Fishery Management Report No. 07-37

The 2006 Hidden Lake Sockeye Salmon Stocking Project and Related Monitoring Parameters

by

Robert T. Baer

May 2007

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

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

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

FISHERY MANAGEMENT REPORT NO. 07-37

THE 2006 HIDDEN LAKE SOCKEYE SALMON STOCKING PROJECT AND RELATED MONITORING PARAMETERS

by

Robert T. Baer
Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

May 2007

The Kodiak Regional Aquaculture Association (KRAA) funds the general operations of the Hidden Lake sockeye salmon stocking project and Pillar Creek Hatchery. The Division of Commercial Fisheries provides biological oversight and evaluation in the management of returning adult runs to the enhanced or rehabilitated systems associated with hatchery stocking projects.

The Division of Sport Fish Fishery Management Reports series was established in 1989 for the publication of an overview of Division of Sport Fish management activities and goals in a specific geographic area. Since 2004, the Division of Commercial Fisheries has also used the Fishery Management Report series. Fishery Management Reports are intended for fishery and other technical professionals, as well as lay persons. Fishery Management Reports are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm. This publication has undergone regional peer review.

Robert T. Baer
Alaska Department of Fish and Game, Division of Commercial Fisheries,
211 Mission Road, Kodiak, Alaska 99615 USA

This document should be cited as:
Baer, R. 2007. The 2006 Hidden Lake stocking project and related monitoring parameters. Alaska Department of Fish and Game, Fishery Management Report No. 07-37, Anchorage.

TABLE OF CONTENTS

Page

LIST OF TABLES ii

LIST OF FIGURES ii

ABSTRACT 1

INTRODUCTION 1

MANAGEMENT PLAN MONITORING GUIDELINES 2

Description of Study Area 2

METHODS 3

Lake Limnology Monitoring 3
- Lake Sampling Protocol 3
- General Water Chemistry and Nutrients 3
- Chlorophyll *a* 4
- Zooplankton 4

Stocking 4

Smolt Monitoring 4

Harvest Monitoring 4

Escapement Monitoring 5

RESULTS AND DISCUSSION 5

Lake Limnology monitoring 5
- Total Nitrogen to Total Phosphorus Ratio 5
- Total Ammonia 5
- Chlorophyll *a* 5
- Total Zooplankton 5
- Diaptomus to Cyclops Density Ratio 6
- Copepod Biomass 6
- Bosmina to Daphnia Density Ratio 6
- Cladoceran Biomass 6
- Cladoceran (Bosmina) Size 6

Stocking 6

Smolt Monitoring 6

Harvest Monitoring 7

Escapement Monitoring 7

OUTLOOK FOR 2007 7

REFERENCES CITED 8

TABLES AND FIGURES 9

LIST OF TABLES

Table **Page**

1. Hidden Lake limnological and fishery data and the monitoring parameters specified in the Hidden Lake Management Plan (HLMP), and the 2006 results. 10
2. Seasonal mean total kjeldahl nitrogen (TKN), nitrate+nitrite (No3+No2), total phosphorus (TP) concentrations, and total nitrogen to total phosphorus ratio by weight (TN:TP) from the epilimnion (1m) and hypolimnion (>25m) of Hidden Lake, 1987, 1990-2006. 11
3. Summary of seasonal mean (including standard deviation -SD) nutrient and algal pigment concentrations by station and depth for Hidden Lake, 1987, 1990-2006. 12
4. Summary of the Hidden Lake weighted mean density and biomass of Cladocerans and Copepods and their density ratio, 1987, 1990-2006. 14
5. Hidden Lake weighted mean Copepod density and biomass by species and the Diaptomus to Cyclops density ratio, 1987, 1990-2006. 15
6. Summary of the Hidden Lake weighted mean density and biomass of Cladocerans by species and the Bosmina to Daphnia density ratio, 1987, 1990-2006. 16
7. Seasonal weighted mean lengths (mm) of zooplankton taxa in Hidden Lake, 1987, 1990-2006. 17
8. Sockeye salmon stocking numbers, life stage, size and release date by year into Hidden Lake, 1992-2006. 18
9. Mean length, weight, and condition coefficient by age of a portion of sockeye salmon smolt emigrating from Hidden Lake, 1993-2002. 19
10. Commercial harvest by species by day in the Foul Bay Special Harvest Area (statistical area 251-41), 2006. 20
11. Estimated age composition of adult sockeye salmon harvest from Foul Bay Special Harvest Area (statistical area 251-41), 1995-2005. 21
12. Commercial harvest by species by year in the Foul Bay Special Harvest Area (statistical area 251-41), 1995-2006. 22
13. Peak salmon escapement counts and indexed total escapement estimates at Hidden Creek (stream no. 251-41-406), 1992-1999. 23

LIST OF FIGURES

Figure **Page**

1. Location of Hidden Lake and the Foul Bay Special Harvest Area on Afognak Island. 24
2. Morphometric map showing the limnology sampling station on Hidden Lake. 25
3. Zooplankton density (A) and biomass (B) compared to sockeye salmon stocking levels for Hidden Lake, 1987, 1990-2006. 26

ABSTRACT

A sockeye salmon *Oncorhynchus nerka* enhancement stocking project was initiated on the Hidden Lake systems in the early 1990s to provide increased harvest opportunities for fishermen in the Kodiak Management Area. Because Hidden 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 Hidden Lake Management Plan (HLMP), ADF&G monitored and examined specific water quality parameters, zooplankton characteristics, juvenile stocking density and commercial salmon harvest in 2006. Specific parameters were tested and compared to criteria established as guidelines for the stocking project to ensure that the project does not adversely affect the Hidden Lake system or surrounding areas.

The 2006 water quality parameters that were measured resulted in: a total nitrogen to total phosphorus ratio of 299:1, a total ammonia level of 8.4 µg/L, and a chlorophyll *a* of 0.72 µg/L. The zooplankton community parameters measured resulted in: a *Diaptomus* to *Cyclops* density ratio of 0.05:1, a copepod biomass of 3.0 mg/m^3, a *Bosmina* to *Daphnia* density ratio of 2.77:1, a cladoceran biomass of 6.1 mg/m^3, and a *Bosmina* size (average length) of 0.47 mm. An estimated 47,085 smolt emigrated from Hidden Lake in the spring of 2006 while a total of 421,668 juveniles were stocked in the summer and fall of 2006. A total of 819 adult sockeye salmon were harvested in the Foul Bay Special Harvest Area (FBSHA) and reported on commercial fish harvest tickets.

The Hidden Lake Stocking Project did not meet the specified nitrogen to phosphorus ratio parameter in 2006. The large discrepancy was due in part to an anomaly in the first sampling date with a very high nitrogen data point. All of the minimum criteria for each of the remaining specified parameters were met and were compatible with KNWR purposes.

Key words: Hidden Lake, Foul Bay, 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 2006 and historical project data collected from the Hidden Lake sockeye salmon *Oncorhynchus nerka* stocking project. Hidden Lake and the activities associated with the sockeye salmon stocking project are located within the boundaries of the Kodiak National Wildlife Refuge (KNWR) and are therefore, subject to U.S. Fish and Wildlife Service (USFWS) and KNWR guiding principles and conditions. Such conditions are described in the Hidden Lake Management Plan (HLMP; Chatto 2002) and are permitted under the special conditions described in the Hidden Lake Special Use Permit (HLSUP). The intention of this report is to fulfill the Alaska Department of Fish and Game (ADF&G) reporting requirements as outlined in the HLMP and HLSUP. This report compares and contrasts the results of a series of concurrent ADF&G studies and monitoring programs to HLMP guidelines intended to ensure compatibility with the KNWR purposes.

Prior to stocking, Hidden 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 and Schrof 2001). In addition to the utilization of the lake's 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 1992 ADF&G in cooperation with Kodiak Regional Aquaculture Association (KRAA) submitted proposals to the USFWS to stock sockeye salmon into Hidden Lake in the Afognak Unit of the KNWR (Chatto 2002; White 1992). The KNWR prepared an Environmental Assessment (EA) for the proposed project, which resulted in a finding of no significant impact (FONSI). A temporary HLSUP for the Hidden Lake project was issued to the ADF&G by the KNWR in 1992, to allow the project to continue until a thorough review of the baseline data could be completed and a comprehensive management plan developed that would contain parameters specific to Hidden Lake. In 2001, the ADF&G consolidated existing information (excluding brown bear and wildlife studies) from the Hidden Lake stocking project into one document (Honnold and Schrof 2001), which was then used for reference in writing the existing KNWR HLMP (Chatto 2002). The HLMP was authorized in April 2002 and the ADF&G was issued a 5-year renewable HLSUP to continue stocking and monitoring work in the KNWR.

Juvenile sockeye salmon have been stocked into Hidden Lake annually since 1992 (Schrof and Byrne 2006). The returning adult sockeye salmon are harvested in the Foul Bay Special Harvest Area (FBSHA; Figure 1). ADF&G has annually monitored the fishery and sampled a portion of the sockeye salmon commercial catch since the first adults returned in 1995.

This report compares and contrasts the 2006 results from a series of concurrent ADF&G studies and monitoring programs to HLMP guidelines intended to ensure compatibility with the KNWR purposes.

MANAGEMENT PLAN MONITORING GUIDELINES

The purpose of the HLMP is to outline the various components of the lake stocking project to determine 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 2002).

Monitoring guidelines were established from data collected at Hidden Lake from 1992–1999. 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 years, then the stocking project may need adjustments to meet the guidelines and purposes of the KNWR (Chatto 2002). Specific parameters monitored include lake nutrient concentrations (total nitrogen, phosphorus, ammonia, and chlorophyll *a*), zooplankton size, density and biomass, juvenile stocking, smolt production and adult harvest estimates (Table 1).

DESCRIPTION OF STUDY AREA

Hidden Lake (58^{o} 23'N, 152^{o} 42'W) is located on the northwest side of Afognak Island (approximately 72 km northwest of the city of Kodiak). The lake is 4.4 km long, up to 0.6 km wide, and has a surface area 1.9 km^2(Figure 2). Hidden Lake is at an elevation of 68 m, has a mean depth of 10.8 m, and a maximum depth of 42.0 m. The Hidden Lake outlet stream (Hidden Lake Creek) is approximately 2.4 km long and empties into the north arm of Foul Bay. A waterfall impassable to anadromous fish is located approximately 1.6 km upstream from the ocean.

Resident fish in Hidden Lake include: rainbow trout *O. mykiss*, Dolly Varden char *Salvenlinus malma*, three spine stickleback *Gasterosteus aculeatus*, and freshwater sculpin *Cottus aleuticus* (Honnold and Schrof 2001).

METHODS

LAKE LIMNOLOGY MONITORING

The HLMP outlines minimum and maximum values and parameters for specific water quality and limnological characteristics that are used as guidelines to ensure that the Hidden Lake sockeye salmon stocking project remains compatible with KNWR objectives (Chatto 2002; Table 1). Parameters to be measured include 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 Hidden Lake in a fixed wing aircraft four times from May–September at six week intervals. An established sampling station in the deepest basin of the lake was identified by a buoy and the location was verified with Global Positioning Satellite (GPS) equipment. Prior to 2000, water samples were collected from the epilimnion (at a depth of 1 m) and the hypolimnion (at a depth ≥25 m). After 2000, water samples were only collected from the epilimnion (at a depth of 1 m). A vertical tow was hauled to collect zooplankton during each survey. Samples were collected following standard ADF&G sampling procedures (ADF&G 2006).

Water samples were collected with a 4-L Van Dorn sampler, and the samples were emptied into 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

Unfiltered water was analyzed for total phosphorus (TP), total Kjeldahl nitrogen (TKN), pH, and Alkalinity. Sample water was filtered through a rinsed 4.25 cm diameter Whatman GF/F cellulose fiber filter and stored frozen in phosphate free soap-washed poly bottles. Filtered water was also analysed for total filterable phoshorus (TFP), filterable reactive phosphorus (FRP), nitrate + nitrite (NO_3^- + NO_2^-), ammonia (NH_{4+}) and Reactive silicon.

Total phosphorus was analyzed using a spectronic Genesys 5 Spectrophotometer (SGS) using the potassium persulfate-sulfuric acid digestion method described in Koenings et al. (1987) adapted from methods in Esienreich et al. (1975). Unfiltered frozen water was sent to South Dakota University for the TKN analysis. The pH of water samples was measured with a Corning 430 meter, while alkalinity (mg L^{-1} as $CaCO_3$) was determined from 100 ml of unfiltered water titrated with 0.02 N H_2SO^4 to a pH of 4.5 and measured with a pH meter (Mettler Toledo Seven easy).

Reactive Silicon was determined with a SG5 spectrophotometer using the ammonium molybdate – sodium sulfite method described in Koenings et al. (1987) and Thompsen et al. (2002). Total filterable phosphorus was determined using the same methods as those for TP utilizing filtered

water. Filterable reactive phosphorus was determined using the potassium persulfate- sulfuric acid method described in Koenings et al. (1987).

Samples for nitrate + nitrite (NO_3^- + NO_2^-) were analyzed using the cadmium reduction method described on the Spectronic Genysis 5 Spectrophotometer using the phenol-sodium hypochlorite method described in Koeings et al. (1987). Total nitrogen, the sum of total Kjeldahl nitrogen and nitrate + nitrite, was calculated for each sample in addition to the ratio of total nitrogen to total phosphorus.

Chlorophyll *a*

For 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 5 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 mortar and pestel, 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 using a Spectronic Genesys 5 Spectrophotometer using methods described in Thomsen et al. (2002).

Zooplankton

For zooplankton analysis, cladocerans and copepods were identified according to taxonomic keys in Edmondson (1959). Zooplankton samples 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).

STOCKING

Stocking densities for Hidden Lake were determined prior to the hatchery egg takes by estimating carrying capacity based on in-season zooplankton biomass (May through July; Schrof and Byrne 2006). Afognak Lake sockeye salmon eggs were collected in early August of 2005 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 then aerially released into Hidden Lake via fixed wing aircraft.

SMOLT MONITORING

Smolt monitoring was not conducted at Hidden Lake in 2006. A population estimate of juvenile sockeye salmon was determined by applying the number of juveniles stocked in 2005 to an estimated freshwater survival rate of 25%. The 25% survival rate was based on an average freshwater survival from 16 years (1991-2006) of stocking and monitoring of Spiridon Lake. From 1991 through 2005 a total of 51,365,777 fry and pre-smolt sockeye salmon have been stocked into Spiridon Lake. The out migration data from 1992 through 2006 resulted in a total of 12,846,610 for a total survival rate of 25% survival (Duesterloh and Watchers 2007; Table 1).

HARVEST MONITORING

ADF&G personnel monitored the commercial harvest within the FBSHA during the fishery opening while stationed on board the *M/V K-HI-C* (Figure 1). Monitoring goals were designed to include the assessment of 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 data (ADF&G 2006; Honnold and Schrof 2001). Although personnel were on site and prepared to collect harvest data, there was no opportunity to collect samples due to a very low sockeye salmon harvest.

ESCAPEMENT MONITORING

No escapement surveys of Hidden Creek were conducted in 2006.

RESULTS AND DISCUSSION

LAKE LIMNOLOGY MONITORING

Total Nitrogen to Total Phosphorus Ratio

The total nitrogen to total phosphorus molar ratio (TN:TP) in Hidden Lake was historically the highest (290.0:1) in 2006 (Table 2) and consequently did not meet the desired criteria ($\leq$ 106:1) specified in the HLMP (Table 1). The TN:TP ratio decreased to the historic low of 54.0:1 calculated in 2001 and again in 2005. The lower ratio was due, in part, to an increased phosphorus concentration, which is typically beneficial in oligotrophic lakes, such as Hidden Lake. The large spike of the TN:TP ratio in 2006 can be attributed to the historical high TKN concentration (234.3 µg/L) which was derived from the four data sampling sets. The first sampling date (25 May) had a TKN concentration of 642.0 µg/L causing the average for the season to be inflated to 234.3 µg/L and resulting in a standard deviation of 276.4 (Table 3). Suspicions arose that the sample was possibly contaminated due to the extremely elevated level of TKN in the first sample date. Consequently the sample was requested to be retesting and the data came back from the lab with the same results. Although this first sample date had very high results even when retested it is still considered abnormally high and should be considered as such when critically evaluated.

Total Ammonia

The 2006 seasonal average concentration of ammonia in Hidden Lake was 8.4 µg/L (Table 3). This ammonia concentration was above the 1992-2005 average (7.0 µg/L) but was within the threshold of $\leq$ 16.2 µg/L specified in the HLMP (Table 1).

Chlorophyll *a*

The seasonal mean Chl *a* concentration in Hidden Lake was 0.72 µg/L (Table 3). As noted in Table 1, the Chl *a* concentrations met the minimum specified parameter of $\geq$ 0.17 µg/L (Table 1). The 2006 Chl *a* concentrations were greater than most years, including the years prior to stocking (1990). These higher concentrations of Chl *a* suggests that there is improved algal biomass, which in turn provides an improved forage for zooplankton.

Total Zooplankton

The seasonal mean zooplankton density in Hidden Lake was 2,597 No./m^3 and the biomass was 11.0 mg/m^3 (Table 4). The 2006 zooplankton density is approximately 1,000 animals/m^3 smaller than the average density from 1992-2005 (3,535 No./m^3) while the 2006 total biomass was greater than the 1992-2005 average biomass of 8.2 mg/m^3 (Table 4; Figure 2). Current zooplankton biomass levels are consistent with the lake's historical data in which there have been corresponding trends between the stocking numbers and zooplankton.

Diaptomus to Cyclops Density Ratio

The *Diaptomus:Cyclops* density ratio of 0.05:1 met the minimum criteria ($\geq$ 0.01:1) specified in the HLMP (Table 1 and 5). The average ratio from 1992-2005 was 0.03:1. Since 1992, the density of *Diaptomus* has been very low and even reported as undetected in most years. Although the *Diaptomus:Cyclops* density ratio has not met the specified criteria in most years, the results indicate the current density has met the minimum requirements from 2004 through 2006 and suggest the *Diaptomous* are rebounding.

Copepod Biomass

The average copepod density in 2006 was 1,280 No./m^3 and the biomass was 3.0 mg/m^3 (Table 5). The 2006 copepod biomass was within the HLMP criteria of $\geq$ 0.40 mg/m^3 (Table 1). The average density of copepods from 1992-2005 was 2,319 No./m^3 and the average biomass was 3.9 mg/m^3 (Table 5).

Bosmina to Daphnia Density Ratio

The *Bosmina* to *Daphnia* density ratio of 2.77:1 was within the minimum criteria ($\geq$ 0.17:1) specified in the HLMP (Table 1 and 6). The average ratio from 1992-2005 was 4.99:1.

Cladoceran Biomass

There were an average of 1,317 No./m^3 cladocerans in Hidden Lake for 2006 and an average biomass of 6.1 mg/m^3 (Table 6). The 2006 biomass was within the minimum criteria of $\geq$ 2.20 mg/m^3 (Table 1 and 4). Average biomass in 2006 was greater than the average biomass (4.3 mg/m^3) from 1992-2005 (Table 6).

Cladoceran (Bosmina) Size

The cladoceran, *Bosmina*, averaged 0.47 mm in length which met the criteria (> 0.40 mm) specified in the HLMP (Table 1 and 7). The average size of *Bosmina* from 1992-2005 was 0.47 mm.

STOCKING

Juvenile sockeye salmon at different life stages were stocked in Hidden Lake on two occasions in 2006. Approximately 253,100 fry (0.45 g) were stocked on May 19, and on October 10, approximately 168,600 pre-smolt (11.8 g) were stocked (Table 8). This stocking level is approximately 126,000 fish greater than the average (295,564) number of sockeye salmon stocked from 1992-2005 (Figure 3).

SMOLT MONITORING

Based on the number of juveniles stocked into Hidden Lake in 2005 (188,342) and using the 25% survival rate, the estimated emigrating population from Hidden Lake in 2006 was approximately 47,085 smolt. Hydroacoustic surveys were traditionally conducted in the spring at Hidden Lake to index the abundance of rearing juvenile sockeye salmon. Due to lack of assurance in counting target vs. non-target species, variations in schooling smolt, and depleted stocking numbers, the low confidence in obtaining a reliable population index with hydroacoustic equipment made the survey unjustifiable. As a practical substitute, the freshwater smolt populations were estimated by using an average survival rate.

In years prior to 2003, the field crews have successfully collected smolt at the creek outlet for age, weight, and length data. In 2003, the field crew was unsuccessful in capturing or observing any sockeye salmon smolt. This may have been due to the limited number of smolt which were stocked. Smolt collection has not been attempted since 2003. From 1993-2002, age 1. smolt, on

average, have dominated the population (98.5%) with few age 2. smolt (1.5%) observed. The average size and weight of age 1. smolt has been 111.2 mm and 12.7 g while the age 2. smolt have averaged 140.8 mm and weighed 27.8 g (Table 9).

HARVEST MONITORING

Despite earlier fishing efforts, commercial salmon harvests in the FBSHA only occurred on one day and did not occur until July 7, 2006 (Table 10). Approximately 16 Chinook salmon *O. tshawytcha*, 819 sockeye salmon, 15 coho salmon *O. kisutch*, 525 pink salmon *O. gorbuscha* and 92 chum salmon *O. keta* compiled the entire 2006 harvest in the FBSHA.

Due to the limited and late harvest timing, the on site monitoring staff was unable to obtain any commercial salmon harvest samples in 2006. Historical average harvests from 1995-2005 indicate that the age 1.2 component represents 63.7% and the age 1.3 component makes up 28.7% (Table 11).

The 2006 sockeye salmon harvest (819) was the smallest harvest in the history of the special harvest area (Table 12). The commercial harvest of non-targeted coho and pink salmon were greater than historical averages while the Chinook and chum salmon were less than historical averages. The increase of coho and pink salmon by-catch can be contributed to the late harvest timing. The commercial fishery in the FBSHA closed on July 10.

ESCAPEMENT MONITORING

Escapement data on Hidden Creek are unavailable for the 2006 season as on site stream surveys of Hidden Creek were discontinued starting in 2000. Data from prior years are documented in Table 13. Pink salmon and steelhead trout *O. mykiss* have had an unobstructed migration access to Hidden Creek because the barrier weir was not installed in 2006. It is likely the pink salmon run occurred during its normal return timing in late July and August, after the FBSHA commercial sockeye salmon fishery closed. Due to the nature and timing of the Foul Bay SHA fishery it does not appear that it has had a negative impact on the migration of natural fish stocks into Hidden Creek.

OUTLOOK FOR 2007

The brood source for Hidden Lake juvenile releases has primarily been from Afognak Lake and is scheduled to be from Afognak Lake in 2007. The scheduled releases of juvenile sockeye salmon in 2007 are 300,000 fry and 200,000 pre-smolt for a total projected release of 500,000 sockeye salmon into Hidden Lake. All other operations and monitoring projects planned for 2007 are expected to be consistent with the 2006 monitoring goals and objectives.

REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 2006. Salmon research operational plans for the Kodiak area, 2006. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K06-4, Kodiak.

ADF&G (Alaska Department of Fish and Game). 1994. Alaska Sockeye Salmon Culture Manual, Special Fisheries Report No. 6. Juneau.

Chatto, D. T. 2002. Hidden Lake sockeye enhancement project management plan. US Fish and Wildlife Service, Kodiak National Wildlife Refuge, Kodiak.

Duesterloh S. and G. M. Watchers. 2007. 2006 Kodiak smolt projects summary. Alaska Department of fish and Game, Regional Information Report 4K07-02, Kodiak.

Edmondson, W. T. (ed) 1959. Freshwater biology, second edition. John Wiley and Sons, Inc. USA.

Eisenreich, S. J., R. T. Banner, and D. E. Armstrong. 1975. A simplified phosphorous analysis technique. Environ Letters 9:43-53.

Honnold, S. G. and S. T. Schrof. 2001. The results of sockeye salmon *Oncorhynchus nerka* stocking into Hidden Lake on the Kodiak National Wildlife Refuge: juvenile and adult production, commercial harvest, and ecosystem effects, 1987-1999. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K01-32, Kodiak.

Koenings, J. P., J. A. Edmundson, G.B. Kyle, and J. M. Edmundson. 1987. Limnology field and laboratory manual: Methods for assessing aquatic production. Alaska Department of Fish and Game, FRED Division Report Series 71, Juneau.

Kyle, G. B. 1996. Stocking sockeye salmon *Oncorhynchus nerka* in barren lakes of Alaska: effects on the macrozooplankton community. Fisheries Research 28:29-44.

Schrof, S. T. and G. Byrne. 2006. Pillar Creek Hatchery annual management plan, 2006. Alaska Department of Fish and Game, Division of Commercial Fisheries, Fishery Management Report 06-46, Kodiak.

Schrof, S. T. and S. G. Honnold. 2003. Salmon enhancement, rehabilitation, evaluation, and monitoring efforts conducted in the Kodiak Management Area through 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K03-41, Kodiak.

Thomsen, S. et al. 2002 Kodiak lake assessment/limnology project laboratory analysis operational plan. Alaska Department of Fish and Game, Division of Commercial Fisheries, *In* Regional Information Report 4K02-36, Kodiak.

White, L. E. 1992. Limnology and fisheries assessment of the potential production of sockeye salmon (*Oncorhynchus nerka*) in Hidden Lake. Alaska Department of Fish and Game, Fred Division. Cooperative Agreement No. 90-013, Kodiak.

TABLES AND FIGURES

Table 1.-Hidden Lake limnological and fishery data and the monitoring parameters specified in the Hidden Lake Management Plan (HLMP), and the 2006 results.

Parameter	Criteria Specified in HLMP	2006 results
Lake Limnology Monitoring		
Total Nitrogen : Total Phosphorous Molar Ratio	≤ 106	299.0
Total Ammonia (µg/L)	≤ 16.2	8.4
Chlorophyl a (Chl a) (µg/L)	≥ 0.17	0.72
Diaptomus :*Cyclops* Density Ratio	≥ 0.01	0.05
Copepod Biomass (mg/m^3)	≥ 0.40	3.0
Bosmina :*Daphnia* Density Ratio	≥ 0.17	2.77
Cladoceran Biomass (mg/m^3)	≥ 2.20	6.1
Cladoceran (*Bosmina*) average size (mm)	> 0.40	0.47
Stocking		
Sockeye	[a]	421,668
Smolt Monitoring		
Sockeye Salmon Population Estimate (25% survival estimation)	[a]	47,085
Harvest Monitoring		
Foul Bay SHA (251-41)		
Chinook	[a]	16
Sockeye	[a]	819
Coho	[a]	15
Pink	[a]	525
Chum	[a]	92
Escapement Monitoring		
Hidden Creek (251-406)	[a]	ns

[a] not a specified paremeter in the HLMP

ns - not surveyed

Table 2.-Seasonal mean total kjeldahl nitrogen (TKN), nitrate+nitrite (No_3+No_2), total phosphorus (TP) concentrations, and total nitrogen to total phosphorus ratio by weight (TN:TP) from the epilimnion (1m) and hypolimnion (>25m) of Hidden Lake, 1987, 1990-2006.

Year	Depth (m)	TKN (µg/L N)	No3+No2 (µg/L N)	TP (µg/L N)	TN:TP Ratio
1987	1	90.1	82.0	4.2	91
	25	80.7	90.9	4.0	94
1990	1	101.3	65.9	3.9	94
	29	79.2	88.7	2.1	177
1991	1	75.2	53.4	4.1	70
	30	82.9	70.4	3.1	110
1992	1	93.7	64.9	4.0	87
	27	98.8	74.3	5.1	76
1993	1	102.0	45.7	3.7	88
	42	84.2	90.4	3.1	124
1994	1	120.3	19.7	4.6	67
	40	88.2	54.9	4.3	74
1995	1	108.6	39.4	3.8	87
	43	91.7	64.2	3.6	95
1996	1	92.6	38.9	3.4	85
	42	80.4	72.5	3.7	91
1997		93.0	20.1	3.1	80
	43	87.7	47.7	3.3	91
1998	1	100.5	13.3	3.1	83
	42	98.2	17.2	3.2	80
1999	1	92.8	51.3	3.1	104
	42	81.0	73.0	3.2	107
2000	1	NA	48.2	4.9	NA
2001	1	99.5	25.8	5.1	54
2002	1	115.0	24.2	5.5	56
2003	1	102.7	57.1	4.7	75
2004	1	179.8	43.0	8.1	61
2005	1	152.0	37.0	7.7	54
2006	1	234.3	40.4	2.1	299
Mean 87-91:	1	88.9	67.1	4.1	84.9
Mean 92-05:	1	111.7	36.9	4.6	75.5

Table 3.-Summary of seasonal mean (including standard deviation -SD) nutrient and algal pigment concentrations by station and depth for Hidden Lake, 1987, 1990-2006.

		Total		Total		Filterable		Total Kjeldahl							
	Depth	Phosphorus		filterable-P		reactive-P		nitrogen		Ammonia		Nitrate+nitrite		Chlorophyll *a*	
Year	(m)	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD
1987	1	4.2	0.4	2.2	0.7	0.9	0.1	90.1	2.4	4.3	3.1	82.0	11.7	0.15	0.0
	25	4.0	1.6	2.9	0.9	1.1	0.2	80.7	11.4	4.6	3.2	90.9	5.7	0.06	0.1
1990	1	3.9	2.2	3.6	3.8	2.1	1.1	101.3	48.7	3.8	4.3	65.9	11.3	0.29	0.0
	29	2.1	1.2	1.4	0.3	1.2	0.2	79.2	34.0	6.1	2.3	88.7	16.4	0.11	0.0
1991	1	4.1	1.9	4.0	3.1	3.4	2.6	75.2	44.5	12.0	4.1	53.4	25.1	0.18	0.1
	30	3.1	0.7	2.5	0.7	1.9	0.8	82.9	19.1	13.6	3.4	70.4	13.7	0.07	0.1
1992	1	4.0	0.4	2.0	0.4	1.8	0.2	93.7	41.0	4.1	2.9	64.9	15.8	0.22	0.1
	27	5.1	3.8	2.5	0.9	2.4	1.1	98.8	34.3	3.7	2.5	74.3	16.0	0.11	0.1
1993	1	3.7	2.6	5.1	6.3	3.0	3.3	102.0	30.9	12.6	11.4	45.7	22.1	0.79	0.4
	42	3.1	1.6	2.4	1.1	1.9	1.1	84.2	23.4	16.2	9.0	90.4	16.1	0.20	0.2
1994	1	4.6	1.7	1.7	0.5	1.2	0.5	120.3	33.3	4.3	2.5	19.7	19.9	1.11	0.3
	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.87	0.9
	40	4.3	2.3	1.5	0.5	1.2	0.4	88.2	17.7	7.4	3.8	54.9	3.4	0.08	0.1
1995	1	3.8	2.2	2.2	1.6	1.7	1.2	108.6	24.6	9.7	3.0	39.4	15.8	0.77	0.3
	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.70	0.3
	43	3.6	2.2	2.0	0.8	1.3	0.7	91.7	12.9	10.2	1.9	64.2	3.6	0.22	0.2
1996	1	3.4	0.9	3.6	0.4	1.9	0.2	92.6	8.0	3.8	4.6	38.9	13.8	0.51	0.1
	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.46	0.1
	42	3.7	1.5	3.6	0.8	1.9	0.4	80.4	7.1	7.2	3.7	72.5	5.1	0.14	0.1
1997	1	3.1	1.4	1.9	0.4	1.6	0.3	93.0	8.8	7.8	8.3	20.1	13.2	0.39	0.1
	2		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.41	0.1
	43	3.3	1.2	2.7	1.1	2.2	1.1	87.7	14.2	15.1	9.5	47.7	3.0	0.12	0.1

-continued-

Table 3.-(page 2 of 2)

Year	Depth (m)	Total Phosphorus (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
1998	1	3.1	1.0	2.4	0.8	1.7	0.9	100.5	11.5	5.5	4.5	13.3	4.8	0.45	0.2
	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.18	0.2
	42	3.2	0.5	2.5	0.8	1.8	0.8	98.2	16.6	6.4	3.8	17.2	5.8	0.38	0.2
1999	1	3.1	0.4	1.7	0.3	1.2	0.3	92.8	8.9	10.7	1.6	51.3	20.7	0.17	0.1
	42	3.2	0.3	1.9	0.2	1.3	0.3	81.0	7.3	15.1	4.4	73.0	10.3	0.09	0.1
2000	1	4.9	4.0	2.8	1.3	1.4	1.4	NA	NA	11.9	10.3	48.2	15.1	1.03	1.2
2001	1	5.1	1.8	4.1	2.6	3.3	3.7	99.5	19.7	5.5	4.4	25.8	12.3	0.64	0.2
2002	1	5.5	4.0	2.0	0.7	2.0	1.3	115	26.9	6.2	2.3	24.2	15.6	0.60	0.1
2003	1	4.7	2.3	1.6	1.0	3.2	0.6	102.7	21.3	3.7	3.2	57.1	18.6	0.70	0.2
2004	1	8.2	8.3	4.5	4.6	3.1	1.4	179.8	120.6	7.4	2.0	43.0	22.1	0.48	0.3
2005	1	7.7	2.3	5.0	1.2	3.8	0.4	152.0	22.0	4.7	2.3	37.1	22.2	0.48	0.2
2006	1	2.1	1.2	1.4	0.8	2.2	1.2	234.3	276.4	8.4	2.8	40.4	17.8	0.72	0.4
mean 87-91:	1	4.1	1.5	3.2	2.6	2.1	1.3	88.9	31.9	6.7	3.8	67.1	16.0	0.21	0.0
mean 92-05:	1	4.6	2.4	2.9	1.6	2.2	1.1	111.7	29.0	7.0	4.5	37.7	16.6	0.6	0.3

SD - standard deviation
NA - not analyzed

Table 4.-Summary of the Hidden Lake weighted mean density and biomass of Cladocerans and Copepods and their density ratio, 1987, 1990-2006.

	Cladoceran		Copepod		Total		Cladoceran to Copepod ratio[a]	
Year	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)
1987	2,056	7.5	3,820	9.3	5,876	16.8	0.54	0.45
1990	1,581	5.2	4,193	12.6	5,774	17.8	0.38	0.29
1991	818	3.8	3,526	9.0	4,344	12.8	0.23	0.30
1992	873	3.8	3,130	6.3	4,003	10.1	0.28	0.38
1993	829	2.7	309	0.7	1,138	3.4	2.68	0.79
1994	1,162	5.1	153	0.4	1,315	5.5	7.59	0.92
1995	1,215	4.8	1,171	2.9	2,386	7.6	1.04	0.62
1996	692	2.2	2,170	4.9	2,862	7.1	0.32	0.31
1997	683	3.8	373	0.8	1,056	4.6	1.83	0.83
1998	1,281	4.1	1,110	2.7	2,391	6.8	1.15	0.61
1999	618	2.9	3,357	6.0	3,975	8.9	0.18	0.32
2000	728	2.5	601	1.1	1,329	3.5	1.21	0.70
2001	1,156	2.7	339	1.1	1,495	3.8	3.41	0.72
2002	3,282	9.5	1,452	2.5	4,734	12.0	2.26	0.79
2003	1,631	5.7	8,517	12.3	10,148	18.0	0.19	0.32
2004	1,701	7.4	3,564	5.6	5,265	13.0	0.48	0.57
2005	1,165	3.1	6,221	6.9	7,386	10.0	0.19	0.31
2006	1,317	6.1	1,280	3.0	2,597	11.0	1.03	0.55
mean 87-91:	1,485	5.5	3,846	10.3	5,331	15.8	0.39	0.35
mean 92-05:	1,215	4.3	2,319	3.9	3,535	8.17	1.63	0.58

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

Table 5.-Hidden Lake weighted mean Copepod density and biomass by species and the Diaptomus to Cyclops density ratio, 1987, 1990-2006.

		Diaptomus		*Cyclops*		Totals		
	Sample	Density	Biomass	Density	Biomass	Density	Biomass	Diaptomus to Cyclops
Year	Dates	No./m^3	mg/m^3	No./m^3	mg/m^3	No./m^3	mg/m^3	Density Ratio
1987	3	803	2.4	3,017	6.9	3,820	9.3	0.27
1990	4	1,106	5.1	3,087	7.5	4,193	12.6	0.36
1991	5	782	2.7	2,744	6.3	3,526	9.0	0.28
1992	6	804	1.7	2,326	4.6	3,130	6.3	0.35
1993	6	0	0.0	309	0.7	309	0.7	0.00
1994	7	0	0.0	153	0.4	153	0.4	0.00
1995	7	0	0.0	1,171	2.9	1,171	2.9	0.00
1996	6	1	0.0	2,169	4.9	2,170	4.9	0.00
1997	6	1	0.0	372	0.8	373	0.8	0.00
1998	5	0	0.0	1,110	2.7	1,110	2.7	0.00
1999	5	0	0.0	3,357	6.0	3,357	6.0	0.00
2000	5	0	0.0	601	1.1	601	1.1	0.00
2001	5	0	0.0	339	1.1	339	1.1	0.00
2002	5	0	0.0	1,452	2.5	1,452	2.5	0.00
2003	4	6	0.0	8,511	12.3	8,517	12.3	0.00
2004	4	70	0.3	3,494	5.3	3,564	5.6	0.02
2005	4	57	0.1	6,164	6.8	6,221	6.9	0.01
2006	4	56	0.1	1,224	2.9	1,280	3.0	0.05
mean 87-91:		897	3.4	2,949	6.9	3,846	10.3	0.30
mean 92-05:		67	0.2	2,252	3.7	2,319	3.87	0.03

Table 6.-Summary of the Hidden Lake weighted mean density and biomass of Cladocerans by species and the Bosmina to Daphnia density ratio, 1987, 1990-2006.

		Bosmina		*Daphnia*		*Holopedium*		Totals		*Bosmina to*
Year	Sample Dates	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
1987	3	1,059	2.7	788	2.6	209	2.2	2,056	7.5	1.34
1990	4	1,028	3.0	502	1.7	51	0.5	1,581	5.2	2.05
1991	5	529	1.5	177	0.5	112	1.8	818	3.8	2.99
1992	6	614	1.6	86	0.2	173	2.0	873	3.8	7.14
1993	6	89	0.2	526	1.0	214	1.5	829	2.7	0.17
1994	7	574	1.2	389	1.0	199	2.9	1,162	5.1	1.48
1995	7	764	1.6	203	0.5	248	2.6	1,215	4.8	3.76
1996	6	535	1.1	20	0.0	137	1.1	692	2.2	26.75
1997	6	277	0.5	177	0.3	229	3.1	683	3.8	1.56
1998	5	724	1.3	454	1.5	103	1.3	1,281	4.1	1.59
1999	5	210	0.3	258	0.7	150	1.9	618	2.9	0.81
2000	5	376	0.9	53	0.1	299	1.6	728	2.5	7.09
2001	5	585	1.3	46	0.1	525	1.4	1,156	2.7	12.72
2002	5	1,639	3.7	1,218	3.8	425	2.0	3,282	9.5	1.35
2003	4	878	3.0	437	0.8	316	1.9	1,631	5.7	2.01
2004	4	847	3.7	442	1.3	412	2.4	1,701	7.4	1.92
2005	4	583	1.1	392	0.7	190	1.2	1,165	3.1	1.49
2006	4	505	1.1	182	0.3	630	4.7	1,317	6.1	2.77
mean 87-91:		872	2.4	489	1.6	124	1.5	1,485	5.5	1.78
mean 92-05:		621	2	336	1	259	2	1,215	4.3	4.99

Table 7.-Seasonal weighted mean lengths (mm) of zooplankton taxa in Hidden Lake, 1987, 1990-2006.

Year	*Diaptomus*	*Cyclops*	*Bosmina*	*Daphnia*	*Holopedium*
1987	0.88	0.81	0.52	0.86	0.97
1990	1.02	0.83	0.55	0.87	0.96
1991	0.93	0.81	0.54	0.77	1.14
1992	0.77	0.76	0.52	0.81	1.00
1993	*	0.79	0.50	0.66	0.83
1994	*	0.90	0.47	0.76	0.92
1995	*	0.83	0.47	0.74	0.84
1996	1.10	0.81	0.47	0.62	0.83
1997	*	0.77	0.42	0.62	0.87
1998	*	0.82	0.44	0.86	0.90
1999	*	0.72	0.40	0.76	0.93
2000	*	0.71	0.49	0.59	0.71
2001	*	0.93	0.48	0.79	0.53
2002	*	0.71	0.49	0.83	0.70
2003	1.15	0.67	0.46	0.70	0.76
2004	1.16	0.69	0.48	0.84	0.75
2005	0.68	0.58	0.46	0.64	0.78
2006	1.17	0.82	0.47	0.61	0.84
mean 87-91:	0.94	0.82	0.54	0.83	1.02
mean 92-05:	0.97	0.76	0.47	0.73	0.81

* *Diaptomus* were not identified in the samples collected.

Table 8.-Sockeye salmon stocking numbers, life stage, size and release date by year into Hidden Lake, 1992-2006.

	Fry	Fingerling	Pre-Smolt	Total Stocked
1992			260,000	260,000
Date/Size[a]			5-Sep/ 6.0 g	
1993	448,000	106,600		554,600
Date/Size[a]	29-Apr/ 0.25 g	4-Jun/ 0.5g		
1994	250,000			250,000
Date/Size[a]	5-May/ 0.25 g			
1995			98,650	98,650
Date/Size[a]			2-Nov/ 9.5 g	
1996	252,000		138,800	390,800
Date/Size[a]	14-May/ 0.4 g		15-Oct/ 9.0 g	
1997		287,700	167,500	455,200
Date/Size[a]		4-Jun/ 0.6 g	22-Oct/ 9.5 g	
1998	316,667		340,400	657,067
Date/Size[a]			4-Sep/ 7.0 g	
1999			310,000	310,000
Date/Size[a]			6-Oct/ 9.4 g	
2000	172,000		332,400	504,400
Date/Size[a]	20-Jun/ 0.7 g		24-Aug/ 5.0 g	
2001		66,500	249,000	315,500
Date/Size[a]		25-May/ 0.8 g	5-Oct/ 13.5 g	
2002			51,600	51,600
Date/Size[a]			2-Oct/ 11.0 g	
2003			31,006	31,006
Date/Size[a]			14-Sep/ 13.9 g	
2004			70,736	70,736
Date/Size[a]			7,8-Oct/ 9.0 g	
2005		113,679	74,663	188,342
Date/Size[a]		23-Jun/1.4 g	3-Oct/ 11.7 g	
2006	253,100		168,568	421,668
Date/Size[a]	19-May/0.45 g		10-Oct/ 11.8 g	
mean 1992-2005:				295,564

[a] Fry are released from April to July at up to 200% of emergent size (normally 0.15 to 0.5 g depending on the stock). Fingerling are released from June to September at a size of >200% to <2100% of emergent size (normally 0.3 to 5.25 g depending on the stock). Pre-smolt are released from August to November at a size of >2100% of emergent size but not yet at the physiological stage of smolting (normally 5 to 13 g).

Table 9.-Mean length, weight, and condition coefficient by age of a portion of sockeye salmon smolt emigrating from Hidden Lake, 1993-2002.

				Age-1				Age-2			
Year	Statistical Weeks	Dates Collected	Number Sampled	No. and %	Mean Length (mm)	Mean Weight (g)	Condition Factor (K)	No. and %	Mean Length (mm)	Mean Weight (g)	Condition Factor (K)
1993	21	May 17-23	324	324 100.0%	100.5	8.5	0.83	0 0.0%			
1994	24-27	June 7-July 4	218	214 98.2%	122.9	16.2	0.87	4 1.8%	145.0	29.1	0.92
1995	23-26	May 31-June 27	153	148 96.7%	124.5	20.5	1.00	5 3.3%	164.3	45.8	1.02
1996	23-25	May 31-June 20	440	426 96.8%	125.3	18.4	0.94	14 3.2%	159.5	41.6	0.95
1997	23-26	May 31-June 27	442	439 99.3%	109.2	11.4	0.87	3 0.7%	120.0	14.7	0.78
1998	22-26	May 24-June 27	462	455 98.5%	111.1	12.3	0.89	7 1.5%	140.0	24.1	0.87
1999	23-26	May 31-June 27	262	262 100.0%	96.6	7.4	0.81	0 0.0%			
2000	23-25	May 31-June 20	521	509 97.7%	113.4	12.5	0.85	12 2.3%	146.8	28.6	0.88
2001	22-26	May 24-June 27	447	441 98.7%	95.5	7.4	0.85	6 1.3%	97.7	8.1	0.85
2002	23-24	May 31-June 13	243	240 98.8%	112.9	12.5	0.86	3 1.2%	153	30.2	0.84
mean 1993-2002:			3,512	3,458 98.5%	111.2	12.7	0.88	54 1.5%	140.8	27.8	0.89

Table 10.-Commercial harvest by species by day in the Foul Bay Special Harvest Area (statistical area 251-41), 2006.

Date	Chinook	Sockeye	Coho	Pink	Chum
7-Jul	16	819	15	525	92
Total	16	819	15	525	92

Table 11.-Estimated age composition of adult sockeye salmon harvest from Foul Bay Special Harvest Area (statistical area 251-41), 1995-2005.

Year	Sample Size		Ages 1.1	0.2	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	2.4	Total[a]
1995[b]	485	Numbers	1,067	0	44	41,988	0	756	44	0	0	578	0	0	44,479
		Percent	2.4	0.0	0.1	94.4	0.0	1.7	0.1	0.0	0.0	1.3	0.0	0.0	100
1996[b]	537	Numbers	292	0	0	9,165	117	18,039	1,459	0	0	117	0	0	29,189
		Percent	1.0	0.0	0.0	31.4	0.4	61.8	5.0	0.0	0.0	0.4	0.0	0.0	100
1997	562	Numbers	788	0	0	8,288	19	8,344	656	19	38	469	56	38	18,751
		Percent	4.2	0.0	0.0	44.2	0.1	44.5	3.5	0.1	0.2	2.5	0.3	0.2	100
1998	646	Numbers	2,447	0	0	3,949	365	1,054	397	0	0	58	0	0	8,270
		Percent	29.6	0.0	0.0	47.8	4.4	12.7	4.8	0.0	0.0	0.7	0.0	0.0	100
1999[b]	603	Numbers	68	0	0	36,414	0	1,906	2,450	0	0	204	0	0	41,042
		Percent	0.2	0.0	0.0	88.7	0.0	4.6	6.0	0.0	0.0	0.5	0.0	0.0	100
2000[b]	733	Numbers	376	0	0	16,768	0	8,022	1,100	0	27	536	0	0	26,829
		Percent	1.4	0.0	0.0	62.5	0.0	29.9	4.1	0.0	0.1	2.0	0.0	0.0	100
2001	551	Numbers	517	0	0	8,602	0	20,206	123	0	0	374	0	0	29,822
		Percent	1.7	0.0	0.0	28.8	0.0	67.8	0.4	0.0	0.0	1.3	0.0	0.0	100
2002	903	Numbers	2,361	37	0	22,160	84	8,588	214	0	0	0	0	0	33,444
		Percent	7.1	0.1	0.0	66.3	0.3	25.7	0.6	0.0	0.0	0.0	0.0	0.0	100
2003	669	Numbers	44	0	0	40,222	0	9,205	867	0	0	844	0	0	51,182
		Percent	0.1	0.0	0.0	78.6	0.0	18.0	1.7	0.0	0.0	1.6	0.0	0.0	100
2004	411	Numbers	0	0	0	9,949	0	7,314	2,343	0	0	123	0	0	19,729
		Percent	0.0	0.0	0.0	50.4	0.0	37.1	11.9	0.0	0.0	0.6	0.0	0.0	100
2005	232	Numbers	0	0	0	96	0	5,487	96	0	0	1,723	0	0	7,402
		Percent	0.0	0.0	0.0	1.3	0.0	74.1	1.3	0.0	0.0	23.3	0.0	0.0	100
1995-2005	6,332	Numbers	7,960	37	44	197,601	584	88,922	9,749	19	65	5,026	56	38	310,139
		Percent	2.6	0.0	0.0	63.7	0.2	28.7	3.1	0.0	0.0	1.6	0.0	0.0	100.0

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

[b] Includes fish reported for statistical area 251-40 that were actually harvested in Foul Bay SHA.

Table 12.-Commercial harvest by species by year in the Foul Bay Special Harvest Area (statistical area 251-41), 1995-2006.

Year	Chinook	Sockeye	Coho	Pink	Chum
1995	15	44,479	0	20	8
1996	6	29,889	15	7	63
1997	0	18,751	0	5	2
1998	17	8,270	0	55	57
1999	12	41,042	0	415	364
2000	5	26,829	0	1	23
2001	104	29,822	0	1,141	53
2002	196	33,444	0	120	1,243
2003	55	51,181	0	80	98
2004	27	19,729	0	0	29
2005	4	7,401	0	0	0
2006	16	819	15	525	92
1995-2005	40	28,258	1	168	176

Table 13.-Peak salmon escapement counts and indexed total escapement estimates at Hidden Creek (stream no. 251-41-406), 1992-1999.

Date[a]	Sockeye[b]	Pink	Coho
10-Sep-92	1	1,259	1,019
23-Aug-93	1	6,000	500
29-Jul-94	420		
23-Aug-94		3,302	
7-Oct-94			1,500
3-Jul-95	575		
23-Aug-95		7,128	
13-Sep-95			49
7-Jun-96	471		
12-Aug-96		736	
22-Aug-96			15
10-Jun-97	7		
10-Sep-97		0	0
13-Aug-98		8,000	0
9-Aug-99	0	0	0

[a] ADF&G Salmon Escapement Database (all data are from foot surveys).

[b] Runs are a result of stocking juvenile salmon into Hidden Lake.

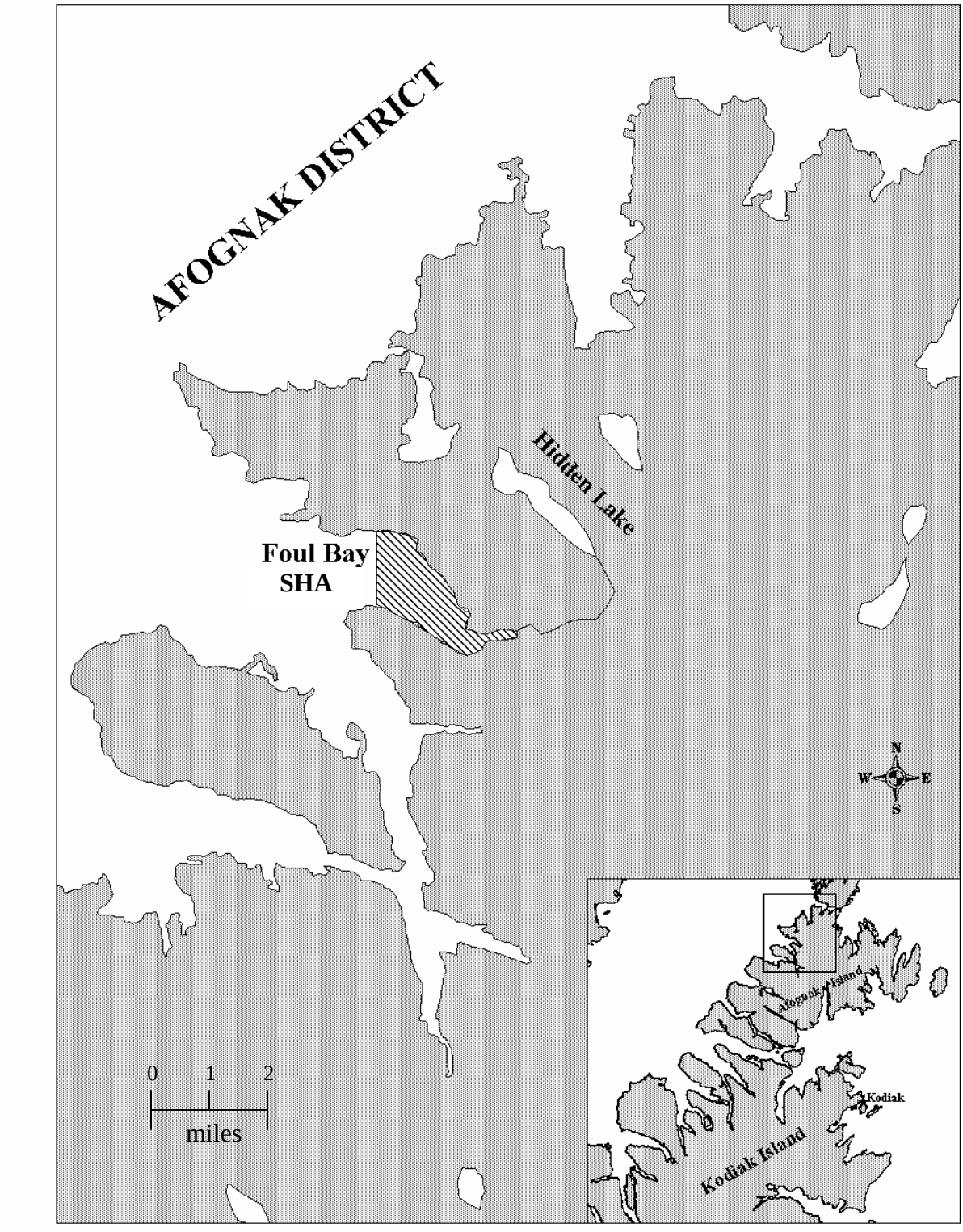

Figure 1.-Location of Hidden Lake and the Foul Bay Special Harvest Area on Afognak Island**.**

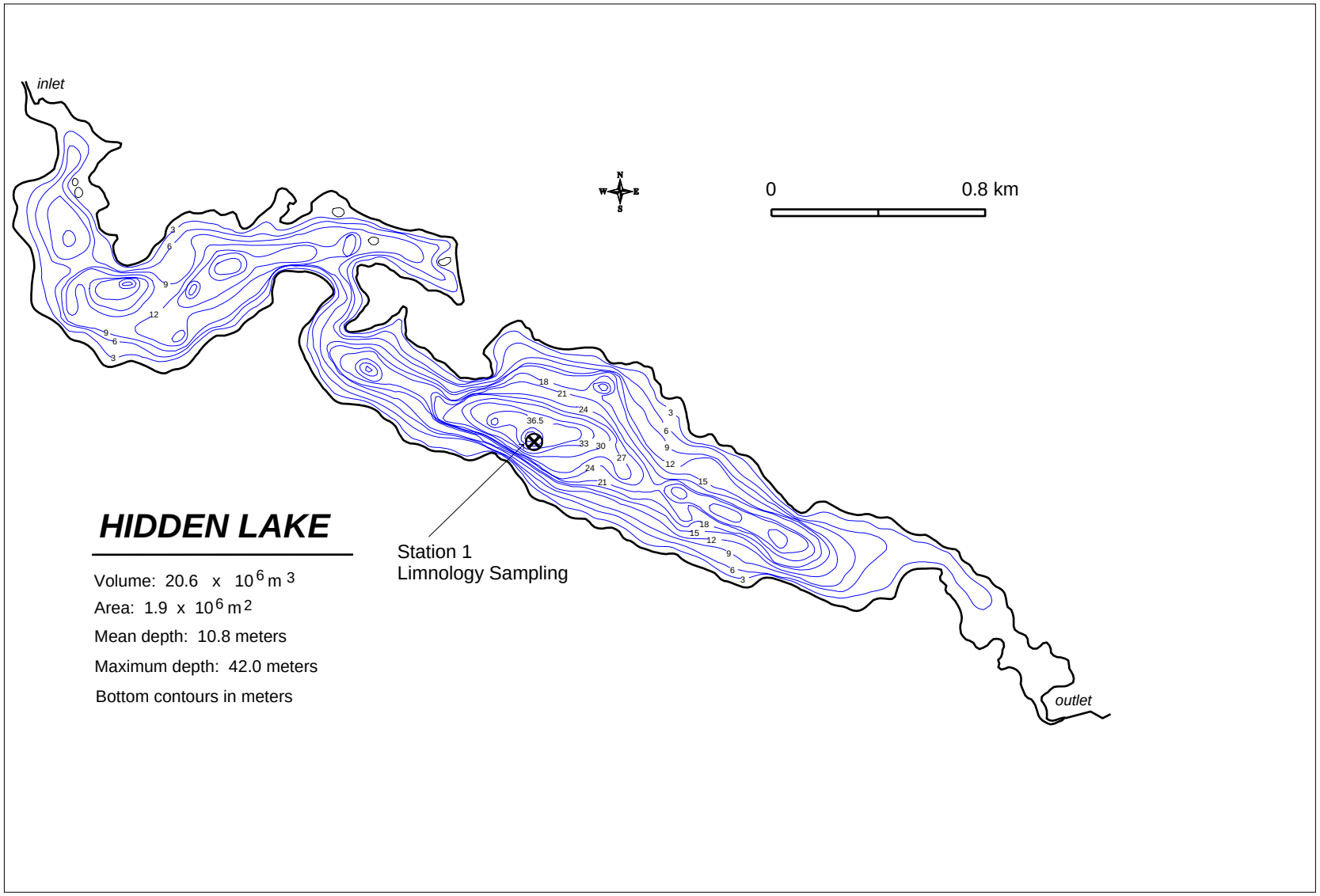

Figure 2.-Morphometric map showing the limnology sampling station on Hidden Lake.

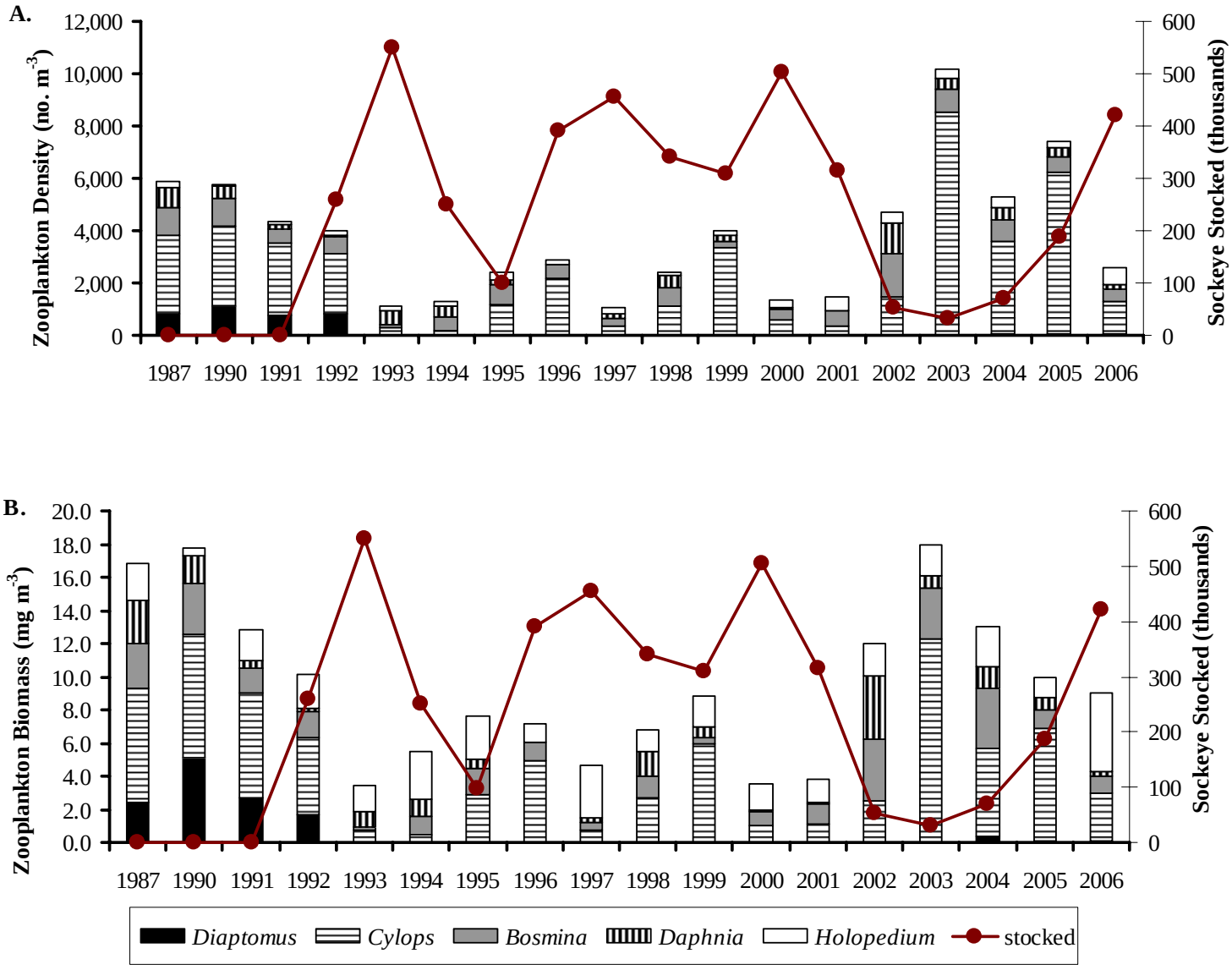

Figure 3.-Zooplankton density (A) and biomass (B) compared to sockeye salmon stocking levels for Hidden Lake, 1987, 1990-2006.