	Chum
1994	130,891	4,584	32,331	2,291
1995	11,889	2,194	46,422	2,169
1996	164,114	3,622	44,701	4,684
1997	66,480	4,889	54,236	2,575
1998	90,447	2,211	103,715	4,812
1999	192,773	2,149	61,004	13,700
2000	81,931	565	108,254	13,070
2001	59,733	345	70,883	12,885
2002	201,534	2,331	222,860	8,189
2003	259,714	66	73,549	10,643
2004	75,775	12	23,644	2,105
2005	59,494	0	33,254	2,106
1994-2004	120,439	1,838	80,927	7,483

Table 13.-Estimated age composition of adult sockeye salmon harvest from Spiridon Bay Special Harvest Area (statistical area 254-50), 1994-2005.

Year	Sample Size		Ages													
			0.2	1.1	0.3	1.2	2.1	1.3	0.4	2.2	2.3	3.1	3.2	3.3	1.4	2.4	Total
1994	1,329	Percent	0.0	0.1	0.0	99.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
		Numbers	0	149	0	114,624	356	30	0	21	9	0	0	0	0	0	115,189
1995	1,313	Percent	0.1	19.9	0.1	60.2	1.9	4.9	0.0	11.6	1.3	0.0	0.0	0.0	0.0	0.0	100
		Numbers	19	6,312	37	19,089	595	1,563	0	3,667	409	0	0	0	0	0	31,691
1996	1,875	Percent	0.0	1.8	0.0	79.0	4.6	0.2	0.0	14.3	0.0	0.1	0.0	0.0	0.0	0.0	100
		Numbers	0	2,846	0	128,123	7,448	303	0	23,192	0	111	97	0	0	0	162,120
1997	1,703	Percent	0.0	2.8	0.0	62.6	2.8	2.4	0.0	29.3	0.0	0.0	0.0	0.0	0.0	0.0	100
		Numbers	0	1,795	0	40,359	1,824	1,558	0	18,908	25	7	7	0	0	0	64,483
1998	1,943	Percent	0.0	4.2	0.0	81.8	2.0	0.6	0.0	10.7	0.5	0.0	0.1	0.0	0.0	0.0	100
		Numbers	0	3,726	0	72,354	1,785	543	0	9,448	485	0	111	0	0	0	88,452
1999	2,345	Percent	0.0	0.4	0.0	47.8	0.2	32.7	0.0	17.4	1.5	0.0	0.1	0.0	0.0	0.0	100
		Numbers	0	689	86	91,129	298	62,405	0	33,167	2,836	0	168	0	0	0	190,778
2000	1,997	Percent	0.0	0.1	0.1	71.5	0.2	3.0	0.0	18.3	6.6	0.0	0.1	0.0	0.1	0.0	100
		Numbers	9	122	60	58,559	176	2,419	0	14,987	5,446	0	110	0	42	0	81,930
2001	1,534	Percent	0.0	1.1	0.1	58.5	3.4	17.2	0.0	19.0	0.7	0.0	0.0	0.0	0.0	0.0	100
		Numbers	0	674	51	34,921	2,022	10,300	28	11,334	391	0	0	0	7	7	59,735
2002	1,572	Percent	0.0	0.2	0.0	36.1	2.0	35.8	0.0	24.7	1.0	0.0	0.1	0.0	0.1	0.0	100
		Numbers	0	466	59	71,962	4,077	71,479	0	49,330	1,909	0	119	0	139	0	199,540
2003	1,782	Percent	0.0	0.3	0.0	46.3	0.0	26.9	0.0	21.2	5.1	0.0	0.0	0.0	0.1	0.0	100
		Numbers	0	849	0	120,346	68	69,908	0	55,122	13,201	0	68	0	151	0	259,714
2004	1,761	Percent	0.0	0.1	0.0	27.8	0.0	54.6	0.0	7.8	9.4	0.0	0.0	0.0	0.2	0.0	100
		Numbers	0	101	29	21,029	22	41,349	0	5,880	7,156	0	29	22	160	0	75,775
2005	1,272	Percent	0.0	7.5	0.0	38.3	0.0	52.2	0.0	1.5	0.3	0.0	0.0	0.0	0.0	0.0	100
		Numbers	0	4,475	0	22,812	25	31,081	0	909	193	0	0	0	0	0	59,494
Mean	1,741	Percent	0.0	1.3	0.0	58.1	1.4	19.7	0.0	16.9	2.4	0.0	0.1	0.0	0.0	0.0	100
1994-2004:		Numbers	3	1,612	29	70,227	1,697	23,805	3	20,460	2,897	11	64	2	45	1	120,855

[a] Totals may not add exactly due to rounding.

Table 14.-Indexed peak salmon escapements by species at Telrod Creek (254-403), 1995-2005.

Year	Date	Sockeye[a]	Pink[a]
1995	15-Aug	120	233
1996	15-Sep	10	238
1997	11-Sep		350
	9-Oct	3,000	
1998	17-Aug	5,013	327
1999	31-Aug	1,220	
	10-Sep		60
2000	4-Sep	1,321	353
2001	18-Aug	1,600	450
2002	13-Aug		1,710
	17-Aug	1,880	
2003	14-Aug	5,252	450
2004	3-Aug	1,200	0
2005	11-Jul	500	100

[a] Survey estimates include salmon in stream mouth.

Table 15.-Indexed peak salmon escapements by species for the Spiridon river (254-401), 1995-2005.

Year	Date	Observer	Survey Conditions	Survey counts [a] pink	chum	coho
1995	17-Aug	ADF&G	good	87,800	22,000	
	13-Oct	FWS	good			10,300
1996	29-Aug	FWS	good	5,700	8,000	
	16-Oct	FWS	excellent			10,600
1997	1-Aug	ADF&G	good	18,100	5,500	
	9-Oct	ADF&G	excellent			13,300
1998	14-Aug	ADF&G	fair	29,500	6,150	
	14-Sep	FWS	good			1,750
1999	11-Aug	ADF&G	fair		15,000	
	27-Aug	ADF&G	fair	15,500		
2000	21-Aug	FWS	fair	1,000	16,500	
	20-Oct	FWS	good			2,900
2001	1-Aug	ADF&G	poor		3,000	
	7-Aug	ADF&G	fair	18,000		
	29-Oct	FWS	good			4,550
2002	2-Sep	ADF&G	fair to poor	32,000	6,500	
	3-Sep	ADF&G	poor		7,380	
					13,880 [b]	
2003	5-Aug	ADF&G	poor	5,000	5,700	
	5-Sep	ADF&G	poor			700
2004[c]						
2005[d]	8-Aug	ADF&G	poor	5,000	6,400	0
	26-Aug	ADF&G	good to excellent	50	15,500	

[a] Survey counts include stream, mouth, and bay areas.

[b] The 2002 peak chum estimate was a sum of the September 2 and 3 survey estimates. ADF&G manager's sum estimates were from surveys conducted on two consecutive days in determining the indexed peak count.

[c] No surveys were conducted in 2004.

[d] The August 8 survey only included the upper river drainage.

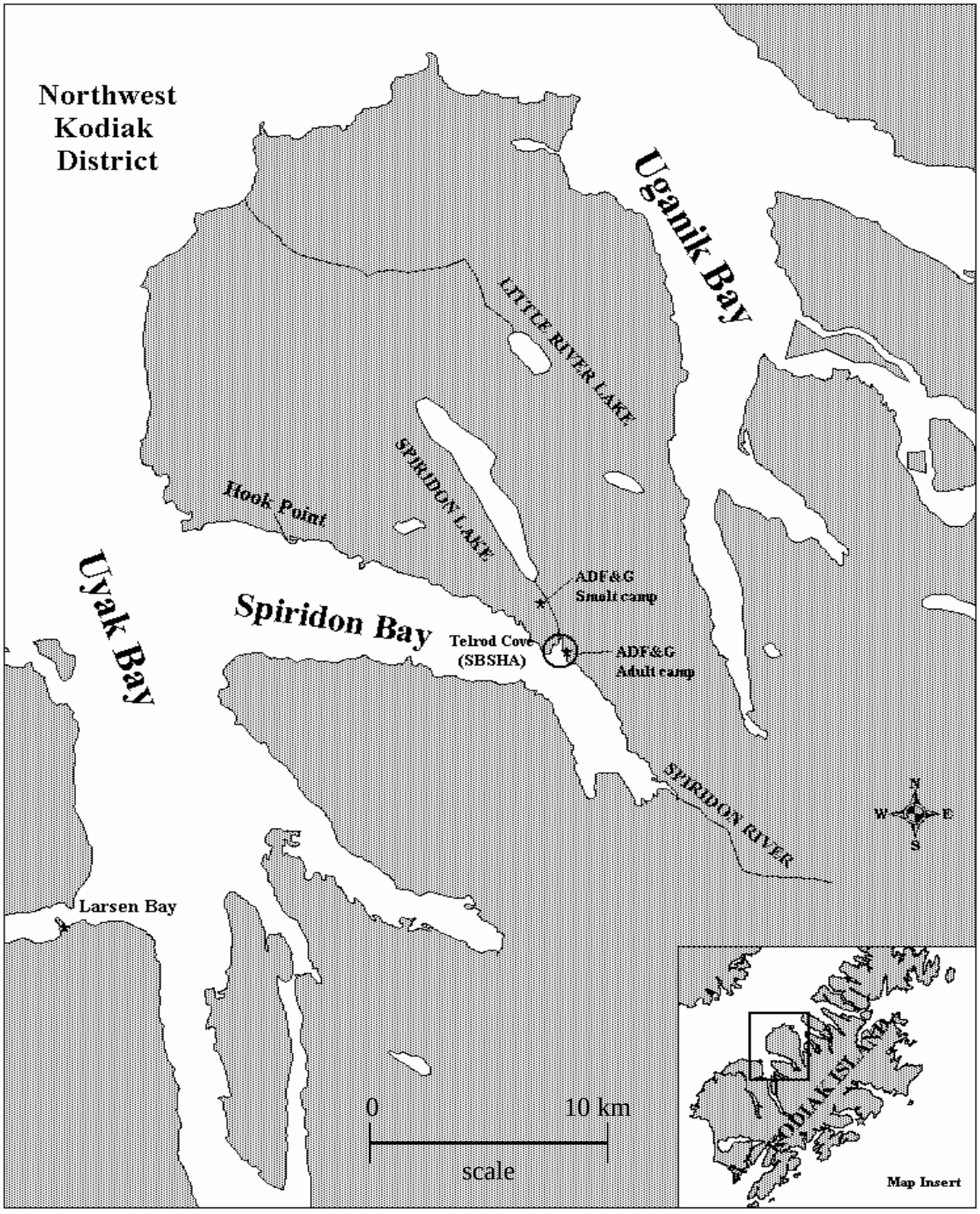

Figure 1.-Locations of the ADF&G smolt and adult salmon field camps, Spiridon Lake, Telrod Cove, and Spiridon Bay in the Northwest Kodiak Commercial Fishing District.

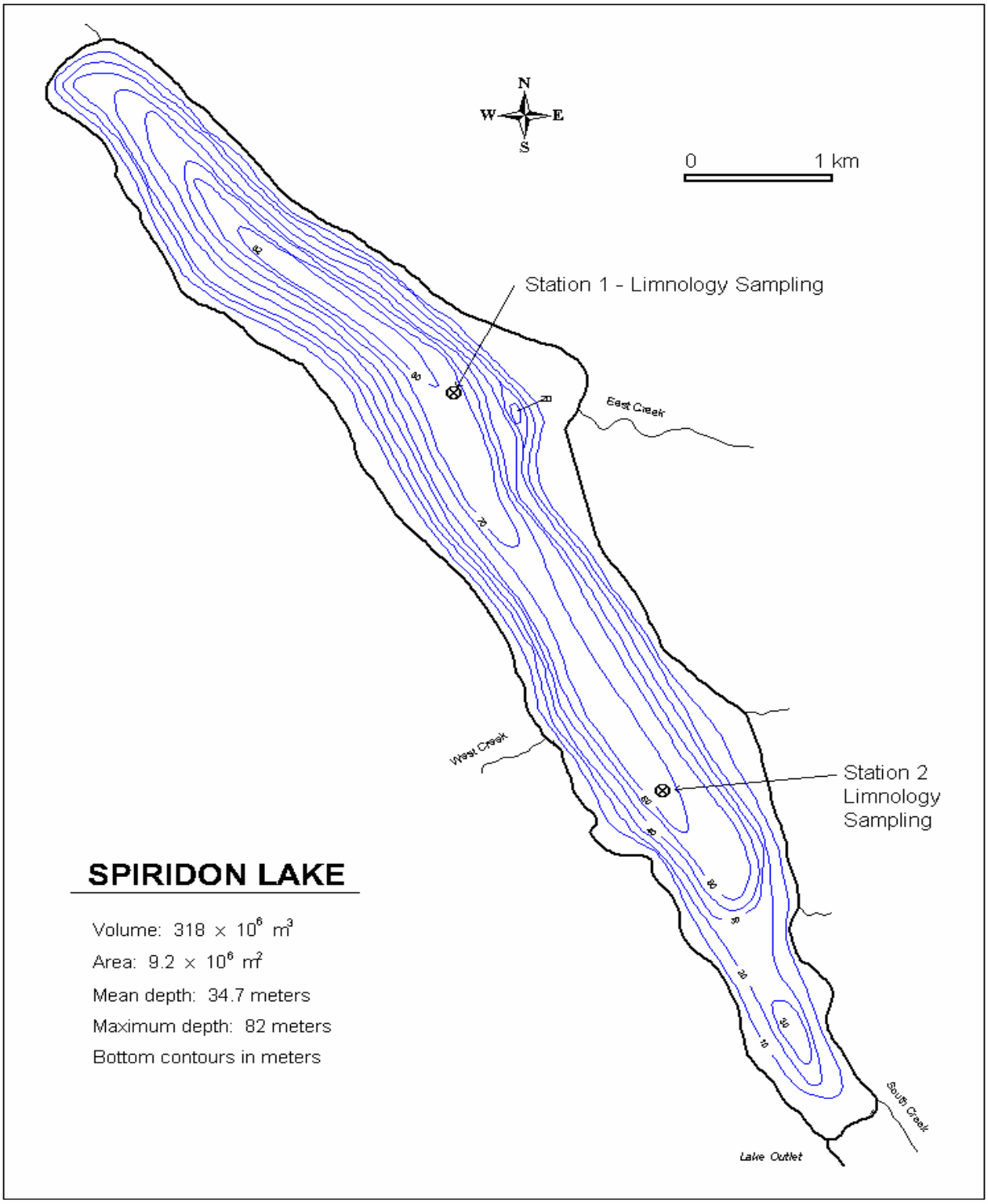

Figure 2.-Morphometric map showing the limnology sampling stations on Spiridon Lake.

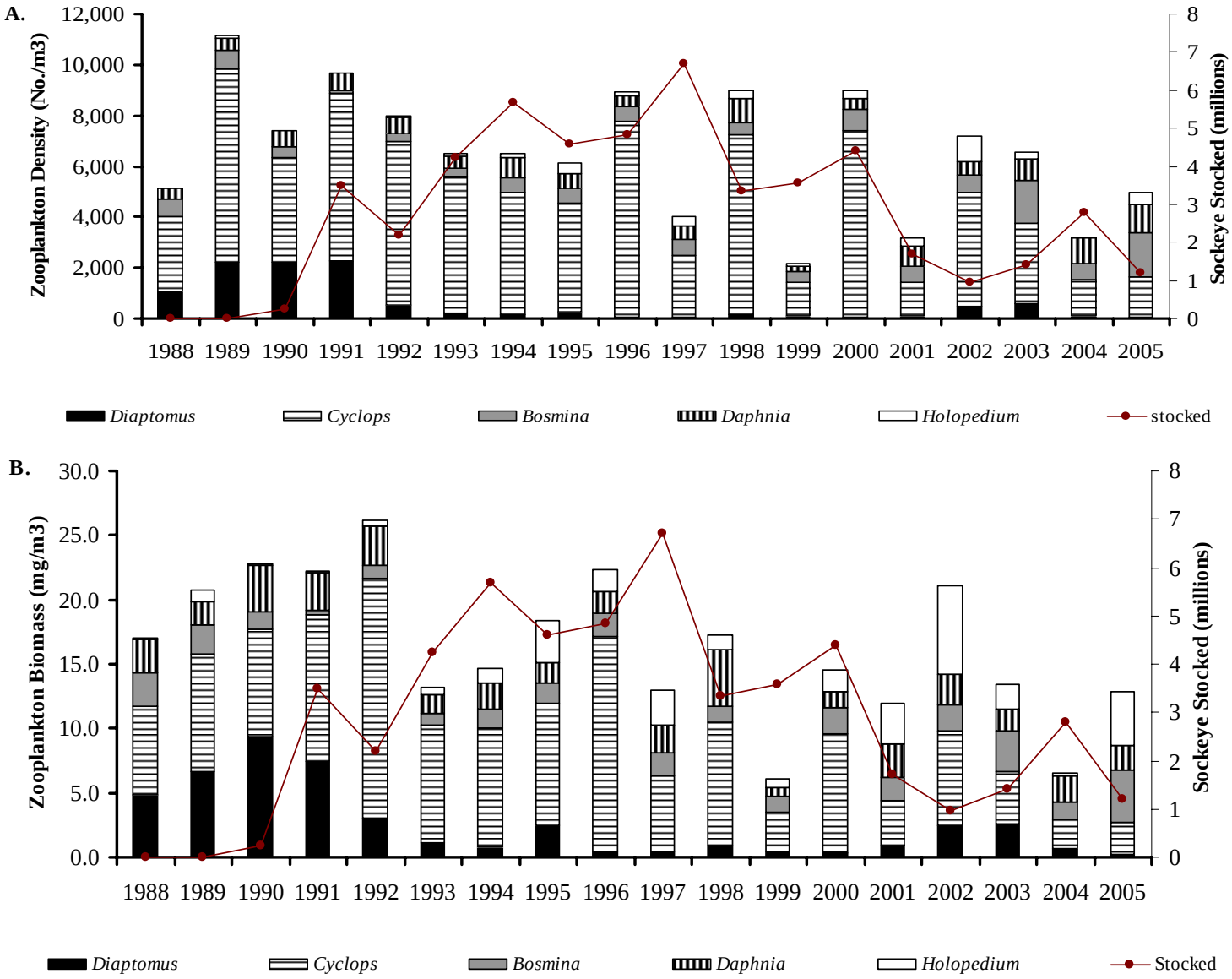

Figure 3.-Zooplankton density (A) and biomass (B) compared to sockeye salmon stocking levels for Spiridon Lake, 1988-2005.