U.S. Fish and Wildlife Service
Office of Subsistence Management
Fisheries Resource Monitoring Program

Neva, Pavlof, and Hoktaheen Sockeye Salmon Stock Assessment, 2002 to 2005

Final Report for Study 02-012

Benjamin W. Van Alen
USDA Forest Service
Juneau Ranger District
8510 Mendenhall Loop Road
Juneau, Alaska 99801

September 2008

TABLE OF CONTENTS

TABLE OF CONTENTS ii
LIST OF FIGURES iv
LIST OF TABLES vi
ABSTRACT 9
INTRODUCTION 10
BACKGROUND 12
Neva 12
Pavlof 23
Hoktaheen 26
OBJECTIVES 29
METHODS 29
Sockeye Escapement Assessment 29
Neva 2004 and 2005 29
Weir: 30
Weir-to-Spawning Ground Mark-Recapture Escapement Estimate: 30
Stream and Beach Mark-Recapture Escapement Indexing - 2004: 32
Visual Survey Counts: 34
Age, Sex, and Length Sampling: 35
Harvest Monitoring: 35
Pavlof 2004 36
Trap-to-Spawning Ground Mark-Recapture Estimate: 36
Stream Mark-Recapture Escapement Indexing: 37
Visual Survey Counts: 37
Age, Sex, and Length Sampling: 37
Hoktaheen 2004 37
Stream Mark-Recapture Escapement Indexing: 38
Visual Survey Counts: 38
Age, Sex, and Length Sampling: 38
Limnology Sampling 38
Light, Temperature, and Dissolved Oxygen Profiles 39
Zooplankton Composition and Density 40
RESULTS 40
Sockeye Escapement Assessment 40
Neva 2004 40
Weir and Weir-based Mark-Recapture Estimate of Total Escapement: 40
Stream and Beach Mark-Recapture for Indexing Escapement: 49
Visual Survey Counts: 51
Age, Sex, and Length Composition: 52
Harvest Monitoring: 54
Neva 2005 56
Weir and Weir-based Mark-Recapture Estimate of Total Escapement: 56
Visual Survey Counts: 60
Age, Sex, and Length Composition: 60

Harvest Monitoring: 61
Pavlof 2004 63
Trap-to-Spawning Ground Mark-Recapture Estimate of Total Escapement: 63
Stream Mark-Recapture for Indexing Escapement: 66
Foot/Boat Survey Counts: 67
Age, Sex, and Length Composition: 69
Hoktaheen 2004 70
Stream Mark-Recapture for Indexing Escapement: 70
Comparison of Abundance Indices - 2001 to 2004: 72
Foot/Boat Survey Counts: 73
Adult Age, Sex, and Length: 74
Limnology 2004 76
Light, Temperature, and Dissolved Oxygen Profiles 76
Secondary Production 80
DISCUSSION 84
CONCLUSIONS 89
RECOMMENDATIONS 91
ACKNOWLEDGEMENTS 92
LITERATURE CITED 94

(Cover photo: Frederick Gallant, III, Hoonah Indian Association, holds up a large male sockeye salmon while sampling at Hoktaheen Lake on September 6, 2002.)

LIST OF FIGURES

Figure 1. Map of northern Southeast Alaska showing the location of Neva, Pavlof, and Hoktaheen Lakes..... 10
Figure 2. Bathymetric map of Neva Lake showing 5 m depth contours and approximate locations of the two fixed sampling stations, the main inlet stream, the outlet, and the beach spawning study area. 12
Figure 3. Subsistence/personal use effort and harvest of sockeye salmon at Neva from 1985 to 2005 as reported on permits returned to ADF&G. (from ADF&G, Division of Commercial Fisheries database, October, 2007) 14
Figure 4. ADF&G salmon statistical areas and sections in the Icy Strait and northern Chatham Strait area. (from ADF&G, Chart No. 3) 15
Figure 5. Weekly purse seine harvest of chum salmon in Excursion Inlet, Statistical Area 114-80, 1960 to 2005. (from ADF&G, Division of Commercial Fisheries, Alexander Database, October, 2006)..... 19
Figure 6. Weekly purse seine harvest of sockeye salmon in Excursion Inlet, Statistical Area 114-80, 1960 to 2005. (from ADF&G, Division of Commercial Fisheries, Alexander Database, October, 2006)..... 19
Figure 7. Bathymetric map of Pavlof Lake showing 1 m depth contours and locations of the two fixed sampling stations, the study area in the main inlet stream, and the fish pass and trap at the outlet of the lake. (from ADF&G) 23
Figure 8. Average daily mean stream flow (cubic-feet per-second) and minimum and maximum (truncated at 1,000 from peaks up to 3,370) daily measurements for Pavlof River, June 1, 1957 to September 30, 1981. (from USGS)..... 24
Figure 9. Subsistence/personal use effort and harvest of sockeye salmon at Pavlof from 1985 to 2005 as reported on permits returned to ADF&G. (from ADF&G, Division of Commercial Fisheries, Alexander Database, March, 2007)..... 26
Figure 10. Bathymetric map of Hoktaheen Lakes with 5 m depth contours, location of limnology sampling stations A and B, and locations of the Main Inlet Stream and outlet..... 27
Figure 11. Subsistence/personal use effort and harvest of sockeye salmon at Hoktaheen from 1985 to 2005 as reported on permits returned to ADF&G. (from ADF&G, Division of Commercial Fisheries database, 2007) 28
Figure 12. Map of the North end of Neva Lake showing the main inlet stream and Neva Creek..... 33
Figure 13. Key to spawning area mark-recapture sampling procedures. 34
Figure 14. Cumulative proportion of sockeye salmon counted through the Pavlof outlet fishpass, 2002, 2003, and 2004..... 65
Figure 15. Daily sockeye migration and stream depth at the Neva weir, 2004..... 86
Figure 16. Daily stream depth and temperature at the Neva weir, 2004. 86

Figure 17. Daily stream depth and temperature at the Neva weir, 2005. 87
Figure 18. Photo of the Neva Creek weir and trap, under construction, June 2003. 88

LIST OF TABLES

Table 1. Subsistence use and harvest of salmon by households in Hoonah, 1985, 1987, and 1996. (from ADF&G, Division of Subsistence, Community Profile Database, 2003) 11

Table 2. Historic commercial harvest of sockeye salmon in Icy Strait, and Hoktaheen Cove and Excursion Inlet (Neva), and Northern Chatham Strait, and Freshwater Bay (Pavlof), 1889 to 1927. (from Rich and Ball, 1933) 17

Table 3. Commercial purse seine effort and harvest of sockeye salmon in waters adjacent to Neva Lake (Icy Strait and Excursion Inlet), Pavlof Lake (Upper Chatham Strait and Freshwater Bay), and Hoktaheen Lake (Hoktaheen Cove), 1960 to 2005. (from ADF&G, Division of Commercial Fisheries, Alexander Database, October 2006) 18

Table 4. Sport fish effort and harvest in Excursion Inlet and Neva Lake, 1984 to 2002. (from ADF&G, Division of Sport Fish, Statewide Harvest Database, 2005) 20

Table 5. Sport fish harvest and effort in the Sitka area (on and around Baranof and Chichagof Islands) and Glacier Bay areas, 1977 to 2005. (from ADF&G, Division of Sport Fish, Statewide Harvest Database, 2007) 21

Table 6. Peak aerial, foot, or boat counts of sockeye salmon at Neva, Pavlof, and Hoktaheen, 1960 to 2003. (from ADF&G, Division of Commercial Fisheries, Alexander Database, January 2005) 22

Table 7. Limnology sampling dates in Neva, Pavlof, and Hoktaheen Lakes, 2004. 39

Table 8. Latitude and longitude coordinates for the limnological sampling stations in Neva, Pavlof, and Hoktaheen Lakes, 2002, 2003, and 2004. 39

Table 9. Weather and stream measurements and daily numbers of fish counted and finclipped at the Neva Creek weir, 2004. 42

Table 10. Mark and recapture data, and abundance estimates, for sockeye salmon marked at the Neva Creek weir, 2004. 46

Table 11. Estimated daily escapement of adult and jack sockeye salmon into Neva Lake, June 4 to October 13, 2002 to 2005. 47

Table 12. Data collected for modified Jolly-Seber estimates of the abundance of adult and jack sockeye salmon in Neva Lake's main inlet stream (MIS) and beach study areas, 2004. 50

Table 13. Visual counts of sockeye salmon in Neva Lake's outlet and main inlet stream (foot surveys) and lake (boat surveys), 2004 52

Table 14. Age composition of sockeye salmon in the Neva Lake escapement, 2004. 53

Table 15. Length composition (mm) of sockeye salmon in the Neva Lake escapement, 2004. 54

Table 16. Observed sport and subsistence effort and harvest of salmon in the Neva Creek/South Creek area, June 24 to August 17, 2004. 55

Table 17. Weather and stream measurements and daily numbers of fish counted and finclipped at the Neva Creek weir, 2005. 57
Table 18. Age composition of sockeye salmon in the Neva Lake escapement, 2005. 60
Table 19. Length composition (mm) of sockeye salmon in the Neva Lake escapement, 2005. 61
Table 20. Age composition of the sockeye salmon escapement into Neva Lake, 2002 through 2005. 61
Table 21. Observed subsistence effort and harvest of salmon in the Neva Creek/South Creek area, July 3 to August 13, 2005. 62
Table 22. Observed and reported subsistence harvest of sockeye salmon in the Neva Creek and South Creek area, 2002 to 2005. 62
Table 23. Daily counts of upstream migrating salmon, Dolly Varden char, and cutthroat trout passed through the trap at the top of Pavlof Lake's outlet fishpass, 2004. 64
Table 24. Mark-recapture estimate of the escapement of adult and jack sockeye salmon in Pavlof Lake, 2004. 66
Table 25. Mark-recapture index of the abundance of adult and jack sockeye salmon in Pavlof Lake's main inlet stream study area, 2004. 67
Table 26. Foot survey counts of sockeye salmon in the main inlet stream study area, Pavlof Lake, 2004. 68
Table 27. Age and sex composition of sockeye salmon sampled from the trap at the top of the outlet fishpass at Pavlof Lake, 2004. 69
Table 28. Age composition of sockeye salmon sampled from the trap at the top of the outlet fishpass at Pavlof Lake, 2002, 2003, and 2004. 69
Table 29. Length composition (mm), by sex, of sockeye salmon sampled from the trap at the top of the outlet fishpass at Pavlof Lake, 2004. 70
Table 30. Modified Jolly-Seber estimate of the abundance of adult sockeye salmon in upper Hoktaheen Lake's main inlet stream study area, 2004. 71
Table 31. Modified Jolly-Seber estimate of the abundance of adult sockeye salmon in upper Hoktaheen Lake's outlet stream study area, 2004..... 72
Table 32. Abundance index of sockeye salmon in Hoktaheen Lake's main inlet stream from the first two-day mark-recapture trip made in early-September in 2001, 2002, 2003, and 2004. 72
Table 33. Abundance index of sockeye salmon in upper Hoktaheen Lake's outlet stream study area from mid-September two-day mark-recapture trips in 2002, 2003, and 2004. 73
Table 34. Boat and foot survey counts of live adult sockeye salmon in the Hoktaheen Lake system, 2004. 73
Table 35. Age and sex composition of sockeye salmon sampled in the main inlet stream to upper Hoktaheen Lake from September 3 to 17, 2004..... 74
Table 36. Age and sex composition of sockeye salmon sampled in the outlet stream of upper Hoktaheen Lake from September 14 to 27, 2004. 75
Table 37. Age composition of sockeye salmon sampled in the main inlet stream and outlet of upper Hoktaheen Lake from 2001 to 2004. 75

Table 38. Length composition (mm), by sex, of adult sockeye salmon sampled in Hoktaheen Lake's main inlet stream from September 3 to 17, 2004... 76
Table 39. Length composition (mm), by sex, of sockeye salmon sampled in the outlet stream of upper Hoktaheen Lake from September 14 to 27, 2004. 76
Table 40. Light meter and secchi disk readings at Stations A in Neva, Pavlof, and Hoktaheen Lakes, 2004. 77
Table 41. Euphotic zone depths in Neva, Pavlof, and Hoktaheen Lakes, 2004... 78
Table 42. Temperature and dissolved oxygen profiles for Neva Lake, 2004. 79
Table 43. Temperature and dissolved oxygen profiles for Pavlof Lake, 2004. ... 79
Table 44. Temperature and dissolved oxygen profiles for Hoktaheen Lake, 2004. 80
Table 45. Density, size, and biomass of zooplankton in Neva Lake, June to October, 2004. 81
Table 46. Density, size, and biomass of zooplankton in Pavlof Lake, June to October, 2004. 82
Table 47. Density, size, and biomass of zooplankton in Hoktaheen Lake, September 2004. 83

ABSTRACT

The escapement of sockeye salmon into Neva Lake was 5,003 fish in 2002, 11,393 in 2003, 9,513 in 2004, and 5,263 in 2005 based on weir counts and mark-recapture data. On average, the midpoint of the run was August 8 and 80% of the run passes between July 12 and September 9. The inlet stream spawners spawned mostly in August and September and the lake spawners spawned mostly in October and November. Age-1. fish dominated the escapements and up to 24% of the fish were jacks. The subsistence and sport effort and harvest was relatively small.

The sockeye escapement into Pavlof Lake was 1,350 in 2002, 1,474 in 2003, and 715 in 2004 based on Peterson mark-recapture estimates with coefficient of variations less than 7%. Nearly all the fish entered the lake between June 21 and August 14 and spawned in the lower part of the main inlet stream from late-July to mid-August. Age-1.3 fish dominated the escapement and few jacks were observed. Thirty to 69% of the fish used the fishpass to migrate into the lake.

At Hoktaheen Lake, 3,438 (CV=3%) and 565 (CV=4%) sockeye salmon spawned in the upper lake's main inlet stream study area in 2003 and 2004 based on modified Jolly-Seber mark-recapture estimates. Most of these fish were in and off the mouth of the creek the first week of September. The only other concentration of spawners observed was in the upper half of the stream connecting the upper and lower lakes where 325 and 251 sockeye spawned from mid to late September in 2003 and 2004. Lake spawners might be present but none were observed in the tannin stained water. Age-1. and age-2. fish were sampled from the escapements.

Key words: Sockeye salmon, *Oncorhynchus nerka*, subsistence, Neva, Pavlof, Hoktaheen, escapement, weir, mark-recapture, age composition, zooplankton, limnology.

Citation: Van Alen, B. W. 2008. Neva, Pavlof, and Hoktaheen sockeye salmon stock assessment; 2002 to 2005. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fishery Resource Monitoring Program, Final Report Study No. 02-012. Anchorage, Alaska.

INTRODUCTION

Sockeye salmon returns to Neva Lake (Alaska Department of Fish and Game, Division of Commercial Fisheries stream number 114-80-045), Pavlof Lake (112-50-010), and Hoktaheen Lake (113-94-003) have long been an important subsistence resource for Tlingit families living in Hoonah and other areas of northern Southeast Alaska (de Laguna 1960; Schroeder and Kookesh 1990; Goldschmidt and Haas 1998; Figure 1). Household subsistence surveys done in Hoonah in 1996 found that 86% of the families used salmon and 65% used sockeye salmon (Table 1).

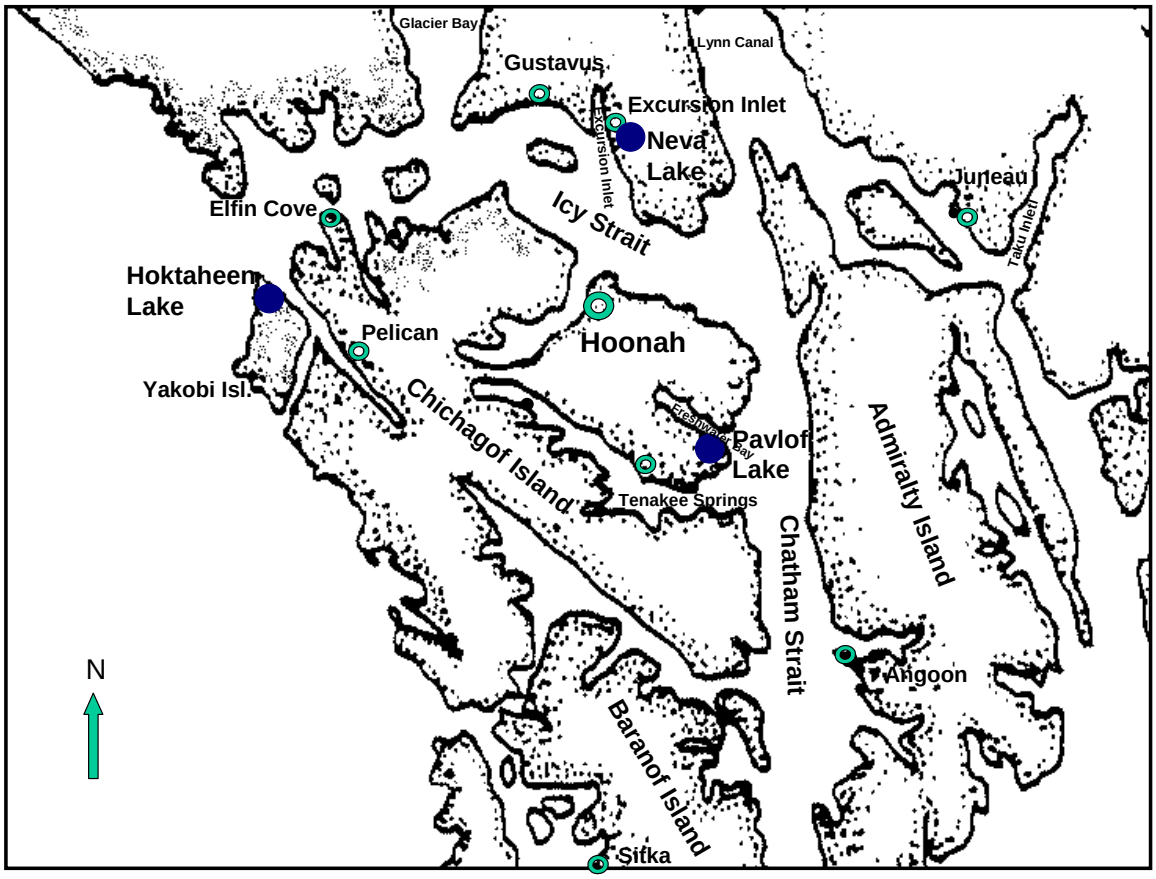


Figure 1. Map of northern Southeast Alaska showing the location of Neva, Pavlof, and Hoktaheen Lakes.

Table 1. Subsistence use and harvest of salmon by households in Hoonah, 1985, 1987, and 1996. (from ADF&G, Division of Subsistence, Community Profile Database, 2003)

	Sockeye Salmon		All Salmon	
Year	Percent Households Using	Percent Households Harvesting	Percent Households Using	Percent Households Harvesting
1985	32%	17%	86%	55%
1987	38%	29%	92%	69%
1996	65%	43%	86%	74%

Unfortunately, little is known about the health of these sockeye runs. Management has had to rely on infrequent and imprecise aerial survey counts and subsistence harvest reports to assess run sizes and trends. I am not aware of any prior studies that estimated or indexed the sockeye escapement into these lakes. We do not know if escapements are at levels that would maximize returns and harvests. We do not know if management is too conservative and if subsistence harvests limits could be liberalized, or, if these runs are depressed and need rebuilding. Rebuilding perhaps from over harvesting that occurred with the onset of commercial fishing in the late-1800s and early-1900s (Bean 1891; Moser 1899; Rich and Ball 1933; Cooley 1963; Van Alen 2000). Most importantly, we do not know if escapements are trending downward and if management actions are needed to protect these important subsistence resources.

This project estimates sockeye escapements into Neva and Pavlof Lakes, indexes the sockeye escapement into Hoktaheen Lake, and collects associated biological and limnological data needed to assess the current status of these important subsistence stocks. Mark-recapture methods are used to estimate the relative and/or absolute sockeye escapement in all lakes. This information is needed to estimate escapement goals and understand the current status of these runs (Geiger et al. 2003).

This final project report covers the third year (2004) of a joint Hoonah Indian Association (HIA)/U.S. Forest Service/Alaska Department of Fish and Game (ADF&G) study into the status of Neva, Pavlof, and Hoktaheen sockeye salmon. Results from the 2002 season were reported in Van Alen (2004) and for the 2003 season in Van Alen (2005). The stock assessment of sockeye salmon in Hoktaheen Lake was part of an Organized Village of Kake and ADF&G project in 2001 (Conitz and Cartwright 2002) but was included in this project since Hoktaheen is in the traditional fishing area of the Hoonah people.

This Neva, Pavlof, and Hoktaheen sockeye stock assessment project is one of several sockeye stock assessment projects done in southeast Alaska since 2001 with support by the U.S. Fish & Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program. Funding for these projects has been a fortunate consequence of the Federal government's 1999 assumption from the State of Alaska of the management of subsistence fisheries on Federal public lands. These projects all involve cooperation among community Tribal associations, ADF&G, and Forest Service.

There were also two Federal Office of Subsistence Management-funded, "Traditional Ecological Knowledge" projects recently completed regarding subsistence use of salmon in the Hoonah area (Ratner and Dizard 2005; Langdon 2006). Results from these studies will help us assure the adequacy of these runs for meeting escapement and subsistence needs.

BACKGROUND

Neva

Neva Lake (58˚24.219' N, 135˚24.258' W; NAD27 datum) is located on the mainland on the east side of Excursion Inlet (Figure 2). The lake is about 2 km southeast of the unincorporated community of Excursion Inlet, about 22 km east of Gustavus, and about 40 km across Icy Strait from Hoonah. The lake lies at an elevation of 44 m, has a surface area of 36.1 ha, and a maximum depth of 19 m. There is one main inlet stream that flows into the northeast end of the lake. The outlet of Neva Lake (Neva Creek) flows from the northwest end of the lake about 1.2 km before entering the glacial South Creek which then flows about 1 km before entering Excursion Inlet on the south side of the cannery complex.

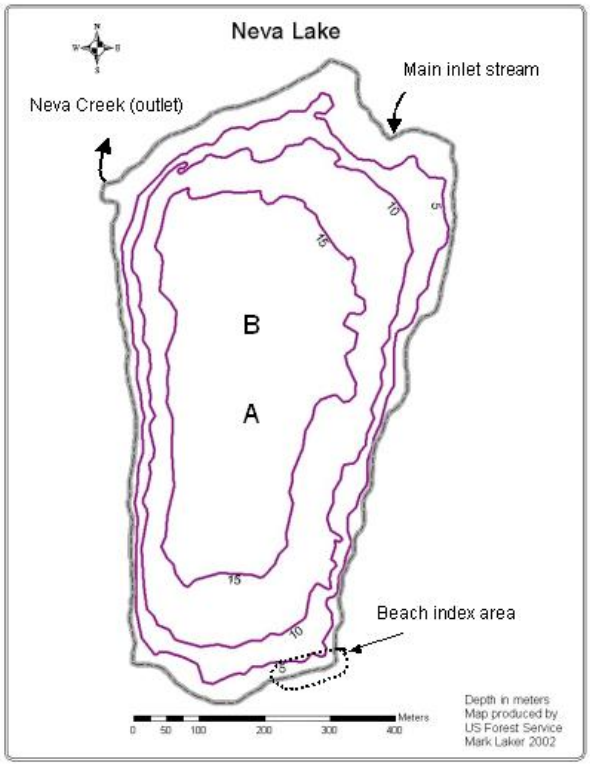


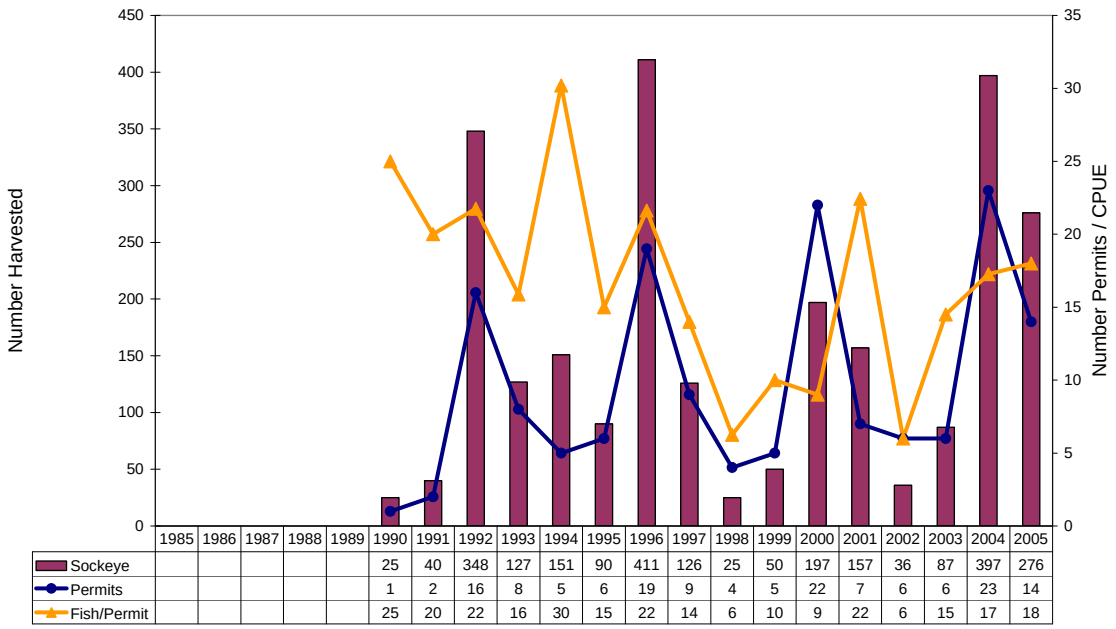
Figure 2. Bathymetric map of Neva Lake showing 5 m depth contours and approximate locations of the two fixed sampling stations, the main inlet stream, the outlet, and the beach spawning study area.

Neva Lake is in the traditional lands used for subsistence harvesting and gathering by the Huna Tlingit (Schroeder and Kookesh 1990). There used to be a village of Wooshkeetaan clan people in Excursion Inlet near the present cannery site (Goldschmidt and Haas 1998). Villagers would fish for "a good run of sockeye" salmon returning to Neva Lake and there were several smokehouses in the area. Stone barriers are still evident in Neva Creek that were built to fish upstream migrating salmon (Langdon 2006).

A salmon cannery began operation in Excursion Inlet in 1918. The location and ownership of the cannery has changed several times over the years (Galginaitis 2003). During World War II, between August 1942 and November 1943, over 3,000 civilian and U.S. Army workers constructed a barge terminal at Excursion Inlet as a potential resupply port for the Aleutian campaign (Cohen 1988). The $17 million port was never needed and from July 1945 to January 1946 the Army used about 700 German prisoners of war to dismantle and salvage as much as possible. A dam, reservoir, and water distribution system remained that is still used by the cannery today. This water system diverts water out of Neva Lake's main inlet stream. Neva Lake is accessible by road from the cannery.

The State currently holds title to the land surrounding Neva Lake and outlet, and the cannery site is privately owned, but the majority of the watershed is on National Forest System Land. The State is currently in the process of transferring some land selections in the Excursion Inlet/South Creek area to the Haines Borough. In the 1970s and 1980s, the State subdivided and sold land along the eastern shore of Excursion Inlet and there are now about 80 cabins/homes and a sport fishing lodge in the area that are mostly used for summer recreation. Unguided clients from sport fish lodges often target salmon at the mouth of South Creek.

This area is in the Federal subsistence customary and traditional use area for residents in the Hoonah area (Federal Register 50 CFR Part 100 and 36 CFR Part 242) and in an area designated by the State as subsistence (5 AAC 01.716). A permit is required to take salmon for subsistence or personal use in southeast Alaska. ADF&G, Commercial Fisheries Division, staff have issued these permits, one per household, and has maintained records of the permits issued, returned, and the reported harvest since 1984. The return of these permits is voluntary. No sockeye salmon were reported harvested at Neva prior to 1990. The effort and harvest has peaked every four years, 1992, 1996, 2000, and 2004, with as many as 23 permits being fished and 411 sockeye harvested (Figure 3). Subsistence and personal use fishing for Neva sockeye salmon occurs both in saltwater, at the mouth of South Creek, and in freshwater in South Creek and Neva Creek. A pool in the lower part of Neva Creek is a traditional site for taking sockeye salmon with a gaff.



	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sockeye						25	40	348	127	151	90	411	126	25	50	197	157	36	87	397	276
Permits						1	2	16	8	5	6	19	9	4	5	22	7	6	6	23	14
Fish/Permit						25	20	22	16	30	15	22	14	6	10	9	22	6	15	17	18

Figure 3. Subsistence/personal use effort and harvest of sockeye salmon at Neva from 1985 to 2005 as reported on permits returned to ADF&G. (from ADF&G, Division of Commercial Fisheries database, October, 2007)

Neva sockeye salmon would primarily be harvested in commercial fisheries in Excursion Inlet (Statistical Area 114-80; Figure 4) and Icy Strait. These fisheries also harvest sockeye salmon bound for Lynn Canal, Taku River, Chatham Strait, other northern inside systems, and since 2000, to Snettisham Hatchery. Rich and Ball (1933) reported no harvests of sockeye salmon in Excursion Inlet prior to 1914 and annual harvests of zero to 50,722 sockeye salmon in Excursion Inlet from 1914 to 1927 (Table 2). Beach seines, purse seines, gillnets, and traps fishing on passing stocks in Icy Strait harvested hundreds of thousands of sockeye salmon annually through 1927 (Rich and Ball 1933; Table 2). Commercial harvest estimates for Icy Strait and Excursion Inlet from 1928 to statehood (1959) are not available. Traps were outlawed in 1959; however, the purse seine fishing effort remained high in Icy Strait into the early 1970s (Table 3). The annual sockeye harvest has ranged between zero and 2,584 fish in Excursion Inlet since 1960 (Table 3). Seine openings in Excursion Inlet have been directed at fall run chum salmon returning to Excursion River. Returns and harvests of these fall chum salmon has declined dramatically since the early 1960s (Figure 5). There was a marked increase in sockeye harvest in the 1980s and 1990s when openings were advanced from September to August (Figure 6).

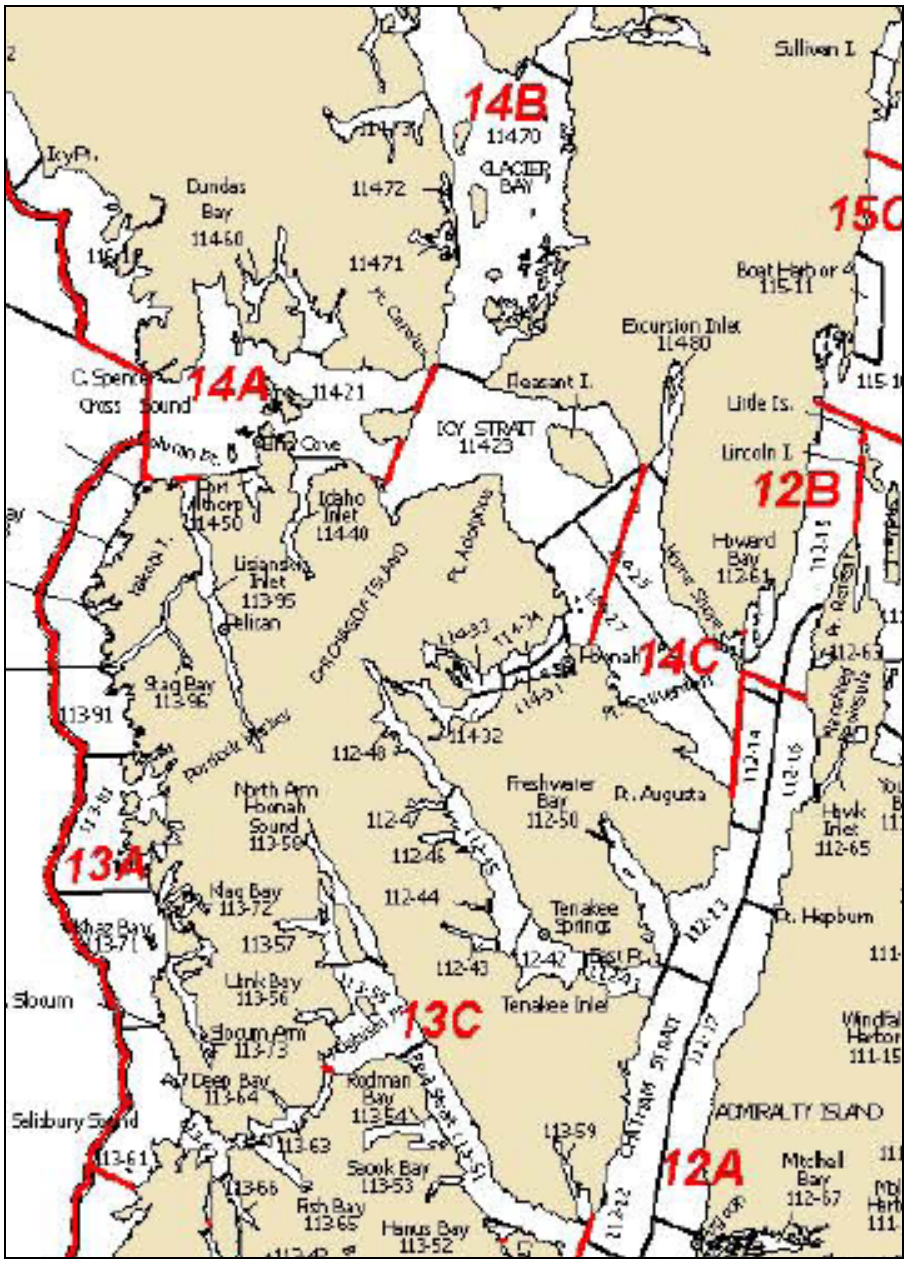


Figure 4. ADF&G salmon statistical areas and sections in the Icy Strait and northern Chatham Strait area. (from ADF&G, Chart No. 3)

The ADF&G, Division of Sport Fish, estimates sport effort, catch, and harvest from an annual statewide mail survey (Mills and Howe 1992). Twelve or more responses are needed for estimates to be useable. There have been too few responses to estimate effort or harvests of salmon in the Neva Lake system but the sport fish harvest of sockeye salmon in the entire Excursion Inlet area (excluding the Excursion River) has averaged only 34 fish from 1984 to 1999 (Table 4). There has been an increasing trend in sport effort and harvest in both the Excursion Inlet area (Table 4) and the Glacier Bay Area that includes Excursion Inlet (Table 5).

Aerial and foot escapement surveys have been conducted by ADF&G, Commercial Fisheries Division, intermittently since 1960. These surveys are primarily geared to indexing pink and chum salmon escapements. They should not be considered a reliable estimate or index of sockeye abundance without further study. Survey locations, dates, and observers are not standardized (Bevan 1961; Jones et al. 1998) and usually only a small fraction of the escapement is visible due to the forest canopy, dark water, and the natural dispersal of fish within a system. Nevertheless, counts as high as 1,250 sockeye salmon have been made in Neva Lake in recent years (Table 6).

Table 2. Historic commercial harvest of sockeye salmon in Icy Strait, and Hoktaheen Cove and Excursion Inlet (Neva), and Northern Chatham Strait, and Freshwater Bay (Pavlof), 1889 to 1927. (from Rich and Ball, 1933)

Year	Icy Strait[a]	Hoktaheen Cove	Excursion Inlet	Northern Chatham Strait[b]	Freshwater Bay
1889	51,600				
1890	144,000			4,902	
1891	91,200				
1892				21,875	
1893					
1894					
1895				4,260	
1896				36,969	
1897				566	
1898					
1899					
1900	151,901			194,200	25,000
1901	96,547			131,055	
1902	218,084			128,080	
1903	236,167			241,175	
1904	432,262			199,200	
1905	584,275	8,279		93,664	
1906	375,459	11,348		177,200	
1907	511,265	7,000		121,394	
1908	661,140	10,677		256,619	
1909	626,511	10,391		304,351	
1910	609,802	9,896		150,892	
1911	635,726	7,196		158,956	
1912	818,162	7,197		248,964	1,000
1913	686,268	5,344		208,937	
1914	1,304,877	7,686	3	223,738	
1915	768,068	8,301		241,763	
1916	679,561			127,681	560
1917	712,770		6,036	270,713	179
1918	827,768	2,519	61	242,056	
1919	822,679	5,463	385	205,552	808
1920	608,953	3,218	50,722	173,875	
1921	271,138			91,406	
1922	425,725	653	390	103,996	
1923	518,006	5,266	78	86,297	30
1924	552,789	2,310	2,382	121,589	
1925	525,391	2,335	3,039	153,412	
1926	523,110	1,834	546	140,680	
1927	345,635	2,021	2,469	102,367	
Spearman's rho non-parametric trend test (Conover 1980):					
rho	0.46	-0.85	0.35	0.22	-0.83
P-value	0.01	0.00	0.30	0.21	0.04
N	31	20	11	33	6

[a] The beach seine, purse seine, gillnet, and traps in the Icy Strait District primarily targeted passing stocks. Hoktaheen and Excursion Inlet (Neva) are in this district.

[b] The Northern Chatham Strait area includes the beach seine, purse seine, gillnet, and trap harvests north of Pt. Gardner and Takatz Bay. Freshwater Bay (Pavlof) is in this district.

Table 3. Commercial purse seine effort and harvest of sockeye salmon in waters adjacent to Neva Lake (Icy Strait and Excursion Inlet), Pavlof Lake (Upper Chatham Strait and Freshwater Bay), and Hoktaheen Lake (Hoktaheen Cove), 1960 to 2005. (from ADF&G, Division of Commercial Fisheries, Alexander Database, October 2006)

	Icy Strait (Dist. 114)		Excursion Inlet (Dist. 114-80)		Upper Chatham (Dist. 112)		Freshwater Bay (Dist. 112-50)		Hoktaheen Cove (Dist. 113-94)	
Year	Sockeye Harvest	Boat-Days	Sockeye Harvest	Boat-Days	Sockeye Harvest	Boat-Days	Sockeye Harvest	Boat-Days	Sockeye Harvest	Boat-Days
1960	136,796	1,552			12,399	236	1,046	58		
1961	213,619	2,965			45,493	726	69	15		
1962	136,712	1,208			11,148	160	114			
1963	201,535	5,440			24,268	1,312	18	4		
1964	204,304	4,162	9		34,225	1,282				
1965	280,730	4,682	1		48,756	1,383	15			
1966	216,858	2,747	12		28,737	1,363	3			
1967	160,019	3,113	306		15,891	525	17			
1968	230,741	3,004	2		41,874	3,213	448		1,073	
1969	231,624	3,627			29,563	1,610				
1970	163,224	4,384	4	190	49,598	4,844	14	27	149	6
1971	88,758	3,188	3	232	18,533	1,728			315	36
1972	96,853	3,374	13	220	33,761	2,651	528	48	8	3
1973	130,805	1,714	10	102	32,118	620			205	4
1974	20,594	656	2	184	23,639	858				
1975	2,391	226	0	110						
1976	21	303	21	303						
1977										
1978					1,261	434				
1979	3	53	2	52	1,577	261	8	4		
1980	1,792	216	1,685	198	1,300	662				
1981	10,638	596	266	238	17,188	602				
1982	234	119			26,524	3,408				
1983	2,333	135	85	28	25,979	1,001				
1984	6,882	190	1,876	138	22,208	1,548				
1985	3,638	253	919	26	37,140	2,448				
1986	1,479	69	168	35	8,391	2,181				
1987	3,793	307	396	156	44,989	1,486				
1988	1,244	135	952	73	3,927	642				
1989	6,111	164	151	2	48,985	1,653				
1990	4,161	110	2,348	52	17,477	873				
1991	4,307	208	1,153	31	40,289	2,735				
1992	6,454	180	2,584	65	54,403	1,869				
1993	9,806	249	216	1	81,676	2,989				
1994	10,536	412			76,582	4,044				
1995	264	8	264	8	20,387	2,799	1,576	54		
1996					37,482	3,102				
1997	5,123	259	518	5	25,946	2,528	1,582	46		
1998					30,820	2,546				
1999	17,301	893	105	24	55,942	3,725				
2000	1,111	99	376	77	30,594	2,538				
2001	43,739	443			64,427	1,777				
2002	4,592	262	46		24,751	1,761				
2003	11,973	288	3		68,316	1,945				
2004	35,254	427			173,008	2,366				
2005	13,354	466			116,013	3,135				

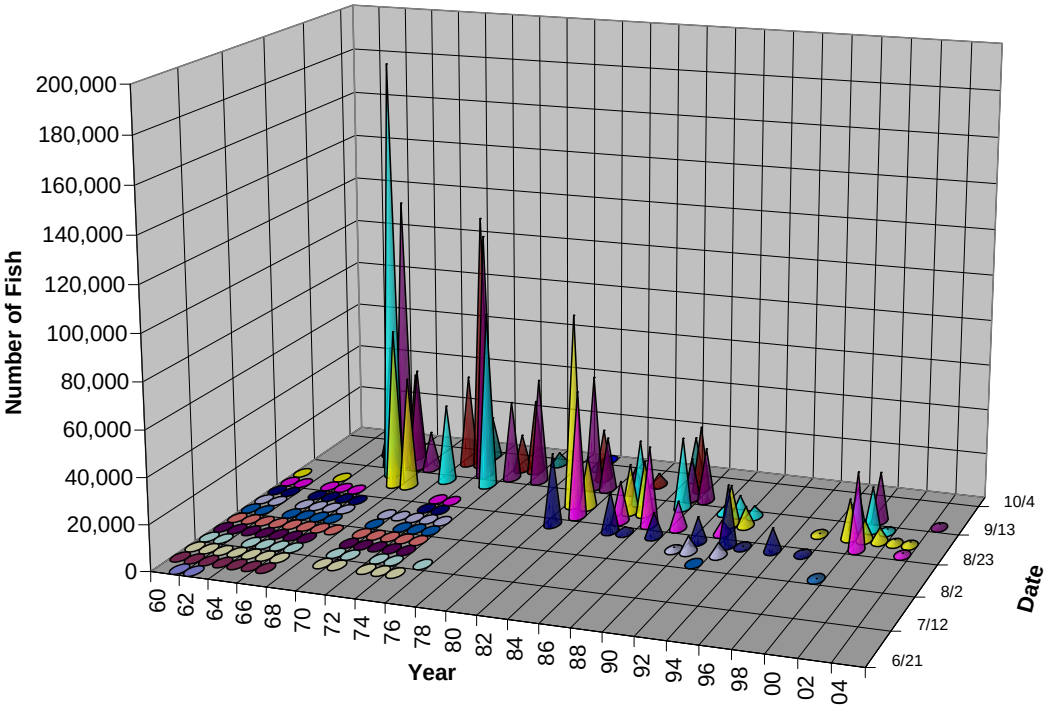


Figure 5. Weekly purse seine harvest of chum salmon in Excursion Inlet, Statistical Area 114-80, 1960 to 2005. (from ADF&G, Division of Commercial Fisheries, Alexander Database, October, 2006)

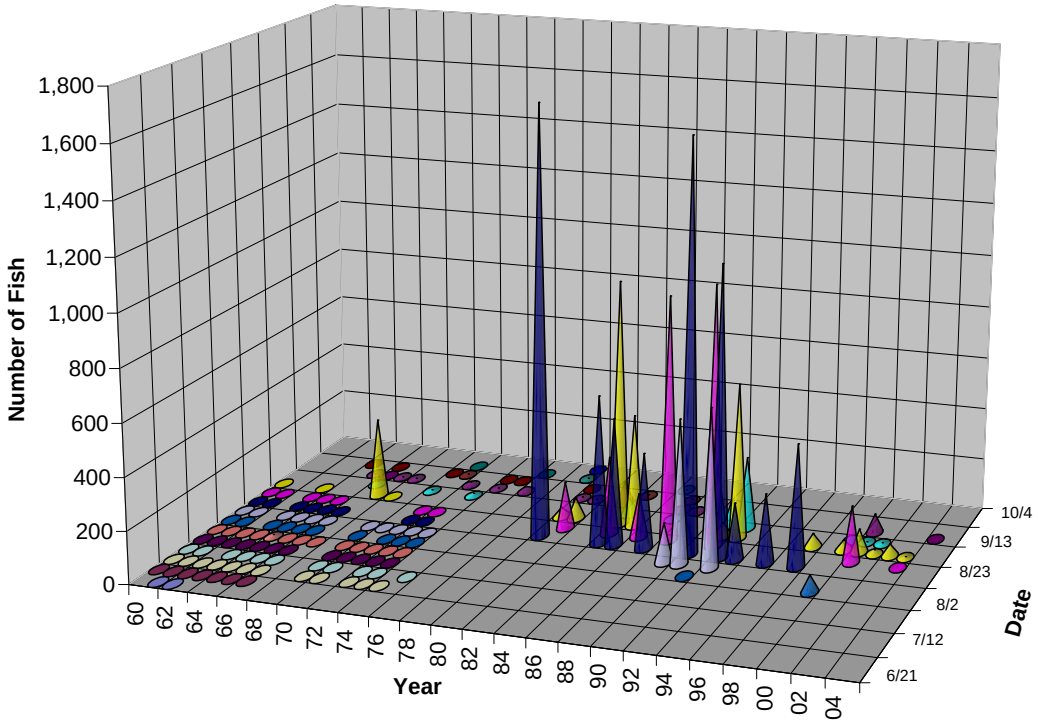


Figure 6. Weekly purse seine harvest of sockeye salmon in Excursion Inlet, Statistical Area 114-80, 1960 to 2005. (from ADF&G, Division of Commercial Fisheries, Alexander Database, October, 2006)

Table 4. Sport fish effort and harvest in Excursion Inlet and Neva Lake, 1984 to 2002. (from ADF&G, Division of Sport Fish, Statewide Harvest Database, 2005)

Year	Number of Anglers	Number of Trips	Days Fished	Coho Harvest	Sockeye Harvest	Number of Responses
1984	12	55	33	59	0	1
1985	163	130	121	50	0	3
1986	204	681	706	45	11	6
1987	225	449	444	44	110	6
1988	402	2,135	1,893	54	0	5
1989	290	273	321	152	28	10
1990	232	249	443	0	21	9
1991	724	1,252	3,164	176	0	19
1992	660	1,383	1,420	97	66	29
1993	588	1,042	1,062	163	0	24
1994	1,166	1,428	2,496	1,053	74	42
1995	1,113	1,419	3,042	290	34	40
1996	613	1,197	1,633	620	0	34
1997	1,170	1,921	2,867	840	50	52
1998	1,005	1,955	2,720	924	124	49
1999	1,257	1,675	3,357	2,762	32	51
2000	365	901	1,415	916	0	15
2001	277	234	616	1,098	0	12
2002	378	410	1,546	4,080	0	21
2003						
Average	571	989	1,542	706	29	23
Spearman's rho rank correlation trend test:						
r_s =	0.57	0.32	0.54	0.89	0.03	0.71
P =	0.01	0.18	0.02	0.00	0.89	0.00
n =	19	19	19	19	19	19

Table 5. Sport fish harvest and effort in the Sitka area (on and around Baranof and Chichagof Islands) and Glacier Bay areas, 1977 to 2005. (from ADF&G, Division of Sport Fish, Statewide Harvest Database, 2007)

		Sitka Area (includes Pavlof)[a]:					Glacier Bay Area (includes Excursion Inlet and Neva):				
Watertype	Year	Number of Anglers	Number of Trips	Days Fished	Coho Harvest	Sockeye Harvest	Number of Anglers	Number of Trips	Days Fished	Coho Harvest	Sockeye Harvest
Freshwater	1977			6,927	261	192			1,362	0	6
	1978			5,303	176	56			129	0	0
	1979			3,946	154	36			79	0	0
	1980			5,510	326	69			143	9	43
	1981			3,844	184	0			196	11	22
	1982			5,663	146	0			17	0	0
	1983			4,998	336	76			253	0	0
	1984	2,720	2,938	4,258	255	102	208	429	535	124	78
	1985	2,941	4,670	4,680	348	0	291	747	433	12	0
	1986	2,809	3,942	4,587	115	38	646	805	651	167	11
	1987	2,582	4,826	5,611	42	14	428	673	1,845	88	143
	1988	3,089	4,112	5,077	308	1,092	682	1,176	1,009	837	419
	1989	2,424	4,017	5,154	261	214	511	1,023	887	559	0
	1990	2,826	3,676	4,404	87	120	598	813	1,371	495	0
	1991	3,026	3,610	6,970	390	323	997	1,995	2,335	780	48
	1992	3,535	5,066	6,674	461	0	559	1,706	2,029	349	164
	1993	3,148	6,142	9,444	925	177	627	1,640	1,912	212	142
	1994	3,031	5,776	7,789	389	151	627	1,788	2,114	669	0
	1995	3,251	4,273	7,718	937	77	866	2,808	4,071	846	219
	1996	2,355	3,324	4,426	479	252	369	877	903	154	99
	1997	3,309	4,840	7,123	828	547	1,173	1,931	3,087	815	271
	1998	2,822	3,075	5,298	823	259	804	598	1,187	129	81
	1999	3,268	5,051	8,368	1,196	637	666	1,118	1,351	197	0
	2000	1,748	4,178	6,289	324	212	1,026	2,257	3,249	749	244
	2001	1,369	3,163	4,733	137	133	1,111	2,905	3,503	1,668	108
	2002	1,644	2,457	4,395	396	82	962	2,315	3,173	1,356	0
	2003	1,409	2,694	3,606	510	60	640	1,757	2,115	1,023	319
	2004	1,100	2,049	3,313	1,007	90	916	1,386	2,244	882	349
	2005	1,601	3,028	4,326	1,517	0	1,000	1,685	2,340	1,519	145
Spearman's rho rank correlation trend test:											
	r_s =	-0.44	-0.38	-0.05	0.64	0.30	0.67	0.57	0.80	0.85	0.50
	P =	0.04	0.08	0.79	0.00	0.11	0.00	0.01	0.00	0.00	0.01
	n =	22	22	29	29	29	22	22	29	29	29
Saltwater	1977			30,817	2,855	620			3,013	744	231
	1978			27,638	2,188	268			1,529	880	169
	1979			36,564	1,554	754			2,563	227	0
	1980			33,172	1,876	1,326			2,299	207	17
	1981			34,650	3,122	594			2,242	562	22
	1982			37,686	3,741	628			2,747	1,163	0
	1983			39,160	4,312	306			3,237	619	41
	1984	9,367	28,715	35,791	2,389	533	941	1,411	2,848	247	0
	1985	12,429	32,650	31,935	3,332	210	1,876	3,407	3,468	324	0
	1986	13,733	32,786	35,173	3,962	328	2,380	2,973	3,213	224	0
	1987	14,005	38,882	39,972	2,673	433	2,716	4,023	5,333	956	121
	1988	16,736	36,028	43,603	2,437	2,055	2,445	7,395	8,267	508	91
	1989	17,618	44,824	54,076	8,030	1,934	4,144	5,612	8,008	1,817	216
	1990	22,612	46,777	57,502	7,721	1,224	3,483	5,013	6,486	1,251	21
	1991	23,009	44,672	61,223	11,084	487	7,318	12,145	19,630	4,873	84
	1992	29,824	55,978	71,607	8,706	434	5,221	9,072	13,250	1,158	215
	1993	28,460	52,358	65,500	13,593	949	6,017	9,394	13,142	2,508	172
	1994	40,327	67,455	100,204	42,489	1,987	8,220	9,401	16,105	6,142	93
	1995	37,258	62,777	93,420	15,677	1,502	9,224	13,343	21,243	2,130	477
	1996	32,219	41,539	60,556	35,413	2,789	6,266	9,224	13,533	4,513	228
	1997	34,501	53,446	81,442	37,125	2,962	8,890	12,763	20,083	5,140	264
	1998	37,305	46,188	72,136	50,645	3,522	6,812	8,368	13,071	3,652	99
	1999	34,042	55,906	96,789	75,050	6,929	7,955	11,361	21,556	11,793	85
	2000	22,190	50,067	84,602	39,182	2,170	8,115	21,355	38,126	12,522	172
	2001	24,502	50,642	87,657	83,377	1,829	8,415	18,499	38,963	25,250	146
	2002	21,856	39,122	63,361	39,809	1,206	7,394	14,631	28,506	29,636	544
	2003	28,920	42,308	66,237	67,997	2,124	10,452	16,915	32,109	19,625	604
	2004	25,234	46,914	78,318	69,083	2,301	9,776	18,309	37,506	26,114	759
	2005	25,529	52,533	84,164	96,644	1,582	10,998	25,465	47,473	28,176	790
Spearman's rho rank correlation trend test:											
	r_s =	0.55	0.49	0.86	0.93	0.68	0.90	0.91	0.95	0.90	0.65
	P =	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n =	22	22	29	29	29	22	22	29	29	29

[a]The Sitka Area included all of Baranof and Chichagof/Yakobi Island (Hoktaheen) prior to 2000. Starting in 2000, the sport effort and harvest in the Northern part of Chichagof Island and Yakobi Island is included with the Glacier Bay Area.

Table 6. Peak aerial, foot, or boat counts of sockeye salmon at Neva, Pavlof, and Hoktaheen, 1960 to 2003. (from ADF&G, Division of Commercial Fisheries, Alexander Database, January 2005)

	Neva Creek		Pavlof River		Hokatheen Cove	
Year	Number Counted	Number of Surveys	Number Counted	Number of Surveys	Number Counted	Number of Surveys
1960						
1961			200	1		
1962			300	1		
1963			850	1		
1964						
1965			2,500	3	3,000	1
1966			4,000	1		
1967			2,500	5		
1968			3,300	4	2,000	2
1969					1,500	2
1970						
1971						
1972					0	1
1973					500	2
1974						
1975						
1976						
1977					1,500	1
1978					500	1
1979						
1980						
1981			800	1		
1982			200	2		
1983			170	4		
1984			150	2		
1985			0	1		
1986			0	2		
1987			200	5		
1988	100	1				
1989	140	2	100	3		
1990	470	3	300	6		
1991	300	2				
1992	0	1	300	4		
1993	0	1	800	5		
1994	0	2	100	2		
1995	250	1	400	3		
1996	610	2	400	2		
1997	50	4	620	2	2	3
1998	123	10	350	5		
1999	810	4	40	3	150	2
2000	215	4	200	4	404	3
2001	1,250	4	300	2	745	3
2002	100	2	100	2		
2003	150	1			150	2

Pavlof

Pavlof Lake (57°50.605' N, 135°02.672' W) is located on the northeast side of Chichagof Island (Figure 1). Pavlof Lake empties directly into Pavlof Harbor on the southeast side of Freshwater Bay. There is a short 4 m falls on the outlet. Pavlof Harbor is about 48 km by boat from Hoonah and Angoon and 24 km from Tenakee Springs. Pavlof Lake has a surface area of 36.6 ha, a maximum depth of 8 m, a mean depth of 2.3 m, a volume of 860,000 m^3, and an elevation of 5 m (Figure 7; Barto and Cook 1999). This small, shallow lake has an extensive growth of lily pads (Nuphar spp.) and other aquatic vegetation. The small lake does little to buffer rainfall or snowmelt events and there is a wide range in daily stream flows, particularly in the fall (Figure 8).

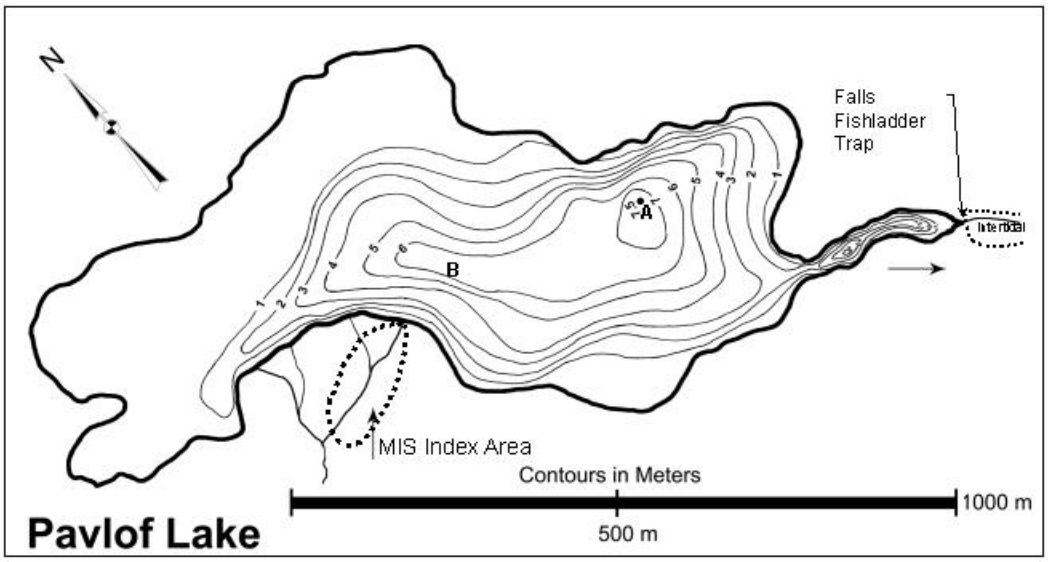


Figure 7. Bathymetric map of Pavlof Lake showing 1 m depth contours and locations of the two fixed sampling stations, the study area in the main inlet stream, and the fish pass and trap at the outlet of the lake. (from ADF&G)

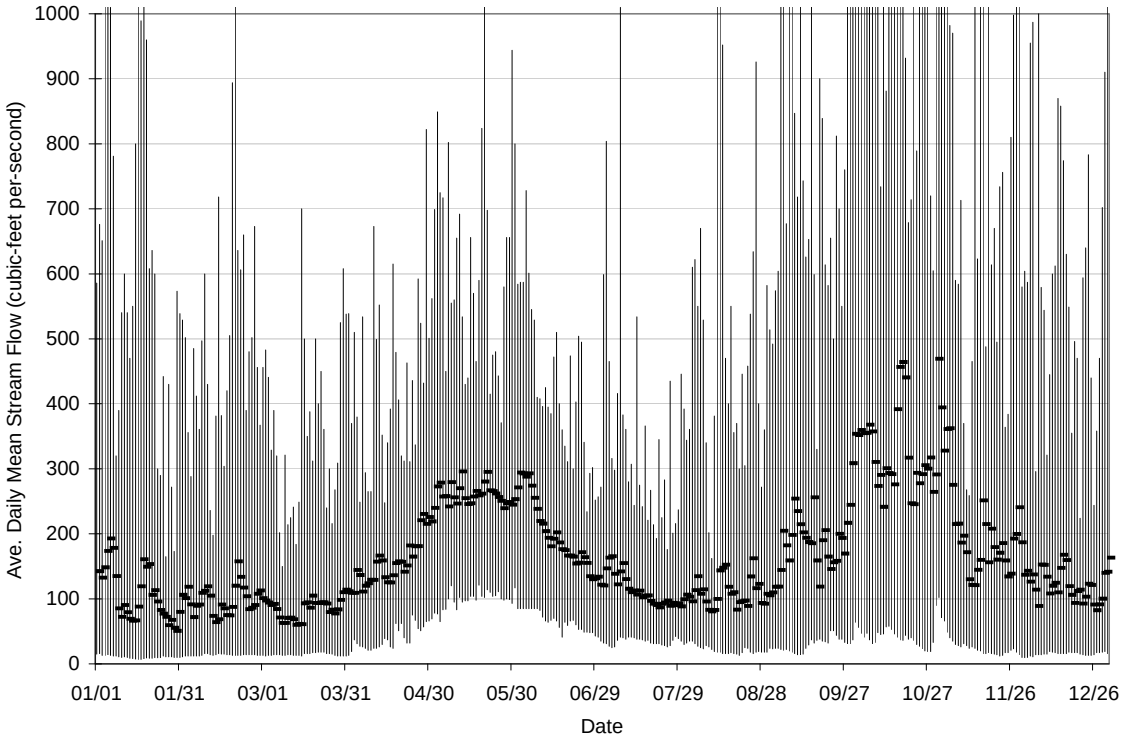


Figure 8. Average daily mean stream flow (cubic-feet per-second) and minimum and maximum (truncated at 1,000 from peaks up to 3,370) daily measurements for Pavlof River, June 1, 1957 to September 30, 1981. (from USGS)

The Pavlof Harbor area is in the traditional territory of Wooshkeetaan clan members associated with Angoon, Auk (Juneau), and Tenakee (Goldschmidt and Haas 1998). Goldschmidt and Haas reported that Wooshkeetan people from Angoon had lived for a time in a small village near Pavlof Harbor called Asaank’´i and that a smoke house was located below the waterfall at the outlet of Pavlof Lake. De Laguna (1960) interviewed an elderly man in Angoon who also collaborated Goldschmidt and Haas’s report. He said when he was a small boy there were two “Wuckitan” lineage houses in a small village about a mile east of “the sockeye stream in Freshwater Bay”. De Laguna (1960) clarifies that this territory originally belonged to an independent division of the Wuckitan, the Freshwater Bay branch, and that they subsequently “inherited rights at Angoon when the Kootznahoo branch of this sib became extinct.” A picture of a Tlingit man gaffing salmon in 1901 in a Freshwater Bay creek (believed to be Pavlof Creek with the waterfall in the background) is shown on Page 107 in the book “The Tlingit Indians” by Emmons (1991).

Shroeder and Kookesh (1990) report that a cannery was operated in Pavlof Harbor in 1889 and 1919-1923. The waterfall was incorporated into cannery operations. The Federal Works Progress Administration constructed a concrete fish ladder with 14 step pools on the left side (looking downstream) of the falls in 1935. Prior to the construction of this fish ladder it is believed that the cascading falls at the outlet of the lake was a

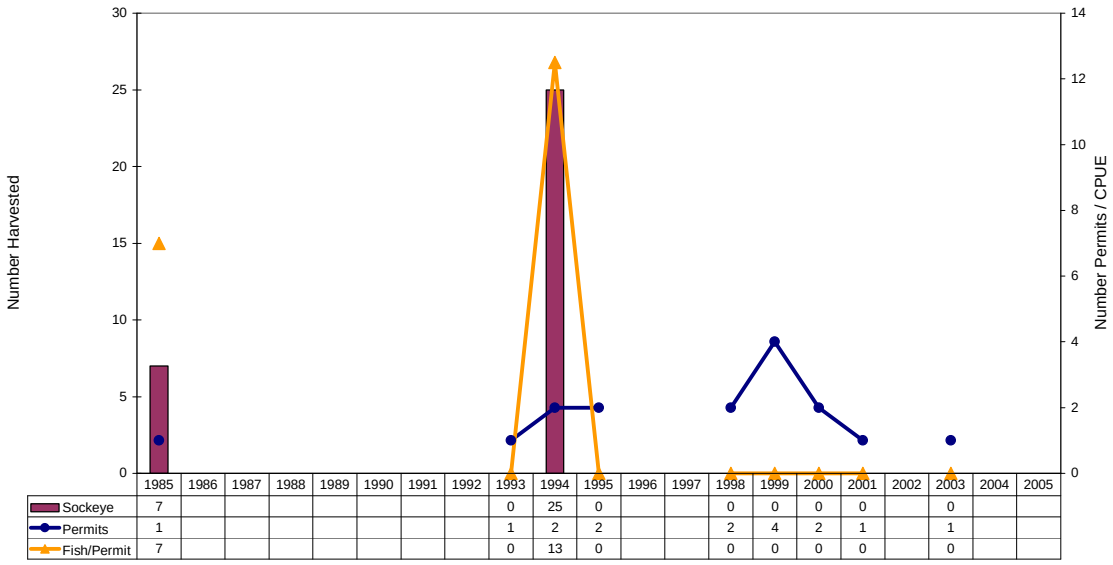
partial barrier to upstream migrating salmon (Barto and Cook 1999). The Forest Service installed an aluminum "Alaskan steep pass" inside the concrete fish ladder in 1986. The Forest Service also installed an "Alaskan steep pass" fishpass on a waterfall in the main inlet tributary in 1987. The intent of this upper fishpass is to provide coho salmon with better access to upriver spawning and rearing habitat.

The State of Alaska currently holds title to the land around the lake and outlet but the majority of the watershed is on National Forest System Lands. Large portions of the watershed were clearcut logged in years 1977 to 1981, 1987 and 1988, and 1991 to 1993. Roads now traverse the watershed and provide vehicle access with Hoonah. The area immediately around the lake and outlet has not been logged and it is not possible to drive to the lake or outlet.

Barto and Cook (1999) conducted a limnology and fisheries investigation of Pavlof Lake in 1997. Their study evaluated rearing conditions for sockeye salmon and applied empirical sockeye production models developed by Koenings and Burkett (1987) to identify potential management or enhancement strategies for optimizing sockeye production. They concluded that the lake's sockeye carrying capacity was relatively small, that sockeye production was near capacity, and that coho production might be compromised if the lake was fertilized in an attempt to boost sockeye production.

Coho salmon spawners from Pavlof were a brood source for an ADF&G, Fisheries Rehabilitation Enhancement and Development Division's, effort to boost recreational sport fishing opportunities in the Juneau area. Between 1987 and 1996, 109 coho salmon adults were killed during egg take operations in late-September in the upper reaches of the main inlet stream. These eggs were incubated in Juneau and the fry released into Juneau area streams.

The Pavlof area is not in either a Federal or State customary and traditional use area. Subsistence use data ranked the Pavlof Lake area as high use by residents of Tenakee Springs and middle use by residents of Hoonah and Angoon (ADF&G, Subsistence Division, Tongass Land Management Plan Revision, 1996). Pavlof has not been listed on the annual subsistence/personal use permits issued by ADF&G and sockeye harvests have only been reported in two years (Figure 9).



	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sockeye	7								0	25	0			0	0	0	0		0		
Permits	1								1	2	2			2	4	2	1		1		
Fish/Permit	7								0	13	0			0	0	0	0		0		

Figure 9. Subsistence/personal use effort and harvest of sockeye salmon at Pavlof from 1985 to 2005 as reported on permits returned to ADF&G. (from ADF&G, Division of Commercial Fisheries, Alexander Database, March, 2007)

Sockeye salmon returning to Pavlof Lake would be harvested in Icy Strait and Chatham Strait area fisheries. Rich and Ball (1933) reported six years of sockeye harvested in Freshwater Bay starting with 25,000 harvested in 1900 and ending with 30 in 1923 (Table 2). Sockeye harvests in Freshwater Bay since statehood (1959) are between zero and 1,582 fish (Table 3). These seine openings target pink salmon.

Pavlof Harbor is a popular anchorage for pleasure boaters and sport fishing for trout and salmon is also popular in the area. However, the sport harvest of sockeye salmon in the Pavlof area is small. Only nine sockeye salmon were reported harvested in the Pavlof Lake, Pavlof Bay, Freshwater Bay area from 1977 to 1999 (ADF&G, Division of Sport Fish, Statewide Harvest Survey database, 2002). The saltwater sport effort and harvests are trending upward in the area (Table 5).

Aerial and foot escapement surveys since 1980 have usually counted around 200 sockeye salmon in the Pavlof River (Table 6). The run timing of sockeye and pink salmon overlaps and the tannin stained water makes counting fish difficult.

Hoktaheen

Hoktaheen Lake (58°03.236’ N, 136°30.381’ W) is located on the northwest side of Yakobi Island, about 25 km from the community of Pelican (Figure 1). The lake is at about 51 m in elevation and drains a watershed area of about 20 km2. It has a surface area of 67 ha, an average depth of about 20 m, and a maximum depth of about 50 m (Conitz and Cartwright 2002; Figure 10). There are two lakes in the Hoktaheen Lake

system. A short, 0.5 km, stream connects the larger, upper lake to the lower lake. The outlet of the smaller lake flows about 2 km to Hoktaheen Cove on the Gulf of Alaska.

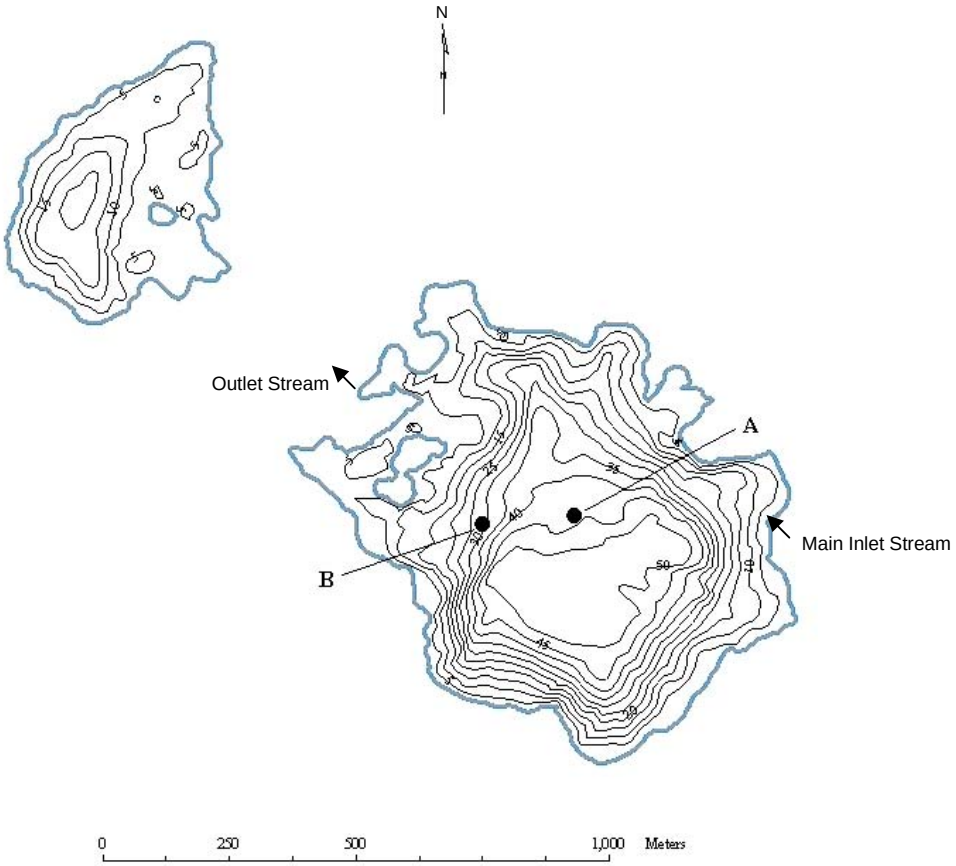
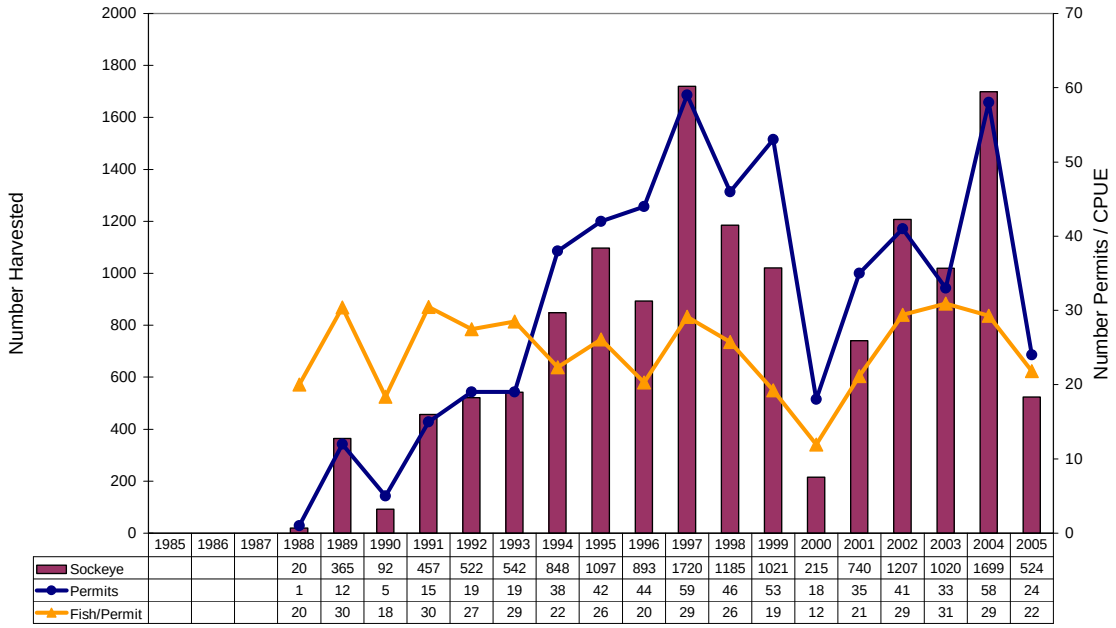


Figure 10. Bathymetric map of Hoktaheen Lakes with 5 m depth contours, location of limnology sampling stations A and B, and locations of the Main Inlet Stream and outlet.

The Hoktaheen Lake system on Yakobi Island is within the traditional subsistence harvesting and gathering area claimed by the Hoonah people. Goldschmidt and Hass (1998) believed that the Hoktaheen Cove area belonged to the T'akdeintaan clan. They reported that "Hoktaheen Creek is a good sockeye stream" and that smokehouses were located there. The summer camps and smoke houses are now gone but subsistence fishers from Hoonah, Pelican, and Elfin Cove continue to make day or overnight trips to Hoktaheen Cove. Travel is often by skiff and weather and sea conditions must be good for safe boating.

Hoktaheen Lake is in the West Chichagof Yakobi Wilderness Area. The entire watershed is on National Forest land.

The reported subsistence harvest of sockeye salmon at Hoktaheen peaked at 1,720 fish in 1997 (Figure 11). Harvests vary with effort and the fish-per-permit, a rough indicator of annual abundances, is variable but steady. The public has expressed concern about aggressive fishing and possible overharvest in the Hoktaheen subsistence and personal use fisheries (Conitz and Cartwright 2002).



	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sockeye				20	365	92	457	522	542	848	1097	893	1720	1185	1021	215	740	1207	1020	1699	524
Permits				1	12	5	15	19	19	38	42	44	59	46	53	18	35	41	33	58	24
Fish/Permit				20	30	18	30	27	29	22	26	20	29	26	19	12	21	29	31	29	22

Figure 11. Subsistence/personal use effort and harvest of sockeye salmon at Hoktaheen from 1985 to 2005 as reported on permits returned to ADF&G. (from ADF&G, Division of Commercial Fisheries database, 2007)

The historical commercial harvests of sockeye salmon in Hoktaheen Cove decreased significantly (Spearman's rho rank correlation trend test, at $\rho = 0.05$; Conover 1980) from around 10,000 fish a year in years 1905 to 1910 to around 2,000 fish a year by 1927 (Rich and Ball 1933; Table 2). We don't know what the sockeye harvest was from then to statehood but less than 1,800 have been harvested since statehood and the last time Hoktaheen Cove was open to seining was in 1973 (Table 3). There have not been seine fisheries operating in the immediate vicinity of Hoktaheen Cove in recent years, but those at the mouth of Lisianski Inlet, in Icy Straits, and southward along the outside Chichagof Island coast may incidentally harvest some sockeye salmon returning to Hoktaheen Lake.

The sport harvest of sockeye salmon from Hoktaheen is unknown; the ADF&G, Division of Sport Fish Division's statewide harvest survey has received less than three responses a year from those fishing in the Hoktaheen area. However, the area around Hoktaheen Cove has become increasingly popular for sport fishing since the late 1980s (Conitz and Cartwright 2002).

Escapement surveys have only been done in a few years at Hoktaheen. These aerial surveys have been directed at indexing escapements of pink salmon and no surveys were flown in the 1980s and early 1990s. Recent counts have been in the hundreds and historical counts were in the thousands (Table 6).

OBJECTIVES

The project objectives for 2004 were:

1) Use an outlet weir/trap and mark-recapture methods to estimate the annual escapement of sockeye salmon into Neva and Pavlof Lakes such that the estimated coefficient of variation is less than 10%.

2) Use mark-recapture methods to index the number of sockeye spawning in Neva, Pavlof, and upper Hoktaheen Lake's main inlet streams, Neva Lake's beach spawning area, and upper Hoktaheen Lake's outlet stream such that the estimated coefficient of variation is less than 20%.

3) Estimate the age, length, and sex composition of the sockeye escapements into Neva, Pavlof, and Hoktaheen Lakes such that the estimated coefficient of variation is less than 10% for the principal age class.

4) Collect baseline data on the in-lake productivity of Neva, Pavlof, and Hoktaheen Lakes using established ADF&G limnological sampling procedures which may include zooplankton sampling and vertical temperature, dissolved oxygen, and light intensity profile measurements.

The project objective for 2005 was:

1) Use an outlet weir/trap and mark-recapture methods to estimate the annual escapement of sockeye salmon into Neva Lakes such that the estimated coefficient of variation is less than 10%.

METHODS

Sockeye Escapement Assessment

Neva 2004 and 2005

In 2004 and 2005, the escapement of adult sockeye salmon into Neva Lake was estimated using the combination of a weir and mark-recapture. Validating weir counts with a companion mark-recapture study is to assure that Objective #1, the estimate of total

escapement, is accurate. Only the fish observed at a weir are counted and fish could pass uncounted before or after the weir is operated, at times when the weir is not operational, or through unknown breaks in the weir (McGregor and Bergander 1993; Shaul 1994; Kelley and Josephson 1997; Kelley and Bachman 1999; Kelley and Bachman 2000; Lewis and Cartwright 2002; Conitz and Cartwright 2003b). In both 2002 and 2003, a non-project person pulled pickets on the weir during a peak passage days and the mark-recapture studies were needed to estimate the total escapement (Van Alen 2004 and 2005).

In 2004, independent mark-recapture studies were also done to index the abundance of sockeye spawning in Neva Lake's main inlet stream (MIS) and beach spawning "study" areas. Visual counts of sockeye in, and out, of the MIS and beach study areas were also made in conjunction with these mark-recapture trips. These survey counts and mark-recapture estimates might prove to be a good predictor of the total escapement but three or more years of paired observations are needed to develop expansion factors (Heinl et al. 2000).

Weir: Upstream migrating adult salmon, trout, and char were counted as they were passed upstream out of a trap mounted on the face of a weir installed across Neva Creek. The weir was placed about 80 meters downstream from the lake. The weir was operated continuously in 2004 from June 16 through October 13 and in 2005 from June 20 through September 25. The weir trap was checked for fish early each morning and checked at other times during the day and evening as needed to pass fish without delaying their upstream migration. Separate counts were kept for adult and jack sockeye and coho salmon. Jacks were identified by their visual appearance.

The weir was constructed using an aluminum bipod and channel superstructure and 19.05 mm x 305 cm (¾ in x 10 ft) EMT conduit pickets (see Appendix A in Van Alen 2004 for design specifications). Seven bipods were used to support the 16.5 m wide weir. Upstream migrating salmon, trout, and char were counted and sampled from a 152.5 x 244 x 244 cm (5 x 8 x 8 ft), bear proof, trap attached to the front of the weir. The maximum gap between pickets in the weir and trap was 2.54 cm (each 8 ft channel had two 1-1/2" end holes and 52 1-1/8" picket holes). Filter fabric was laid bank-to-bank under the weir and trap to control erosion and sandbags were placed end-to-end around the upstream base of both. Fish were passed upstream out of the trap through pulled pickets or through a "fish" door in the side of the trap and into quiet water created with a short sand bag and picket diversion. A plastic fish tub, aluminum fish-measuring trough, and scale card/data holder were mounted on the side of the trap next to the fish door. A labeled array of hand tally counters was used to initially record the number of adult and jack, marked and unmarked, salmon, trout, and char passed upstream. The weather (clear, partly cloudy, overcast, showers, rain), stream depth, and water and air temperature was recorded at a gauging station located about 20 meters above the weir each morning between 0800 and 0900 hour.

Weir-to-Spawning Ground Mark-Recapture Escapement Estimate: The total escapement of sockeye salmon into Neva Lake was also estimated by marking fish at the

weir and sampling them for marks on the spawning grounds. In 2004, a running average of half (50%) of the adult and jack sockeye salmon counted through the weir each day were marked with an adipose fin clip and either a left axillary clip for the first third of the run, a left ventral clip for the middle third of the run, or a dorsal clip for the last third of the run. The dates for each third of the run were approximated as start-of-run to July 24, July 25 to August 12, and August 13 to end-of-run based on the average thirds of the 2002 and 2003 weir counts. These finclips involved severing the entire adipose fin, the entire axillary fin, the lower two-thirds of the ventral fin, and cutting across the posterior base of the last four dorsal fin rays. Scissors were used to do the finclips. Most clips were done with the fish's head in the water. The marked fish were allowed to recover in an area of quiet water next to the trap and all sockeye released continued their upstream migration without delay.

In 2004, eight recapture "trips" on 14 different days were then made between August 11 and October 15 to examine sockeye salmon for marks in the MIS and beach spawning areas. Fish were captured in the MIS using dip nets and in the beach study areas with a 21 m long by 3.66 m deep beach seine with 3.81 cm square mesh of No. 9 knotted Nylon web. Hand punches were used to give an opercule mark to all fish examined so fish were only sampled once (i.e., sampled without replacement). The opercule marking was also part of a separate "spawning area mark-recapture" study that I describe in the next section. Again, counts were kept of the number of adult and jack sockeye salmon marked and examined for marks.

Partially stratified maximum likelihood Darroch estimates, and standard errors, were calculated with the Stratified Population Analysis System (SPAS) freeware (Arnason et al. 1995). The SPAS program also computes Darroch, Schaefer, and Pooled Peterson estimates as described in Seber (1982). The Darroch model is probably the best estimator for this type of 2-sample mark-recapture data that is stratified by both date of marking and location and date of recapture (Schaefer 1951; Seber 1982). The Darroch model provides abundance estimates for the MIS and beach recovery strata when the number of recovery strata is less than or equal to the three release strata. When the number of recovery strata exceed the number of release strata only the number in each release strata are estimated. The SPAS software includes goodness-of-fit tests for "complete mixing" and "equal proportion" of marked fish among strata. If either or both of these tests are significant, at $P \leq 0.05$, bias with the stratified Darroch model will probably be less than for the pooled Peterson estimator and the use of the Darroch model is indicated. The chi-square test statistic was used to test the hypothesis of equal probability of marked fish when pooling recovery strata (Bernard and Hansen 1992). Separate analyses were completed for adults, jacks, and adults and jacks combined. I used different combinations of pooled or dropped release strata, and comparisons with Schaefer, pooled Peterson, and independent Jolly-Seber estimates (see "Stream and Beach Mark-Recapture Escapement Indexing" section below) to examine the robustness of the Darroch abundance estimates.

In 2005, the weir-to-above-weir mark-recapture study was done specifically to validate the accuracy of the weir count. A full recapture effort would only be done if there is less

than a 5% probability than the proportion of marked fish above the weir could equal or exceed that marked at the weir based on an one-tailed exact binomial test of goodness-of-fit (Sokal and Rohlf 1995). This test can be done using the Excel function "=BINOMDIST(number with marks, number examined for marks, proportion marked at the weir, TRUE)". The p-value returned is the probability that the observed proportion of marked fish above the weir is equal or greater than the expected proportion marked at the weir. A p-value <0.05 says that there is less than a 5% chance that the observed proportion equals or exceeds the expected proportion, that fish likely passed the weir uncounted, and that a mark-recapture study is needed to estimate the total escapement. The one-tailed test is used since only the fish that are seen at the weir are counted and if fish passed unnoticed then the proportion of marked fish in the lake could only be less than that marked at the weir. Plans were to finclip a running average of 25% of the adult and jack sockeye salmon passed through the weir and the weir operators succeeded in marking 22% of the adults and 28% of the jacks. All marked fish were given an adipose finclip and a left axillary, left ventral, or dorsal clip for each predicted third of the run. The middle third was July 29 to August 13 based on the 2002, 2003, and 2004 weir counts.

Stream and Beach Mark-Recapture Escapement Indexing - 2004: Mark and recapture trips were made to index jack and adult sockeye salmon in both the MIS and the beach "study" areas. The stream "study area" was between the lake and 58˚24.561' N, 135˚23.967' W. All the sockeye observed in the MIS stayed within the study area except for a few that eventually moved into two small side tributaries when water levels increased late in the season (Figure 12). The stream gradient is steeper and boulders and bedrock dominate the substrate upstream from the study area. The beach study area included two small (one set) beach spawning areas on the Southeast side of the lake between about 58˚23.981' N, 135˚24.246' W and 58˚23.949' N, 135˚24.348' W. We assume that the sockeye spawning in the MIS and beach study areas are separate populations given their geographic and temporal separation. In 2002, there were no sockeye salmon that were marked in the MIS and recovered in the beach study area or marked on the beach and recovered in the MIS (Van Alen 2004). In 2003, there was one fish that was marked at the beach and recovered in the MIS (Van Alen 2005).

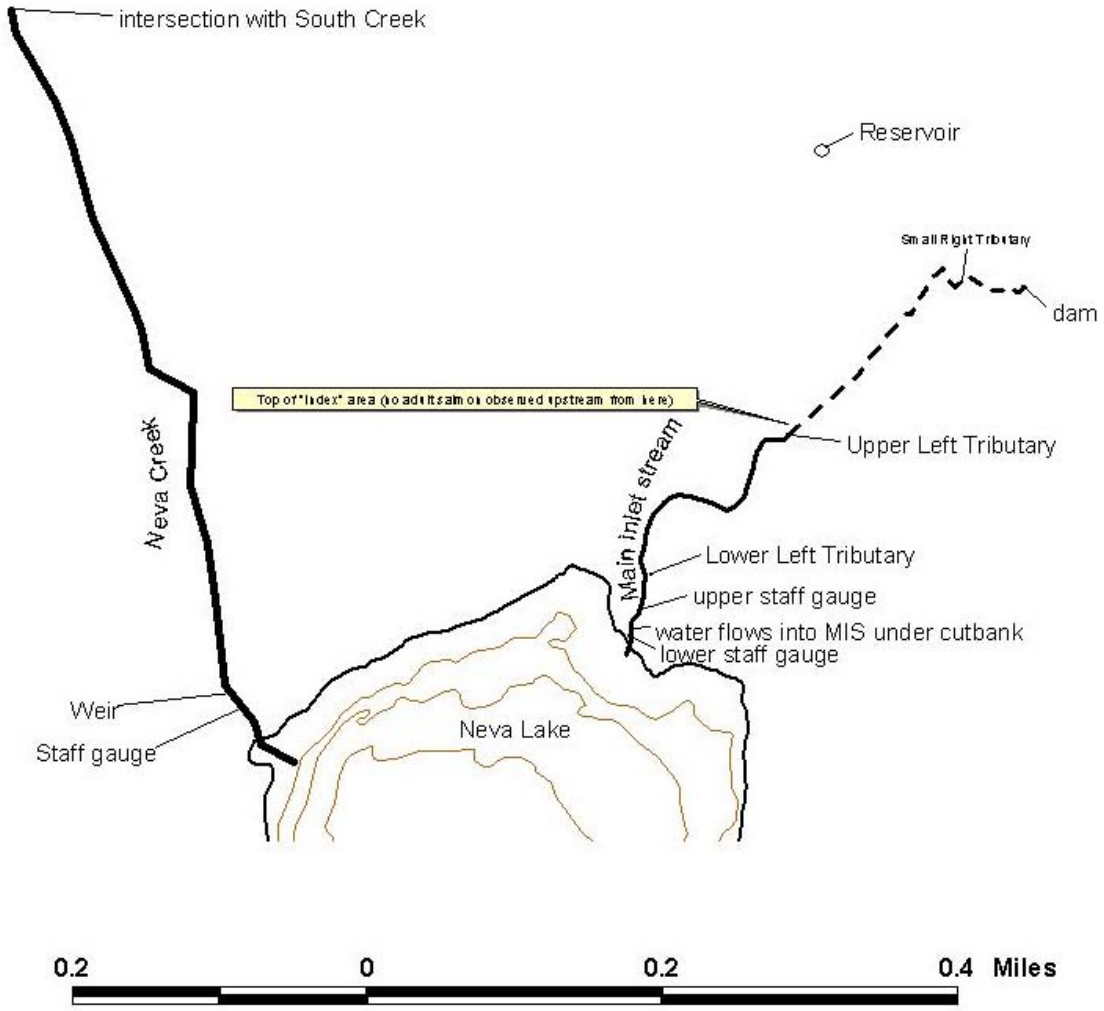


Figure 12. Map of the North end of Neva Lake showing the main inlet stream and Neva Creek.

All sockeye captured on both the marking (day 1) and recapture (day 2) days were given that trip's mark – a left opercule punch unique for that trip. Round, square, heart, rectangle, and triangle punch shapes were used. All sockeye captured on the day 2 were also given that trip's right opercule punch to facilitate sampling without replacement. Records were kept, for jacks and adults, of the number of sockeye salmon with and without opercule marks. A key to guide this sampling procedure was printed on the back of the data form (Figure 13).

Key to Spawning Mark-Recapture Sampling:

On Day One:

IF	Then	and Record
fish has the current trip's left opercule punch	Disregard	nothing
fish has no left opercule punch	mark with the current trip's left opercule punch	"New (no opercule mark)"
fish has only left opercule punch(es) from earlier trip(s)	mark with the current trip's left opercule punch	recapture in appropriate column

On Day Two:

IF	Then	and Record
fish has the current trip's right opercule punch	Disregard	nothing
fish has no left opercule punch	mark with the current trip's left **and** right opercule punch	"New (no opercule mark)"
fish has only left opercule punch(es) from earlier trip(s)	mark with the current trip's left **and** right opercule punch	recapture in appropriate column
fish has current trip's left opercule punch w/ or w/o punch(es) from earlier trip(s)	mark with the current trip's right opercule punch	recapture of current trips mark

Figure 13. Key to spawning area mark-recapture sampling procedures.

All sampling was done without replacement by disregarding a fish with that trips left opercule punch on day 1 and disregarding a fish with that trips right opercule punch on day 2. Data for both the "Weir Mark-Recapture" and "Spawning Mark-Recapture" sampling was recorded on the same data form (see Appendix A in Van Alen 2005).

A two-sample Peterson estimate was calculated for each trip and used in a modified Jolly-Seber (Schwarz et al. 1993) estimator for multiple mark-recaptures in an open population (J. Blick, ADF&G, personal communication 1998; Cook 1998; Crabtree 2001; Conitz and Cartwright 2003a). The "Blick-modified" Jolly-Seber estimator requires three or more recovery events and recaptures of fish marked from an earlier trip (Seber 1982). The notation and formulas used to calculate the Blick-modified Jolly-Seber estimates are provided in the column headings of Table 12 and the parametric bootstrap method used to calculate standard errors is detailed in Conitz and Cartwright (2005).

Visual Survey Counts: Foot and boat surveys were conducted in conjunction with the MIS and beach mark-recapture trips. Each observer had hand tally counters and kept their own counts of live sockeye salmon. In the MIS study area there were times when each observer counted live sockeye salmon when walking upstream and then when walking downstream. In the lake, each observer counted live sockeye salmon in, and out of, the beach study area from a skiff that was slowly motored around the perimeter of the

lake. Each observer's counts were recorded separately and when averaged they provide an estimate of what proportion of all the sockeye observed are in the study area(s). Separate counts were not made for adult and jack sockeye salmon.

Foot surveys were also done periodically through the summer to count the number of live sockeye and coho salmon in Neva Creek from the weir to the confluence with South Creek. We also kept counts of the number of coho salmon observed in the MIS and lake.

Age, Sex, and Length Sampling: Adult sockeye salmon were sampled at the weir for age (scales), sex, and length data following standard ADF&G sampling procedures (ADF&G 2001). Approximately every seventh jack or adult sockeye salmon was systematically sampled through the course of the run. Tweezers were used to pluck three scales from the preferred area on the left side of the each fish (INPFC 1963). Scales were mounted on gummed "scale cards" (Clutter and Whitesel 1956) and sex and length data recorded on optical scanner data forms. Mid-eye to fork length was measured to the nearest millimeter by laying each fish on a fixed ruler in a "measuring trough". Scales were aged at the ADF&G, Commercial Fisheries Division, Aging Lab in Juneau. Age classes are recorded in European notation where a period separates the number of fresh water and marine annuli (Koo 1962).

After the scales were aged, the scale samples were stratified by age and week as described by Conitz and Cartwright (2003a). Let n be the total number of samples aged, nk be the number of samples in stratum k, and N be the estimated escapement. The proportion of each stratum k was calculated by

$$\hat{p}_k = \frac{n_k}{n} \tag{1}$$

The estimated standard error was derived from the binomial formula with correction for finite population size (Thompson 1992, p. 35-36):

$$SE(\hat{p}_k) = \sqrt{\left(1 - \frac{n}{N}\right)\frac{\hat{p}_k(1-\hat{p}_k)}{n-1}} \tag{2}$$

The estimated mean length and associated standard error for stratum k were calculated as the sample mean of a simple random sample (Thompson 1992, p. 42-43):

$$\bar{y}_k = \frac{1}{n_k}\sum_{i=1}^{n_k} y_{ki} \text{, and } SE(\bar{y}_k) = \sqrt{\frac{1}{n_k}}\sqrt{\left(\frac{1}{n_k - 1}\right)\sum_{i=1}^{n_k}(y_{ki} - \bar{y}_i)^2} \tag{3}$$

Harvest Monitoring: In 2004 and 2005, the operators of the Neva weir monitored the subsistence/personal use and sport fishing effort and harvest in the Neva Creek and South Creek area. The weir operators travel route to and from the weir site, two or more times a

day, enabled routine monitoring of fishing activities in and off the mouth of South Creek. The weir operators made an effort to get harvest and effort information by speaking directly with all individuals or groups observed fishing in the area. Fishing activities in Neva Creek were monitored during routine foot surveys of the creek (see the "Visual Survey Counts" section above) and by occasional visits to the traditional fishing site in the lower part of the creek. Basic harvest, and effort data was recorded on a daily data form (see Appendix A.3. in Van Alen 2005).

Pavlof 2004

The original project plan was to index the annual escapement of Pavlof sockeye salmon by marking and recapturing them on the spawning grounds. Plans were expanded in 2002, 2003, and 2004 to also estimate the total escapement by marking fish as they enter the lake through a trap installed at the top the existing fishpass and recapturing them on the spawning grounds. We assumed that sockeye migrate into Pavlof Lake both up the fish ladder and up the falls so the trap count was not anticipated to be the total escapement estimate.

Year 2004 was the third season of fishery technician work for the Hoonah Indian Association crew working at Pavlof Lake. Project activities focused on camp and field safety and procedures, how to capture, handle, and sample fish, and record keeping. The crew lived in a floating wall tent anchored near the outlet of Pavlof Lake (see Appendix B of Van Alen 2004 for the technical design specifications).

Trap-to-Spawning Ground Mark-Recapture Estimate: Upstream migrating salmon were captured and counted as they were passed upstream of a trap installed at the top of the outlet fishpass. Separate counts were made for adults and jacks in 2004. All trapped sockeye (and coho) salmon were marked with an adipose fin clip. The trap was in place from June 23 to August 22, 2004.

The aluminum channel and picket trap design was the same as used at the Neva weir. Salmon that ascended the fish pass were led through a "V" channel and picket entrance into the trap. The trap and V-entrance were on bedrock and sand bags were placed end-to-end around the outside of both.

The crew did boat surveys around the lake and foot surveys up the main inlet stream in 2002, 2003, and 2004 and only found sockeye spawning in the lower part of the main inlet stream. The lower approximately 300 meters of the main inlet stream, and fish schooled immediately off the mouth of the MIS, was designated the MIS study area again this season. The upper end of the study area was at 57˚50.468' N, 135˚03.211' where there was a logjam extending across the river. A few sockeye salmon were observed immediately upstream of the MIS study area but the highest concentration of fish was clearly within the study area. The left fork of the main inlet stream was included in the MIS study area but the stream level was only high enough to flow this way on one survey trip in 2003.

In 2004, five, two-day, mark-recapture, trips were done between July 21 and August 12 to examine sockeye salmon for marks in the MIS study area. A 21 m long by 3.66 m deep beach seine with 3.81 cm square mesh and No. 9 knotted Nylon web was used to catch the sockeye salmon in a sequence of sets from upstream to downstream. Hand punches were used to give an opercule mark to all fish examined as part of the "Stream Mark-Recapture Escapement Indexing" study (see below). These opercule marks enabled us to "sample without replacement". A simple Peterson model was used to estimate the total escapement.

Stream Mark-Recapture Escapement Indexing: "Stream mark and recapture" trips were done in conjunction with the "trap to spawning ground" mark and recapture trips described above. Thus, five, two-day, mark-recapture trips were done in the MIS study area between July 21 and August 12.

All sockeye captured on both the marking (day 1) and recapture (day 2) days were given a unique opercule punch for that "trip". All sockeye captured on the day 2 were also given an opercule punch. Records were kept of the number of new fish marked on both days and the number of day 1 recaptures on day 2. All sampling was done without replacement by disregarding a fish with that trips' left opercule punch on day 1 and disregarding a fish with that trips' right opercule punch on day 2. I used the modified Jolly-Seber method described for Neva Lake to estimate the total number of sockeye spawning in the MIS study area.

Visual Survey Counts: Foot surveys were conducted in conjunction with the MIS mark-recapture indexing trips. In 2004, counts of the number of live sockeye salmon in the MIS study area were made on July 19, 21, and 30 and August 6, 11, 12, and 19. Each observer made their own counts during two passes of the MIS study area - one walking upstream and one walking downstream. Sockeye were schooled off the mouth of the MIS in July but we were unable to count them due to poor water clarity, glare, and the way they moved in and out of view. No attempt was made to count sockeye salmon outside of the MIS study area since no sockeye were observed spawning anywhere in the lake or lake outlet and it took too much time to count the few sockeye spawning upstream of the study reach.

Age, Sex, and Length Sampling: Adult sockeye salmon were sampled at the trap for age (scales), sex, and length data. The sampling plan called for the crew to sample every third sockeye salmon they passed upstream of the trap. Sampling, processing, and analysis procedures were the same as described above for the Neva Lake samples.

Hoktaheen 2004

Field studies in 2001 (Conitz and Cartwright 2002) and 2002 and 2003 (Van Alen 2004 and 2005) found sockeye spawning in an inlet stream on the East side of the upper (larger) lake (58˚03.379' N, 136˚30.973' W) and in the upper section of the stream that connects the two lakes. Spawning was observed in the inlet stream the first three weeks

in September and in the outlet stream the last two weeks in September. Based on this information we planned our fieldwork in 2004 for the month of September.

Stream Mark-Recapture Escapement Indexing: Project personnel camped at upper Hoktaheen Lake from September 3 to 28, 2004. They completed five, two-day, mark-recapture "trips" to the upper Hoktaheen Lake's MIS "study area" (this stream flows into the north west side of the lake) and four, two-day, mark-recapture trips to the "study area" in the upper third of the stream that connects the upper and lower lakes. The MIS study area included sockeye schooling immediately off the mouth of the stream and extended upstream to a bedrock section of the stream at 58˚03.897' N, 136˚30.951' W. Few sockeye were observed spawning above this MIS study area. The study area in the outlet stream extended from the outlet of the upper lake at 58˚03.370' N, 136˚30.939' W downstream about 0.2 km. Again few sockeye salmon were observed spawning downstream from the study area. Dip nets were used to capture sockeye salmon in the MIS and a 21 m long by 3.66 m deep beach seine with 3.81 cm square mesh of No. 9 knotted Nylon web was used to capture sockeye off the mouth of the MIS and in the outlet stream.

All sockeye captured on both the marking and recapture days were marked on the left opercule with that trip's uniquely shaped hole punch (round, square, triangle, heart, tree). All sockeye captured during the recapture day(s) were also given that trip's right opercule punch. Records were kept of the number of new fish marked on both days, the number of day 1 recaptures on day 2, and the number of recaptures from earlier trips. All sampling was done without replacement by disregarding a fish with that trip's mark on the marking day and disregarding a fish with that trip's right opercule punch on the recapture day(s).

Simple Peterson estimates were calculated for each day that fish were examined for marks. The abundance of sockeye salmon was estimated on September 4, 8, 13, 18, and 23 in the MIS study area and on September 15, 19, 24, and 28 in the outlet study area.

Visual Survey Counts: Foot and boat surveys were conducted in conjunction with the mark-recapture indexing trips. Counting procedures were the same as those used at Neva Lake.

Age, Sex, and Length Sampling: Adult sockeye salmon were sampled for age (scales), sex, and length data from both the MIS and outlet study areas. The sampling, processing, and analysis procedures were the same as described above for the Neva Lake samples.

Limnology Sampling

In 2004, limnology sampling was done four times in Neva and Pavlof Lakes and twice in Hoktaheen Lake (Table 7).

Table 7. Limnology sampling dates in Neva, Pavlof, and Hoktaheen Lakes, 2004.

Neva Lake	Pavlof Lake	Hoktaheen Lake
6/16	6/16	9/5
7/24	7/24	9/27
8/29	8/29	
10/12	10/12	

Two buoy and anchor sampling stations, "Station A" and "Station B", were setup over the deepest part of each lake (Table 8). Zooplankton samples were taken at both stations and physical data at Station A.

Table 8. Latitude and longitude coordinates for the limnological sampling stations in Neva, Pavlof, and Hoktaheen Lakes, 2002, 2003, and 2004.

Lake	Station A	Station B
Neva	58°24.219' N, 135°24.258' W	58°24.270' N, 135°24.290' W
Pavlof	57°50.605' N, 135°02.672' W	57°50.629' N, 135°02.921' W
Hoktaheen	58°03.236' N, 136°30.381' W	58°03.292' N, 136°30.630' W

Light, Temperature, and Dissolved Oxygen Profiles

The subsurface light intensity was measured at 0.5-meter intervals from just below (5 cm) the surface down to one percent of the surface light reading using a Licor LI-250 submarine photometer. Readings were in µmol s-1 m-2. The vertical light extinction coefficient (Kd) and euphotic zone depth (EZD) was calculated following procedures described by Conitz and Cartwright (2002a). The vertical light extinction coefficient (Kd) was calculated as the slope of the light intensity (natural log of percent subsurface light) versus depth. The euphotic zone depth (EZD) was calculated as EZD = 4.6205/Kd and is defined as the part of the lake where photosynthesis is possible. Water transparency was also measured with a 20 cm diameter Secchi disk (Koenings et al. 1987).

All vertical temperature and dissolved oxygen (DO) measurements were made with a Yellow Springs Instruments Model 58 DO meter and probe. The Model 58 DO meter was calibrated each trip by taking the average value of two 30 ml Winker titrations from a water sample collected at 1 m (Koenings et al. 1987). Readings were taken at one-meter intervals down to 20 meters then at five-meter intervals to within 2 m of the bottom or 50 meters, whichever is less. Dissolved oxygen (DO) readings were in mg L-1 and temperature readings were in °C. The mg L-1 DO readings were converted to percent O_2 saturation using the following formula:

$$\%O_2 saturation = (DO/(0.004399 * temp^2 - 0.381784 + 14.571252)) * 100 \qquad (4)$$

The parameters in this equation were computed from data presented in Table 6.1 of Wetzel and Likens (2000). This regression of the solubility of O_2 on temperature had a

correlation coefficient of 0.9998. No adjustment was made for altitude (barometric pressure) since Neva, Pavlof, and Hoktaheen Lakes are all at relatively low elevations of 44, 5, and 51 meters, respectively.

Zooplankton Composition and Density

A vertical zooplankton tow was made at both stations each trip. A 0.5 m diameter, 153 um mesh, 1:3 conical net was used. Vertical tows were pulled from 2 m from the bottom of the lake at 0.5 m/sec. Specimens were preserved in neutralized 10% formalin (Koenings et al. 1987). Zooplankton samples were analyzed at the ADF&G Commercial Fisheries Division Limnology Laboratory in Soldotna, Alaska. The identification to genus or species, enumeration, and density and biomass estimates were done as described by Conitz et al. 2002 and Koenings et al. 1987). The zooplankton density (individuals per m^2 surface area) and biomass (weight per m^2 surface area) were estimated by species and by the sum of all species (referred to as total zooplankton density or biomass).

RESULTS

Sockeye Escapement Assessment

Neva 2004

Weir and Weir-based Mark-Recapture Estimate of Total Escapement: In 2004, the adult salmon weir was operated continuously on the outlet of Neva Lake from June 16 to October 13 (Table 9). The weir count totaled 9,513 sockeye salmon – 9,229 adults and 284 jacks. The first sockeye passed on June 21 and there were still a few sockeye passing on October 13. Counts of other species totaled 831 coho salmon (including 100 jacks), 36 pink salmon, 2 chum salmon, 5 cutthroat trout, and 96 Dolly Varden char.

Project personnel succeeded in finclipping a running average of 50% of the adult and 49% of the jack sockeye passed upstream of the weir as part of a weir-to-spawning area mark-recapture estimate of the total escapement past the weir (Table 9). The sockeye were marked with an adipose clip and either a left axillary finclips, a left ventral finclip, or a dorsal finclip for each of three release strata – June 16 to July 24, July 25 to August 12, and August 13 to October 17. The dates for these release strata were based on the approximate thirds of the run observed in 2002 and 2003. Adult and jack sockeye salmon were sampled for the proportion of marked fish in the main inlet stream on 10 different days and in beach spawning areas on four different days. Using the SPAS program (Arnason et al. 1996), either one or both of the tests for complete mixing or equal proportions were not significant ($\alpha < 0.05$) for the stratified Darroch abundance estimates of adult, jack, and adult+jack sockeye salmon (Table 10). This suggests that the Pooled Peterson estimator is appropriate (Arnason et al. 1995). The pooled Peterson estimate of the escapement of adult sockeye salmon was 9,239 (CV=3%) which was only 10 fish greater than the weir count. There was a greater difference in the weir counts and Pooled

Peterson estimates of jack sockeye salmon, 284 versus 408 (CV=16%), respectively, but too few were recaptured (a total of 20) to know if jacks were actually undercounted at the weir. Given the relatively small number of jacks, <4.3% of the escapement, and the high variability around the estimate of jacks, I am comfortable using the weir count of 9,513 as the estimate the total sockeye escapement in 2004. Weir operations went smoothly in 2004 and there were no instances when salmon were suspected to have passed through the weir uncounted. No fresh dead (pre-spawn) salmon were observed on the face of the weir or anywhere upstream and there was no indication of any handling mortality associated with the counting, marking, and sampling of fish at the weir.

In this final report covering project results from 2002 to 2005, I seek to report the best estimates of the daily and total number of sockeye salmon that escaped into Neva Lake each year. The weir was not operated through the entire run in all years so I filled-in for missing weir counts using linear interpolation and the EM algorithm (McLachlan and Krishnan 1997) between the earliest date of weir operation (June 4, 2002 and 2003) and the latest date of weir operation (October 13, 2004; Table 11). In 2002 (Van Alen 2004) and 2003 (Van Alen 2005), I estimated the total in-lake escapement with the weir to above-weir mark-recapture study since a non-project person, or persons, had pulled pickets each year on a day when there was a high abundance of fish at the weir. In 2004, no fish were estimated to have passed before the weir was operational on June 16 (since no sockeye were counted in the first five days of weir operation), or through the weir uncounted, and the daily and total weir counts serve as the best estimates of daily and total escapements (Table 11). The midpoint of the sockeye escapement in 2004 was August 11. The middle 80% of the sockeye escapement was between July 25 and September 14.

Table 9. Weather and stream measurements and daily numbers of fish counted and finclipped at the Neva Creek weir, 2004.

	Weather and Stream Measurements:[a]					Sockeye Counted:				Sockeye Finclipped:					Number of Other Species Counted:						
Date	Weather	Water Level (cm)	Thermometer Water Temp (°C)	Air Temp (°C)	Data Logger Water Temp (oC)	Adults	Jacks	Total	Cum	Finclip Used (Adipose +)	Adults	Cum. % Adults Clipped	Jacks	Cum. % Jacks Clipped	Adult Coho	Jack Coho	Total Coho	Pink	Chum	Cutthroat	Dolly Varden
6/16						0	0	0	0.00		0		0								
6/17	Clear	25.5	16.0	12.5		0	0	0	0.00		0		0								
6/18	Clear	25.5	16.0	14.0		0	0	0	0.00		0		0								
6/19	Clear	24.0	18.5	17.0		0	0	0	0.00		0		0								
6/20	Clear	21.5	19.0	15.0		0	0	0	0.00		0		0								
6/21	Clear	20.0	19.0	14.0		22	0	22	0.00	Left Axillary	10	45%	0								
6/22	Clear	19.5	18.5	12.0		0	0	0	0.00		0	45%	0								
6/23	Clear	19.5	19.0	13.0		0	0	0	0.00		0	45%	0								
6/24	Clear	21.5	19.0	14.0		0	0	0	0.00		0	45%	0								
6/25	Clear	20.0	19.0	14.0		147	2	149	0.02	Left Axillary	75	50%	2								
6/26	Partly Cloudy	19.5	19.5	13.0		17	0	17	0.02	Left Axillary	8	50%	0								
6/27	Overcast	19.5	19.0	12.5		22	0	22	0.02	Left Axillary	11	50%	0								
6/28	Overcast	19.0	19.0	13.0		39	1	40	0.03	Left Axillary	20	50%	0								
6/29	Overcast	18.5	18.5	13.0		1	0	1	0.03		0	50%	0								
6/30	Overcast	18.0	18.0	12.5		4	0	4	0.03	Left Axillary	4	51%	0								
7/1	Showers	17.5	18.0	13.0		4	0	4	0.03		0	50%	0								
7/2	Showers	17.5	17.5	13.0		0	0	0	0.03		0	50%	0								
7/3	Showers	17.0	18.0	14.5		77	0	77	0.04	Left Axillary	37	50%	0								
7/4	Overcast	17.0	18.0	14.0		221	4	225	0.06	Left Axillary	110	50%	0								1
7/5	Showers	16.5	17.0	12.5		87	2	89	0.07	Left Axillary	44	50%	0								
7/6	Partly Cloudy	16.5	17.0	12.0		62	1	63	0.07	Left Axillary	34	50%	0								
7/7	Partly Cloudy	16.0	18.0	13.5		2	0	2	0.08		0	50%	0								
7/8	Clear	15.5	17.5	13.0		0	0	0	0.08		0	50%	0								
7/9	Overcast	15.0	18.0	12.0		0	0	0	0.08		0	50%	0								
7/10	Rain	14.5	18.0	13.0		0	0	0	0.08		0	50%	0								
7/11	Overcast	14.5	18.0	14.0		0	0	0	0.08		0	50%	0								
7/12	Partly Cloudy	14.0	18.0	13.0		0	0	0	0.08		0	50%	0								
7/13	Partly Cloudy	13.5	18.0	13.5		0	0	0	0.08		0	50%	0								
7/14	Clear	13.5	18.5	13.0		0	0	0	0.08		0	50%	0	20%							
7/15	Clear	13.0	19.0	14.5		0	0	0	0.08		0	50%	0	20%							
7/16	Clear	13.0	19.5	14.5		0	0	0	0.08		0	50%	0	20%							

(continued)

Table 9. (page 2 of 4)

	Weather and Stream Measurements:[a]					Sockeye Counted:				Sockeye Finclipped:					Number of Other Species Counted:						
Date	Weather	Water Level (cm)	Thermometer Water Temp (°C)	Air Temp (°C)	Data Logger Water Temp (oC)	Adults	Jacks	Total	Cum	Finclip Used (Adipose +)	Adults	Cum. % Adults Clipped	Jacks	Cum. % Jacks Clipped	Adult Coho	Jack Coho	Total Coho	Pink	Chum	Cutthroat	Dolly Varden
7/17	Overcast	12.5	19.5	13.5		0	0	0	0.08		0	50%	0	20%							
7/18	Partly Cloudy	12.5	19.5	14.0		0	0	0	0.08		0	50%	0	20%							
7/19	Partly Cloudy	12.0	18.5	13.5		0	1	1	0.08	Left Axillary	0	50%	1	27%							
7/20	Partly Cloudy	12.0	19.0	15.0		0	0	0	0.08		0	50%	0	27%							
7/21	Showers	12.0	19.0	15.0		0	0	0	0.08		0	50%	0	27%							
7/22	Overcast	12.0	19.0	14.5		0	2	2	0.08	Left Axillary	0	50%	2	38%							
7/23	Partly Cloudy	12.0	19.0	14.0		0	0	0	0.08		0	50%	0	38%							
7/24	Showers	12.0	19.0	14.0		0	3	3	0.08	Left Axillary	0	50%	3	50%							
7/25	Showers	12.5	19.0	13.5		448	26	474	0.13	Left Ventral	225	50%	16	57%							1
7/26	Showers	12.5	18.0	14.0		105	6	111	0.14	Left Ventral	51	50%	2	54%							
7/27	Rain	12.0	18.5	14.5		23	1	24	0.14	Left Ventral	11	50%	0	53%							1
7/28	Showers	15.5	18.5	14.5		1383	19	1402	0.29	Left Ventral	691	50%	6	47%							34
7/29	Showers	16.0	18.0	13.0		254	2	256	0.31	Left Ventral	128	50%	0	46%							
7/30	Showers	15.5	18.0	12.0		198	1	199	0.34	Left Ventral	96	50%	1	46%							1
7/31	Partly Cloudy	15.0	18.0	14.0		57	3	60	0.34	Left Ventral	32	50%	2	47%							
8/1	Showers	14.0	18.0	13.0		33	1	34	0.34	Left Ventral	17	50%	0	47%							
8/2	Showers	14.0	17.5	13.0		28	1	29	0.35	Left Ventral	15	50%	1	47%							
8/3	Showers	14.0	17.5	13.0		20	1	21	0.35	Left Ventral	8	50%	1	48%							
8/4	Partly Cloudy	13.5	17.5	12.5		4	1	5	0.35	Left Ventral	2	50%	1	49%							
8/5	Partly Cloudy	13.5	17.5	12.0		39	5	44	0.36	Left Ventral	20	50%	4	51%							
8/6	Partly Cloudy	13.0	18.0	14.5		24	5	29	0.36	Left Ventral	12	50%	2	50%							
8/7	Partly Cloudy	12.5	18.0	15.0		6	1	7	0.36	Left Ventral	3	50%	0	49%							
8/8	Clear	13.0	18.5	15.0		0	0	0	0.36		0	50%	0	49%							
8/9	Clear	12.5	18.5	14.0		1	0	1	0.36	Left Ventral	1	50%	0	49%							
8/10	Overcast	12.0	19.0	14.5		504	18	522	0.41	Left Ventral	250	50%	9	50%							
8/11	Partly Cloudy	13.0	19.0	14.0		1619	14	1633	0.59	Left Ventral	811	50%	8	50%				1			
8/12	Partly Cloudy	13.0	18.5	13.0		194	3	197	0.61	Left Ventral	97	50%	1	50%				1			
8/13	Clear	12.0	18.5	13.0		185	13	198	0.63	Dorsal	93	50%	6	50%							
8/14		12.0	18.5	12.0		94	1	95	0.64	Dorsal	41	50%	1	50%							
8/15	Clear	11.5	19.0	16.0		25	1	26	0.64	Dorsal	19	50%	0	50%							

(continued)

Table 9. (page 3 of 4)

	Weather and Stream Measurements:[a]					Sockeye Counted:				Sockeye Finclipped:					Number of Other Species Counted:						
Date	Weather	Water Level (cm)	Thermometer Water Temp (°C)	Air Temp (°C)	Data Logger Water Temp (oC)	Adults	Jacks	Total	Cum	Finclip Used (Adipose +)	Adults	Cum. % Adults Clipped	Jacks	Cum. % Jacks Clipped	Adult Coho	Jack Coho	Total Coho	Pink	Chum	Cutthroat	Dolly Varden
8/16	Clear	11.0	19.5	16.0		20	4	24	0.64	Dorsal	15	50%	4	51%				1			
8/17	Clear	11.0	19.5	15.0		38	3	41	0.65	Dorsal	9	50%	1	51%							
8/18	Overcast	10.5	19.5	15.5		48	5	53	0.65	Dorsal	25	50%	1	50%							
8/19	Showers	10.5	19.5	15.0		15	1	16	0.65	Dorsal	9	50%	1	50%							
8/20	Overcast	11.0	19.0	15.0		60	4	64	0.66	Dorsal	29	50%	3	51%							
8/21	Partly Cloudy	11.0	19.5	15.5		3	1	4	0.66	Dorsal	3	50%	0	50%							
8/22	Clear	10.5	19.5	15.5		21	4	25	0.66	Dorsal	13	50%	1	50%							
8/23	Clear	10.5	18.0	10.0		9	2	11	0.66	Dorsal	4	50%	2	50%							
8/24	Clear	10.0	18.0	10.0		5	0	5	0.67		0	50%	0	50%							
8/25	Overcast	10.0	18.0	12.0		2	0	2	0.67	Dorsal	2	50%	0	50%							
8/26	Showers	9.5	18.0	14.0		0	2	2	0.67		0	50%	0	50%							
8/27	Showers	11.0	18.0	13.0		361	18	379	0.71	Dorsal	180	50%	12	51%	1		1				
8/28	Showers	11.5	18.0	12.0		128	5	133	0.72	Dorsal	64	50%	2	51%				1			
8/29	Overcast	11.5	18.0	12.5		29	1	30	0.72	Dorsal	20	50%	1	51%							
8/30	Partly Cloudy	11.5	17.0	10.5		10	0	10	0.72		0	50%	0	51%							
8/31	Clear	11.0	17.0	19.0		8	1	9	0.72	Dorsal	5	50%	0	51%							
9/1	Partly Cloudy	11.0	17.0	9.0		2	0	2	0.73		0	50%	0	51%							
9/2	Rain	10.5	17.0	12.0		0	0	0	0.73		0	50%	0	51%							
9/3	Rain	12.5	16.5	11.5		338	10	348	0.76	Dorsal	169	50%	4	51%		1	1	6		1	
9/4	Overcast	14.0	17.0	11.0		324	10	334	0.80	Dorsal	162	50%	3	50%	4	1	5	1			
9/5	Showers	14.0	16.5	10.0		97	7	104	0.81	Dorsal	51	50%	4	50%		3	3	1			
9/6	Rain	14.5	16.0	10.0		81	0	81	0.82	Dorsal	40	50%	0	50%	2	2	4	1			
9/7	Clear	15.5	15.0	5.5		48	1	49	0.82	Dorsal	22	50%	1	50%		1	1				
9/8	Clear	14.5	14.5	10.0		37	0	37	0.83	Dorsal	20	50%	0	50%		3	3				
9/9	Clear	14.0	14.0	5.0		35	3	38	0.83	Dorsal	16	50%	2	50%		1	1				
9/10	Partly Cloudy	13.5	13.0	4.0		23	0	23	0.83	Dorsal	10	50%	0	50%							
9/11	Overcast	12.5	13.5	8.0		14	0	14	0.83	Dorsal	11	50%	0	50%							
9/12	Rain	13.5	13.5	9.0		67	5	72	0.84	Dorsal	33	50%	3	50%	3	1	4				
9/13	Rain	17.5	13.5	9.0		444	12	456	0.89	Dorsal	215	50%	5	50%	85	16	101	1			5
9/14	Overcast	20.0	14.0	8.0		257	5	262	0.92	Dorsal	134	50%	4	51%	130	8	138	1			2

(continued)

Table 9. (page 4 of 4)

	Weather and Stream Measurements:[a]					Sockeye Counted:				Sockeye Finclipped:					Number of Other Species Counted:						
Date	Weather	Water Level (cm)	Thermometer Water Temp (°C)	Air Temp (°C)	Data Logger Water Temp (oC)	Adults	Jacks	Total	Cum	Finclip Used (Adipose +)	Adults	Cum. % Adults Clipped	Jacks	Cum. % Jacks Clipped	Adult Coho	Jack Coho	Total Coho	Pink	Chum	Cutthroat	Dolly Varden
9/15	Showers	19.0	14.0	9.0		139	4	143	0.93	Dorsal	70	50%	0	50%	25	3	28	1			
9/16	Clear	18.5	13.0	5.5		47	4	51	0.94	Dorsal	27	50%	3	50%	18	6	24	1			1
9/17	Clear	17.5	13.0	6.5		61	0	61	0.94	Dorsal	27	50%	0	50%	11	1	12	3			3
9/18	Clear	16.5	12.5	5.0		21	6	27	0.95	Dorsal	13	50%	4	51%		1	1				
9/19	Clear	15.5	12.0	4.0		31	6	37	0.95	Dorsal	15	50%	1	50%	1	2	3	2			1
9/20	Rain	15.0	12.0	8.0		10	2	12	0.95	Dorsal	2	50%	1	50%	1		1	2			
9/21	Rain	19.0	12.0	10.0		105	2	107	0.96	Dorsal	53	50%	1	50%	19	6	25	7			
9/22	Rain	23.0	12.5	9.0		72	5	77	0.97	Dorsal	27	50%	2	50%	48	1	49	3			8
9/23	Rain	29.5	13.0	10.0		113	1	114	0.98	Dorsal	47	50%	0	49%	133	8	141	1			7
9/24	Showers	37.5	12.5	8.5		43	4	47	0.99	Dorsal	34	50%	2	49%	84	6	90				6
9/25	Overcast	40.0	12.0	6.0		13	1	14	0.99	Dorsal	10	50%	1	50%	32	5	37				1
9/26	Rain	38.5	12.0	9.0		6	0	6	0.99	Dorsal	5	50%	0	50%	16		16				2
9/27	Overcast	41.5	11.5	11.0		38	3	41	0.99	Dorsal	13	50%	0	49%	57	8	65	1			1
9/28	Overcast	40.5	11.0	8.0		3	0	3	0.99	Dorsal	3	50%	0	49%	8	2	10				
9/29	Showers	39.5	11.0	9.0		13	1	14	1.00	Dorsal	13	50%	1	49%	5	1	6				1
9/30	Rain	38.0	11.0	9.0		10	0	10	1.00	Dorsal	4	50%	0	49%	14	3	17				2
10/1	Showers	36.0	11.0	10.0		5	0	5	1.00	Dorsal	3	50%	0	49%	1	2	3				2
10/2	Overcast	36.5	11.0	10.0		4	0	4	1.00		0	50%	0	49%	4	1	5				
10/3	Overcast	35.0	11.0	9.0		0	0	0	1.00		0	50%	0	49%	4		4				
10/4	Showers	34.5	11.0	9.5		6	1	7	1.00	Dorsal	5	50%	1	49%	3	4	7			1	4
10/5	Overcast	39.0	10.5	10.0		4	0	4	1.00	Dorsal	2	50%	0	49%	10	1	11				2
10/6	Rain	40.5	10.5	7.5		3	0	3	1.00	Dorsal	1	50%	0	49%	6	1	7		2		4
10/7	Overcast	40.5	10.0	7.5		3	1	4	1.00	Dorsal	2	50%	0	49%	1		1			1	
10/8	Showers	39.0	10.0	7.0		0	0	0	1.00		0	50%	0	49%	1		1				2
10/9	Showers	38.0	10.0	8.0		0	0	0	1.00		0	50%	0	49%	1		1				2
10/10	Overcast	36.5	10.0	8.0		4	0	4	1.00	Dorsal	2	50%	0	49%							1
10/11	Partly Cloudy	35.0	10.0	4.5		0	0	0	1.00		0	50%	0	49%	1	1	2				
10/12	Rain	33.5	10.0	4.5		1	0	1	1.00	Dorsal	0	50%	0	49%						1	2
10/13	Overcast	35.5	10.0	9.0		1	0	1	1.00		0	50%	0	49%	2		2				
Totals						9,229	284	9,513			4,615		140		731	100	831	36	2	5	96

[a] Observations were made about 0900 hour.

Table 10. Mark and recapture data, and abundance estimates, for sockeye salmon marked at the Neva Creek weir, 2004.

Marking Data:				Recapture Data:										Darroch Abundance Estimate:				Pooled Peterson Estimate:	
At the Neva Creek weir:				Main Inlet Stream						Beach									
Marking Dates	Finclip Strata	Weir Count	Number Marked	Aug. 11	Aug. 27-28	Sept. 8-9	Sept. 14-15	Sept. 22	Oct. 8-9	Oct. 10-11	Oct. 14-15	Total	% Recaptured	Number	S.E. (Number)	Prob. of Capture	S.E. (Prob. Capture)	Number	S.E. (Number)
Adults																			
				Number recaptured:										(Complete mixing Significance = 0.00, Equal prop. significance = 0.19)					
June 16 to July 24	Left Axillary	705	353	1	12	39	13	0	0	0	0	65	18%	1,261	289	0.28	0.06		
July 25 to Aug. 12	Left Ventral	4,940	2,470	0	7	119	59	30	2	71	63	351	14%	3,918	725	0.63	0.12		
Aug. 13 to Oct. 13	Dorsal	3,584	1,792	0	0	7	9	11	3	46	58	134	7%	4,186	798	0.43	0.08		
	Total	9,229	4,615	1	19	165	81	41	5	117	121	550		9,365	421			9,239	261
				Number examined for marks and Percent Marked:										(CV = 4%)				(CV = 3%)	
				5	45	341	177	69	14	215	236	1,102							
				20%	42%	48%	46%	59%	36%	54%	51%	50%							
Jacks																			
				Number recaptured:										Release stratas 1 and 2 pooled and recovery stratas 1-3 and 4-6 pooled:					
June 16 to July 24	Left Axillary	16	8	0	0	0	0	0	0	0	0	0	0%	(Complete mixing Significance = 0.13, Equal prop. significance = 0.05)					
July 25 to Aug. 12	Left Ventral	108	54	0	0	9	2	0	0	1	0	12	22%	254	64	0.24	0.06		
Aug. 13 to Oct. 13	Dorsal	160	78	0	0	0	1	0	0	2	5	8	10%	107	25	0.73	0.17		
	Total	284	140	0	0	9	3	0	0	3	5	20		360	60			408	65
				Number examined for marks and Percent Marked:										(CV = 17%)				(CV = 16%)	
				0	5	30	9	4	0	5	7	60							
					0%	30%	33%	0%		60%	71%	33%		Total adults and jacks from above 3x11 Darroch estimates:					
														9,725	425			9,647	269
														(CV = 4%)				(CV = 3%)	
Adults and Jacks Combined																			
				Number recaptured:										(Complete mixing Significance = 0.00, Equal prop. significance = 0.11)					
June 16 to July 24	Left Axillary	721	361	1	12	39	13	0	0	0	0	65	18%	1,353	307	0.27	0.06		
July 25 to Aug. 12	Left Ventral	5,048	2,524	0	7	128	61	30	2	72	63	363	14%	4,214	714	0.60	0.10		
Aug. 13 to Oct. 13	Dorsal	3,744	1,870	0	0	7	10	11	3	48	63	142	8%	4,113	761	0.45	0.08		
	Total	9,513	4,755	1	19	174	84	41	5	120	126	570		9,680	413			9,686	271
				Number examined for marks and Percent Marked:										(CV = 4%)				(CV = 3%)	
				5	50	371	186	73	14	220	243	1,162							
				20%	38%	47%	45%	56%	36%	55%	52%	49%							

Table 11. Estimated daily escapement of adult and jack sockeye salmon into Neva Lake, June 4 to October 13, 2002 to 2005.

	2002				2003				2004				2005				Average
Date	Adults	Jacks	Total	Cum. Prop.	Adults	Jacks	Total	Cum. Prop.	Adults	Jacks	Total	Cum. Prop.	Adults	Jacks	Total	Cum. Prop.	Cum. Prop.
6/4	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/5	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/6	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/7	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/8	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/9	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/10	1	0	1	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/11	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/12	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/13	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/14	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/15	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/16	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/17	1	0	1	0.000	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/18	2	0	2	0.001	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/19	0	0	0	0.001	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/20	1	0	1	0.001	0	0	0	0.000	0	0	0	0.000	0	0	0	0.000	0.000
6/21	0	0	0	0.001	0	0	0	0.000	22	0	22	0.002	0	0	0	0.000	0.001
6/22	1	0	1	0.001	1	0	1	0.000	0	0	0	0.002	0	0	0	0.000	0.001
6/23	1	0	1	0.001	4	1	5	0.001	0	0	0	0.002	0	0	0	0.000	0.001
6/24	0	0	0	0.001	0	0	0	0.001	0	0	0	0.002	0	0	0	0.000	0.001
6/25	0	0	0	0.001	5	1	6	0.001	147	2	149	0.018	0	0	0	0.000	0.005
6/26	1	0	1	0.002	2	0	2	0.001	17	0	17	0.020	48	1	49	0.009	0.008
6/27	62	0	62	0.014	0	0	0	0.001	22	0	22	0.022	18	0	18	0.013	0.013
6/28	35	0	35	0.021	0	0	0	0.001	39	1	40	0.026	26	1	27	0.018	0.017
6/29	0	0	0	0.021	4	2	6	0.002	1	0	1	0.026	42	2	44	0.026	0.019
6/30	31	0	31	0.027	1	1	2	0.002	4	0	4	0.027	61	5	66	0.039	0.024
7/1	188	0	188	0.065	0	0	0	0.002	4	0	4	0.027	32	2	34	0.045	0.035
7/2	333	7	340	0.133	15	11	26	0.004	0	0	0	0.027	29	2	31	0.051	0.054
7/3	203	3	206	0.174	29	14	43	0.008	77	0	77	0.035	56	4	60	0.063	0.070
7/4	28	0	28	0.180	63	36	99	0.017	221	4	225	0.059	18	5	23	0.067	0.081
7/5	83	1	84	0.196	21	11	32	0.019	87	2	89	0.068	0	0	0	0.067	0.088
7/6	12	0	12	0.199	2	4	6	0.020	62	1	63	0.075	0	0	0	0.067	0.090
7/7	11	3	14	0.201	0	3	3	0.020	2	0	2	0.075	18	0	18	0.070	0.092
7/8	8	0	8	0.203	0	0	0	0.020	0	0	0	0.075	0	0	0	0.070	0.092
7/9	18	3	21	0.207	0	0	0	0.020	0	0	0	0.075	22	5	27	0.075	0.095
7/10	8	0	8	0.209	0	0	0	0.020	0	0	0	0.075	6	3	9	0.077	0.095
7/11	11	0	11	0.211	0	0	0	0.020	0	0	0	0.075	1	1	2	0.078	0.096
7/12	9	2	11	0.213	0	0	0	0.020	0	0	0	0.075	60	5	65	0.090	0.100
7/13	0	4	4	0.214	0	0	0	0.020	0	0	0	0.075	4	0	4	0.091	0.100
7/14	28	9	37	0.221	8	11	19	0.022	0	0	0	0.075	2	0	2	0.091	0.102
7/15	22	18	40	0.229	1	2	3	0.022	0	0	0	0.075	2	0	2	0.091	0.105
7/16	11	10	21	0.234	0	0	0	0.022	0	0	0	0.075	0	0	0	0.091	0.106
7/17	4	6	10	0.236	0	0	0	0.022	0	0	0	0.075	1165	20	1185	0.317	0.162
7/18	28	15	43	0.244	359	137	496	0.066	0	0	0	0.075	87	18	105	0.337	0.180
7/19	35	17	52	0.255	225	136	361	0.097	0	1	1	0.075	74	14	88	0.353	0.195
7/20	1	4	5	0.256	21	24	45	0.101	0	0	0	0.075	58	3	61	0.365	0.199
7/21	0	2	2	0.256	914	221	1135	0.201	0	0	0	0.075	49	0	49	0.374	0.227
7/22	13	18	31	0.262	61	31	92	0.209	0	2	2	0.075	6	1	7	0.375	0.231
7/23	1	3	4	0.263	3	4	7	0.210	0	0	0	0.075	0	0	0	0.375	0.231
7/24	190	49	239	0.311	0	0	0	0.210	0	3	3	0.076	10	0	10	0.377	0.243
7/25	79	24	103	0.331	1	0	1	0.210	448	26	474	0.126	56	1	57	0.388	0.264
7/26	247	26	273	0.386	2	4	6	0.210	105	6	111	0.137	0	0	0	0.388	0.280
7/27	81	13	94	0.405	1	3	4	0.211	23	1	24	0.140	230	9	239	0.434	0.297
7/28	94	16	110	0.427	49	18	67	0.217	1383	19	1402	0.287	141	5	146	0.461	0.348
7/29	25	14	39	0.435	1758	156	1914	0.385	254	2	256	0.314	35	3	38	0.469	0.400
7/30	15	8	23	0.439	217	14	231	0.405	198	1	199	0.335	55	2	57	0.479	0.415
7/31	25	24	49	0.449	59	17	76	0.411	57	3	60	0.341	40	1	41	0.487	0.422
8/1	49	47	96	0.468	122	20	142	0.424	33	1	34	0.345	52	7	59	0.498	0.434
8/2	12	13	25	0.473	170	22	192	0.441	28	1	29	0.348	42	5	47	0.507	0.442
8/3	3	5	8	0.475	8	1	9	0.442	20	1	21	0.350	49	1	50	0.517	0.446
8/4	3	14	17	0.478	4	7	11	0.443	4	1	5	0.351	92	2	94	0.535	0.452
8/5	32	32	64	0.491	333	34	367	0.475	39	5	44	0.355	5	0	5	0.536	0.464
8/6	3	4	7	0.492	112	13	125	0.486	24	5	29	0.358	94	3	97	0.554	0.473
8/7	10	13	23	0.497	71	8	79	0.493	6	1	7	0.359	67	3	70	0.567	0.479
8/8	297	64	361	0.569	279	32	311	0.520	0	0	0	0.359	81	3	84	0.583	0.508
8/9	176	30	206	0.610	91	12	103	0.529	1	0	1	0.359	74	4	78	0.598	0.524
8/10	92	54	146	0.639	4	3	7	0.530	504	18	522	0.414	33	8	41	0.606	0.547
8/11	74	42	116	0.663	4	0	4	0.530	1619	14	1633	0.586	30	3	33	0.612	0.598
8/12	177	29	206	0.704	195	29	224	0.550	194	3	197	0.606	23	2	25	0.617	0.619
8/13	25	12	37	0.711	131	12	143	0.562	185	13	198	0.627	11	2	13	0.619	0.630
8/14	26	9	35	0.718	580	73	653	0.620	94	1	95	0.637	40	3	43	0.628	0.651
8/15	38	42	80	0.734	632	84	716	0.682	25	1	26	0.640	40	2	42	0.636	0.673

(continued)

Table 11. (Page 2 of 2)

	2002				2003				2004				2005				Average
Date	Adults	Jacks	Total	Cum. Prop.	Adults	Jacks	Total	Cum. Prop.	Adults	Jacks	Total	Cum. Prop.	Adults	Jacks	Total	Cum. Prop.	Cum. Prop.
8/16	26	15	41	0.742	201	32	233	0.703	20	4	24	0.642	60	1	61	0.647	0.684
8/17	33	19	52	0.753	67	17	84	0.710	38	3	41	0.647	0	0	0	0.647	0.689
8/18	54	20	74	0.768	6	2	8	0.711	48	5	53	0.652	0	0	0	0.647	0.695
8/19	24	21	45	0.777	2	1	3	0.711	15	1	16	0.654	55	2	57	0.658	0.700
8/20	22	18	40	0.785	3	3	6	0.712	60	4	64	0.661	65	0	65	0.670	0.707
8/21	31	25	56	0.796	40	8	48	0.716	3	1	4	0.661	65	0	65	0.683	0.714
8/22	54	25	79	0.812	58	25	83	0.723	21	4	25	0.664	131	2	133	0.708	0.727
8/23	39	8	47	0.821	48	19	67	0.729	9	2	11	0.665	113	11	124	0.732	0.737
8/24	15	14	29	0.827	13	4	17	0.731	5	0	5	0.666	28	1	29	0.737	0.740
8/25	20	20	40	0.835	47	17	64	0.736	2	0	2	0.666	0	0	0	0.737	0.743
8/26	16	11	27	0.840	54	13	67	0.742	0	2	2	0.666	50	2	52	0.747	0.749
8/27	19	16	35	0.847	29	16	45	0.746	361	18	379	0.706	50	0	50	0.756	0.764
8/28	28	12	40	0.855	36	14	50	0.750	128	5	133	0.720	85	8	93	0.774	0.775
8/29	17	10	27	0.861	10	5	15	0.752	29	1	30	0.723	60	1	61	0.786	0.780
8/30	30	16.5	46.5	0.870	524	97	621	0.806	10	0	10	0.724	47	0	47	0.795	0.799
8/31	43	23	66	0.883	138	35	173	0.821	8	1	9	0.725	113	7	120	0.817	0.812
9/1	16	10	26	0.888	292	98	390	0.856	2	0	2	0.725	55	1	56	0.828	0.824
9/2	45	35	80	0.904	514	53	567	0.905	0	0	0	0.725	27	4	31	0.834	0.842
9/3	13	14	27	0.910	81	28	109	0.915	338	10	348	0.762	35	1	36	0.841	0.857
9/4	22	9	31	0.916	34	15	49	0.919	324	10	334	0.797	30	3	33	0.847	0.870
9/5	18.8	9	27.8	0.921	39	18	57	0.924	97	7	104	0.808	39	0	39	0.854	0.877
9/6	15.6	9	24.6	0.926	41	14	55	0.929	81	0	81	0.816	89	2	91	0.872	0.886
9/7	12.4	9	21.4	0.931	36	13	49	0.933	48	1	49	0.821	109	2	111	0.893	0.895
9/8	9.2	9	18.2	0.934	49	20	69	0.939	37	0	37	0.825	0	0	0	0.893	0.898
9/9	6	9	15	0.937	53	23	76	0.946	35	3	38	0.829	0	0	0	0.893	0.901
9/10	28	7	35	0.944	21	17	38	0.949	23	0	23	0.832	190	7	197	0.930	0.914
9/11	0	5	5	0.945	18	7	25	0.952	14	0	14	0.833	45	1	46	0.939	0.917
9/12	5	0	5	0.946	17	7	24	0.954	67	5	72	0.841	17	5	22	0.943	0.921
9/13	4	9	13	0.949	62	13	75	0.960	444	12	456	0.889	46	1	47	0.952	0.937
9/14	3	0	3	0.949	38	10	48	0.965	257	5	262	0.916	17	0	17	0.955	0.946
9/15	1	11	12	0.952	25	6	31	0.967	139	4	143	0.931	0	0	0	0.955	0.951
9/16	9.0	2.8	11.9	0.954	7	4	11	0.968	47	4	51	0.937	0	0	0	0.955	0.954
9/17	14.3	4.4	18.7	0.958	9	7	16	0.970	61	0	61	0.943	19	2	21	0.959	0.957
9/18	9.6	3.0	12.6	0.960	2	2	4	0.970	21	6	27	0.946	32	3	35	0.966	0.961
9/19	8.2	2.5	10.7	0.963	3	4	7	0.971	31	6	37	0.950	12	0	12	0.968	0.963
9/20	5.4	1.7	7.1	0.964	7	6	13	0.972	10	2	12	0.951	8	4	12	0.971	0.964
9/21	23.2	7.2	30.4	0.970	31	8	39	0.975	105	2	107	0.962	11	2	13	0.973	0.970
9/22	18.7	5.8	24.5	0.975	14	3	17	0.977	72	5	77	0.970	34	0	34	0.980	0.975
9/23	21.6	6.7	28.3	0.981	0	2	2	0.977	113	1	114	0.982	28	4	32	0.986	0.981
9/24	11.1	3.4	14.5	0.983	14	3	17	0.978	43	4	47	0.987	11	1	12	0.988	0.984
9/25	26.1	8.1	34.2	0.990	139	13	152	0.992	13	1	14	0.989	10	3	13	0.990	0.990
9/26	4.0	1.2	5.3	0.991	15	1	16	0.993	6	0	6	0.989	5.3	0.3	5.5	0.991	0.991
9/27	13.7	4.2	17.9	0.995	32	2	34	0.996	38	3	41	0.994	18.0	0.9	18.9	0.995	0.995
9/28	3.5	1.1	4.5	0.996	13	3	16	0.997	3	0	3	0.994	4.6	0.2	4.8	0.996	0.996
9/29	4.7	1.5	6.2	0.997	8	4	12	0.999	13	1	14	0.995	6.2	0.3	6.5	0.997	0.997
9/30	2.4	0.7	3.1	0.998	2	1	3	0.999	10	0	10	0.997	3.1	0.2	3.3	0.998	0.998
10/1	1.3	0.4	1.7	0.998	2	0	2	0.999	5	0	5	0.997	1.7	0.1	1.8	0.998	0.998
10/2	1.6	0.5	2.2	0.999	5	0	5	0.999	4	0	4	0.997	2.2	0.1	2.3	0.999	0.998
10/3	0.0	0.0	0.0	0.999	0	0	0	0.999	0	0	0	0.997	0.0	0.0	0.0	0.999	0.998
10/4	1.6	0.5	2.2	0.999	2	0	2	1.000	6	1	7	0.998	2.2	0.1	2.3	0.999	0.999
10/5	1.3	0.4	1.7	0.999	3	0	3	1.000	4	0	4	0.999	1.7	0.1	1.8	0.999	0.999
10/6	0.5	0.2	0.7	0.999	0	0	0	1.000	3	0	3	0.999	0.7	0.0	0.8	0.999	0.999
10/7	0.7	0.2	1.0	1.000	0	0	0	1.000	3	1	4	0.999	1.0	0.0	1.0	1.000	1.000
10/8	0.4	0.1	0.5	1.000	2	0	2	1.000	0	0	0	0.999	0.5	0.0	0.5	1.000	1.000
10/9	0.0	0.0	0.0	1.000	0	0	0	1.000	0	0	0	0.999	0.0	0.0	0.0	1.000	1.000
10/10	0.7	0.2	1.0	1.000	0	0	0	1.000	4	0	4	1.000	1.0	0.0	1.0	1.000	1.000
10/11	0.0	0.0	0.0	1.000	0	0	0	1.000	0	0	0	1.000	0.0	0.0	0.0	1.000	1.000
10/12	0.2	0.1	0.2	1.000	0	0	0	1.000	1	0	1	1.000	0.2	0.0	0.3	1.000	1.000
10/13	0.2	0.1	0.2	1.000	0	0	0	1.000	1	0	1	1.000	0.2	0.0	0.3	1.000	1.000
Total	**3,818**	**1,185**	**5,003**		**9,468**	**1,925**	**11,393**		**9,229**	**284**	**9,513**		**5,018**	**244**	**5,263**		
Weir Count	3,397	1,074	4,656		9,248	1,851	11,099		9,229	284	9,513		4,970	242	5,212		
Difference	421	111	347		220	74	294		0	0	0		48	2	51		

Shaded cells with whole numbers entries are estimated and shaded cells with values to one decimal place are interpolated (see below).

The boxed areas in the Cumulative Proportion columns show the median and second and third quartiles and 80% of the fish escaped between the lines.

Notes for 2002:

The 5,003 total is the Pooled Peterson estimate for adults and jacks (CV=5%); one or both tests for complete mixings or equal proportions were NOT significant, this model should be best.

The recapture went through Nov 13, which is a month after the last fish was marked at the weir, so this mark-recap. estimate is good for the whole run and the BEST total estimate.

I had previously reported in Van Alen (2004) and Van Alen (2005) that the escapement of sockeye salmon into Neva Lake in 2002 was 53 fish less at 4,951.

The missing values on 8/30 and 9/5-9/8 were linerally interpolated. The EM algorithm was used to fill-in the missing values after 9/15 using the 2002-2005 data block after adjusting the estimated escapement of adults that passed through the weir uncounted on 7/3 (Van Alen 2004) down by 33 fish so the season total equals 5,003.

Notes for 2003:

The total of 11,393 is unchanged from Van Alen (2005). I assume that no sockeye passed after the weir was pulled on 10/9 (the E-M Algorithm would have increased this number by 7 fish).

Notes for 2004:

Based on early season weir counts, I assume that no sockeye passed before the weir was operational on 6/16. The EM algorithm would have estimated an escapement of one fish.

Notes for 2005:

Based on early season weir counts, I assume that no sockeye passed before the weir was operational on 6/20. The EM algorighm would have estimated an escapement of three fish.

The EM algorithm increases the total weir count by 51 fish that probably passed after the weir was pulled on 9/25.

Stream and Beach Mark-Recapture for Indexing Escapement: In 2004, five mark-recapture trips were successfully accomplished in the MIS study area and two in the beach study areas in conjunction with the weir mark-recapture study (Table 12). Unfortunately, I was unable to compute modified Jolly-Seber estimates of the abundance of adult sockeye salmon in the MIS due to no recaptures from the first sampling trip (Table 12). For this dataset the first sampling trip was August 27-28 which was a couple of weeks later than the first sampling trips in 2002 and 2003. A sampling trip was initially done on August 11 but only five sockeye were captured and marked so this trip has already been excluded from the model. There were few live but many dead sockeye salmon in the main inlet stream prior to the August 27-28 trip. Water levels were quite low in the stream during August. Too few recaptures of jacks also precluded estimating the number of jacks in the main inlet stream study area (Table 12). More than two trips are needed to use the Jolly-Seber method and harsh weather after mid-October limited us to only two mark-recapture trips in the beach study area. Despite the inability to compute Jolly-Seber estimates of the abundance of adult and jack sockeye salmon in the MIS and beach study areas, these mark-recapture trips yielded the Peterson estimates of the abundance of live sockeye salmon in these locations each trip (Table 12) and these estimates can be compared with similar estimates in other years.

Table 12. Data collected for modified Jolly-Seber estimates of the abundance of adult and jack sockeye salmon in Neva Lake's main inlet stream (MIS) and beach study areas, 2004.

			Peterson Estimates for each Trip:							Modified Jolly-Seber Estimates:										
Index Area, Adults or Jacks	Trip No.	Dates	Number of New Fish Marked on Day 1 (M)	Number of New Fish Marked on Day 2	Number of Recaptures on Day 2 (R)	Total Number Caught on Day 2 (C)	Peterson Estimate for Trip (N*)	SE (N*)	CV (N*)	Marks from Trip 1	Marks from Trip 2	Marks from Trip 3	Marks from Trip 4	n = Total Number Caught this Trip	m = Total Number Recaps. this Trip	Ni = Peterson Est. for this Trip	M = m*N/n	$\phi = M_{i+1}$ / (M-m+n)	B = N_{i+1} - ϕN	B* = B log(ϕ)/(ϕ-1)
MIS, Adults	1	Aug. 27-28	18	27	13	31	55	6	11%					45	0	55	0	0.000	391	[a]
	2	Sept. 8-9	254	87	161	415	391	11	3%					341	0	391	0	0.268	93	168
	3	Sept. 14-15	128	54	99	227	198	6	3%		84			182	84	198	91	0.176	37	78
	4	Sept. 22	51	18	44	95	72	2	3%			32		69	32	72	33	0.201	10	21
	5	Oct. 8-9	10	4	2	12	25	8	34%				8	14	8	25	14			
																		Total = sum(B*) =		[a]
																		SE, CV =		[a]
MIS, Jacks	1	Aug. 27-28	1	4	0	4	9	4	50%					5	0	9	0	0.000	38	[a]
	2	Sept. 8-9	23	7	10	17	38	5	14%		6			30	0	38	0	0.340	4	7
	3	Sept. 14-15	3	7	1	8	17	6	38%					10	6	17	10	0.000	5	[a]
	4	Sept. 22	3	1	1	2	5	1	28%					4	0	5	0			
	5	Oct. 8-9	0	0	0	0														
																		Total = sum(B*) =		[a]
																		SE, CV =		[a]
MIS, Adults and Jacks	1	Aug. 27-28	19	31	13	44	63	8	12%					50	0	63	0	0.000	429	[a]
	2	Sept. 8-9	277	94	171	265	429	12	3%					371	0	429	0	0.266	97	174
	3	Sept. 14-15	131	61	100	161	211	6	3%		90			192	90	211	99	0.167	41	89
	4	Sept. 22	54	19	45	64	77	2	3%			32		73	32	77	34	0.189	10	21
	5	Oct. 8-9	10	4	2	6	25	8	34%				8	14	8	25	14			
																		Total = sum(B*) =		[a]
																		SE, CV =		[a]
Beach, Adults	1	Oct. 10-11	124	89	29	118	495	67	14%					213	0	495	0	0.475	175	581
	2	Oct. 14-15	120	115	47	162	410	38	9%	58				235	58	410	101			[a]
																		Total = sum(B*) =		[a]
																		SE, CV =		[a]
Beach, Jacks	1	Oct. 10-11	2	3	0	3	11	6	55%					5	0	11	0	0.221	5	15
	2	Oct. 14-15	4	3	3	6	8	1	15%	1				7	1	8	1			[a]
																		Total = sum(B*) =		[a]
																		SE, CV =		[a]
Beach, Adults and Jacks	1	Oct. 10-11	126	92	29	121	515	70	14%					218	0	515	0	0.462	175	593
	2	Oct. 14-15	124	118	50	168	413	37	9%	59				242	59	413	101			[a]
																		Total = sum(B*) =		[a]
																		SE, CV =		[a]

[a]No estimate possible due to lack of recoveries or less than three trips.

Visual Survey Counts: In 2004, counts of live sockeye salmon peaked in the MIS in mid-September and were still high in the lake when the last surveys were done in mid-October (Table 13). When counts are summed across all the MIS and Lake survey areas, the highest counts were obtained on September 15. The 958 average count on September 15 was 10% of the 9,513 escapement into the lake.

On August 7, partially spawned sockeye salmon were observed among 49 dead sockeye salmon observed in the MIS, an unusual sighting attributed to the low flows and warm water that persisted through July and August. The 51 live sockeye counted in the MIS on August 7 and the 7 sockeye counted in the MIS on August 11 were pale and appeared stressed by the low flow conditions.

On August 13, 130 dead, un-spawned, adult sockeye salmon were found stranded in the shallow, braided, section of the outlet stream several hundred feet below the weir. It appeared that this die-off resulted when they tried to ascend the stream during a period of low flows and warm water.

On October 14, the day after the weir was pulled for the season, we observed 161 sockeye in the outlet stream in the vicinity of the lower fishing hole. A few sockeye salmon were also observed spawning in the outlet above the weir in October and there were six sockeye observed a short distance below the weir when it was pulled on October 13. I assume that the sockeye spawning above the weir are natural outlet spawners but the sockeye observed below the weir might be either there because they have yet to migrate to the lake or will be spawning in the outlet stream.

We found it difficult to count sockeye salmon on and off the beach study areas since they would spook offshore and mix with sockeye milling in the lake and both groups had to be counted simultaneously. This makes expanding the abundance estimate for the beach study areas to an abundance estimate for the entire lake difficult.

Table 13. Visual counts of sockeye salmon in Neva Lake's outlet and main inlet stream (foot surveys) and lake (boat surveys), 2004.

				Lake			
Date	Observer	Outlet Fish Hole[a]	MIS	Index Area	Off MIS	Other	Total
6/24	Lonn	100					
6/25	Lonn	60					
6/26	Lonn	30					
6/27	Lonn	50					
6/28	Lonn	35					
6/29	Lonn	15					
6/30	Lonn	15					
7/1	Lonn	8					
7/2	Lonn	5					
7/3	Lonn	70					
7/4	Lonn	35					
7/5	Lonn	60					
7/6	Lonn	10					
7/7	Lonn	1					
7/10	Lonn	0					
7/11	Lonn	0					
7/13	Lonn	0					
8/7	Lonn		52		40		40
8/11	Brownlee		7				
	Van Alen		7				
	Average		7				
8/13	Lonn		17		40		40
8/15	Lonn		13		26		26
8/17	Lonn		5		26		26
8/19	Lonn		9		7		7
8/21	Lonn		3		40		40
8/23	Lonn		8		40		40
8/25	Lonn		14		55		55
8/27	Abbott		29		48		48
	Lonn		29		7		7
	Murphy		26		13		13
	Average		28		23		23
8/28	Abbott		48		69		69
	Lonn		52		75		75
	Murphy		56		59		59
	Average		52		68		68
9/1	Lonn		97		100		100
9/6	Lonn		350		60		60
9/8	Lonn		323				
	McBride		299				
	Van Alen		296				
	Average		306				
9/9	Lonn		283	40	40	230	310
	McBride		260	40	50	303	393
	Van Alen		291	40	50	333	423
	Average		278	40	47	289	375
9/14	Lagoudakis		211				
	Lonn		249				
	Van Alen		289				
	Average		250				
9/15	Lagoudakis		165	100	50	570	720
	Lonn		230	70	130	820	1020
	Van Alen		229	60	40	410	510
	Average		208	77	73	600	750
9/20	Lonn		64			40	40
9/22	Lonn		86	140	40	480	660
	Van Alen		99	140	40	440	620
	Average		93	140	40	460	640
10/5	Lonn		33				
10/8	Lonn		26				
	Murphy		18				
	Sheakley		15				
	Average		20				
10/9	Lonn		28	250	50	365	665
	Murphy		30	210	66	439	715
	Sheakley		29	300	64	529	893
	Average		29	253	60	444	758
10/10	Lonn		44	300	60	466	826
	Murphy		20	250	28	450	728
	Sheakley		58	290	27	599	916
	Average		41	280	38	505	823
10/11	Lonn		30	200	100	424	724
	Murphy		27	190	120	454	764
	Sheakley		31	170	70	396	636
	Average		29	187	97	425	708
10/14	Lonn	171		280	110	455	845
	Murphy	150		160	31	361	552
	Sheakley			360	25	472	857
	Average	161		267	55	429	751
10/15	Lonn		46	230	70	478	778
	Murphy		31	200	60	359	619
	Sheakley		41	270	40	367	677
	Van Alen		44	280	80	426	786
	Average		41	245	63	408	715

[a]A traditional subsistence fishing site in lower Neva Creek.

Age, Sex, and Length Composition: In 2004, based on a sample of 480 fish with ageable scales, ninety-six percent of the Neva sockeye escapement were "one check", age-1.-, fish aged 1.2 (70%), 1.3 (16%), and 1.1 (jacks, 10%, Table 14). The sex composition was 45% males.

Table 14. Age composition of sockeye salmon in the Neva Lake escapement, 2004.

	Brood Year and Age Class					
	2001	2000	2000	1999	1999	
	1.1	1.2	2.1	1.3	2.2	Total
Percentages are weighted by the weekly weir counts						
Male						
Sample Size	38	142	3	36	8	227
Percent	9.7	26.8	0.2	6.3	2.4	45.4
Std. Error	2.2	2.8	0.2	1.4	1.5	3.1
Escapement	922	2,547	24	600	227	4,320
Female						
Sample Size		203		44	6	253
Percent		43.5		9.4	1.8	54.6
Std. Error		3.2		1.7	0.8	3.1
Escapement		4,136		889	168	5,193
All Fish						
Sample Size	38	345	3	80	14	480
Percent	9.7	70.3	0.2	15.7	4.2	100.0
Std. Error	2.2	3.1	0.2	2.1	1.7	
Escapement	922	6,683	24	1,489	395	9,513

The average mid-eye-to-fork length was 360 mm for the age-1.1 jacks, 499 mm for the age-1.2 fish, and 557 mm for the age-1.3 fish (Table 15).

Table 15. Length composition (mm) of sockeye salmon in the Neva Lake escapement, 2004.

		Brood Year and Age Class					
		2001	2000	2000	1999	1999	
		1.1	1.2	2.1	1.3	2.2	Total
Combined Periods (Lengths weighted by period escapements)							
Male	Avg. Length	360	496	402	562	509	454
	Std. Error	2.7	2.1	13.0	3.7	5.0	4.5
	Sample Size	38	142	3	36	8	227
Female	Avg. Length		502		557	497	512
	Std. Error		1.4		3.3	9.3	1.9
	Sample Size		203		44	6	253
All Fish	Avg. Length	360	499	402	557	504	495
	Std. Error	2.7	1.2	13.0	2.5	5.1	2.4
	Sample Size	38	345	3	80	14	480

Harvest Monitoring: In 2004, the State subsistence fishery for "Neva Creek" sockeye salmon was open from June 1 to through August 15 with a possession and annual limit of 40 fish per household. The subsistence fishery had been open from June 1 through July 31 in past years. In 2003, the possession and annual limit was 25 sockeye salmon and in 2002 and prior years had been 10 sockeye salmon. The State fishery was open to any Alaskan resident who obtained a permit. The permits were issued by the ADF&G, Division of Commercial Fisheries. Federal regulations provide Hoonah area residents with a "Customary and Traditional Use Determination" for the subsistence harvest of salmon in this area. This distinction allows residents of Hoonah to also use rod and reel gear to take salmon in freshwater. A special condition on the 2004 Federal Subsistence Fishing Permit for salmon, trout, and char stated "The harvest limit and seasons for sockeye salmon is the same as listed on ADF&G subsistence and personal use fishing permits." In 2004, all subsistence fishing was done by people with a State subsistence/personal use permit.

From June 16 to August 17, 2004, the weir operator interviewed sport and subsistence fishers observed in his multiple daily trips back and forth to the weir site. He was able to look for, and talk with, people fishing in and off the mouth of South Creek, in South Creek, and at the subsistence fishing sites in lower Neva Creek. He observed a sport fish harvest of 64 sockeye salmon and a subsistence/personal use harvest of 312 sockeye salmon (Table 16). The subsistence harvest reported on State permits in 2004 was 397 sockeye salmon (Figure 3).

Table 16. Observed sport and subsistence effort and harvest of salmon in the Neva Creek/South Creek area, June 24 to August 17, 2004.

Date	Hour	No. in Party	User Group	Location Fished (Saltwater, Intertidal, South Creek, Neva Creek)	Gear (BS=beach seine, GN=gillnet, S=spear, G=gaff, D=dipnet, R=rod&reel)	Units of Gear	Hours Fished per Units of Gear	Total Hours Fished (gear x hrs)	Sockeye Harvest	Coho Harvest	Chum Harvest	Pink Harvest
Jun-24	9:00	4	Subsistence	Saltwater	GN	1	13	13	75	1	5	0
Jun-27	9:00	1	Subsistence	Neva Creek	G	1	0.25	0.25	6	0	0	0
Jun-29	10:00	1	Subsistence	Neva Creek	G	1	0.25	0.25	8	0	0	0
Jul-01	10:45	6	Sport	Intertidal	R	6	2.5	15	4	0	0	0
Jul-02		3	Sport	Intertidal	R	3	2	6	2	0	0	0
Jul-04		2	Subsistence	Neva Creek	G				20	0	0	0
Jul-05	10:30	5	Sport	Intertidal	R	5	1.5	7.5	3	0	0	0
Jul-08	11:00	4	Sport	Intertidal	R	4	2	8	2	0	0	0
Jul-11	19:15	4	Subsistence	Saltwater	BS	1	3	3	12	0	0	0
Jul-12	13:30	5	Subsistence	Saltwater	GN	1	1	1	0	0	0	0
Jul-12		5	Subsistence	Intertidal	GN	1	3	3				
Jul-13	11:00	5	Sport	Intertidal	R	5	2	10	6	0	0	0
Jul-14	11:00	4	Sport	Intertidal	R	4	2	8	1	0	0	0
Jul-15	12:30	5	Subsistence	Neva Creek	G	2	1	2	2	0	0	0
Jul-15	14:00	3	Subsistence	Saltwater	GN	1	3.5	3.5	24	0	0	0
Jul-15	17:00	3	Sport	Intertidal	R	3	4	12	1	0	0	0
Jul-17	11:45	3	Subsistence	Saltwater	GN	1	1	1	35	0	0	0
Jul-17	13:00	4	Subsistence	South Creek	G & D	2			7	0	0	0
Jul-17	17:00	3	Subsistence	Intertidal	GN	1	4	4	0	0	0	0
Jul-17	17:30	2	Sport	Intertidal	R	2	3	6	3	0	0	0
Jul-20	11:00	1	Sport	Intertidal	R	1	2.5	2.5	3	0	0	0
Jul-21	14:10	6	Sport	Intertidal	R	6	5	30	20	0	0	0
Jul-21	14:30	2	Sport	Intertidal	R	2	1	2	2	0	0	0
Jul-25	11:35	1	Subsistence	Neva Creek	G	1	0.3	0.3	30	0	0	0
Jul-25		3	Sport	Intertidal	R	3	2.5	7.5				
Jul-29			Subsistence	Neva Creek	G				12	0	0	0
Jul-29	19:10	2	Subsistence	Neva Creek	S	1	1	1	30	0	0	0
Jul-31			Subsistence	Neva Creek	G				8	0	0	0
Jul-31	10:20	2	Sport	Intertidal	R	2	0.75	1.5	1	0	0	1
Jul-31	14:15	3	Sport	Intertidal	R	3	4	12	6	0	0	0
Jul-31	14:15	4	Sport	Intertidal	R	4	4	16	8			
Aug-04			Subsistence	Neva Creek	G				11	0	0	0
Aug-11	8:45	1	Subsistence	Neva Creek	G	1			17	0	0	0
Aug-16	14:00	4	Sport	Intertidal	R	4	5	20	2	0	0	0
Aug-17	18:40	1	Subsistence	Neva Creek	G	1	2	2	15	0	0	0
Totals:			Sport	Intertidal	R	57	43.75	164	64	0	0	1
			Subsistence	Saltwater	BS	1	3	3	12	0	0	0
					GN	4	18.5	18.5	134	1	5	0
				Intertidal	GN	2	7	7	0	0	0	0
				South Creek	G & D	2	0		7	0	0	0
				Neva Creek	G	7	3.8		129	0	0	0
					S	1	1	1	30	0	0	0
					Subtotal Subsistence =	17	33.3	29.5	312	1	5	0
					Total Sport and Subsistence =	74	77.05	193.5	376	1	5	1

Neva 2005

Weir and Weir-based Mark-Recapture Estimate of Total Escapement: In 2005, the Neva weir was operated from June 20 through September 25 (Table 17). The weir count totaled 5,212 sockeye salmon – 4,970 adults and 242 jacks. The first sockeye passed on June 26 and there were still a few sockeye passing when the weir was pulled. An estimated 51 sockeye (48 adults and 2 jacks) entered the lake after the weir was pulled (Table 11) bringing the 2005 sockeye escapement estimate to 5,263 (5,018 adults and 244 jacks). The midpoint of the sockeye escapement was August 2. The middle 80% of the sockeye escapement was between July 17 and September 10. Weir counts of other species totaled 301 coho salmon (including 157 jacks), 158 pink salmon, 0 chum salmon, 8 cutthroat trout, and 390 Dolly Varden char.

Weir operations went relatively smooth in 2005. There were nine days over the course of the summer that the weir operator closed the weir when he was attending to other business. There were no instances when salmon were suspected to have passed through the weir uncounted although there was a lot of black and brown bear activity and wolf activity at the weir and evidence of people fishing at the weir this year.

Many of the sockeye salmon observed at the weir this year appeared stressed by warm water temperatures and low flow conditions that persisted through much of the summer. On July 17, 2005, there was a rush of 1,165 adult sockeye salmon through the weir and an additional 18 sockeye died at the weir before the operator pulled pickets and counted them through in batches. Other occasions with adult sockeye dying at the weir were 1 on July 21, 14 on August 10, 19 on August 11, 5 on August 31, 1 on September 2, 8 on September 10, 2 on September 11, 3 on September 14, 3 on September 17, 2 on September 22, and 3 on September 24. Thus, a total of 79 adult sockeye salmon died at the weir in 2005 which is an unusually high number compared to other years and is apparently related to the stress of low flows and warm water. A die-off of 100 or more pre-spawned sockeye salmon was observed in Neva Creek on August 14 and 15. These fish were stranded and died in the shallow, braided, section of Neva Creek several hundred feet below the weir. This is the same area that a die-off of 130 sockeye salmon was observed on August 13, 2004.

The weir-to-spawning area mark-recapture study to validate the accuracy of the weir counts was limited to one recapture trip in 2005 due to limited funds and funding that ended in September. The weir operator finclipped 22 percent of the adult and 28 percent of the jack sockeye salmon counted through the weir (Table 17). On August 31, 19 percent of the adults (63 of 326) and 30 percent of the jacks (3 of 10) were found to have been marked at the weir. There was not less than a 5% probability that the proportion of marked fish in the inlet stream (66 of 336, 19.6%) was less than that marked at the weir (1,148 of 5,212, 22.0%). The one-tailed exact binomial test for goodness-of-fit (Sokal and Rohlf, 1995) p-value was 0.1615. Thus, the 5,263 expanded weir count (Table 11) is considered to be the best estimate of the escapement of adult and jack sockeye salmon into Neva Lake in 2005.

Table 17. Weather and stream measurements and daily numbers of fish counted and finclipped at the Neva Creek weir, 2005.

	Weather and Stream Measurements:[a]				Sockeye Counted:				Sockeye Finclipped:								
Date	Weather	Water Level (cm)	Therm-ometer Water Temp (°C)	Air Temp (°C)	Adults	Jacks	Total	Cum. Prop.	Finclip Used (Adipose +)	Adults	Cum. % Adults Clipped	Jacks	Cum. % Jacks Clipped	Coho	Pink	Cutthroat	Dolly Varden
6/20					0	0	0	0.00									
6/21					0	0	0	0.00									
6/22					0	0	0	0.00									
6/23					0	0	0	0.00									
6/24	clear				0	0	0	0.00									
6/25	partly cloudy				0	0	0	0.00									
6/26	partly cloudy				48	1	49	0.01	Left axillary	12	25%	1	100%				
6/27	clear	17.5	19.0	18.0	18	0	18	0.01	Left axillary	5	26%	0	100%				
6/28	overcast	19.5	18.0	14.5	26	1	27	0.02	Left axillary	6	25%	0	50%				
6/29	cloudy	18.0	17.0	13.0	42	2	44	0.03	Left axillary	10	25%	0	25%				
6/30		19.0	17.0	14.0	61	5	66	0.04	Left axillary	13	24%	1	22%				1
7/1	cloudy	17.5	17.5	14.0	32	2	34	0.05	Left axillary	8	24%	0	18%				
7/2	cloudy	17.0	17.0	12.0	29	2	31	0.05	Left axillary	12	26%	0	15%				
7/3	rain	17.5	17.0	15.0	56	4	60	0.06	Left axillary	24	29%	0	12%				3
7/4	showers	19.0	17.0	12.0	18	5	23	0.07	Left axillary	6	29%	2	18%				2
7/5					trap closed		0	0.07	Left axillary		29%		18%				
7/6	cloudy	18.3	17.0	12.0	0	0	0	0.07	Left axillary	0	29%	0	18%				1
7/7	showers	17.5	17.0	12.3	18	0	18	0.07	Left axillary	5	29%	0	18%				
7/8					trap closed		0	0.07			29%		18%				
7/9	partly cloudy	17.0	18.0	14.0	22	5	27	0.08	Left axillary	5	29%	0	15%				4
7/10	showers	16.5	17.0	14.5	6	3	9	0.08	Left axillary	3	29%	0	13%				
7/11	showers		17.0	13.0	1	1	2	0.08	Left axillary	1	29%	1	16%				
7/12		17.0	17.0	14.0	60	5	65	0.09	Left axillary	4	26%	0	14%				3
7/13	showers	16.0	17.0	14.0	4	0	4	0.09	Left axillary	0	26%	0	14%				
7/14	rain	15.0	17.0	12.0	2	0	2	0.09	Left axillary	2	26%	0	14%				
7/15	rain	15.0	17.0	13.0	2	0	2	0.09	Left axillary	0	26%	0	14%				
7/16	clear	14.8	17.0	12.0	0	0	0	0.09	Left axillary	0	26%	0	14%				
7/17	rain	17.5	17.0	12.0	1165	20	1185	0.32	Left axillary	60	11%	0	9%				1
7/18		19.0	16.0	13.0	87	18	105	0.34	Left axillary	26	12%	0	7%				14
7/19	partly cloudy	19.0	17.0	12.0	74	14	88	0.36	Left axillary	50	14%	4	10%				36
7/20	overcast	18.5	17.0	13.5	58	3	61	0.37	Left axillary	19	15%	1	11%				11
7/21	overcast	18.0	17.0	15.0	49	0	49	0.38	Left axillary	6	15%	0	11%				1
7/22		17.5	17.0	13.0	6	1	7	0.38	Left axillary	6	15%	1	12%		1		3
7/23	overcast	17.0	17.0	13.0	0	0	0	0.38	Left axillary	0	15%	0	12%				

(continued)

Table 17. (page 2 of 3)

	Weather and Stream Measurements:[a]				Sockeye Counted:				Sockeye Finclipped:									
Date	Weather	Water Level (cm)	Therm-ometer Water Temp (°C)	Air Temp (°C)	Adults	Jacks	Total	Cum. Prop.	Finclip Used (Adipose +)	Adults	Cum. % Adults Clipped	Jacks	Cum. % Jacks Clipped	Coho	Pink	Cutthroat	Dolly Varden
7/24	overcast	16.0	17.0	14.0	10	0	10	0.38	Left axillary	5	15%	0	12%				
7/25	overcast	16.5	17.0	15.0	56	1	57	0.39	Left axillary	10	15%	0	12%				1
7/26		16.0	16.0	12.0	0	0	0	0.39	Left axillary	0	15%	0	12%				
7/27	rain	18.5	17.0	14.0	230	9	239	0.44	Left axillary	70	17%	1	12%		4		7
7/28	rain	19.5	17.0	13.0	141	5	146	0.47	Left axillary	30	17%	1	12%		7		17
7/29	overcast	19.0	18.0	12.0	35	3	38	0.47	Left ventral	18	18%	1	13%		7		
7/30	partly cloudy	19.0	16.0	12.0	55	2	57	0.48	Left ventral	0	17%	0	13%		3		2
7/31		18.5	17.0	10.0	40	1	41	0.49	Left ventral	10	17%	0	12%		5		7
8/1	overcast	18.0	17.0	11.0	52	7	59	0.50	Left ventral	20	18%	2	13%		10	1	12
8/2	overcast	17.5	17.0	14.0	42	5	47	0.51	Left ventral	20	18%	0	13%		8		9
8/3	rain	17.5	16.5	12.0	49	1	50	0.52	Left ventral	10	18%	0	13%				
8/4	rain	17.0	17.0	13.0	92	2	94	0.54	Left ventral	7	18%	0	13%		4		
8/5	rain	17.0	17.0	14.0	5	0	5	0.54	Left ventral	0	18%	0	13%				
8/6	overcast	19.8	17.5	14.0	94	3	97	0.56	Left ventral	14	18%	3	15%		9		3
8/7	partly cloudy	19.5	17.0	13.0	67	3	70	0.57	Left ventral	20	18%	3	16%		9		13
8/8	overcast	19.0	17.0	14.0	81	3	84	0.59	Left ventral	30	19%	3	18%		7		4
8/9	clear	18.8	17.5	14.0	74	4	78	0.60	Left ventral	38	19%	3	20%		3		9
8/10	clear	18.5	18.0	14.0	33	8	41	0.61	Left ventral	20	20%	8	24%		3		
8/11	clear	18.0	21.0	20.0	30	3	33	0.62	Left ventral	0	20%	0	24%		2		3
8/12	clear	17.5	21.0	14.0	23	2	25	0.62	Left ventral	0	20%	0	23%				2
8/13	clear	18.0	19.0	14.0	11	2	13	0.63	Left ventral	0	19%	0	23%		1	1	2
8/14	clear	16.8	20.5	20.0	40	3	43	0.63	Dorsal	0	19%	0	23%		1		
8/15	clear	16.5	19.0	14.0	40	2	42	0.64	Dorsal	0	19%	0	22%		3	1	
8/16	overcast	16.0	18.0	13.0	60	1	61	0.65	Dorsal	10	19%	0	22%				
8/17					trap closed		0	0.65	Dorsal		19%		22%				
8/18					trap closed		0	0.65	Dorsal		19%		22%				
8/19	overcast	18.0	18.0	15.0	55	2	57	0.66	Dorsal	0	19%	0	22%		3		
8/20	showers	18.0	18.0	14.0	65	0	65	0.68	Dorsal	12	19%	0	22%		5		1
8/21	partly cloudy	17.5	17.5	12.5	65	0	65	0.69	Dorsal	29	19%	0	22%		5	1	1
8/22	partly cloudy	19.5	18.0	14.0	131	2	133	0.71	Dorsal	25	19%	0	22%		5		
8/23	partly cloudy	20.5	17.5	12.0	113	11	124	0.74	Dorsal	48	20%	3	22%	3	5		
8/24	overcast	19.5	17.0	12.0	28	1	29	0.74	Dorsal	4	20%	0	22%	0	2		
8/25					trap closed		0	0.74	Dorsal		20%		22%	0			

(continued)

Table 17. (page 3 of 3)

	Weather and Stream Measurements:[a]				Sockeye Counted:				Sockeye Finclipped:								
Date	Weather	Water Level (cm)	Therm-ometer Water Temp (°C)	Air Temp (°C)	Adults	Jacks	Total	Cum. Prop.	Finclip Used (Adipose +)	Adults	Cum. % Adults Clipped	Jacks	Cum. % Jacks Clipped	Coho	Pink	Cutthroat	Dolly Varden
8/26	overcast	19.0	18.0	12.0	50	2	52	0.75	Dorsal	30	20%	2	23%	1	1		
8/27	partly cloudy	19.0	18.0	13.0	50	0	50	0.76	Dorsal	20	21%	0	23%	2	2		
8/28	clear	19.5	18.0	14.0	85	8	93	0.78	Dorsal	33	21%	3	23%	4	1		1
8/29	overcast	19.5	16.5	12.0	60	1	61	0.79	Dorsal	23	21%	1	24%	5			
8/30	overcast	20.0	16.0	10.0	47	0	47	0.80	Dorsal	10	21%	0	24%	4	3		
8/31	rain	23.0	16.0	12.0	113	7	120	0.83	Dorsal	72	22%	7	27%	0	1		
9/1	rain	19.0	16.0	13.0	55	1	56	0.84	Dorsal	8	22%	1	27%	4	1		
9/2	rain	21.5	15.0	12.0	27	4	31	0.84	Dorsal	4	22%	0	26%	3	3		
9/3	overcast	25.0	15.5	10.0	35	1	36	0.85	Dorsal	8	22%	0	26%	6	2		1
9/4	rain	24.5	15.0	9.5	30	3	33	0.86	Dorsal	10	22%	0	26%	9	3	1	
9/5	rain	24.0	15.5	12.0	39	0	39	0.86	Dorsal	6	22%	0	26%	0	2		2
9/6	rain	25.5	15.0	11.0	89	2	91	0.88	Dorsal	20	22%	0	26%	40	7	2	7
9/7	rain	31.0	15.0	12.0	109	2	111	0.90	Dorsal	28	22%	2	26%	21	3	1	23
9/8					trap closed		0	0.90	Dorsal		22%		26%	0			
9/9					trap closed		0	0.90	Dorsal		22%		26%	0			
9/10		32.0	15.0	13.0	190	7	197	0.94	Dorsal	40	22%	4	27%	23	4		10
9/11	showers	33.0	15.5	12.0	45	1	46	0.95	Dorsal	7	22%	0	27%	9	3		13
9/12	rain	31.0	15.0	11.0	17	5	22	0.95	Dorsal	4	22%	2	27%	3	2		7
9/13		31.0	15.0	12.0	46	1	47	0.96	Dorsal	8	22%	0	27%	8	1		5
9/14		30.0	14.0	12.0	17	0	17	0.96	Dorsal	1	22%	0	27%	18	4		8
9/15					trap closed		0	0.96	Dorsal		22%		27%	0			
9/16					trap closed		0	0.96	Dorsal		22%		27%	0			
9/17		37.0	13.0	10.0	19	2	21	0.97	Dorsal	3	22%	1	28%	2	0		5
9/18					32	3	35	0.98	Dorsal		22%		27%	6	1		3
9/19	rain	31.0	14.0	12.0	12	0	12	0.98	Dorsal	1	22%	0	27%	7	0		6
9/20	rain	27.0	12.0	10.0	8	4	12	0.98	Dorsal	0	22%	0	27%	23	0		10
9/21	rain	30.0	13.0	10.0	11	2	13	0.98	Dorsal	0	22%	2	27%	29	1		19
9/22	rain	45.0	13.0	12.0	34	0	34	0.99	Dorsal	5	22%	0	27%	13	0		17
9/23	rain	43.0	13.0	10.0	28	4	32	1.00	Dorsal	4	22%	2	28%	12	1		15
9/24	rain	43.0	12.5	9.0	11	1	12	1.00	Dorsal	1	22%	0	28%	32	0		43
9/25	rain	42.0	15.0	12.0	10	3	13	1.00	Dorsal	2	22%	1	28%	14	0		22
9/26																	
Totals					4,970	242	5,212			1,081		67		301	158	8	390

[a] Observations were made about 0900.

Visual Survey Counts: In 2005, regular surveys were not done to count sockeye salmon in the outlet (Neva Creek), inlet, or lake beyond those reported above in the "Weir and Weir-based Mark-Recapture Estimate of Total Escapement" section.

Age, Sex, and Length Composition: In 2005, over 1,200 sockeye salmon were sampled for age, sex, and length through the course of weir operation. This sample size exceeded the study plan for a seasonal total of 600 fish sampled with weekly sampling goals based on the historical weekly proportion of the 2002 to 2004 escapement. For this analysis we report on an escapement-weighted subset of 600 of the fish sampled.

In 2005, based on a sample of 444 fish with ageable scales, and percentages weighted by the weekly escapement, we found that 86% of the sockeye escapement were "one check", age-1., fish. The main age classes were age-1.2 (43%), age-1.3 (40%), and age-2.2 (11%; Table 18). The sex composition was 40% males.

Table 18. Age composition of sockeye salmon in the Neva Lake escapement, 2005.

	Brood Year and Age Class						
	2002	2001	2001	2000	2000	1999	
	1.1	1.2	2.1	1.3	2.2	2.3	Total
Percentages are weighted by the weekly weir counts							
Male							
Sample Size	12	89	8	87	8	1	205
Percent	3.3	15.8	1.6	16.1	3.2	0.4	40.4
Std. Error	1.3	2.0	0.6	2.1	1.6	0.4	3.1
Escapement	174	831	86	845	167	23	2,127
Female							
Sample Size		124		102	12	1	239
Percent		26.9		23.8	7.7	1.2	59.6
Std. Error		2.8		2.6	2.3	1.2	3.1
Escapement		1,413		1,254	406	63	3,136
All Fish							
Sample Size	12	213	8	189	20	2	444
Percent	3.3	42.7	1.6	39.9	10.9	1.6	100.0
Std. Error	1.3	3.1	0.6	3.0	2.5	1.3	
Escapement	174	2,245	86	2,099	573	86	5,263

The average mid-eye-to-fork length was 358 mm for the age-1.1 jacks, 499 mm for the age-1.2 fish, and 557 mm for the age-1.3 fish (Table 19).

Table 19. Length composition (mm) of sockeye salmon in the Neva Lake escapement, 2005.

		Brood Year and Age Class						
		2002	2001	2001	2000	2000	1999	
		1.1	1.2	2.1	1.3	2.2	2.3	Total
Combined Periods (Lengths weighted by period escapements)								
Male	Avg. Length	358	500	395	564	525	565	503
	Std. Error	4.9	3.7	8.3	3.1	15.5		4.4
	Sample Size	12	89	8	87	8	1	205
Female	Avg. Length		499		550	519	565	522
	Std. Error		2.7		2.5	7.7		2.5
	Sample Size		124		102	12	1	239
All Fish	Avg. Length	358	499	395	557	521	565	520
	Std. Error	4.9	2.2	8.3	2.0	7.5	<0.1	2.4
	Sample Size	12	213	8	189	20	2	444

Age-1. fish dominated the escapement all four years (Table 20). The relatively high proportion of one-ocean fish in 2002 and 2003 contributed to the higher proportions of two-ocean fish and three-ocean fish in subsequent years.

Table 20. Age composition of the sockeye salmon escapement into Neva Lake, 2002 through 2005.

		Age								
Year	Sample Size	0.1	1.1	1.2	2.1	1.3	2.2	1.4	2.3	Total
2002	606	0%	22%	45%	0%	28%	4%	0%	0%	100%
2003	1,054		20%	71%	2%	5%	2%		1%	100%
2004	480		10%	70%	0%	16%	4%			100%
2005	444		3%	43%	2%	40%	11%		2%	100%

Harvest Monitoring: In 2005, as in 2002, 2003, and 2004, the weir operator monitored subsistence effort and harvest in the Neva Creek and South Creek area by meeting with fishers he observed in the area on his multiple daily trips between Excursion Inlet and the weir site. He documented a subsistence harvest of at least 590 sockeye salmon in 2005 (Table 21). The reported harvest on State subsistence/personal use permits was 276 sockeye salmon in 2005 (Table 22). A harvest of 34 sockeye salmon was also reported on Federal subsistence fishing permits in 2005. This was the first reported harvests on Federal permits.

Table 21. Observed subsistence effort and harvest of salmon in the Neva Creek/South Creek area, July 3 to August 13, 2005.

Date	Hour	No. in Party	Location Fished (Saltwater, Intertidal, South Creek, Neva Creek)	Gear (BS=beach seine, GN=gillnet, S=spear, G=gaff, D=dipnet, R=rod&reel)	Units of Gear	Hours Fished per Units of Gear	Total Hours Fished (gear x hrs)	Sockeye Harvest	Coho Harvest	Chum Harvest	Pink Harvest
7/3	10:00	2	Intertidal	GN	1	2	2	30	0	0	0
7/7	11:50	2	Intertidal	BS	1	2	2	80	0	0	0
7/11	14:00	2	Intertidal	Cast Net	2	2	4	30	0	0	0
7/16	10:00	3	Intertidal	GN	1	?		120	0	0	0
7/17	13:00	2	Intertidal	GN	1	2	2	30	0	0	0
7/22	10:00	2	Intertidal	GN	1	2	2	30	0	0	0
7/23	13:00	2	Intertidal	GN	1	2	2	80	0	0	0
7/29	15:00	2	Intertidal	BS	1	2	2	80	0	0	0
8/5	10:00	2	Neva Creek	G	2	0.5	1	11	0	0	0
8/5	11:00	2	Neva Creek	G	2	0.3	0.6	21	0	0	0
8/5	13:00	3	Intertidal	BS	1	3	3	40	0	0	0
8/9	15:00	2	Neva Creek	G	1	2	2	6	0	0	0
8/10	16:30	2	Neva Creek	D	2	0.5	1	10	0	0	0
8/13	13:00	3	Intertidal	BS	1	3	3	22	0	0	0
Total					18	23.3	26.6	590	0	0	0

Table 22. Observed and reported subsistence harvest of sockeye salmon in the Neva Creek and South Creek area, 2002 to 2005.

Year	Observed During Onsite Harvest Monitoring	Reported on State Subsistence and Personal Use Permits	Reported on Federal Subsistence Permits
2002	44	36	0
2003	278	87	0
2004	312	397	0
2005	590	276	34

Pavlof 2004

Trap-to-Spawning Ground Mark-Recapture Estimate of Total Escapement: The trap was operated at the top of the fishpass at the outlet of Pavlof Lake from June 23 to August 22, 2004. All the salmon, trout, and char that ascended the fish pass on these dates were counted. Counts totaled 234 sockeye, 867 coho, 799 pink, and 42 chum salmon (Table 23). Eight hundred and fifty five Dolly Varden char and 23 cutthroat trout were also counted. Jacks comprised 9% (21) of the 234 sockeye salmon passed through the trap. There were no sockeye salmon that died in the trap in 2004.

Table 23. Daily counts of upstream migrating salmon, Dolly Varden char, and cutthroat trout passed through the trap at the top of Pavlof Lake's outlet fishpass, 2004.

Date[a]	Weather (at ~0800hr)	Water Level (inches)	Water Temp. (˚C)	Air Temp. (˚C)	Daily Sockeye Adults	Daily Sockeye Jacks	Total Sockeye	Cum. Sockeye	Cum. Percent Sockeye	Daily Coho Adults	Daily Coho Jacks	Daily Coho	Daily Pink	Daily Chum	Daily Dolly Varden	Daily Cutthroat
Jun-23	clear	8.5	17	17	0	0	0	0	0%	0	0	0	0	0	0	0
Jun-24	clear	8.5	17	17	0	0	0	0	0%	0	0	0	0	0	0	0
Jun-25	clear	8.5	17.5	18	0	0	0	0	0%	0	0	0	0	0	5	0
Jun-26	overcast	8.5	18		11	0	11	11	5%	0	0	0	0	0	35	0
Jun-27	showers	10.0	17		3	0	3	14	6%	0	0	0	0	0	64	0
Jun-28	overcast	10.5	17	17	2	0	2	16	7%	0	0	0	0	0	73	2
Jun-29	overcast	10.5	17	15	0	0	0	16	7%	0	0	0	0	0	72	0
Jun-30	overcast	10.5	17	18	1	0	1	17	7%	0	0	0	0	0	17	0
Jul-01	overcast	7.5	15	16	0	0	0	17	7%	0	0	0	0	0	35	0
Jul-02	rain	6.5	17	18	0	0	0	17	7%	0	0	0	0	0	66	2
Jul-03	overcast	6.5	15	16	9	0	9	26	11%	0	0	0	0	0	79	0
Jul-04	overcast	6.5	15	15	29	0	29	55	24%	0	0	0	0	0	65	0
Jul-05	overcast	6.0	15	13	7	0	7	62	26%	0	0	0	0	0	108	0
Jul-06	overcast	7.0	15	16	9	0	9	71	30%	0	0	0	0	0	66	3
Jul-07	partly cloudy	8.0	15	22	3	0	3	74	32%	0	0	0	0	0	29	0
Jul-08	clear	7.0	17	26	5	0	5	79	34%	0	0	0	0	0	35	0
Jul-09	overcast	6.5	15	18	1	0	1	80	34%	0	0	0	0	0	2	0
Jul-10	showers	6.5	15	16	25	5	30	110	47%	1	0	0	0	0	15	0
Jul-11	overcast	6.0	15	16	1	0	1	111	47%	0	0	0	0	0	3	0
Jul-12	clear	5.5	15	19	4	0	4	115	49%	0	0	0	0	0	0	0
Jul-13	clear	5.5	15	21.4	11	1	12	127	54%	2	0	0	0	0	2	0
Jul-14	partly cloudy	5.0	17	21.5	35	5	40	167	71%	2	2	0	0	0	26	2
Jul-15	clear	5.0	16	22.2	0	1	1	168	72%	0	0	0	0	0	3	1
Jul-16	clear	5.5	18.5	21.7	15	7	22	190	81%	0	0	0	0	0	5	1
Jul-17	partly cloudy	4.5	18	14	7	0	7	197	84%	1	0	0	0	0	5	1
Jul-18	partly cloudy	5.0	17	22.5	0	0	0	197	84%	1	0	0	0	0	4	1
Jul-19	clear	4.5	18	22	0	0	0	197	84%	1	0	0	0	0	14	0
Jul-20	showers	4.0	17	16	0	0	0	197	84%	0	0	0	0	0	1	0
Jul-21	overcast	5.5	17	15	3	0	3	200	85%	0	0	0	0	0	0	0
Jul-22	partly cloudy	5.5	17	15	1	0	1	201	86%	0	0	0	0	0	0	0
Jul-23	partly cloudy	4.5	18	24.3	4	0	4	205	88%	0	0	0	0	1	0	0
Jul-24	rain	5.0	17	20.6	0	0	0	205	88%	0	0	0	0	1	3	0
Jul-25	partly cloudy	5.5	17	18.9	1	0	1	206	88%	10	2	0	1	0	0	0
Jul-26	overcast	5.0	17	15.9	0	0	0	206	88%	6	0	0	0	0	1	0
Jul-27	partly cloudy	5.0	16	18.2	0	0	0	206	88%	0	0	0	0	1	0	0
Jul-28	overcast	6.0	16		15	1	16	222	95%	114	9	0	8	6	8	1
Jul-29	showers	8.5	15		4	0	4	226	97%	31	1	0	80	14	1	0
Jul-30	overcast	7.0	15	12	0	0	0	226	97%	41	0	0	94	5	1	2
Jul-31	clear		14.5	15	0	0	0	226	97%	28	0	0	36	0	2	1
Aug-01	showers		14.5	13.5	0	0	0	226	97%	15	2	0	54	0	1	2
Aug-02	overcast		14	13	1	0	1	227	97%	20	3	0	26	1	0	1
Aug-03	overcast		15	13	0	0	0	227	97%	32	5	0	23	2	0	0
Aug-04	partly cloudy		14.5	17	1	0	1	228	97%	50	1	0	30	0	1	0
Aug-05	partly cloudy		15	17	1	0	1	229	98%	59	5	0	16	0	1	1
Aug-06	overcast	5.0	15	14	0	0	0	229	98%	25	0	0	6	0	1	0
Aug-07	overcast	5.0	15	13	2	1	3	232	99%	26	0	0	43	1	1	0
Aug-08	clear	4.5	16	20	0	0	0	232	99%	1	0	0	5	0	0	0
Aug-09	clear	4.0	17	19	0	0	0	232	99%	36	1	0	12	2	1	0
Aug-10	partly cloudy	4.0	17	22	0	0	0	232	99%	42	0	0	31	5	2	2
Aug-11	partly cloudy	3.5	17	18	0	0	0	232	99%	57	2	0	32	3	1	0
Aug-12	overcast	4.0	16.5	14	0	0	0	232	99%	24	1	0	33	0	1	0
Aug-13	partly cloudy	4.0	17		1	0	1	233	100%	44	4	0	61	0	0	0
Aug-14	clear	4.0	18	17	1	0	1	234	100%	29	1	0	51	0	0	0
Aug-15	partly cloudy	4.0	17.5	20	0	0	0	234	100%	22	1	0	29	0	0	0
Aug-16	clear	3.5	17	18	0	0	0	234	100%	25	0	0	26	0	0	0
Aug-17	partly cloudy	4.0	18.5	22	0	0	0	234	100%	16	0	0	24	0	0	0
Aug-18	clear	3.0	17	18	0	0	0	234	100%	11	1	0	22	0	0	0
Aug-19	showers	3.0	18	18.5	0	0	0	234	100%	4	1	0	15	0	0	0
Aug-20	partly cloudy	4.0	18	18.5	0	0	0	234	100%	8	1	0	0	0	0	0
Aug-21	clear	3.0	18	18	0	0	0	234	100%	26	0	0	26	0	0	0
Aug-22	clear	3.5	17	18	0	0	0	234	100%	11	3	0	15	0	0	0
Total					213	21	234			821	46	0	799	42	855	23

[a] The trap was operated continuously from 1900hr on June 23 to 0900hr on August 22.

In 2004, the first sockeye salmon passed on June 26 and the last on August 14. The midpoint of the sockeye run was on July 13 and half of the sockeye escaped between July 3 and 15. The timing of the 2004 run was later than in 2003 and 2002 (Figure 14).

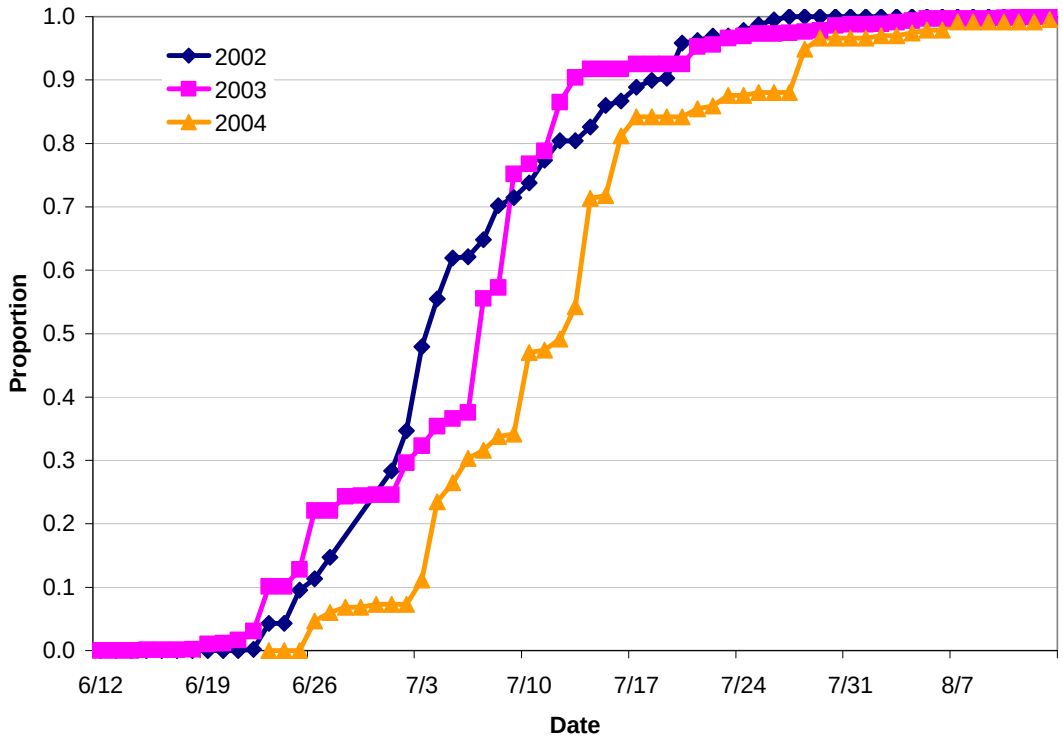


Figure 14. Cumulative proportion of sockeye salmon counted through the Pavlof outlet fishpass, 2002, 2003, and 2004.

All (100%) of the sockeye passed upstream of the trap were marked with an adipose finclip clip as part of the trap to spawning ground mark-recapture study. Two marked fish were recaptured in the trap and re-released – these fish had dropped back over the falls and re-ascended the fish pass.

Between July 21 and August 12, five mark-recapture trips were made to the main inlet stream "study area" (Table 24). The study area includes the fish schooled off the mouth of the main inlet stream as well as those in the stream. All the sockeye sampled and marked on the July 21-22 and July 25-26 dates were caught in a beach seine fished at the mouth of the main inlet stream. One hundred and sixty-six (33%) of the 508 sockeye examined on these trips had adipose fin clip yielding a simple Peterson escapement estimate of 715 (CV 3%) sockeye salmon into Pavlof Lake (Table 24). Thus, thirty percent (213 of 715) of the sockeye salmon used the fish pass to migrate into the lake in 2004.

Table 24. Mark-recapture estimate of the escapement of adult and jack sockeye salmon in Pavlof Lake, 2004.

Marking Data - from Trap on Outlet Fishpass:			
Release Period	Trap Count	Total Marked	
Total	234	234	
Recapture Data - from MIS Index Area:			
Date	Number Examined	Number with Marks	Percent Marked
7/21	173	45	26%
7/22	31	11	35%
7/25	96	20	21%
7/26	73	16	22%
7/29	69	37	54%
7/30	42	20	48%
8/6	9	8	89%
8/7	5	3	60%
8/11	6	4	67%
8/12	4	2	50%
Total	508	166	33%
Peterson Estimate[a]:			
Number	S.E.	CV	
715	24	3%	

[a] Chapman's modification (Seber 1982):

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1 \qquad \mathrm{var}(\hat{N}) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

Stream Mark-Recapture for Indexing Escapement: In 2004, project personnel completed the five, two-day, mark recapture trips to the study area in the main inlet stream described above. The modified Jolly-Seber estimate of sockeye spawning in the main inlet stream study area was 701 (Table 25). Standard errors could not be calculated since estimates of survival (Φ) were greater than one in trips 2 and 4. I do not know if this is due to errors in our record keeping or methods. Most of these fish were in and off the mouth of the main inlet stream during the first trip on July 21-22. Based on these estimates, 98% (701 of the 715 escapement) spawned in the study area in the lower part of the main inlet stream from late-July to early-August.

Table 25. Mark-recapture index of the abundance of adult and jack sockeye salmon in Pavlof Lake's main inlet stream study area, 2004.

Peterson Estimates for each Trip:

Trip No.	Dates	Number of New Fish Marked on Day 1 (M)	Number of New Fish Marked on Day 2	Number of Recaptures on Day 2 (R)	Total Number Caught on Day 2 (C)	Peterson Estimate for Trip (N*)	SE (N*)	CV (N*)
1	July 21-22	173	31	10	41	663	159.47	24.0%
2	July 25-26	158	63	24	87	415	44.89	10.8%
3	July 29-30	109	139	27	166	655	95.96	14.6%
4	Aug. 6-7	36	27	12	39	113	20.13	17.8%
5	Aug. 11-12	38	27	9	36	143	32.05	22.4%

Modified Jolly-Seber Estimates:

Trip No.	Dates	Marks from Trip 1	Marks from Trip 2	Marks from Trip 3	Marks from Trip 4	n = Total Number Caught this Trip	m = Total Number Recaps. this Trip	Ni = Peterson Est. for this Trip	M = m*N/n	ϕ = M_{t+1} / (M– μ+ν)	B = Ni+1 - fN	B* = B log(f)/ (f-1)
1	July 21-22					204	0	663	0	0.471	246	795
2	July 25-26	38				221	38	559	96	1.363	-106	-91
3	July 29-30	40	104			248	144	655	380	0.178	-3	-7
4	Aug. 6-7	3	17	28		63	48	113	86	1.179	10	9
5	Aug. 11-12	2	7	38	7	65	54	143	119	0.000	0	
											Total = sum(B*) =	707
											SE, CV =	[a]

[a]No standard error estimates could be calculated since survival rates in trips 2 and 4 were greater than one.

Foot/Boat Survey Counts: No beach spawning sockeye salmon were observed in the lake. Sockeye salmon were observed milling off the main inlet stream in mid- to late-July. These fish were difficult to see and no counts were attempted. Formal foot survey counts were conducted in the main inlet stream on July 19, 21, 30, August 6, 11, 12, and 19 (Table 26). The highest count of sockeye salmon in the MIS study area was 171 sockeye salmon (averaged across three observers) on July 30. This peak survey count was 24% of the 715 fish escapement. The sockeye salmon appeared to have moved from the lake to the main inlet stream on July 28 or 29. The run was essentially over on August 19.

Table 26. Foot survey counts of sockeye salmon in the main inlet stream study area, Pavlof Lake, 2004.

Date	Observer	Upstream Count	Downstream Count	Average
Jul-19	Jerome Abbott	0	0	0
	Myron Murphy	0	0	0
	Average	0	0	0
Jul-21	Ben Van Alen	2	2	2
	Myron Murphy	2	2	2
	Average	2	2	2
Jul-25		- no counts made/recorded -		
Jul-26		- no counts made/recorded -		
Jul-30	Ben Van Alen	190	184	187
	Bill Dalton, Jr.	128	126	127
	Jerome Abbott	206	192	199
	Average	175	167	171
Aug-06	Jerome Abbott	115	122	119
	Myron Murphy	110	112	111
	Average	113	117	115
Aug-11	Eli Sheakley	93	101	97
	Jerome Abbott	89	96	93
	Average	91	99	95
Aug-12	Ben Van Alen	43	53	48
	Eli Sheakley	62	82	72
	Jerome Abbott	55	68	62
	Kyle Brownlee	50	61	56
	Average	53	66	59
Aug-19	Bill Dalton, Jr.	4	4	4
	Eli Sheakley	3	5	4
	Jerome Abbott	4	4	4
	Myron Murphy	4	4	4
	Average	4	4	4

Age, Sex, and Length Composition: Sixty-three percent of the 82 ageable sockeye salmon sampled at the trap were age-1.3 and 35% were age-1.2 (Table 27). Age-1.3 fish were the dominant age class all three years (Table 28). The average length of the age-1.3 fish was 576 mm (Table 29).

Table 27. Age and sex composition of sockeye salmon sampled from the trap at the top of the outlet fishpass at Pavlof Lake, 2004.

	Brood Year and Age Class			
	2000	1999	1998	
	1.2	1.3	1.4	Total
Male				
Sample Size	7	30	1	38
Percent	9.1	41.6	1.9	52.6
Std. Error	3.5	7.4	1.9	7.6
Female				
Sample Size	20	24		44
Percent	25.8	21.6		47.4
Std. Error	7.2	4.3		7.6
All Fish				
Sample Size	27	54	1	82
Percent	34.9	63.2	1.9	100.0
Std. Error	7.4	7.4	1.9	

Table 28. Age composition of sockeye salmon sampled from the trap at the top of the outlet fishpass at Pavlof Lake, 2002, 2003, and 2004.

		Age						
Year	Sample Size	1.1	1.2	1.3	1.4	2.2	2.3	Total
2002	49		2%	94%		4%		100%
2003	233	0%	5%	92%			3%	100%
2004	82		33%	66%	1%			100%

Table 29. Length composition (mm), by sex, of sockeye salmon sampled from the trap at the top of the outlet fishpass at Pavlof Lake, 2004.

		Brood Year and Age Class			
		2000	1999	1998	
		1.2	1.3	1.4	Total
Combined Periods					
Male	Avg. Length	539	586	565	574
	Std. Error	4.7	4.2		4.6
	Sample Size	7	30	1	38
Female	Avg. Length	507	565		531
	Std. Error	7.7	4.0		6.0
	Sample Size	20	24		44
All Fish	Avg. Length	513	576	565	553
	Std. Error	6.5	3.4		4.5
	Sample Size	27	54	1	82

Hoktaheen 2004

Stream Mark-Recapture for Indexing Escapement: Between September 3 and 23, 2004, five independent, two day, mark-recapture trips were made to the study area in upper Hoktaheen Lake's main inlet stream. Sockeye salmon were caught using seines at the mouth and dipnets in the stream. When summed across all trips, 727 sockeye salmon were marked, 359 were examined for marks, and 144 marked fish were recaptured. The modified Jolly-Seber estimate of the total sockeye abundance in the main inlet stream study area was 565 (CV 4.4%; Table 30). Most of the sockeye salmon that spawned in the main inlet stream were in or off the mouth of the stream in early-September as we observed in 2002 and 2004.

Table 30. Modified Jolly-Seber estimate of the abundance of adult sockeye salmon in upper Hoktaheen Lake's main inlet stream study area, 2004.

Peterson Estimates for each Trip:

Trip No.	Dates	Number of New Fish Marked on Day 1 (M)	Number of New Fish Marked on Day 2	Number of Recaptures on Day 2 (R)	Total Number Caught on Day 2 (C)	Peterson Estimate for Trip (N*)	SE (N*)	CV (N*)
1	Sept. 3-4	202	99	67	166	498	37.68	7.6%
2	Sept. 7-8	149	56	34	90	389	44.65	11.5%
3	Sept. 12-13	106	38	19	57	309	49.42	16.0%
4	Sept. 17-18	47	17	22	39	82	8.02	9.7%
5	Sept. 22-23	8	5	2	7	23	7.75	33.7%

Modified Jolly-Seber Estimates:

Trip No.	Dates	Marks from Trip 1	Marks from Trip 2	Marks from Trip 3	Marks from Trip 4	n = Total Number Caught this Trip	m = Total Number Recaps. this Trip	Ni = Peterson Est. for this Trip	M = m*N/n	$\phi = M_{i+1} / (M-\mu+\nu)$	B = Ni+1 - fN	B* = B log(f)/(f-1)
1	Sept. 3-4					301	0	498	0	0.706	38	461
2	Sept. 7-8	112				205	112	389	213	0.654	55	67
3	Sept. 12-13	32	61			144	93	309	200	0.206	19	38
4	Sept. 17-18	11	4	25		64	40	82	52	0.281	0	0
5	Sept. 22-23	0	3	1	8	13	12	23	21	0.000	0	
											Total = sum(B*) =	565
											SE, CV =	25, 4.4%

Four mark-recapture trips were completed in 2004 in the study area in the upper third of upper Hoktaheen Lake's outlet stream. Between September 14 and 28, 241 were marked, 139 were examined for marks, and 43 were recaptured. The modified Jolly-Seber estimate of sockeye spawning in this outlet stream study area was 251 (CV = 6.8%; Table 31). As in the main inlet stream, there did not appear to be many new fish arriving in the study area after the first mark-recapture trip.

Table 31. Modified Jolly-Seber estimate of the abundance of adult sockeye salmon in upper Hoktaheen Lake's outlet stream study area, 2004.

Peterson Estimates for each Trip:

Trip No.	Dates	Number of New Fish Marked on Day 1 (M)	Number of New Fish Marked on Day 2	Number of Recaptures on Day 2 (R)	Total Number Caught on Day 2 (C)	Peterson Estimate for Trip (N*)	SE (N*)	CV (N*)
1	Sept. 14-15	41	48	17	65	153	22.78	14.9%
2	Sept. 18-19	53	25	15	40	137	21.98	16.0%
3	Sept. 23-24	28	14	6	20	86	21.87	25.4%
4	Sept. 27-28	23	9	5	14	59	15.21	25.8%

Modified Jolly-Seber Estimates:

Trip No.	Dates	Marks from Trip 1	Marks from Trip 2	Marks from Trip 3	n = Total Number Caught this Trip	m = Total Number Recaps. this Trip	Ni = Peterson Est. for this Trip	M = m*N/n	$\phi = M_{i+1} / (M-\mu+\nu)$	B = Ni+1 - fN	B* = B log(f)/(f-1)
1	Sept. 14-15				89	0	153	0	0.732	25	160
2	Sept. 18-19	37			78	37	137	65	0.347	38	62
3	Sept. 23-24	6	12		42	18	86	37	0.454	20	29
4	Sept. 27-28	1	1	13	32	15	59	28			
										Total = sum(B*) =	251
										SE, CV =	17, 6.8%

Comparison of Abundance Indices - 2001 to 2004: The Peterson abundance estimate of sockeye salmon in the main inlet stream study area in early September was 498 in 2004 compared to 1,840 in 2003, 737 in 2002, and 660 in 2001 (Table 32). In the outlet stream study area, the abundance index was 137 fish in 2004 compared to 210 in 2003 and 233 in 2002 (Table 33).

Table 32. Abundance index of sockeye salmon in Hoktaheen Lake's main inlet stream from the first two-day mark-recapture trip made in early-September in 2001, 2002, 2003, and 2004.

Year	Date Marked	Number Marked	Date Examined	Number Examined for Marks	Number Recaptured	Peterson Estimate	SE	CV%
2001	9/3	178	9/4	132	35	660	83	13%
2002	9/5	312	9/6	242	102	737	45	6%
2003	9/4	425	9/5	496	114	1840	128	7%
2004	9/3	202	9/4	166	67	498	38	8%

Table 33. Abundance index of sockeye salmon in upper Hoktaheen Lake's outlet stream study area from mid-September two-day mark-recapture trips in 2002, 2003, and 2004.

Year	Date Marked	Number Marked	Date Examined	Number Examined for Marks	Number Recaptured	Peterson Estimate	SE	CV%
2002	9/17	140	9/18	62	37	233	20	9%
2003	9/17	42	9/18	48	9	210	50	24%
2004	9/18	53	9/19	40	15	137	22	16%

Foot/Boat Survey Counts: In 2004, boat and foot surveys were made to count live sockeye adults in the main inlet stream and outlet study areas on days when mark-recapture sampling was done (Table 34). As in 2002 and 2003, we observed adult sockeye spawning only in the upper lake's main inlet stream and outlet. No sockeye salmon were observed in lower Hoktaheen Lake in a boat survey around the lake on September 17, 2004. Thirty three sockeye salmon were observed swimming along the southeast shore of upper Hoktaheen Lake during a boat survey on September 27, 2004, the projects last day in the field. The lake is stained dark from tannin and it is difficult to see salmon if they are more than one or two meters deep. We did not attempt to count the sockeye schooled off the mouth of the main inlet stream since they are difficult to see and swim in and out of view yielding variable and unreliable counts.

Table 34. Boat and foot survey counts of live adult sockeye salmon in the Hoktaheen Lake system, 2004.

	Upper Lake's Main Inlet Stream		Outlet of Upper Lake					
Date	Above Index Area	Index Area	Below Index Area	Index Area	Upper Lake[a]	Lower Lake Total	Hoktaheen Creek Total	Total
9/4	91	214						304
9/7	33	209						242
9/8	25	192						217
9/12	23	141						165
9/13	8	108						116
9/14			7	62				69
9/15			12	75				87
9/17	3	54				0	0	58
9/18		41	5	49	0			95
9/19			9	78				87
9/22	4	19						23
9/23		15	6	46				66
9/24			7	72				79
9/27			7	85	33			124

[a]These fish were all observed along the Southeast shore of the lake.

Consistent with the mark-recapture estimates (Tables 30 and 31), the survey counts were higher in the main inlet stream than in the outlet until late in September (Table 34).

Adult Age, Sex, and Length: Sockeye salmon were sampled for scales (age), sex, and length data both from the main inlet stream (147 ageable scales) and the outlet (95 ageable scales) study areas. In the main inlet stream, age-1. fish comprised 96% of the sample and 53% were age-1.3 (Table 35). In the outlet stream, age-1. fish also comprised 96% of the sample but 55% were age-1.2 (Table 36). The inlet stream sample included only two age-1.1 jacks and few were observed in our mark-recapture sampling.

Table 35. Age and sex composition of sockeye salmon sampled in the main inlet stream to upper Hoktaheen Lake from September 3 to 17, 2004.

	Brood Year and Age Class					
	2001	2000	1999	1999	1998	
	1.1	1.2	1.3	2.2	2.3	Total
Male						
Sample Size	2	33	36		3	74
Percent	2.5	18.1	25.4		1.9	47.9
Std. Error	1.7	4.0	5.2		1.3	5.7
Female						
Sample Size		34	33	2	3	72
Percent		22.0	27.6	0.6	1.9	52.1
Std. Error		5.0	5.5	0.4	1.3	5.7
All Fish						
Sample Size	2	68	69	2	6	147
Percent	2.5	40.3	52.8	0.6	3.7	100.0
Std. Error	1.7	5.7	5.7	0.4	1.8	

Table 36. Age and sex composition of sockeye salmon sampled in the outlet stream of upper Hoktaheen Lake from September 14 to 27, 2004.

	Brood Year and Age Class			
	2000	1999	1998	
	1.2	1.3	2.3	Total
Male				
Sample Size	30	30	1	61
Percent	27.4	24.5	0.5	52.4
Std. Error	6.5	3.9	0.5	6.7
Female				
Sample Size	17	14	3	34
Percent	27.8	17.3	2.4	47.6
Std. Error	7.0	6.1	1.6	6.7
All Fish				
Sample Size	47	44	4	95
Percent	55.3	41.7	3.0	100.0
Std. Error	6.8	6.8	1.7	

About half the fish were age-2. in 2001 and 2002 but age-1. fish dominated the samples from the main inlet stream in 2003 and 2004 (Table 37).

Table 37. Age composition of sockeye salmon sampled in the main inlet stream and outlet of upper Hoktaheen Lake from 2001 to 2004.

		Age					
Year	Sample Size	1.1	1.2	1.3	2.2	2.3	Total
Main Inlet Stream:							
2001	95	4%	19%	29%	18%	29%	100%
2002	218		25%	24%	44%	7%	100%
2003	262	1%	5%	90%	1%	2%	100%
2004	147	1%	46%	47%	1%	4%	100%
Outlet:							
2001			- not sampled-				
2002	213	0%	37%	37%	16%	9%	100%
2003	149		18%	77%	2%	3%	100%
2004	95		49%	46%		4%	100%

The average length of sockeye sampled from the main inlet stream was 525mm and from the outlet stream was 524mm (Tables 38 to 39).

Table 38. Length composition (mm), by sex, of adult sockeye salmon sampled in Hoktaheen Lake's main inlet stream from September 3 to 17, 2004.

		Brood Year and Age Class					
		2001	2000	1999	1999	1998	
		1.1	1.2	1.3	2.2	2.3	Total
Male	Avg. Length	355	489	566		569	531
	Std. Error	15.0	6.1	3.7		7.3	6.4
	Sample Size	2	33	36		3	74
Female	Avg. Length		483	554	498	538	521
	Std. Error		4.1	3.9	22.5	3.3	4.6
	Sample Size		34	33	2	3	72
All Fish	Avg. Length	355	486	559	498	553	525
	Std. Error	15.0	3.5	2.8	22.5	8.6	3.9
	Sample Size	2	68	69	2	6	147

Table 39. Length composition (mm), by sex, of sockeye salmon sampled in the outlet stream of upper Hoktaheen Lake from September 14 to 27, 2004.

		Brood Year and Age Class			
		2000	1999	1998	
		1.2	1.3	2.3	Total
Male	Avg. Length	506	568	550	530
	Std. Error	4.1	3.8		4.6
	Sample Size	30	30	1	61
Female	Avg. Length	482	549	558	513
	Std. Error	4.5	5.8	5.0	6.7
	Sample Size	17	14	3	34
All Fish	Avg. Length	496	558	558	524
	Std. Error	3.6	3.4	3.8	4.0
	Sample Size	47	44	4	95

Limnology 2004

Light, Temperature, and Dissolved Oxygen Profiles

An underwater photometer was used to record the incident light levels in Neva, Pavlof, and Hoktaheen Lakes at 0.5 m intervals from just below the lake surface (depth 0.0) to the depth with about 1% of this subsurface reading (Table 40).

Table 40. Light meter and secchi disk readings at Stations A in Neva, Pavlof, and Hoktaheen Lakes, 2004.

Light Meter Readings (μmol s^{-1} m^{-2}):										
	Neva				Pavlof				Hoktaheen	
Depth (m)	Jun-16	Jul-24	Aug-29	Oct-12	Jun-16	Jul-24	Aug-29	Oct-12	Sep-05	Sep-27
0.0	- meter problems -	-931.9	-304.3	-64.2	-1370.7	-32.6	-161.2	-377.2	-40.9	-23.4
0.5		-750.1	-252.9	-38.4	-1051.2	-2.7	-83.3	-90.8	-11.7	-23.4
1.0		-675.7	-280.8	-30.1	-847.7	-2.0	-73.9	-54.7	-6.0	-13.2
1.5		-558.6	-251.6	-23.3	-655.0	-1.5	-49.5	-21.9	-2.8	-13.0
2.0		-478.3	-231.5	-17.1	-540.7	-1.2	-42.4	-5.0	-2.0	-3.9
2.5		-463.2	-221.0	-14.3	-444.8	-1.0	-29.5	-3.3	-1.2	-0.4
3.0		-488.3	-211.2	-12.9	-352.9	-0.9	-23.3	-3.8	-0.6	
3.5		-489.6	-197.4	-10.3	-294.7	-0.7	-16.8	-3.6	-0.4	
4.0		-440.0	-197.5	-8.1	-228.8	-0.6	-17.9	-2.5	-0.2	
4.5		-361.1	-180.8	-6.4	-182.7	-0.5	-7.0	-1.8	-0.1	
5.0		-279.0	-162.3	-5.4	-151.7	-0.3	-4.6	-1.7	-0.1	
5.5		-227.0	-148.8	-3.0	-129.1	-0.2	-2.2		-0.1	
6.0		-216.6	-138.6	-2.3	-94.8	-0.2	-1.2		-0.1	
6.5		-150.4	-122.7	-1.8	-74.1	-0.1	-0.8		-0.1	
7.0		-116.6	-107.8	-1.7	-52.0				0.0	
7.5		-85.8	-92.8	-1.5					0.0	
8.0		-79.5	-83.1	-1.3					0.0	
8.5		-55.4	-78.4	-1.1						
9.0		-53.5	-64.1	-1.0						
9.5		-51.0	-55.6	-0.8						
10.0		-31.3	-50.2	-0.7						
10.5		-22.5	-47.8	-0.6						
11.0		-17.5	-42.2	-0.6						
11.5		-12.8	-38.5	-0.5						
12.0		-9.8	-35.6	-0.5						
12.5		-7.0	-32.9	-0.5						
13.0		-5.6	-31.1	-0.5						
13.5		-5.5	-29.1	-0.4						
14.0		-3.6								
14.5		-1.8								
15.0		-1.4								
15.5		-1.2								
16.0		-1.1								
16.5		-0.7								
Secchi Disk (averaged depth of disappear/reappear readings in meters):										
	7.8	6.8	7.0	3.9	6.3	3.8	3.3	1.8	2.6	2.5

The mean euphotic zone depths (EZD) were 15.8 m in Neva Lake, 7.1 m in Pavlof Lake, and 4.1 m in Hoktaheen Lake (Table 41). These EZD's were similar to those observed in these lakes in 2002 and 2003.

Table 41. Euphotic zone depths in Neva, Pavlof, and Hoktaheen Lakes, 2004.

Lake	Sample Date	EZD (m)
Neva	Jul-24	10.5
	Aug-29	24.8
	Oct-12	12.3
	Average	15.8
Pavlof	Jun-23	10.4
	Jul-17	7.3
	Aug-18	6.0
	Oct-15	4.6
	Average	7.1
Hoktaheen	Sep-05	5.1
	Sep-27	3.2
	Average	4.1

Vertical temperature stratification was evident in Neva Lake from the first sampling on June 16 to the last sampling on October 12 (Table 42). The epilimnion extended down to about 6 m on the July 24 and August 29 sampling dates. The lowest reading in the hypolimnion was 4.5 °C. The percent O_2 saturation was above 80% at all depths down to 8 m in the June, July, and August trips (Table 36).

Vertical stratification in temperature or dissolved oxygen was evident but less pronounced in the 8 m deep Pavlof Lake (Table 43). The temperature averaged 14.4, 16.4, and 16.3 °C on the June, July, and August trips. The percent O_2 saturation increased from June to August.

Vertical temperature stratification was evident in Hoktaheen Lake in early-September but not in late-September (Table 44). The epilimnion extended down to about 7 m on September 5. The hypolimnion remained below 6 °C in September. Compared to Neva Lake, the percent O_2 saturation was lower near the surface but higher at depths.

Table 42. Temperature and dissolved oxygen profiles for Neva Lake, 2004.

	Temperature (^oC)				Dissolved Oxygen (mg L^{-1})				Percent O_2 Saturation[a]			
Depth (m)	Jun-16	Jul-24	Aug-29	Oct-12	Jun-16	Jul-24	Aug-29	Oct-12	Jun-16	Jul-24	Aug-29	Oct-12
1	14.6	19.5	18.7	10.0	8.4	8.1	8.1	9.6	83%	88%	87%	85%
2	14.5	19.6	18.7	10.0	8.6	7.8	8.0	9.6	84%	85%	86%	85%
3	14.4	19.6	18.7	10.0	8.5	7.5	7.9	9.5	83%	82%	85%	84%
4	13.2	19.2	18.6	10.0	8.9	7.0	7.8	9.0	85%	76%	84%	79%
5	12.7	17.0	18.6	10.0	8.8	11.1	7.6	8.8	83%	115%	82%	78%
6	12.1	15.0	17.6	10.0	9.3	12.2	10.9	8.3	86%	121%	115%	73%
7	9.9	12.3	14.3	10.0	10.3	12.1	10.8	7.8	91%	113%	106%	69%
8	8.0	10.3	11.5	9.8	10.3	11.1	9.7	7.1	87%	99%	89%	62%
9	6.9	8.7	9.7	9.6	8.9	8.8	8.4	6.3	73%	76%	74%	55%
10	6.2	7.4	8.3	9.4	8.1	6.5	7.7	5.3	65%	54%	66%	46%
11	5.6	6.5	7.3	8.7	7.2	7.5	6.6	4.0	57%	61%	55%	34%
12	5.3	6.0	6.7	7.5	6.3	6.0	4.9	2.8	49%	48%	40%	23%
13	4.9	5.7	6.3	6.9	4.2	3.2	2.6	1.8	33%	25%	21%	15%
14	4.8	5.3	6.0	6.4	3.3	-0.1	1.3	0.1	25%	-1%	11%	1%
15	4.7	5.1	5.6	5.9	2.5	-2.4	-1.1	-0.9	19%	-19%	-9%	-7%
16	4.6		5.3	5.7	1.2		-1.8	-0.9	9%		-14%	-7%
17	4.5		5.3	5.7	-0.2		-2.1	-0.9	-1%		-16%	-7%

[a] $\%O_2$ saturation = (dissolved oxygen) / (0.005399 * temperature^2 - 0.381784 * temperature + 14.571252)

Table 43. Temperature and dissolved oxygen profiles for Pavlof Lake, 2004.

	Temperature (^oC)			Dissolved Oxygen (mg L^{-1})			Percent O_2 Saturation[a]		
Depth (m)	Jun-23	Jul-17	Aug-18	Jun-23	Jul-17	Aug-18	Jun-23	Jul-17	Aug-18
1	16.9	19.4	18.7	7.5	7.8	9.3	78%	85%	100%
2	16.0	18.2	17.5	7.3	6.5	9.0	74%	69%	94%
3	15.3	17.2	16.1	6.9	5.7	6.1	69%	59%	62%
4	14.8	15.8	16.1	5.5	5.1	6.1	55%	52%	62%
5	12.0	14.3	15.2	5.0	2.8	4.5	46%	28%	45%
6	11.2	13.5	13.9	4.2	-1.1	0.1	38%	-10%	1%
7	10.9			3.5			32%		

[a] $\%O_2$ saturation = (dissolved oxygen) / (0.005399 * temperature^2 - 0.381784 * temperature + 14.571252)

Table 44. Temperature and dissolved oxygen profiles for Hoktaheen Lake, 2004.

	Temperature (^oC)		Dissolved Oxygen (mg L^{-1})		Percent O_2 Saturation[a]	
Depth (m)	Sep-05	Sep-27	Sep-05	Sep-27	Sep-05	Sep-27
1	14.5	9.7	8.1	9.3	80%	82%
2	14.4	9.7	8.0	9.1	79%	80%
3	14.4	9.7	8.1	8.9	80%	78%
4	13.7	9.7	8.0	8.9	77%	78%
5	12.2	9.7	8.0	8.7	75%	76%
6	9.4	9.6	8.7	8.4	76%	74%
7	8.1	9.5	9.1	8.2	77%	72%
8	6.9	9.2	9.7	8.0	80%	70%
9	5.9	8.9	10.1	7.6	81%	65%
10	5.5	8.6	10.2	7.2	81%	62%
11	5.2	8.1	10.4	6.9	82%	59%
12	4.9	7.1	10.7	6.9	84%	56%
13	4.7	6.3	10.9	6.7	85%	54%
14	4.6	5.8	10.7	6.6	83%	53%
15	4.6	5.4	10.6	6.5	82%	51%
16	4.5	5.0	10.5	6.4	81%	50%
17	4.5	4.7	10.4	6.4	80%	49%
18	4.5	4.6	10.4	6.1	80%	47%
19	4.5	4.6	10.3	5.9	80%	45%
20	4.4	4.5	10.3	5.5	79%	42%
25	4.4	4.5	6.8	3.8	52%	30%
30	4.5	4.5	3.1	2.5	24%	19%
35	4.5	4.6	1.7	1.5	13%	11%
40	4.5	4.6	1.6	0.9	12%	7%
45	4.5	4.6	1.2	0.6	9%	4%
50	4.6	4.6	0.1	0.3	1%	2%

[a] $\%O_2$ saturation = (dissolved oxygen) / (0.005399 * temperature^2 - 0.381784 * temperature + 14.571252)

Secondary Production

The seasonal mean density (number m-2) of macro zooplankton from vertical tows at Stations A and B in Neva, Pavlof, and Hoktaheen Lakes was 311,311, 16,022, and 153,698 (Tables 45, 46, and 47). The weighted biomass (mg m-2) was 582, 13, and 463, respectively (Tables 45, 46, and 47). The samples were dominated by Daphnia in Neva Lake, Bosmina in Pavlof Lake, and Cyclops in Hoktaheen Lake. The density and biomass of zooplankton in Pavlof Lake was extremely low but the lake is only 7.5 m deep.

Table 45. Density, size, and biomass of zooplankton in Neva Lake, June to October, 2004.

Taxa	Macrozooplankton Density (no./m^2), by date 6/16	7/24	8/29	10/12	Seasonal Mean	%	Weighted Mean Wet Length (mm)	Weighted Biomass (mg/m^2)	%
Station A:									
Ergasilis									
Epischura									
Ovig. *Epischura*									
Diaptomus									
Ovig *Diaptomus*									
Cyclops	184,921	35,660	7,641	84,055	78,069	26%	0.84	193.37	32%
Ovig. *Cyclops*	14,264	4,160	509	509	4,861	2%	1.10	21.48	4%
Harpaticus									
Nauplii	3,057	4,755	3,566	1,528	3,227	1%			
Bosmina	108,507	12,481	12,736	16,811	37,634	13%	0.40	55.37	9%
Ovig. *Bosmina*	1,019	0	0	5,094	1,528	1%	0.52	3.87	1%
Daphnia l.	116,149	79,640	152,827	225,166	143,446	48%	0.73	331.32	54%
Ovig. *Daphnia l.*	2,038	594	509	2,547	1,422	0%	0.94	5.74	1%
Daphnia r.	509	0	509	0	255	0%	1.05	1.03	0%
Holopedium									
Ovig. *Holopedium*									
Chydorinae									
Polyphemus									
Immature Cladocera	40,754	17,236	32,094	29,037	29,780	10%			
Totals					300,221			612.18	
Tow Depth (m)	16.0	15.0	16.0	16.0					
Station B:									
Ergasilis									
Epischura									
Ovig. *Epischura*									
Diaptomus									
Ovig *Diaptomus*									
Cyclops	259,722	67,159	13,075	87,961	106,979	36%	0.83	259.71	42%
Ovig. *Cyclops*	20,801	11,887	0	0	8,172	3%	1.06	33.27	5%
Harpaticus									
Nauplii	5,943	9,509	7,132	2,377	6,240	2%			
Bosmina	115,894	28,528	70,131	20,801	58,839	20%	0.39	83.75	14%
Ovig. *Bosmina*	1,783	594	0	7,132	2,377	1%	0.47	4.94	1%
Daphnia l.	120,054	131,347	255,561	273,391	195,088	65%	0.76	493.39	81%
Ovig. *Daphnia l.*	1,783	0	1,189	0	743	0%	1.05	3.00	0%
Daphnia r.	594	0	0	0	149	0%			0%
Holopedium									
Ovig. *Holopedium*									
Chydorinae	0	0	594	0	149		0.32	0.14	
Polyphemus									
Immature Cladocera	36,848	33,282	61,810	61,810	48,438	16%			
Totals					427,173			878.20	
Tow Depth (m)	16.0	15.5	16.0	16.0					
Average of Stations A and B					363,697			745.19	

Table 46. Density, size, and biomass of zooplankton in Pavlof Lake, June to October, 2004.

	Macrozooplankton Density (no./m^2), by date								
Taxa	6/23	7/17	8/18	10/15	Seasonal Mean	%	Weighted Mean Wet Length (mm)	Weighted Biomass (mg/m^2)	%
Station A:									
Ergasilis									
Epischura									
Ovig. *Epischura*									
Diaptomus									
Ovig *Diaptomus*									
Cyclops	2,717	1,494	7,429	34	2,919	2%	0.49	2.32	3%
Ovig. *Cyclops*									
Harpaticus	34	0	0	0	9	0%	0.70	0.01	0%
Nauplii	306	2,140	9,212	0	2,915	2%			
Bosmina	883	6,079	380,073	102	96,784	80%	0.31	83.31	93%
Ovig. *Bosmina*	0	0	11,292	0	2,823	2%	0.36	3.34	4%
Daphnia l.	0	0	1,189	170	340	0%	0.73	0.79	1%
Ovig. *Daphnia l.*									
Daphnia r.									
Holopedium									
Ovig. *Holopedium*									
Chydorinae	0	0	1,189	0	297	0%	0.31	0.26	0%
Polyphemus									
Immature Cladocera	0	238	58,244	0	14,621	12%			
Totals					120,706			90.02	
Tow Depth (m)	5.5	5.0	6.5	5.0					
Station B:									
Ergasilis									
Epischura									
Ovig. *Epischura*									
Diaptomus	0	0	0	85	21		0.72	0.04	0%
Ovig *Diaptomus*									
Cyclops	10,953	764	2,717	0	3,609	3%	0.48	2.73	8%
Ovig. *Cyclops*						0%			
Harpaticus	0	0	340	0	85		0.47	0.06	0%
Nauplii	934	594	1,019	0	637	1%			
Bosmina	14,264	29,716	104,262	85	37,082	31%	0.31	31.73	88%
Ovig. *Bosmina*	85	679	3,057	0	955	1%	0.37	1.19	3%
Daphnia l.	0	0	0	340	85	0%	0.60	0.13	0%
Ovig. *Daphnia l.*						0%			
Daphnia r.						0%			
Holopedium									
Ovig. *Holopedium*									
Chydorinae	255	255	0	0	128		0.28	0.09	0%
Polyphemus									
Immature Cladocera	6,792	1,274	5,094	85	3,311	3%			
Totals					45,912			35.96	
Tow Depth (m)	3.5	2.3	3.5	5.0					
Average of Stations A and B					83,309			62.99	

Table 47. Density, size, and biomass of zooplankton in Hoktaheen Lake, September 2004.

Taxa	Macrozooplankton Density (no./m^2), by date 9/5	9/27	Sept. Mean	%	Weighted Mean Wet Length (mm)	Weighted Biomass (mg/m^2)	%
Station A:							
Ergasilis							
Epischura							
Ovig. *Epischura*							
Diaptomus							
Ovig *Diaptomus*							
Cyclops	356,597	412,464	384,531	80%	0.76	777.94	82%
Ovig. *Cyclops*	4,160	2,972	3,566	1%	1.22	19.56	2%
Harpaticus							
Nauplii	3,566	13,075	8,321	2%			
Bosmina	41,603	90,338	65,971	14%	0.47	134.87	14%
Ovig. *Bosmina*	1,189	7,132	4,161	1%	0.58	13.45	1%
Daphnia l.							
Ovig. *Daphnia l.*							
Daphnia r.							
Holopedium							
Ovig. *Holopedium*							
Chydorinae							
Polyphemus							
Immature Cladocera	13,670	11,887	12,779	3%			
Totals			479,327			945.81	
Tow Depth (m)	48.0	48.0					
Station B:							
Ergasilis							
Epischura							
Ovig. *Epischura*							
Diaptomus							
Ovig *Diaptomus*							
Cyclops	- Not Sampled -	468,925	468,925	98%	0.76	938.31	91%
Ovig. *Cyclops*		1,189	1,189	0%	1.26	7.02	1%
Harpaticus							
Nauplii		4,755	4,755	1%			
Bosmina		46,952	46,952	10%	0.44	84.71	8%
Ovig. *Bosmina*		1,783	1,783	0%	0.59	5.97	1%
Daphnia l.							
Ovig. *Daphnia l.*							
Daphnia r.							
Holopedium							
Ovig. *Holopedium*							
Chydorinae							
Polyphemus							
Immature Cladocera		1,783	1,783	0%			
Totals			525,387			1036.02	
Tow Depth (m)		45.0					
Average of Stations A and B			502,357			990.91	

DISCUSSION

Neva Lake is a relatively small 36.1 ha lake, but the Neva sockeye run has certainly been larger than expected with escapements of 5,002 in 2002, 11,393 in 2003, 9,513 in 2004, and 5,263 in 2005 (Table 11). These are the first estimates on record of the escapement of sockeye salmon into Neva Lake.

The subsistence and sport harvest of Neva sockeye salmon was relatively modest. Project personnel observed subsistence harvests of only 278, 312, and 598 sockeye salmon in 2003, 2004, and 2005, respectively, and a sport harvest of only 53 and 64 sockeye salmon in 2003 and 2004. The harvests reported on the State subsistence/personal use permits were 87, 397, and 276 in these years (Table 22) which suggests a tendency to underreport harvests on permits but more studies are needed to quantify any differences between actual and reported harvests. The harvest monitoring done by personnel operating the weir documents the observed harvest and effort but a formal stratified sampling design (Cochran 1977) would be needed to estimate the total harvest and effort.

The commercial purse seine harvest of Neva sockeye salmon is unknown but few were likely harvested in 2002 to 2005 since there were no seine openings to the West in Icy Strait, sub-Districts 114-21 and 114-23 (Figure 4), less than 300 sockeye harvested in a 1-day opening at Homeshore (114-25) in 2005, and less than 50 sockeye harvested in these years in four 1-day openings in Excursion Inlet (114-80). I would not expect many Neva sockeye to be harvested in seine openings across Icy Strait in the Port Althorp (114-50), Idaho Inlet (114-40), or Point Sophia (114-27) areas or in the Point Augusta (112-14) area. However, in 2001 to 2005 relatively large runs of pink salmon in northern inside areas of Southeast Alaska resulted in an increase in days and boats that fished in the Point Sophia and Point Augusta areas. A few Neva sockeye salmon might migrate through these areas in route to Neva Lake. The commercial seine harvest of Neva sockeye salmon is probably greatest when Excursion Inlet is opened in August to target chum salmon returning to the Excursion River as was done in the 1980s and 1990s (Figure 6). The Excursion River chum stock has declined since the mid-1960s (Figure 5) and it is unlikely that runs will be large enough in the next few years to support a directed seine fishery.

Annual troll harvests of sockeye salmon in District 114 has averaged less than 2,000 fish since the 1998; some are returning to Neva Lake and other small island and coastal systems in the northern inside area of Southeast Alaska, but most are probably returning to the large mainland rivers in Lynn Canal and Taku Inlet. Beginning in 2000, the Snettisham Hatchery has also had total returns of 100,000 to 500,000 sockeye salmon.

The Neva sockeye stock appears quite healthy the past four years given the low exploitation rate and relatively good escapements in such a small lake. Factors contributing to the health of the run includes the prolonged, late-June to early-October,

duration of the escapement into the lake, and the healthy mix of early-running inlet stream spawning and of late-running lake spawning populations. Over 95% of the run has been composed of age-1. fish suggesting that the sockeye juveniles are attaining the threshold size to smolt after their first year of rearing in the lake and that the fry production is not exceeding the lake's rearing capacity. The relatively high zooplankton biomass and proportion of Daphnia in the lake is certainly good for sockeye production. The distribution of ocean age-.1, .2, and .3 fish in the escapements promotes, and reflects, the viability of the stock.

Alaska Department of Fish and Game managers recognized the good health of the Neva sockeye run and increased daily and annual subsistence/personal use harvest limits from 10 fish in 2002 to 25 fish in 2003 and then to 40 fish in 2004. Subsistence fishing was also extended through August 15 in 2004 from the June 1 to July 31 season dates provided in past years. The liberalization in harvest limits and season did not result in any obvious increase in subsistence effort and harvest. However, if effort and harvest increases so will the need to monitor escapements. Federal subsistence harvest limits default to these State limits so nearly all subsistence fishing is done under authority of State subsistence/personal use permits. The first reported harvests on Federal subsistence permits were 34 sockeye salmon in 2005.

The migration of sockeye salmon into the lake is timed with increases in stream flow. This was particularly evident in 2004 when water levels were low well into September and there were distinct pulses of fish through the weir with any increase in water level (Figure 15). Shallow, warm, poorly oxygenated water contributed to the die-off of the 130 adult sockeye salmon observed in Neva Creek on August 13, 2004 and 100 or more sockeye salmon on August 14 and 15, 2005. Between June 20 and September 2, 2004 the temperature of Neva Creek around 0900 hour never got below 17°C (Figure 16). In 2005, the water levels did not get as low as in 2004, nor tend to be as warm, but water temperatures did peak between 18 to 21°C in mid-August (Figure 17). Bjornn and Reiser (1991) reported that the preferred migration temperatures for sockeye salmon are between 7.2 and 15.6 °C and McCullough (1999) reported the upper thermal tolerance for spawning sockeye salmon to be 14.4 to 16.1 °C.

The watershed is relatively undeveloped but the fish processing plant's diversion of water out of the main inlet stream might exacerbate low flow conditions, and migration delays and fish die-offs, during summers with little snow pack and precipitation. Beginning in 2005, the fish processing plant's diversion of water out of Neva Lake's main inlet stream was moderated following renewal of the plant's water right by the State of Alaska, Department of Natural Resources.

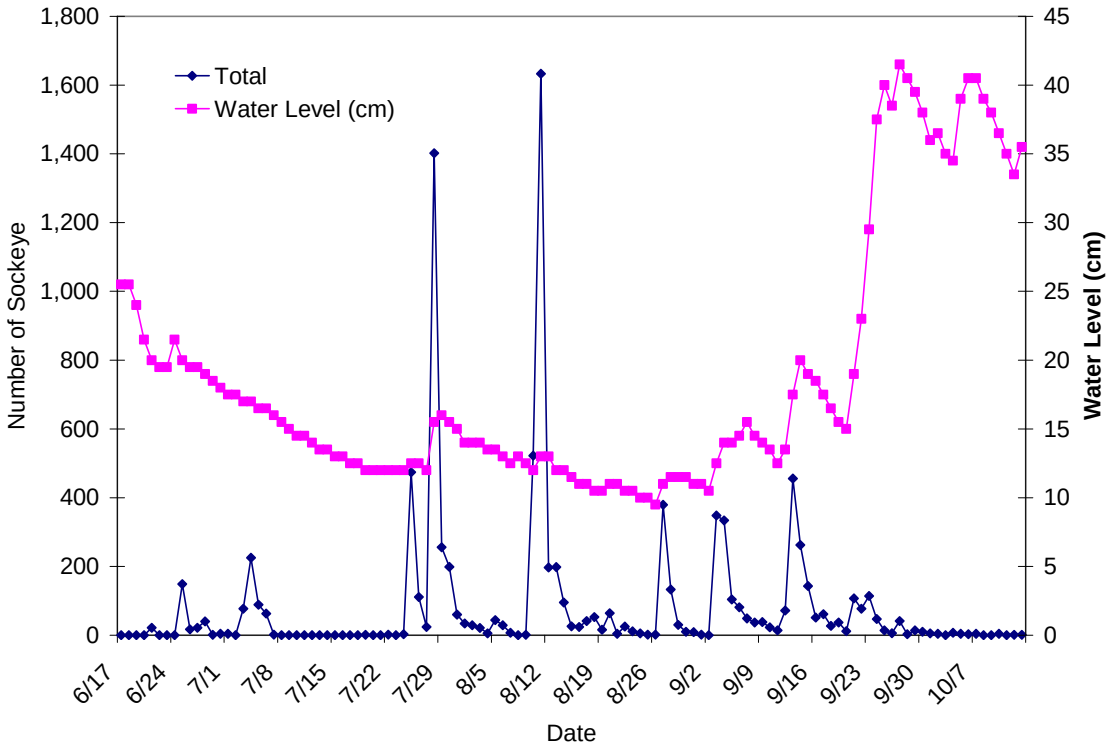


Figure 15. Daily sockeye migration and stream depth at the Neva weir, 2004.

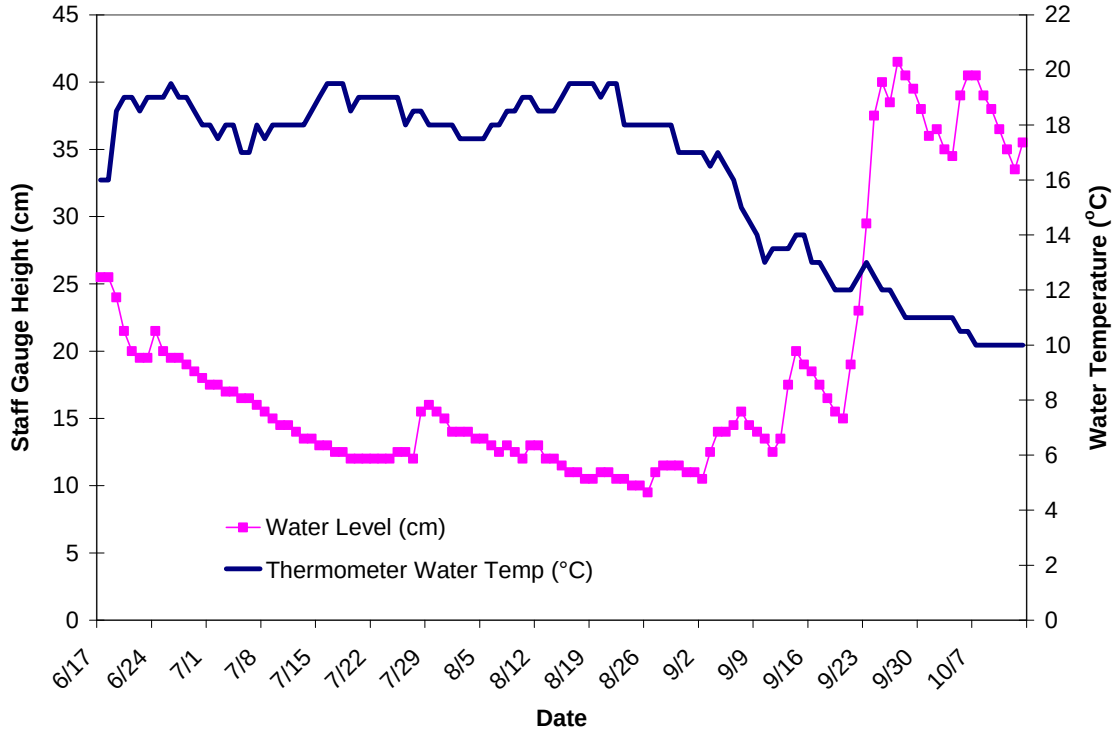


Figure 16. Daily stream depth and temperature at the Neva weir, 2004.

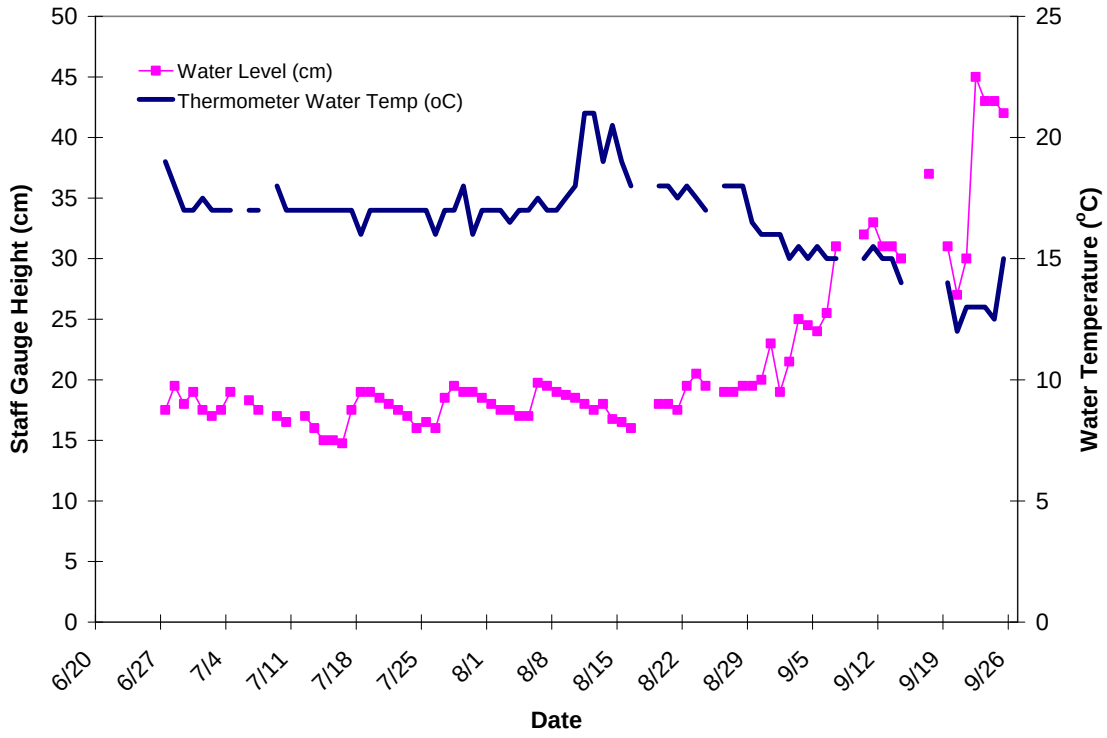


Figure 17. Daily stream depth and temperature at the Neva weir, 2005.

The weir-to-spawning ground mark-recapture estimates were the same as the weir counts in 2004 and 2005 but in 2002 and 2003 I relied on the mark-recapture studies to estimate the total sockeye escapement into Neva Lake. The weir is overbuilt for this small stream (Figure 18) but pickets were pulled and fish were passed by a non-project person during peak sockeye passage days. This weir tampering reflects a complication of operating a weir in a semi-remote location and the value of the back-up mark-recapture study for assuring a reliable estimate of the total escapement

Figure 18. Photo of the Neva Creek weir and trap, under construction, June 2003.

Pavlof Lake proved to be a relatively small producer of sockeye salmon. Sockeye escapements were 1,350 in 2002, 1,474 in 2003, and 715 in 2004. Sockeye escaped into the lake from late-June through early/mid-August. A radio tagging study (Van Alen 2005) and mark-recapture studies in 2002 (Van Alen 2004), 2003 (Van Alen 2005) and 2004 (this paper) confirmed that most sockeye spawn in the lower part of the lake's main inlet stream from late-July to mid-August. The percentage of sockeye salmon that used the fish pass to migrate into the lake was <50% in 2002, 69% in 2003, and 30% in 2004. This variability in percent of fish using the fishpass makes it difficult to extrapolate the count of fish through the fishpass to an estimate of the total escapement into the system.

There has not been any appreciable directed subsistence or sport fishing on Pavlof sockeye salmon for over 30 years and the only appreciable harvest occurs in commercial purse seine fisheries in Icy Strait and Chatham Strait. The Pavlof system is a better producer of coho salmon than sockeye salmon. There are too few sockeye salmon to support directed subsistence fishing by more than a few families.

At Hoktaheen Lake, we were able to build on experiences in 2001 and 2002 to know where and when to mark-recapture sockeye spawners (Conitz and Cartwright 2002; Van Alen 2004). Keeping the fisheries crew at Hoktaheen during the month of September worked well in 2003 and 2004 since weather conditions in September are often too poor

to safely fly in and out of this small lake as needed for the multiple mark-recapture trips. With the fisheries crew on-site they were able to make the multiple trips needed for modified Jolly-Seber estimates of the sockeye escapement in the upper lakes main inlet stream and outlet stream study areas. These were the only two areas with any appreciable numbers of spawning sockeye observed. There might be areas of beach spawning but the dark, tannin stained, water made it difficult to see fish in the lake. The sockeye escapement in 2004 was certainly the smallest observed from 2001 to 2004 (Tables 32 and 33). Only 565 sockeye salmon were estimated spawning in Hoktaheen Lakes main inlet stream study area in 2004 (Table 30) compared to 3,438 in 2003 (Van Alen 2005).

The production of sockeye salmon from Hoktaheen Lakes certainly appears to be moderate and limited by escapements and system productivity. Sockeye salmon likely have a difficult time migrating from the bay to the lower lake during low flow conditions since there are times when a relatively high proportion of the run appears to be milling in Hoktaheen Cove waiting a freshet to raise water levels (B. Davidson, ADF&G, personal communication 2004). There has been no commercial purse seining along outer Yakobi Island since 1973 (Table 3) so the only targeted fishing on this stock in recent years is by subsistence users and, to a lesser extent, sport users. The habitat is pristine and protected as part of the West Chichagof Yakobi Wilderness area. Perhaps the rearing capacity of this tannin-stained lake is limited because most of the zooplankton are in an epilimnion that is too warm for juvenile growth in some years (Table 43). The euphotic zone depths averaged 3.9 to 4.2 meters in 2002 to 2004 compared to euphotic zone depths of 10.6 to 15.8 at Neva Lake (Table 4). The high proportion of age-2. fish observed in 2001 and 2002 (Table 37) reflects slow juvenile growth that is most likely a result of poor lake productivity than of high escapements and overcrowding by abundant fry and juveniles.

CONCLUSIONS

1. Sockeye salmon runs to Neva, Pavlof, and Hoktaheen Lakes have long been an important subsistence resource for Tlingit families living in Hoonah and other areas of northern Southeast Alaska.

2. This report summarizes the sockeye stock assessment project findings from a cooperative Hoonah Indian Association, Alaska Department of Fish and Game, and U.S. Forest Service study. This project used a weir and mark-recapture methods to estimate the sockeye escapement into Neva Lake in 2002-2005, a fishpass trap and mark-recapture to estimate the sockeye escapement into Pavlof Lake in 2002-2004, and mark-recapture to index the sockeye escapement in Hoktaheen Lake in 2002-2004. Age, sex, and length data and limnological data were also collected to help assess the status of these stocks. This is the third and final report for the project FIS02-012; annual reports summarizing project findings for 2002 and 2003 are reported in Van Alen (2004 and 2005), respectively.

3. At Neva in 2004, the sockeye escapement into the lake was estimated to be 9,513 – 9,229 adults and 284 jacks – based on weir counts and validated with weir-to-spawning area mark-recapture studies. In 2005, the sockeye escapement into Neva Lake was estimated to be 5,263 – 5,018 adults and 244 jacks. For comparison, the Neva sockeye escapement was 5,003 (3,818 adults and 1,185 jacks) in 2002 and 11,393 (9,468 adults and 1,925 jacks) in 2003. Weir counts of coho salmon were 581, 1,691, 831, and 301, and Dolly Varden were 287, 279, 96, and 390, in 2002, 2003, 2004, and 2005.

4. The early running sockeye spawn in the main inlet stream in August and September and the later running fish spawn in the lake in October and November. The midpoint of the escapement through the weir was August 11 in 2004 and August 2 in 2005. Averaged across 2002-2005, the mid-point of the run was August 8 and 80% of the run passed from July 12 to September 9. Sockeye salmon passed through the weir as early as June 10 and as late as October 13, the latest date the weir was operated. The sockeye migration into the lake was timed with rainfall events during the early/mid-summer low-flow periods. Die-offs of pre-spawned sockeye salmon were observed during low flow conditions in July and August in both the inlet stream and at a shallow braided section in the upper part of the outlet stream.

5. The age composition of Neva sockeye salmon was mostly, 95+%, age-1. fish in all years. Jack (age-.1) sockeye comprised up to 24% of the escapement.

6. The observed subsistence harvest of Neva Lake sockeye salmon was 44, 278, 312, and 590 in 2002, 2003, 2004, and 2005. Subsistence fishers reported harvests of 36, 87, 397, and 276 sockeye salmon on State permits. The first year Federal subsistence fishing permits were fished was in 2005 and 34 sockeye were reported harvested by two households The observed sport harvest was 53 and 64 sockeye salmon in 2003 and 2004.

7. The Neva sockeye stock appears healthy in 2002 to 2005. There is a good temporal and spatial distribution and abundance of spawners, relatively low harvest by commercial, sport, and subsistence users, and the freshwater habitat is relatively undisturbed and protected.

8. Results from the Neva weir project were used to justify increases in subsistence harvest limits and season dates on State subsistence/personal use harvest permits. Annual escapements need to be monitored if subsistence effort increases in response to the increased subsistence fishing opportunity.

9. At Pavlof in 2004, the sockeye escapement into the lake was 715 (CV = 3%) based on sockeye marked at the outlet fishpass and examined for marks in, and off the mouth, of the main inlet stream. The sockeye escapement into the lake was 1,350 (CV=6%) in 2002 and 1,474 (CV=2%) in 2003. Between 30 and 69 percent of the sockeye salmon used the fishpass to migrate into the lake in years

2002 to 2004. The sockeye migrated into the lake from the third week in June to early/mid-August. Age-1.3 fish dominated the escapement in all years. A radio tagging study in 2003 found that the sockeye spawn in the lower part of the main inlet stream from late-July to mid-August. This was supported by modified Jolly-Seber mark-recapture studies that estimated 1,452 and 707 fish in the main inlet stream study area in 2003 and 2004. The Pavlof system appears to be a better producer of coho salmon than sockeye salmon. There are too few sockeye salmon to support directed subsistence fishing by more than a few families.

10. At Hoktaheen in 2004, 565 (CV = 4.4%) sockeye salmon spawned in upper Hoktaheen Lake's main inlet stream study area and 251 (CV = 6.8%) spawned in upper Hoktaheen Lake's outlet stream study area. Few sockeye salmon were observed outside of these two study areas. These were the smallest escapements observed in the past four years. In 2003, the number of sockeye spawning in these two areas was 3,438 (CV=3%) and 325. From 2001 to 2004, the simple Peterson estimate of the abundance of sockeye salmon in the main inlet stream study area in early September was 498 in 2004 compared to 1,840 in 2003, 737 in 2002, and 660 in 2001. In the outlet stream study area, the abundance index was 137 fish in 2004 compared to 210 in 2003 and 233 in 2002. In 2001 and 2002, half of the sockeye sampled from the main inlet stream were age-2.-. This high proportion of 2-check fish reflects slow growth conditions due more likely to poor lake rearing conditions than abundant spawners and fry.

11. In 2004, the dominant macrozooplankton was *Daphnia* sp. in Neva Lake, *Bosmina* sp. in Pavlof, and *Cyclops* sp. in Hoktaheen. The weighted "seasonal" biomass of zooplankton was 612, 90, and 946 mg/m^2, respectively, in Neva, Pavlof, and Hoktaheen Lakes and the euphotic zone depths were 15.8, 7.1, and 4.1 m, respectively.

RECOMMENDATIONS

The extended timing of the migration of sockeye salmon into Neva Lake and the extended timing of their spawning in the main inlet stream and lake makes it difficult to assess annual escapements with out the aid of a weir project. There is no point in the season when a high proportion of the escapement can be reliably counted during foot or boat surveys. If only two surveys are possible then surveys in mid-August and mid-October would yield the best assessment of the annual escapements to the main inlet stream and beach spawning areas, respectively. If only one survey is possible, then a stream and lake survey in mid-September would probably be the best opportunity to see the highest proportion of the escapement. Counting sockeye salmon in the lake is always challenging and prone to high observer variability. The fish readily swim in and out of view in schools too dense to count individual fish. Counting by 10s, 25s, and 100s is often needed but standardizing counts among observers and trips can be a problem. The person standing in the bow of the boat usually has the best opportunity to see fish while

the person running the outboard has the worst. Given these survey considerations, and the relatively low cost of operating a weir at this semi-remote location, I recommend continuation of a weir/mark-recapture project to estimate annual escapements. We need to know that the good distribution and abundance of escapement is being maintained following the liberalized subsistence harvest limits and season.

At Pavlof Lake this project found a high proportion of the annual escapement in and off the mouth of the main inlet stream in late-July and early-August. Thus, the annual escapement could be roughly indexed by a three or four person crew using a beach seine to mark as many fish as possible on one day and examining as many fish as possible the next. Mark-recapture trips the first week in August yielded Peterson estimates of 326, 437, and 113 in 2002, 2003, and 2004 compared to annual escapement estimates of 1,350, 1,474, and 715. An even rougher, but potentially useful, index of the annual escapement could be obtained from a single foot survey count of sockeye salmon in the lower part of the main inlet stream on, or about, August 5. The average count among observers on August 5 or 6 in 2002, 2003, and 2004 was 182, 295, and 115. These counts tracked with the actual 2002-2004 escapements and the adequacy of sockeye escapements in future years could be questioned if fewer fish are counted.

At Hoktaheen Lake, the only concentrations of sockeye salmon observed were in and off the mouth of the upper lake's main inlet stream in early September and in the upper third of the stream connecting the upper and lower lakes in mid-to-late September. The two day mark-recapture estimates presented in Table 32 appeared to track annual escapements as did a single foot survey count in the main inlet stream on, or about, September 6. Sockeye salmon are readily flushed out or obscured by high water events in the inlet streams for both Pavlof and Hoktaheen Lakes so relying on once-a-season surveys is always a risk.

ACKNOWLEDGEMENTS

This study is a cooperative effort among the Hoonah Indian Association (HIA), the Alaska Department of Fish and Game (ADF&G), and the U.S. Forest Service. Thanks to David Belton for coordinating HIA's project activities and to HIA's Johanna Dybdall and Liv Gray for their help administering this multi-year project. It was a pleasure working with HIA's employees – Jerome Abbott, Bill Dalton, Jr., Frederick Gallant, Lyle James, Tom Mills, Sr., Myron Murphy, Sam Post, and Elijah Sheakley. Their enjoyment with living and working in the field on this project was obvious. We've had safe and productive field seasons that extended well into October's and November's cold and rain.

A number of ADF&G folks were instrumental to the success of this project. Meg Cartwright and Jan Conitz helped administratively, technically, and logistically. Jan's help with deriving standard error estimates for the modified Jolly-Seber estimates was most appreciated. Renate Riffe helped with limnology supplies, procedures, and

sampling. Richard Bloomquist, Mark Olsen, and Iris Frank aged and tabulated our scale, sex, and length samples. John Edmondson and the ADF&G Soldotna Limnology Lab crew processed the zooplankton samples. Lastly, Wayne Lonn's work at the Neva Creek weir in 2002, 2003, and 2004 was outstanding. His career of experience with salmon projects was apparent and appreciated.

Special thanks to Forest Service volunteers Kyle Brownlee, Sam Kroiz, and Nathan Schroeder, and Lorrie Wright and Forest Service employees Greg Albrecht, Chad Hood, Cindi Lagoudakis, Robbie Piehl, Larry Rickards, Pete Schneider, and Dan Shultz for their help on this project. The professionalism of Libby Dougan and her staff in the Sitka Dispatch office was especially reassuring with this bush flying-intensive project.

The cooperation of Ocean Beauty's Dave Forbush, Mike Forbush, Dave McLean, and Bruce Gordon with accommodations and other logistics at Excursion Inlet was most appreciated.

Thanks to the Southeast Regional Advisory Council and the Federal Subsistence Board for associating the importance of these sockeye systems with the funding needed to keep them healthy. Finally, we wish to thank the Hoonah-area residents who rely on the wise stewardship of these salmon resources.

The U.S. Fish and Wildlife Service, Office of Subsistence Management, provided $343,105 in funding support for this three year project through the Fisheries Resource Monitoring Program, under contract number FIS02-012. In 2004, the last year of funding, $80,317 was allocated to HIA and $35,338 was allocated to the Forest Service. The Neva weir was operated in 2005 using unspent funds from HIA's 2004 budget. This report was submitted as the final report to U.S. Fish and Wildlife Service, Office of Subsistence Management, Subsistence Fisheries Monitoring Program for project number 02-012.

LITERATURE CITED

ADF&G (Alaska Department of Fish and Game). 2001. Length, sex, and scale sampling procedure for sampling using the ADF&G adult salmon age-length mark-sense form version 3.0. Alaska Department of Fish and Game, Division of Commercial Fisheries, Region I, Douglas, Alaska.

Arnason, A. N., C. W. Kirby, C. J. Schwarz, and J. R. Irvine. 1996. Computer analysis of data from stratified mark-recovery experiments for estimation of salmon escapements and other populations. Canadian Technical Report of Fisheries and Aquatic Sciences. No. 2106.

Barto, D. L. and B. T. Cook. 1999. A limnology and fisheries investigation of Pavlof Lake. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J99-40, Juneau.

Bean, T. H. 1891. Report of the salmon and salmon rivers of Alaska, with notes on the conditions, methods, and needs of the salmon fisheries. U.S. Fish Commission Bulletin, Volume 9.

Bernard, D.R. and P. A. Hansen. 1992. Mark-recapture experiments to estimate the abundance of fish. Alaska Department of Fish and Game, Division of Sport Fish, Special Publication 92-4, Anchorage, Alaska.

Bevan, D. E. 1961. Variability in aerial counts of spawning salmon. Journal of the Fisheries Research Board of Canada 18:337-348.

Bjornn, T. C. and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19:83-138.

Clutter, R. and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of the International Pacific Salmon Fisheries Commission 9, New Westminster, British Columbia.

Cochran, W.G. 1977. Sampling techniques, third ed. John Wiley and Sons Inc. New York, N.Y.

Cohen, S. 1988. The Forgotten War, Volume II, A pictorial history of World War II in Alaska and Northwestern Canada. Pictorial Histories Publishing Co., Inc., Missoula, Montana.

Conitz, J. and M. A. Cartwright. 2002. Gut-Kook-Hoktaheen annual report 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J02-27, Juneau.

Conitz, J. and M. Cartwright. 2003a. Kanalku, Kook, and Sitkoh subsistence sockeye salmon project, 2002 annual report. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J03-41, Juneau.

Conitz, J. and M. Cartwright. 2003b. Falls, Gut Bay, and Kutlaku Lakes subsistence sockeye salmon project 2002 annual report. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J03-42, Juneau.

Conitz, J. and M. Cartwright. 2005. Falls, Gut Bay, and Kutlaku Lakes subsistence sockeye salmon project 2003 annual report and 2001-2003 final report. Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries, Fishery Data Series 05-13, Juneau.

Conitz, J., M. A. Cartwright, and B. Van Alen. 2002. Falls Lake sockeye salmon stock assessment. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J02-33, Juneau.

Conover, W. J. 1980. Practical Nonparametric Statistics, 2nd edition. Wiley and Sons, New York.

Cook, B. T. 1998. Mark-recapture studies of Sitkoh Lake adult salmon stocks, 1997. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J98-19, Juneau, Alaska.

Cooley, R. A. 1963. Politics and conservation: the decline of the Alaska salmon. Harper and Row, New York.

Crabtree, K. F. 2001. Sockeye salmon escapement estimation for Sitkoh Lake, 1999 and 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J01-31, Juneau.

De Laguna, F. 1960. The story of a Tlingit community: A problem in the relationship between archeological, ethnological, and historical methods. Native American Book Publishers, Brighton, Michigan. U.S. Government Printing Office, Washington, D.C.

Emmons, G. T. 1991. The Tlingit Indians. University of Washington Press, Seattle.

Galginaitis, M. 2003. Couverden timber sales EIS, final resource report for subsistence. Prepared for Tongass National Forest, Juneau Ranger District, March 2003, by Foster Wheeler Environmental Corporation, Anchorage.

Geiger, H. J. and 10 coauthors. 2003. Sockeye salmon stock status and escapement goals in southeast Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J03-04, Juneau.

Goldschmidt, W. R. and T. R. Haas. 1998. Haa Aaní, our land: Tlingit and Haida land rights and use. T. H. Thornton, editor. University of Washington Press, Seattle. Originally distributed in 1948 in mimeograph form.

Heinl, S. C., J. F. Koerner, D. J. Blick. 2000. Portland Canal chum salmon coded-wire-tagging project, 1988-1995. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J00-16, Juneau.

INPFC (International North Pacific Fisheries Commission). 1963. Annual Report 1961. Vancouver, British Columbia.

Jones, E. L. III, T. J. Quinn II, and B. W. Van Alen. 1998. Accuracy and precision of survey counts of pink salmon in a Southeast Alaska stream. North American Journal of Fisheries Management 18:832-846.

Kelley, M. S. and Bachman. 1999. Chilkoot River weir results, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J99-25, Juneau.

Kelley, M. S. and Bachman. 2000. Stock assessment studies of Chilkat River adult salmon stocks in 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J00-29, Juneau.

Kelley, M. S., and R. P. Josephson. 1997. Sitkoh Creek weir results, June 8 to September 7, 1996. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J97-05, Juneau.

Koenings, J. P. and R. D. Burkett. 1987. Population characteristics of sockeye salmon (Oncorhynchus nerka) smolts relative to temperature regimes, euphotic volume, fry density, and forage base within Alaskan lakes. Pages 216-234 in H. D. Smith, L. Margolis, and C. C. Woods (editors). Sockeye salmon (Oncorhynchus nerka) population biology and future management. Canadian Special Publication of Fisheries and Aquatic Sciences. 50:600-611.

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, Fisheries Rehabilitation, Enhancement and Development Division, FRED Report Series 71, Juneau.

Koo, T. S. Y. 1962. Age designation in salmon. [In] Studies of Alaska Red Salmon. University of Washington Press, Seattle.

Langdon, S.J. 2006. Traditional knowledge and harvesting of salmon by *Huna* and *Hinyaa* Tlingit. U.S. Fish and Wildlife Service, Office of Subsistence Management, Final Report (Project No. 02-104), Anchorage.

Lewis, B. A. and M. A. Cartwright. 2002. Klawock Lake sockeye salmon (Oncorhynchus nerka) stock assessment project 2001 annual report. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J02-24, Juneau.

McCullough, D. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to Chinook salmon. Columbia Intertribal Fisheries Commission, Portland, OR. Prepared for the U.S. Environmental Protection Agency Region 10. Published as EPA 910-R-99-010.

McGregor, A. J., and F. Bergander. 1993. Crescent Lake sockeye salmon mark-recapture studies, 1991. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J93-13, Juneau.

McLachlan, G. J., and T. Krishnan. 1997. The EM algorithm and extensions. John Wiley & Sons.

Mills, M. J. and A. L. Howe. 1992. An evaluation of estimates of sport fish harvest from the Alaska statewide mail survey. Alaska Department of Fish and Game, Division of Sport Fish, Special Publication 92-2, Anchorage.

Moser, J. F. 1899. The salmon and salmon fisheries of Alaska. U.S. Fish Commission Bulletin for 1898, Volume 18. 179pp.

Ratner, N. C. and J. A. Dizard. 2005. Hoonah salmon survey. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resources Monitoring Program, Final Report (Study No. FIS02-104). Alaska Department of Fish and Game, Division of Subsistence, Juneau, Alaska.

Rich, W. H. and E. M. Ball. 1933. Statistical review of the Alaska salmon fisheries. Part IV: Southeastern Alaska. Bulletin of the Bureau of Fisheries 47(13):437-673.

Seber, G. A. F. 1982. The estimation of animal abundance, 2nd ed. Griffen, London. 654 pp.

Schaefer, M. B. 1951. Estimation of the size of animal populations by marking experiments. U.S. Fish and Wildlife Service, Fishery Bulletin 69:191-203.

Schroeder, R. F. and M. Kookesh. 1990. Subsistence harvest and use of fish and wildlife resources and the effects of forest management in Hoonah, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper 142, Juneau.

Schwarz, C. J., R. E. Bailey, J. R. Irvine, and F. C. Dalziel. 1993. Estimating salmon spawning escapement using capture-recapture methods. Can. J. Fish. Aquatic. Sci. 50: 1181-1197.

Shaul, L. D. 1994. A summary of 1982-1991 harvests, escapements, migratory patterns, and marine survival rates of coho salmon stocks in Southeast Alaska. Alaska Fishery Research Bulletin 1:10-34 Juneau.

Thompson, S. K. 1992. Sampling. Wiley-Interscience, New York.

Van Alen, B. W. 2000. Status and stewardship of salmon stocks in Southeast Alaska. Pages 161-193 in E. E. Knudsen, C. R. Steward, D.D. McDonald, J. E. Williams, and D. W. Reiser, editors. Sustainable Fisheries Management: Pacific Salmon. Lewis Publishers, New York.

Van Alen, B. W. 2004. Neva, Pavlof, and Hoktaheen sockeye salmon stock assessment, 2002. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, 2002 Annual Report (Study No. 02-012-1). Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J04-33, Juneau, Alaska.

Van Alen, B. W. 2005. Neva, Pavlof, and Hoktaheen sockeye salmon stock assessment, 2003. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, 2003 Annual Report (Study No. 02-012-2), Anchorage, Alaska.

Wetzel, R. G. and G. E. Likens. 2000. Limnological Analysis. Third Edition. Springer, New York.

The U.S. Fish and Wildlife Service, Office of Subsistence Management conducts all programs and activities free from discrimination on the basis of sex, color, race, religion, national origin, age, marital status, pregnancy, parenthood, or disability. For information on alternative formats available for this publication please contact the Office of Subsistence Management to make necessary arrangements. Any person who believes she or he has been discriminated against should write to: Office of Subsistence Management, 3601 C Street, Suite 1030, Anchorage, AK 99503; or O.E.O., U.S. Department of Interior, Washington, D.C. 20240.