Regional Information Report No. 1J10-15

Klawock Lake Subsistence Sockeye Salmon Project 2009 Annual and Final Report

by

Julie Bednarski

August 2010

Alaska Department of Fish and Game Division of Commercial Fisheries

Symbols and Abbreviations

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Weights and measures (metric)	
centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

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

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

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

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

Measures (fisheries)	
fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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

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By
Julie Bednarski
Alaska Department of Fish and Game, Division of Commercial Fisheries, Douglas

Alaska Department of Fish and Game
Division of Commercial Fisheries, Publications Section
802 3rd, Douglas, Alaska, 99824-0020

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The Regional Information Report Series was established in 1987 and was redefined in 2007 to meet the Division of Commercial Fisheries regional need for publishing and archiving information such as project operational plans, area management plans, budgetary information, staff comments and opinions to Board of Fisheries proposals, interim or preliminary data and grant agency reports, special meeting or minor workshop results and other regional information not generally reported elsewhere. Reports in this series may contain raw data and preliminary results. Reports in this series receive varying degrees of regional, biometric and editorial review; information in this series may be subsequently finalized and published in a different department reporting series or in the formal literature. Please contact the author or the Division of Commercial Fisheries if in doubt of the level of review or preliminary nature of the data reported. Regional Information Reports are available through the Alaska State Library and on the Internet at: http://www.sf.adfg.ak.us/statewide/divreports/htlm/intersearch.cfm.

Julie Bednarski,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
802 3rd Street, Douglas,, USA

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ABSTRACT

This report covers the ninth year of sockeye salmon subsistence harvest and escapement data collection at Klawock Lake. Subsistence harvest assessment was conducted using direct observations of fishing and interviews on the fishing grounds. Sockeye salmon counts at Klawock River weir were provided by the Prince of Wales Hatchery Association (POWHA), and adult sockeye salmon age, sex, and length composition was estimated from samples collected at the weir. Otoliths were examined for hatchery marks in samples collected in the subsistence fishery and on the spawning grounds. The minimum estimated subsistence harvest was approximately 5,900 sockeye salmon. The sockeye salmon escapement count at the weir was 19,699 fish, which is considered a minimum estimate because it is likely fish entered the lake before the weir was installed on 13 July and the weir was overtopped by a flood for 12 h on 22 September. Unlike in prior years, no back-up mark-recapture study was conducted in 2009. The minimum estimated terminal run size (escapement plus subsistence harvest) was 25,599 sockeye salmon. Age-1.3 fish dominated the escapement. Hatchery-reared fish comprised an estimated 7% of the 2009 harvest samples and no thermal marked hatchery fish were found in the escapement samples.

Key words: Sockeye salmon, *Oncorhynchus nerka*, subsistence, Klawock, Klawock Lake, Southeast Alaska, escapement, mark-recapture, age composition, hatchery, otolith

INTRODUCTION

BACKGROUND

Historically, Klawock Lake sockeye salmon (*Oncorhynchus nerka*) supported one of the few permanent Tlingit settlements on Prince of Wales Island. Tlingit oral history describes how the original settlers, fleeing a conflict in their home village near the mainland, crossed Prince of Wales Island from Kasaan Bay and discovered Klawock Lake with its exceptional sockeye runs (Langdon 1977). Archeological findings show evidence of human habitation in the Klawock River area dating to 6,000 years ago and link the ancient inhabitants with present day Tlingit residents (Ratner et al. 2006). Klawock was also the site of one of the earliest commercial fisheries in Alaska, where a salmon saltery was established by George Hamilton in 1868 and then sold to the North Pacific Packing and Trading Company, which built a cannery in 1878 (Bower 1929; Langdon 1977; Ellanna and Sherrod 1987).

From the beginning of the commercial fishing period, commercial and subsistence fishing and other harvesting have been completely intertwined in the household economies of Klawock residents. The people of Klawock actively participated in developing commercial fisheries, first working for the canneries as both harvesters and fish processors, and later as owner-operators of not only fishing boats but also canneries. Although the outside commercial fishing industry disrupted traditional systems of resource ownership and harvesting, it also provided new opportunities for people to access resources for traditional uses. In particular, larger commercial vessels enabled extended families to continue to access resources more distant from Klawock, as they had in the past from a network of seasonal villages and camps. Thus, during the earlier commercial fishing period, the involvement of Klawock residents enhanced both the cash and subsistence sectors (Ellanna and Sherrod 1987).

Starting in the 1950s, however, a long decline in the local commercial fishing economy, combined with introduction of the salmon limited entry program, contributed to loss of both commercial fishing capital and access to more distant resources among Klawock residents. The loss of seasonal mobility and access to diverse resources, combined with an influx of new residents due largely to logging and transportation infrastructure development, has put more pressure on nearby subsistence resources, including sockeye salmon from Klawock Lake

(Ellanna and Sherrod 1987). Most present-day Klawock residents rely primarily on the Klawock Lake stock for their subsistence sockeye salmon, although a few alternative locations, including the Sarkar River, are also used, particularly during years of low sockeye salmon abundance at Klawock (Ratner et al. 2006).

Commercial harvest records from the end of the 19th Century indicate annual harvests of sockeye salmon in the Klawock River estuary averaged around 40,000 fish, with peak numbers up to about 70,000 fish (Moser 1899; Rich and Ball 1933). Depletion of the stock became apparent early in the commercial period, and managers responded with attempts at hatchery supplementation and implementation of fishery regulations, measures which were largely ineffective (Rich and Ball 1933; Roppel 1982). The first recorded measures of sockeye salmon escapement into Klawock Lake were a series of weir counts from the 1930s, which ranged from 7,000 to 65,000 fish (Orrell et at. 1963). Later, the Klawock River hatchery staff counted sockeye salmon at a weir operated for collection of hatchery broodstock, but the counts were notoriously unreliable (Lewis and Zadina 2001). Detailed reviews of available historical information on Klawock sockeye salmon, including some assessment of juvenile populations and lake habitat variables, can be found in the annual report series for the stock assessment program beginning in 2001 (Lewis and Zadina 2001; Lewis and Cartwright 2002; Cartwright and Lewis 2004; Cartwright and Conitz 2006; Conitz et al. 2006; Conitz and Cartwright 2007; Conitz 2008, 2009, 2010). The overall impression, both from available historical information and local ecological knowledge, is that abundance of Klawock Lake sockeye salmon was much greater in the past than in recent years (Ratner et al. 2006).

PROJECT HISTORY

The recent sockeye salmon subsistence monitoring project was started in 2001; the main goal has been to produce reliable estimates of sockeye salmon escapement and subsistence harvest in the Klawock Lake system to facilitate better management of the subsistence resource. The primary tool for escapement estimation has been the counting of sockeye salmon migrating through the Klawock River at a fish counting weir near the outlet of the lake, validated with mark-recapture studies conducted in the primary spawning areas. In 2 out of the first 3 years, the mark-recapture estimates were significantly higher than the weir counts, and, consequently, improvements were made to the weir in 2004, which included reducing the spacing between the pickets, increasing the angle of the face of the weir to reduce the water pressure on the weir, and installing a boom log upstream from the weir to stop large floating trees from hitting the weir (Conitz et al. 2006).

Mark-recapture sampling methods were also improved, including the use of individually-numbered tags so that spawners could be tracked to both location and time of spawning (Conitz et al. 2006). Sockeye salmon spawning populations were also estimated independently at the 3 main spawning streams in Klawock Lake using Jolly-Seber mark-recapture methods (Conitz 2009). After comparing these independent estimates with the weir counts for 3 years, the spawning population estimates, while not as precise, were deemed sufficiently accurate that the weir enumeration could be omitted as a cost savings. In 2007, no count of sockeye salmon was obtained at the weir, and the spawning population estimate provided the only measure of sockeye salmon escapement. In 2008, Prince of Wales Hatchery Association (POWHA) personnel counted sockeye salmon at the weir, although without an associated mark-recapture validation study; however, an independent mark-recapture estimate was obtained from the spawning grounds. The use of redundant escapement estimation methods has permitted some degree of continuity in the estimates, even when the primary estimation method has changed.

The subsistence harvest of Klawock sockeye salmon has also been independently estimated since 2001 with a harvest survey conducted on the fishing grounds. In the absence of a harvest survey, the only indicator of the size of the subsistence harvest would be the total catch reported on returned permits, which is not available until at least 1 year following the season, and the reported harvest tends to underestimate the actual harvest (Cartwright and Conitz 2006; Conitz 2008). Other annual project objectives were to sample the sockeye salmon escapement for age, sex, and length distribution, and the escapement and harvest for proportions of otolith-marked hatchery fish.

The present-day Klawock hatchery began incubating sockeye salmon eggs taken from wild brood stock in the 1980s (Lewis and Zadina 2001). The hatchery thermally marked incubating sockeye salmon in their facility from brood year 1999 through brood year 2004, after which the hatchery discontinued sockeye salmon production (Conitz 2009). A thermal mark pattern template was assigned to each year of Klawock hatchery sockeye salmon production by the ADF&G Mark, Tag, and Age Laboratory in Juneau. The laboratory checked a subsample of otoliths and the associated temperature log to verify the thermal mark pattern (John Bruns, Prince of Wales Hatchery Association manager, personal communication 2005). Juvenile and returning adult sockeye salmon have been sampled since 2001 to determine the number and proportions of marked fish.

Escapement estimates from 2001 to 2008 have ranged from 13,000 to 21,000 fish and subsistence sockeye salmon harvest estimates have ranged from 2,500 to 6,500 fish, with the exception of an extremely low harvest of 175 fish in 2005. Estimates of the terminal run size have ranged from 15,000 to 27,000 sockeye salmon, from 2001 to 2008. In 2009, our objectives were once again to estimate the total sockeye salmon subsistence harvest and escapement at Klawock, and provide auxiliary information about the age composition and hatchery contribution to the terminal run. Due to problems retaining a crew for the entire field season, however, we were unable to obtain a complete accounting of the subsistence harvest, and the weir count provided a minimum estimate of the escapement as the back-up mark-recapture study could not be completed.

Objectives

1. Estimate the subsistence harvest of sockeye and other salmon in the subsistence fishery in Klawock Inlet and the Klawock River estuary.
2. Estimate the sockeye salmon spawning population into Klawock Lake system using mark-recapture methods, so that the estimated coefficient of variation is less than 10%.
3. Estimate the age, length, and sex composition of the sockeye salmon in the escapement at Klawock Lake, so the estimated coefficient of variation is less than or equal to 5% for the largest 2 age classes.
4. Estimate the proportion of hatchery-produced sockeye salmon in the escapement and subsistence fishery.

In 2009, due to circumstances beyond our control, the majority of the field work ended in mid-August, which prevented the completion of the mark-recapture study (objective 2).

STUDY SITE

The Klawock River system (ADF&G stream number 103-60-047) is located on the west side of Prince of Wales Island (Figure 1), and drains into Klawock Inlet at the site of the village of Klawock (lat 55° 32.97'N, long 133° 02.60'W). Klawock Lake has 2 main basins and numerous tributaries, with four major tributaries providing most of the sockeye salmon spawning habitat in this system (Figure 2). At the head of the lake, Inlet Creek flows into basin B (maximum depth 49 m), draining a total area of 37.6 km^2. Hatchery Creek, Halfmile Creek, and Threemile Creek flow into basin A, the larger and shallower of the 2 basins (maximum depth 30 m), and drain a total watershed area of 76.1 km^2. The surface elevation of Klawock Lake is 9.1 m, and the lake has a total surface area of 11.9 km^2, mean depth of 17.7 m, maximum depth of 49.0 m, and volume of 209 x 10^6 m^3 (Figure 2). The lake is dimictic and organically stained, and its mean euphotic zone depth (EZD) is 4.2 m, based on limnological data collected from 1986 to 1988 and in 2001 (Lewis and Cartwright 2002). Klawock Lake drains into the Klawock River, which is 2.85 km from the lake outlet to the estuary at the head of Klawock Inlet. The Prince of Wales hatchery and the weir are located on the Klawock River approximately 300 m below the lake. In addition to sockeye salmon, native fish species in Klawock Lake include coho (*O. kisutch*), pink (*O. gorbuscha*), and chum (*O. keta*) salmon, steelhead (*O. mykiss*) and cutthroat trout (*Oncorhynchus clarki*), Dolly Varden char (*Salvelinus malma*), threespine stickleback (*Gasterosteus aculeatus*), and cottids (*Cottus* sp.). Mysid shrimp (*Neomysis mercedis*) are also present in the lake.

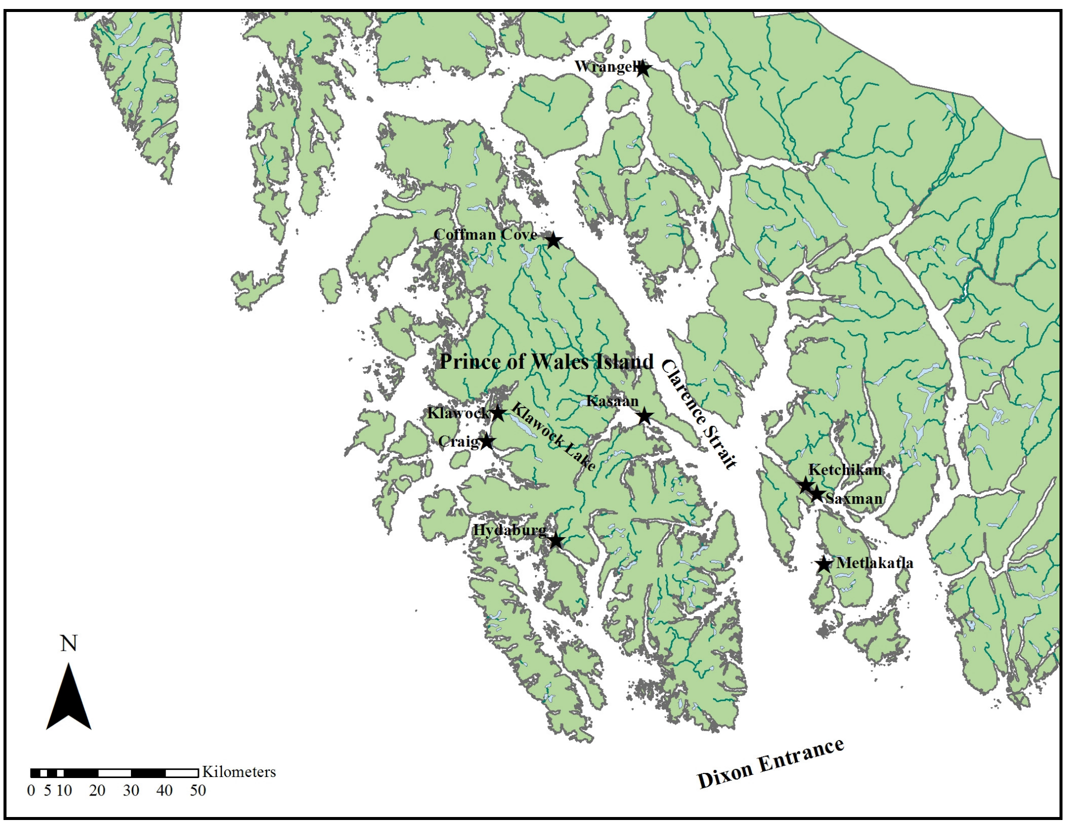

Figure 1.–Geographic location of Klawock Lake, in Southeast Alaska on Prince of Wales Island. The communities of Klawock and Craig, and other towns on and near Prince of Wales Island are shown.

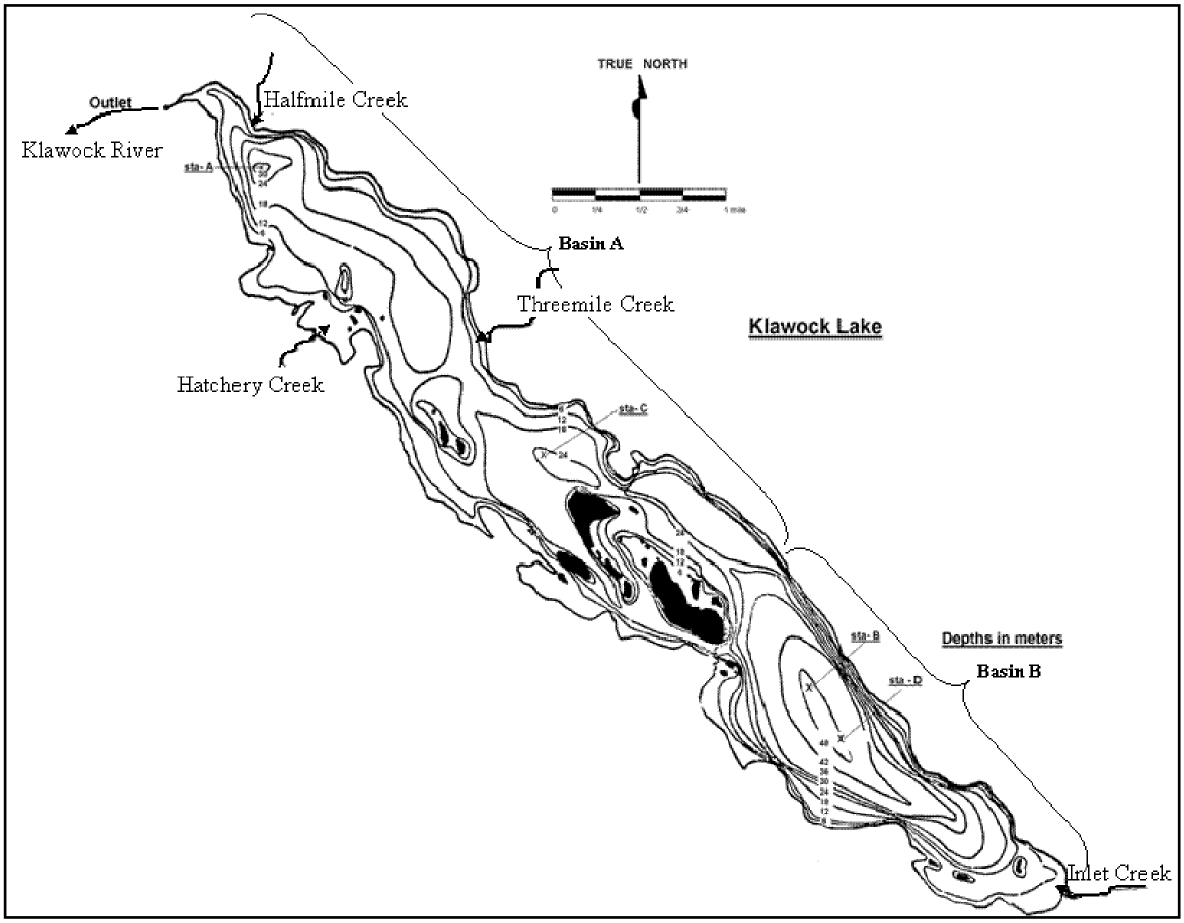

Figure 2.–Bathymetric map of Klawock Lake, showing the 2 main lake basins, 4 main inlet streams (Halfmile, Threemile, Inlet, Hatchery), and the outlet to Klawock River.

METHODS

SUBSISTENCE HARVEST ESTIMATE

By regulation, the subsistence fishery was open on weekdays from 0800 on Mondays to 1700 on Fridays, between 7 July and 7 August 2009. Prior to the season, 3 days out of each 5 day week were selected at random for observations and interviews with subsistence users (Table 1). Sampling days ran from 0600 to 2200, with reduced hours on Monday and Friday. All subsistence fishing was conducted with small, hand-pulled seine nets, usually using 2 boats to deploy a single net. A set was defined as a single net deployment and retrieval. A *boat-party* referred to all the people on 1 or 2 boats fishing the same net. The technicians used binoculars and a motorized skiff to monitor the fishery so they could see all boat-parties fishing in Klawock Inlet. In addition to direct verbal interviews, direct observation and hand signals were used to communicate the size of the catch. To maintain the confidentiality of individual catch information, names of fishers were not recorded. Technicians attempted to interview all boat-parties after each set. However, in cases where technicians were unable to interview a boat-party after a set, the set was recorded as a “missed interview.”

Table 1.–Dates selected for sampling in the Klawock Inlet subsistence fishery in 2009.

Week	Fishery open dates	Actual sampling days
1	7–10 July	W, Th, F (8, 9, 10 Jul)
2	13–17 July	M, T, W (13, 14, 15 Jul)
3	20–24 July	M, T, Th (20, 21, 23 Jul)
4	27–31 July	T, W, Th (28, 29, 30 Jul)
5	3–7 August	M, F (3 and 7 Aug)

The statistical population was designated to be the collection of "net sets." Sets were organized into a day within a week. In week 1, sampling followed a 2-stage design: a day within a week was selected at random (first stage), and then a set within a day (second stage) was selected if needed (Thompson 1992, Bernard et al. 1998). In the second stage estimation, the average harvest for the day was assigned to any set with a "missed interview." In the first stage estimation, the average harvest per day, within a week, was expanded to estimate the harvest for the days not sampled each week.

We let h_{ijk} denote the harvest for set i on day j in week k, and m_{jk} denote the number of completed interviews on day j, in week k (i.e., the total number of sets for which interviews were obtained). Also, M_{jk} denoted the total number of net sets counted on day j in week k (i.e., the total number of sets observed, including any missed interviews), and d_k denoted the total number of days sampled out of D_k fishing days in week k. For a given species, the harvest for week k was estimated as,

$$\hat{H}_k = \frac{D_k}{d_k} \sum_{j=1}^{d_k} \frac{M_{jk}}{m_{jk}} \sum_{i=1}^{m_{jk}} h_{ijk} \; , \tag{1}$$

and the total harvest for the season was estimated as the sum of weekly harvests,

$$\hat{H} = \sum_{k=1}^{5} \hat{H}_k \; . \tag{2}$$

To estimate the variance of $\hat{H}$, we let $\bar{h}_{jk}$ denote the mean harvest per set, on day j in week k, and $\bar{h}_k$ denote the mean harvest for the week. We then estimated the variance for the estimated harvest in week k as,

$$\mathrm{var}(\hat{H}_k) = \frac{D_k}{d_k} \sum_{j=1}^{d_k} M_{jk}^{\,2} \left(1 - \frac{m_{jk}}{M_{jk}}\right) \frac{\sum_{i=1}^{m_{jk}} (h_{ijk} - \bar{h}_{jk})^2}{m_{jk}(m_{jk} - 1)} + D_k^{\,2} (1 - \frac{d_k}{D_k}) \frac{\sum_{j=1}^{d_k} (\bar{h}_{jk} - \bar{h}_k)^2}{d_k(d_k - 1)} \tag{3}$$

(Thompson 1992, p. 129). The overall variance for the season was estimated by summing the 5 weekly variance estimates,

$$\mathrm{var}(\hat{H}) = \sum_{k=1}^{5} \mathrm{var}(\hat{H}_k) \, , \tag{4}$$

and the standard error was estimated by taking the square root of the seasonal variance estimate.

Sockeye Escapement Estimate

Project crew, in cooperation with Prince of Wales Hatchery staff, operated the Klawock River weir from 13 July to 17 November 2009. The weir was located adjacent to the hatchery and spanned the 50 m stream width, about 300 m below the lake. Fish migrating upstream were diverted at the weir into the hatchery's raceway and sampling platform where they were identified by species, counted, and passed upstream. In past years, a mark-recapture study was conducted to estimate the sockeye salmon escapement in the event that weir problems allowed fish to pass uncounted. We had intended to conduct the study in 2009; however, field operations ended in mid-August and the mark-recapture study was not completed.

ESCAPEMENT AGE, SEX, AND LENGTH COMPOSITION

About 600 sockeye salmon were sampled for length, sex, and scales (for age determination) at the weir. Fish were selected systematically to prevent selection bias, and weekly sampling goals were set throughout the run based on average weekly escapements from previous years (Appendix A). Length of each fish was measured from mideye to tail fork, to the nearest millimeter (mm). Sex of the fish was identified by the length and shape of the kype or jaw. Three scales were taken from the preferred area of each fish (INPFC 1963) and prepared for analysis as described by Clutter and Whitesel (1956). Scale samples were analyzed at the ADF&G salmon aging laboratory in Douglas, Alaska. The weekly age-sex distribution, the seasonal age-sex distribution weighted by week, and the mean length by age and sex weighted by week were calculated using equations from Cochran (1977; Appendix B). Age classes were designated by the European aging system where freshwater and saltwater years are separated by a period (e.g., 1.3 denotes a 5-year-old fish with 1 freshwater and 3 ocean years; Koo 1962).

HATCHERY CONTRIBUTION

In 2009, adult sockeye salmon were sampled for otoliths in the Klawock Inlet subsistence fishery and on the spawning grounds in Klawock Lake. Heads from subsistence caught sockeye salmon were collected from fishermen on a voluntary basis. Fishermen were asked to drop off samples in marked collection totes at either of the 2 public docks in Klawock village. The sample-size goal was 200 fish from the subsistence harvest, distributed among weeks of the subsistence fishery roughly in proportion to weekly harvest. If the number of contributed samples exceeded the weekly sampling goal, heads were sampled randomly from those available. In the escapement, sockeye salmon carcasses were sampled from each inlet stream during escapement surveys. Sampling goals in 2009 were 125 heads each from Threemile and Inlet creeks, and 50 heads from Halfmile Creek, for a total of 300 otolith pairs.

Otolith pairs were dissected from the sampled fish, cleaned, and sent to the ADF&G Mark, Tag, and Age Laboratory. Lab staff examined the otoliths under a microscope to determine the presence and identification (hatchery, brood year) of thermal marks. Results were reported in the Thermal Mark Laboratory Mark Summary Report database (http://tagotoweb.adfg.state.ak.us/OTO/reports/MarkSummary.aspx). Estimates of hatchery proportions in the subsistence harvest, escapement, and combined harvest plus escapement were calculated from the proportion of marked otoliths in the respective samples. We assumed that the proportion of hatchery fish in a sample followed a binomial distribution, and estimated the binomial standard error for the proportion.

RESULTS

SUBSISTENCE HARVEST ESTIMATE

Subsistence fishing for sockeye salmon was open for 24 days, Monday to Friday, 7 July to 7 August, and the crew conducted observations and interviews on 9 days through the third week, ending 24 July (Table 2). Estimated subsistence harvest through 24 July was approximately

5,520 (SE = 75) sockeye salmon (Table 2). The crew reported 4 half-day observations and interviews through 7 August, including an additional 373 fish, but not enough data were collected to extrapolate the total harvest over the last 2 weeks of the season. Therefore, we estimate a minimum subsistence harvest of about 5,900 sockeye salmon, but were not able to provide a complete estimate of the subsistence harvest for the season. It is possible, however, that much of the season's harvest was taken in the first 3 weeks of the fishery because was it was reported that little fishing activity occurred between 27 and 31 July, due to the loss of 2 Klawock community members (Sue Domenowske retired ADFG Fisheries Biologist, *personal communication*). In addition, the arrival of large numbers of pink salmon deterred people from fishing during 3 to 7 August. Other salmon species reported in the harvest interviews included 17 coho salmon, 155 pink salmon, and 3 chum salmon; these reported harvests should not be considered season totals.

Table 2.–Summary of subsistence harvest survey results from Klawock Inlet in 2009, including the number of net sets for which harvest interviews were conducted, daily and weekly totals for sockeye salmon, and SE of weekly harvest. Harvest of other salmon species was considered incidental and is not shown. This should not be considered as the season total, as the fishery was open weekdays from 7 July and ended 7 August, and usable data was only collected for the first 3 weeks of the fishery.

Date	Number sets interviewed	Estimated daily harvest	Estimated weekly harvest	SE of weekly harvest
8-Jul	26	334		
9-Jul	14	393	1,896	170
10-Jul	25	669		
13-Jul	23	452		
14-Jul	35	719	2,682	224
15-Jul	18	438		
20-Jul	27	338		
21-Jul	12	63	940	197
23-Jul	6	163		

SOCKEYE ESCAPEMENT ESTIMATE

In 2009, a total of 19,699 sockeye salmon, 16,560 adults and 3,139 jacks, was counted through the weir between 13 July and 17 November (Figure 3; Appendix C). This total should be considered a minimum estimate because it is likely that fish passed through the river before the weir was made fish-tight on 13 July. Over 100 adult sockeye salmon were passed through the weir on 13 July, the 1st day the weir was fish tight. In addition, flood water overtopped the weir on 22 September, allowing fish to swim over the weir for a 12 hr period.

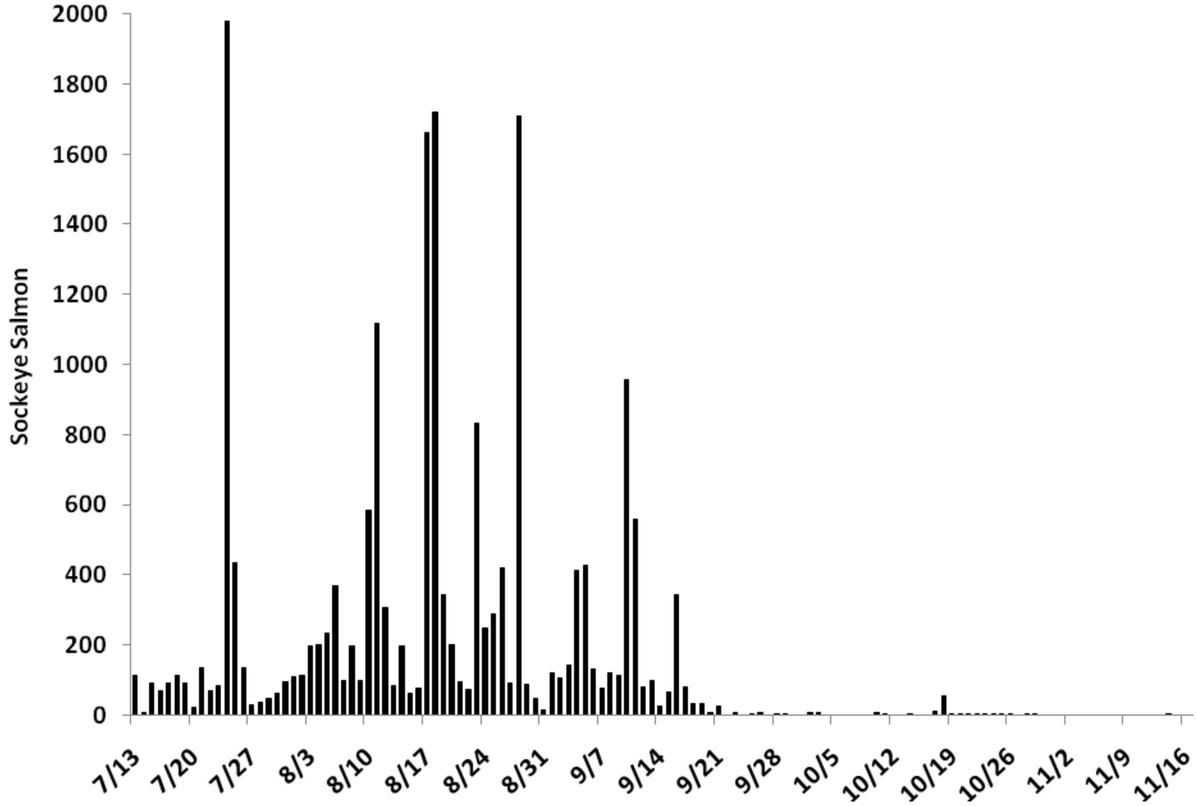

Figure 3.–Daily sockeye salmon escapement counts at the Klawock River weir, 2009.

ESCAPEMENT AGE, SEX, AND LENGTH COMPOSITION

A total of 854 sockeye salmon was sampled from the Klawock Lake escapement in 2009 for age, sex, and length determination. Ages were determined for 719 of these fish. Six age classes and four brood years were represented in the sample. The majority of the fish were age-1.2 (27.7%) and age-1.3 (50.4%; Table 3; Appendix D). The age-1.2 and 2.2 fish were substantially smaller in size than age-1.3 and age-2.3 fish (Table 4).

HATCHERY CONTRIBUTION

Otolith pairs were collected from Klawock Lake sockeye salmon in 2009; 496 otolith pairs from the subsistence fishery and 68 from the escapement (Table 5). We did not meet the sampling goal for escapement otoliths (300) because extremely high water during most of the spawning period made it dangerous to sample in the streams, and most carcasses were swept into the lake, but all available carcasses were sampled. No otolith-marked fish were recovered from the escapement. Overall, hatchery-marked fish accounted for about 7% of the subsistence samples. Marked fish represented brood years 2003 and 2004, most of which were from the 2004 brood year (96%), the last year the hatchery collected sockeye salmon broodstock.

Table 3.–Proportion and SE of age composition sockeye salmon sampled in 2009 at the Klawock River weir, by sex and brood year.

	Age Class						Total
Stratum	1.1	1.2	1.3	2.1	2.2	2.3	
Male							
Sample size	66	79	139	24	11	14	333
Proportion	21.6%	26.3%	39.2%	6.5%	2.5%	3.9%	–
SE	0.9%	1.2%	1.3%	0.1%	0.1%	0.1%	–
Female							
Sample size		83	222	–	24	17	385
Proportion		28.7%	58.1%	–	8.5%	4.7%	–
SE		0.8%	2.0%	–	0.3%	0.1%	–
All Fish							
Sample size	66	202	361	24	35	31	719
Proportion	8.9%	27.7%	50.4%	2.7%	6.0%	4.4%	–
SE	0.1%	0.6%	1.3%	0.0%	0.1%	0.1%	–

Table 4.–Length and SE of sockeye salmon sampled in 2009 at the Klawock River weir, by sex, brood year, and age class.

	Age Class						Total
Stratum	1.1	1.2	1.3	2.1	2.2	2.3	
Male							
Sample size	66	79	139	24	11	14	333
Mean length	372	526	578	381	516	587	
SE	3.1	7.0	4.3	5.2	17.6	6.7	
Female							
Sample size		123	222		24	17	385
Mean length		515	566		525	572	
SE		3.2	2.6		4.6	9.9	
All Fish							
Sample size	66	202	361	24	35	31	719
Mean length	372	519	570	381	524	577	
SE	3.1	3.4	2.3	5.2	4.9	6.6	

Table 5.–Summary of sockeye salmon otolith sample sizes and numbers of hatchery-marked otoliths from the Klawock Inlet subsistence fishery (8–21 July) and the Klawock Lake escapement (31 August–29 September) in 2009.

Sample Date	Number Sampled	Number Analyzed	Number Not Marked	Number marked, by Brood Year		Total Number Marked	Percent Marked
				2003	2004		
Subsistence							
8-Jul	264	255	238	1	16	17	7%
14-Jul	125	122	116		6	6	5%
21-Jul	107	106	94		12	12	11%
Total	496	483	448	1	34	35	7%
Escapement							
31-Aug	6	6	6			0	0%
16-Sep	48	48	48			0	0%
29-Sep	14	13	13			0	0%
Total	68	67	67	0	0	0	0%

DISCUSSION

In 2009, we obtained minimum estimates of the subsistence salmon harvest in the Klawock River Inlet and the escapement of sockeye salmon into Klawock Lake. Although the subsistence harvest estimate only captured the first 3 weeks of the 5 week fishery, it is likely that most fishing coincided with the monitored portion of the fishery due to community bereavement and the arrival of pink salmon in the final weeks of the fishery (Sue Domenowske retired ADFG Fisheries Biologist). Similarly, it is likely that at least 90% of the escapement was enumerated at the weir, assuming the weir was fish tight throughout the season. The weir was not installed until 13 July, but based on previous seasons, at least 95% of the escapement enters the system after 13 July (Lewis and Cartwright 2002; Cartwright and Lewis 2004; Cartwright and Conitz 2006; Conitz et al. 2006; Conitz and Cartwright 2007; Conitz 2008, 2010, 2009). On 22 September a high water event caused water to flow over the top of the weir for approximately 12 hours, but we assume less than 5% of the total escapement passed the weir during this event. This assumption is supported by the fact that daily fish passage in September has never reached 5% of the total escapement, and in most cases was less than 2% of the total escapement. Although there are reasons to believe the weir count of 19,699 sockeye salmon may have been relatively close to the true escapement size in 2009 no back-up mark-recapture study was conducted to verify this assumption, and the reliability of past weir estimates at Klawock have been poor at best (Lewis and Cartwright 2002; Cartwright and Lewis 2004; Cartwright and Conitz 2006).

The estimated escapement in 2009 was above the median (14,800) sockeye salmon escapement at Klawock Lake (2001–2009; Table 6). Since 2001, escapement estimates have ranged from 11,333 to 21,300 sockeye salmon. According to historical information (Orrell et al. 1963) escapement estimates ranged from 7,044 to 65,314 sockeye salmon (median=26,786) in the 1930s (Table 7). Differences in escapement between the 2 periods do not necessarily reflect a similar difference in total run sizes because neither commercial nor subsistence harvest estimates are available for the 1930s. In the more recent period, the number of Klawock sockeye salmon harvested in commercial fisheries is not known, but is assumed to be a small, incidental component of mixed stock fisheries, mainly along the west coast of Prince of Wales Island. Recent years' run sizes appear to be smaller than former run sizes; however, they also appear to be stable, providing adequate escapement into the system and subsistence fishing opportunities for local residents.

The estimated subsistence harvest from the on-site surveys in 2009 was 5,900 sockeye salmon, or about 23% of the terminal run (terminal run = subsistence harvest plus escapement). On-site harvest estimates provide better estimates than those obtained from returned subsistence permits due to the problem of non-reporting of subsistence catch. For example, since 2001 the number reported on returned subsistence permits averaged only 60% of the number estimated through on-site surveys.

Hatchery fish accounted for approximately 7% of the sockeye salmon harvested in the subsistence fishery in 2009, or approximately 430 fish. Unfortunately, we did not meet our objectives for sampling in the escapement and none of the few otoliths collected in the escapement were hatchery-marked. It would be tempting to extrapolate the hatchery contribution to the escapement by multiplying the total escapement by the proportion of hatchery fish (7%) found in the subsistence harvest. One would have to assume that hatchery fish return at a constant proportional rate over the entire run, but it is clear from the three weeks that samples were collected from the subsistence harvest (Table 5) that hatchery fish may not be distributed equally through the run. Furthermore, samples from the July subsistence fishery only represent the first half of the run, and no samples were obtained from the last half of the run in August. The proportion of hatchery fish in the escapement would best be determined through systematic sampling at the weir rather than from the spawning grounds. Other studies have shown that hatchery fish tend to home to the site of release and may not be found in equal proportions at different spawning tributaries within the same system (Geiger et al. 2005; Piston 2008).

Table 6.–Estimated subsistence sockeye salmon harvest, spawning escapement, and terminal run size (escapement plus subsistence harvest, but excluding any commercial harvest) for 2001 to 2009.

Year	Estimated subsistence harvest	Subsistence harvest reported on returned permits	Estimated escapement	Estimated Subsistence harvest + escapement	Subsistence harvest rate
2001	6,400	4,433	13,109 [a]	19,509 [a]	0.33
2002	6,000	3,778	12,600 [a]	18,600 [a]	0.32
2003	6,000	3,195	21,300 [a]	27,300 [a]	0.22
2004	4,500	2,697	11,333 [a]	15,833 [a]	0.28
2005	175	238	14,800	14,975	0.01
2006	3,100	1,849	14,757	17,857	0.17
2007	2,600	2,042	17,500	20,100	0.13
2008	6,700	3,000	21,165	27,865	0.24
2009	5,900 [b]	–	19,699 [b]	25,599 [b]	0.23
Average	4,597	2,654	16,251	20,849	0.21

[a] Adjusted for removal of brood stock for hatchery rearing.
[b] Minimum estimate.

Table 7.–Sockeye salmon counts at the Klawock River weir in the 1930s.

Year	Sockeye Salmon
1930	7,044
1931	34,184
1932	57,294
1934	16,374
1935	20,028
1936	65,314
1937	33,544
1938	15,368
Average	31,144

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APPENDICES

Appendix A.–Approximate weekly sampling schedule for sockeye salmon at the Klawock Lake weir in 2009 (length, sex, and scales).

Statistical Week	Dates	Number of fish to sample
28	5–11 July	20
29	12–18 July	40
30	19–25 July	80
31	26 July–1 August	100
32	2–8 August	120
33	9–15 August	120
34	16–22 August	80
35	23–29 August	40
36	30 August–5 September	20
Total		620

The weekly age-sex distribution, the seasonal age-sex distribution weighted by week, and the mean length by age and sex weighted by week, for smolt and adults, were calculated using equations from Cochran (1977; pages 52, 107–108, and 142–144).

Let,

h = index of the stratum (week),

j = index of the age class,

p_{hj} = proportion of the sample taken during stratum h that is age j,

n_h = number of fish sampled in week h, and

n_{hj} = number observed in class j, week h.

Then the age distribution was estimated for each week of the escapement in the usual manner:

$$\hat{p}_{hj} = n_{hj} / n_h \ . \tag{1}$$

If N_h equals the number of fish in the escapement in week h, standard errors of the weekly age class proportions are calculated in the usual manner (Cochran 1977, page 52, equation 3.12):

$$SE(\hat{p}_{hj}) = \sqrt{\left[\frac{(\hat{p}_{hj})(1-\hat{p}_{hj})}{n_h - 1}\right][1 - n_h / N_h]} \ . \tag{2}$$

The age distributions for the total escapement were estimated as a weighted sum (by stratum size) of the weekly proportions. That is,

$$\hat{p}_j = \sum_h p_{hj}(N_h / N), \tag{3}$$

such that N equals the total escapement. The standard error of a seasonal proportion is the square root of the weighted sum of the weekly variances (Cochran 1977, pages 107–108):

$$SE(\hat{p}_j) = \sqrt{\sum_j^h [SE(\hat{p}_{hj})]^2 (N_h / N)^2} \ . \tag{4}$$

The mean length, by sex and age class (weighted by week of escapement), and the variance of the weighted mean length, were calculated using the following equations from Cochran (1977, pages 142-144) for estimating means over subpopulations. That is, let i equal the index of the individual fish in the age-sex class j, and y_{hij} equal the length of the ith fish in class j, week h, so that,

$$\hat{\bar{Y}}_j = \frac{\sum_h (N_h / n_h) \sum_i y_{hij}}{\sum_h (N_h / n_h) n_{hj}} \text{, and} \tag{5}$$

$$\hat{V}\left(\hat{\bar{Y}}_j\right) = \frac{1}{\hat{N}_j^2} \sum_h \frac{N_h^2 (1 - n_h / N_h)}{n_h (n_h - 1)} \left[\sum_i (y_{hij} - \bar{y}_{hj})^2 + n_{hj}\left(1 - \frac{n_{hj}}{n_h}\right)\left(\bar{y}_{hj} - \hat{\bar{Y}}_j\right)^2\right]. \tag{6}$$

Appendix C.–Daily weir counts for sockeye salmon.

Date	Adult	Jack	Total	Date	Adult	Jack	Total	Date	Adult	Jack	Total
7/13	110	2	112	8/25	218	71	289	10/8	–	–	–
7/14	6	–	6	8/26	362	59	421	10/9	–	–	–
7/15	93	–	93	8/27	52	41	93	10/10	6	1	7
7/16	66	2	68	8/28	1430	280	1,710	10/11	3	–	3
7/17	92	1	93	8/29	69	20	89	10/12	–	–	–
7/18	110	3	113	8/30	38	9	47	10/13	–	–	–
7/19	89	2	91	8/31	11	4	15	10/14	5	–	5
7/20	22	–	22	9/1	81	39	120	10/15	–	–	–
7/21	131	4	135	9/2	91	15	106	10/16	–	–	–
7/22	69	–	69	9/3	99	42	141	10/17	10	–	10
7/23	77	7	84	9/4	334	77	411	10/18	9	47	56
7/24	1853	128	1981	9/5	354	74	428	10/19	2	–	2
7/25	397	36	433	9/6	110	20	130	10/20	3	–	3
7/26	124	10	134	9/7	64	13	77	10/21	5	–	5
7/27	28	2	30	9/8	96	24	120	10/22	5	–	5
7/28	26	10	36	9/9	104	8	112	10/23	5	–	5
7/29	46	3	49	9/10	869	87	956	10/24	3	–	3
7/30	47	16	63	9/11	508	51	559	10/25	2	–	2
7/31	72	22	94	9/12	65	17	82	10/26	3	–	3
8/1	93	18	111	9/13	89	11	100	10/27	–	–	–
8/2	94	18	112	9/14	22	4	26	10/28	5	–	5
8/3	160	37	197	9/15	64	–	64	10/29	2	–	2
8/4	180	22	202	9/16	310	35	345	10/30	–	–	–
8/5	194	38	232	9/17	73	9	82	10/31	–	–	–
8/6	327	41	368	9/18	28	4	32	11/1	–	–	–
8/7	89	10	99	9/19	32	1	33	11/2	–	–	–
8/8	120	78	198	9/20	6	–	6	11/3	–	–	–
8/9	69	28	97	9/21	23	2	25	11/4	–	–	–
8/10	464	120	584	9/22[a]	1	–	1	11/5	1	–	1
8/11	880	236	1,116	9/23	6	–	6	11/6	–	–	–
8/12	209	96	305	9/25	5	–	5	11/7	–	–	–
8/13	63	20	83	9/26	6	–	6	11/8	–	–	–
8/14	154	42	196	9/27	1	–	1	11/9	–	–	–
8/15	27	34	61	9/28	5	–	5	11/10	–	–	–
8/16	34	41	75	9/29	5	–	5	11/11	–	–	–
8/17	1296	366	1,662	9/30	–	–	–	11/12	–	–	–
8/18	1519	202	1,721	10/1	–	–	–	11/13	–	–	–
8/19	307	35	342	10/2	9	–	9	11/14	1	–	1
8/20	152	48	200	10/3	6	–	6	11/15	–	–	–
8/21	54	41	95	10/4	–	–	–	11/16	–	–	–
8/22	44	28	72	10/5	–	–	–	11/17	1	–	1
8/23	652	182	834	10/6	–	–	–	11/18	——Weir Pulled——		
8/24	204	44	248	10/7	–	–	–	Total	16,560	3,139	19,699

[a] Water overtopped the weir for about 12 h during a flood event on 22 September.

Appendix D.–Age composition of sockeye salmon escapement at Klawock Lake, 1982–2009.

	Proportion by Age Class										Proportion Based on Time Spent in Freshwater		
Year	**1.1**	**1.2**	**1.3**	**1.4**	**2.1**	**2.2**	**2.3**	**2.4**	**3.2**	**3.3**	**Age 1.-**	**Age 2.-**	**Age 3.-**
1982	0.00	0.15	0.83	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.98	0.01	0.01
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1984	0.28	0.24	0.29	0.00	0.04	0.09	0.06	0.00	0.00	0.00	0.81	0.19	0.00
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1986	0.00	0.28	0.61	0.00	0.00	0.07	0.04	0.00	0.00	0.00	0.89	0.11	0.00
1987	0.13	0.19	0.37	0.00	0.04	0.16	0.09	0.00	0.00	0.00	0.70	0.29	0.01
1988	0.00	0.35	0.42	0.00	0.00	0.12	0.10	0.00	0.00	0.00	0.78	0.22	0.00
1989	0.03	0.07	0.67	0.00	0.01	0.10	0.12	0.00	0.00	0.00	0.77	0.23	0.00
1990	0.56	0.16	0.09	0.01	0.01	0.14	0.04	0.00	0.00	0.00	0.81	0.19	0.00
1991	0.26	0.37	0.26	0.00	0.04	0.05	0.01	0.00	0.00	0.00	0.89	0.11	0.00
1992	0.18	0.44	0.30	0.00	0.06	0.02	0.01	0.00	0.00	0.00	0.91	0.09	0.00
1993	0.07	0.20	0.50	0.00	0.04	0.08	0.09	0.00	0.00	0.01	0.77	0.22	0.01
1994	0.05	0.06	0.71	0.00	0.01	0.14	0.03	0.00	0.00	0.00	0.82	0.18	0.00
1995	0.26	0.31	0.29	0.00	0.02	0.05	0.07	0.00	0.00	0.00	0.86	0.14	0.00
1996	0.03	0.09	0.67	0.00	0.01	0.09	0.10	0.00	0.00	0.00	0.79	0.21	0.00
1997	0.09	0.27	0.43	0.00	0.01	0.10	0.11	0.00	0.00	0.00	0.79	0.21	0.00
–	–	–	–	–	–	–	–	–	–	–	–	–	–
2001	0.01	0.10	0.49	0.00	0.00	0.12	0.27	0.00	0.00	0.00	0.60	0.40	0.00
2002	0.00	0.35	0.34	0.01	0.03	0.27	0.01	0.00	0.00	0.00	0.70	0.30	0.00
2003	0.01	0.08	0.59	0.00	0.03	0.26	0.03	0.00	0.00	0.00	0.68	0.32	0.00
2004	0.02	0.33	0.34	0.00	0.02	0.27	0.01	0.00	0.00	0.00	0.70	0.30	0.00
2005	0.13	0.13	0.29	0.00	0.05	0.37	0.03	0.00	0.00	0.00	0.55	0.44	0.00
2006	0.14	0.54	0.15	0.00	0.02	0.14	0.01	0.00	0.00	0.00	0.83	0.17	0.00
2007	0.02	0.30	0.36	0.00	0.02	0.22	0.07	0.00	0.00	0.00	0.69	0.31	0.00
2008	0.11	0.44	0.24	0.01	0.00	0.19	0.01	0.00	0.00	0.00	0.79	0.21	0.00
2009	0.09	0.28	0.50	0.00	0.03	0.05	0.04	0.00	0.00	0.00	0.87	0.13	0.00
Average, all years	0.11	0.25	0.42	0.00	0.02	0.14	0.06	0.00	0.00	0.00	0.78	0.22	0.00
SE	0.08	0.08	0.09	0.01	0.03	0.06	0.05	0.00	0.01	0.01	0.07	0.07	0.01
Average, 1982-1997	0.14	0.23	0.46	0.00	0.02	0.09	0.06	0.00	0.00	0.00	0.83	0.17	0.00
SE	0.11	0.09	0.12	0.01	0.04	0.06	0.05	0.01	0.01	0.01	0.07	0.07	0.01
Average, 2001-2008	0.06	0.28	0.37	0.00	0.02	0.21	0.05	0.00	0.00	0.00	0.71	0.29	0.00
SE	0.08	0.13	0.12	0.02	0.04	0.10	0.10	0.00	0.01	0.00	0.11	0.11	0.01