SOCKEYE SALMON ESCAPEMENT ESTIMATION

FOR SITKOH LAKE, 1998

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Regional Information Report[1] No. 1J00-09

Alaska Department of Fish and Game
Division of Commercial Fisheries
Douglas, Alaska

February 2000

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ACKNOWLEDGMENTS

The author thanks Terry Suminski (USFS) for his efforts in coordinating communications and air transportation courtesy of the U. S Forest Service. The author also thanks Craig Farrington and Richard Bloomquist for their assistance collecting data in the field at Sitkoh Lake. Ben Van Alen initiated the project for 1998 and developed the study plan. Jim Blick, John Carlile, and Leon Shaul were consulted regarding the data analysis. Cori Cashen assisted with technical editing and produced the final report.

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ABSTRACT

Two mark-recapture events were conducted at Sitkoh Lake, Chichagof Island in 1998 in order to provide point estimates of the escapement of sockeye salmon *Onchorhynchus nerka*. These events occurred during 9/8-10 and 9/28-30, dates that bracket the peak spawn timing of 1997. The greater of the two estimates is used to represent the spawning population near its peak. This peak estimate is then divided by the peak estimate for 1997 to create a scaling ratio. The scaling ratio is then applied to the total escapement estimate for 1997 to derive an estimate for the total escapement for 1998.

The two point estimates are made by two-day mark-recapture events that are carried out in the designated "study-area" of the lake. A Petersen estimate of the population of the study-area is combined with a visual survey count of the same area to yield a "counted fraction." The inverse of the counted fraction is the "expansion factor," which is multiplied by the visual count of the entire lake to yield the estimate for the total lake population. The greater of the two point estimates is multiplied by the scaling-ratio to estimate a total escapement estimate for 1998.

The 1998 estimate of 6,649 spawners is in the range of estimates for 1982 and 1997, which were 7,228 and 5,979 respectively. The estimate for 1996 of 16,336 is the only other year for which there is an estimate.

The estimation efforts may be improved by additional mark-recapture events, or additional survey counts between mark-recapture events, or by the operation of a weir combined with these mark-recapture events as a means to calibrate the method.

KEY WORDS: mark-recapture, sockeye salmon, *Onchorhynchus nerka*, escapement

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries and the United States Forest Service (USFS), Sitka Ranger District have collaborated to monitor the annual escapement of sockeye salmon to Sitkoh Lake. It is the intention of both agencies to work cooperatively in building a database to assess trends in abundance, stock status, and any effects of the commercial and personal use/subsistence fisheries may have upon the stock.

This year's effort at population estimation relies heavily upon prior studies. An estimate of the peak number of spawners was made using mark-recapture techniques. This estimate was then extrapolated to a total escapement estimate using a spawner population curve determined in a previous study (Cook 1998). During the mark-recapture effort a sub-sample of the adult sockeye were sampled for age, sex, and length data.

Summary of Study Goals

1. Estimate the peak instantaneous escapement population of sockeye salmon to Sitkoh Lake for 1998.

2. Estimate the annual age and sex composition of sockeye salmon escapement with a precision of +/- 5%, 95% of the time.

3. Estimate the total escapement of sockeye salmon to Sitkoh Lake in 1998 by indexing the 1998 peak escapement estimate to the ratio of the peak to total estimate in 1997.

METHODS

Logistics

Transportation to and from Sitkoh Lake was provided by the USFS. via a DeHavilland Beaver on floats. The capacity was adequate for hauling two or three personnel with gear that included a small outboard motor, chest waders and an 18-gallon plastic tote, which contained a seine net. The USFS. also made available the west Sitkoh Lake cabin and the accompanying 12-foot aluminum boat for use by the sampling crew. A crew of two sampled the lake on the first trip and a crew of three participated on the second trip. The workload of these sample trips justifies a three-person crew. The trip with only two people was extended by an additional day so the objectives of the trip could be accomplished.

Sampling Procedures

1. Mark all captured sockeye salmon with an adipose clip and a secondary mark specific to a particular marking event except for fish that appear to be too weak to survive overnight or to remix with the population. Record the number marked for each sampling event.

2. Obtain representative age (scale), length (mid-eye fork), and sex data from a minimum of 300 to a maximum of 600 sockeye salmon throughout the mark-recapture study.

3. Determine a study area (that corresponds with the area of mark-recapture sampling) and a non-study area and conduct surveys of the lake perimeter enumerating sockeye salmon separately for each area.

Mark and Recovery Procedures

Fish were captured for sampling and marking using a beach-seine. The net used on the first sampling trip was approximately 20-m x 2.5-m with a 2 ½ inch square mesh. The net was a good size for this application but the mesh was too large. It caught large fish very effectively but the mesh was large enough that it functioned as a gillnet and removing fish from the net was very difficult and time consuming. It also killed an occasional salmon by suffocation or by cutting into a gill. The net failed to capture any of the one-ocean age sockeye salmon thus biasing the age distribution data. A net with a smaller mesh, two-inch square, was taken on the second trip and fish extraction was both quicker and easier and caused much less trauma to the fish. The net captured 25 one-ocean age sockeye salmon, indicating that it reduced the age/size selectivity.

Sample collection was aided by the use of a 12-foot aluminum boat that is provided by the USFS for cabin users. We brought in a four horsepower outboard motor. The seine net was piled on the bow of the boat and one end was held by a sampler in chestwaders standing in 1.5-m of water and 15 to 20 meters out from a shore area with concentrations of spawning sockeye salmon. The net was then deployed parallel to the shoreline about 25-m out by motoring the boat backwards and letting the net self-feed off the bow. Then both ends of the net were walked towards shore by personnel in chestwaders corralling the salmon for sampling. The boat was positioned next to the net and used as a sampling station.

Both of the sample trips required two main tasks for estimating the population in the lake: (1) Perform a mark-recapture study within the study-area; (2) Survey the entire lake perimeter of the lake obtaining discrete sockeye counts for the study-area and the non-study area.

All captured fish are marked with a clipped adipose. This is an easily observed sign for subsequent captures that they are a recaptured fish and need to be inspected for a second mark. A second mark is applied to distinguish the event (first or second) and the phase of the study (marking phase or recovery phase). During the marking phase of the first event all captured fish were marked by clipping both the adipose fin and the left axillary appendage. During the recapture phase, fish were captured in the same areas as during the marking phase. All fish were examined for marks and given a clip on the dorsal fin (a cut across the base of the posterior four fin rays) to indicate inclusion in the recapture phase of event-one. Newly captured fish were also given clips to the left axillary appendage and the adipose fin so that all event-one fish are similarly marked.

During the marking phase of the second event (the second trip) all new fish were marked with a left ventral fin clip and an adipose fin clip. All fish were examined for marks from the prior trip. Any marked fish recovered were given a left opercular punch. During the recapture phase fish were again captured in the same areas as during the marking phase. All fish were examined for marks and were given a left opercular punch to indicate inclusion in the recapture sample. New fish were given a left opercular punch, a left ventral clip, and an adipose clip so all fish from the second event have similar marks. The complete marking of all new fish during this recovery phase allowed for the possibility of making a third sample trip.

Age, Sex, and Length Sampling Procedures

Age structures (three scales per fish), sex, and length (mid-eye to fork of tail, MEF)(AWL) were collected from a sub-sample of the fish that were captured for the mark-recapture population estimation. A sample size of 300 to 600 was collected for the season. The general procedure was to obtain a certain portion of the total sample goal on each day of marking and from a variety of locations so as to have a distributed sample. A guideline was observed that if a net haul of salmon was going to be AWL sampled, the entire catch was sampled to reduce bias from catchability within the net caused by length/size or gender differences (body shape, kipe development, or behavior). All sockeye salmon that were captured were marked with fin clips according to a prearranged schedule with the exception of those that were so weakened that survival for 24 hours was doubtful. Only new (unmarked) fish were sampled for age, sex, and length data.

Lake Survey Procedures

The survey counts were conducted by motoring the boat at walking speed completely around the perimeter of the lake generally at a distance of about 15-m from the bank or as required by depth or obstacles. A count of all fish encountered on either side of the boat was attempted. Most of the lake perimeter had a sloping bottom such that it was possible to position the boat so that all the visible area was on the shore side of the boat. Certain areas had wide, shallow shores where this was not possible and in these cases, we attempted to count fish on both sides of the boat. In those cases it was helpful to designate a person to watch off each side of the boat and to declare fish as counted when they moved from one side of the boat to the other. The time during which the surveys were performed was chosen with consideration to conditions affecting visibility. Preferred conditions included calm water (little or no wind), no rain and reasonable light levels. Separate counts were made for the study area and the non-study area. On each trip every crew member made their own count and these counts (Table 1) are averaged for the analysis. Multiple counts were made of the study area because of the high density of the fish in the area and the difficulty of seeing across broad shallow zones of shore area.

Estimation Methods

Point estimates for the sockeye salmon population in the lake were determined by two-day mark-recapture studies similar to last year (Cook 1998). A study area was established where there were concentrations of sockeye salmon milling and actively spawning in shallow margins of the lake. A visual count was made from a boat of this discrete area. Then another count was made of the rest of the lake, the

non-study area, by slowly motoring the boat around the perimeter of the lake. Then a mark-recapture study was performed on the study area to yield an estimate of the number of sockeye actually present in the study area. Assuming that we counted the same fraction of fish actually present in both the study area and the non-study area we expand our total count of the lake by the ratio Np/Nv.

Where Np is the population of the study area as estimated by the mark-recapture Peterson estimate and Nv is the visual count of the area. Counts were made by multiple observers of the non-study area and multiple counts by multiple observers were made of the study area. The mean of the multiple counts was used in the analysis (Table 1).

RESULTS

Mark and Recovery Data

This study requires a marking phase and a recovery phase to generate data for a Petersen estimation of the population of the sockeye salmon inside the study area. All capture efforts during marking and mark recoveries were distributed across the designated study area. The area that we used for our study area extended west from the gravel wash at the landing in front of the west cabin to a slight point in the shoreline adjacent to the east end (the end nearest to the cabin) of the island. This area corresponds roughly with areas designated as locations numbered 2 through 11 in the 1997 study (Cook 1998) but also includes the contiguous shoreline continuing east all the way to the landing in front of the cabin site.

Trip # 1: The marking phase occurred on September 9 and continued through the morning of September 10 to achieve adequate coverage of the study area. The areas that were sampled and marked on the morning of September 10 were sampled for recovery data late in the day to allow time for re-mixing of the marked and unmarked fish. The net was set nine times during the marking phase and 431 sockeye salmon were captured and 410 were marked with a dorsal clip and a left axillary clip (Appendix B). Twenty-one were not included in the marking study because they were too weak or died in the process. The recovery phase took place on the afternoon of September 10. All fish caught during this phase were marked with a dorsal clip. The new fish (previously unmarked) were also given the adipose clip and the left axillary clip so that all marked fish from this trip have the same marking scheme. There were eight sets made that captured 214 sockeye salmon and these were examined for marks. There were 113 recovered marks and 101 new fish.

Trip # 2: The marking phase occurred on the afternoon of September 28 and continued through September 29. The net was set six times and captured 307 sockeye salmon (Appendix B). Three of these were too old or weak to be included in the marking study. An adipose clip and a left ventral clip were applied to the 283 new fish captured (Appendix B). Twenty-one marked fish were recovered from the earlier trip. These were given an anal fin clip. The recovery phase took place on September 30. All new fish and those marked during the marking phase were marked with an opercular punch. The new fish (previously unmarked) were also given the adipose clip and the left ventral clip so that all newly marked fish from this trip have the same marking scheme. Seven sets were made that captured 392 sockeye salmon. Only one was too weak to be included in the marking study. There were 178 recoveries of marks applied this trip, the previous day, these were marked with a left opercular punch. There were 186 new fish which were given three marks, a clipped adipose fin, left ventral fin and a left opercular punch. There

were a total of 42 (21 from each day) recoveries of marks from the first trip during the two days of sample efforts, these were given an anal fin clip. The final set of this day (the eighth) was made in a location that had not been set in the previous day during the marking phase and was deemed to be unfit as recapture data. The set caught 81 fish, 75 of these were new, only four marks were recovered from the marking phase of this trip and two marks were recovered from the previous trip. Since this set location was adjacent to other sample areas, this is an indication of how little dispersion and intermixing occurs from site to site as the salmon have settled into their chosen spawning territory. This also high-lights the importance of consistency in the specific locations that are targeted for mark and recapture efforts.

Peak Escapement Estimate

The first trip to Sitkoh Lake on September 8-10 provided the higher estimate of 1,371 for the lake sockeye salmon population. The estimate obtained on the second trip was 1,075 (Table 3). A simple Petersen estimate formula is used: N=MC/R. Information used for the Petersen estimate is as follows:

	Trip #1	Trip #2
Number of marks in the population (M)	410	283
Number of population examined for marks (C)	214	386
Number of "C" with marks (R)	113	178
Estimated population of study area (Np)	776	614
Visual survey total lake (Nv)	720	731
Visual survey of study area (nv)	388	380
Visual survey of non study area	297	286
Expansion factor (Ef=Np/nv):	2.00	1.61
Point estimate for lake population (Ef * Nv)	1,371	1,075

Total Escapement Estimate

The greater population estimate of 1,371, is our minimum estimate of the peak spawner population. Assuming that the area under the spawner population curve is the same as last year we can use the ratio of 1997 total run to 1997 peak count and extrapolate the 1998 peak population value to provide an estimate of 1998 total sockeye spawner population.

The peak of the spawning population for the lake in 1997 was estimated to be 1,232. The best estimate for the total escapement was 5,979. The ratio 5,979/1,232=4.85, applying this ratio to the peak escapement estimate for 1998 (4.85 * 1,371) gives a total escapement estimate of 6,649.

Year	**1982**	**1996**	**1997**	**1998**
Estimated Escapement	*7,228*	*16,336*	*5,979*	*6,649*

The escapement of 7,228 for 1982 comes directly from a weir count and was not checked or adjusted by a mark-recapture study. The estimate of 16,336 for 1996 was generated by a mark-recapture study and displaced the weir count of 9,465 which proved to be an inadequate representation of the total escapement (Kelley and Josephson, 1997). The estimates for 1997 and 1998 are not associated with any weir data and

come only from mark-recapture studies conducted in the lake. Any sockeye salmon that may spawn in the outlet stream or in the depths of the lake where they cannot be visibly counted are not included in the estimates for 1997 and 1998.

When normal distribution curves are fit to the data for 1997 and 1998 it is revealed that the lake population may have reached its peak in the interim between the two sample trips and may have approached 1,580. This would increase the total escapement to about 7,663 (4.85 * 1,580). This could be considered an upper limit to the estimate but this results from the application of statistical modeling that may "overwork" the data given that a curve is fitted to only two data points.

Peak Lake Population Timing

The data does suggest that the timing of the peak lake population appears to be earlier in 1998 than in 1997. The "best guess" at the timing shift is from peak to peak of the fitted curves, that is nine days, from September 27 in 1997 to September 18 in 1998 (Figure 1).

Age, Sex, and Length Distribution

A total of 444 sockeye salmon were sampled for age, sex, and length data. The number of samples collected on each day is as follows: 9/9, 120; 9/10, 35; 9/28, 66; 9/29, 223. Since three scales were collected per fish, 444 samples produced 410 usable ages (92% ageable data). It is apparent from the lengths and age data that the net used on the first trip was selective for larger fish. Since it functioned as a gillnet it allowed smaller fish to pass through. There was not a single one-ocean age (jack) captured using the 2 ½ inch mesh net. On the second trip, using a two-inch square mesh net, 25 jacks were captured of which, 21 were age 1.1 and four were age 2.1. Since sampling bias is known to be present for the jack-size sockeye salmon the following percentages consider only the larger two and three-ocean age fish. Data for 1997 is included for comparison, it also has been adjusted slightly by the removal of only three jacks, two age 1.1 and one age 2.1. Of 1,618 sockeye salmon captured during 1997 only three were jacks suggesting that the 2 ½ inch square-mesh net was selecting for larger, older fish.

		Brood Year						
		1994	1994	1993	1993	1992		
Year	Age	0.3	1.2	1.3	2.2	2.3	Male	Female
1998	Percent	0	43.6	54.0	1.3	1.0	53.0	47.0

		Brood Year						
		1993	1993	1992	1992	1991		
Year	Age	0.3	1.2	1.3	2.2	2.3	Male	Female
1997	Percent	0.3	34.9	56.0	6.8	2.0	48.6	51.4

The length data (MEF) shows that all age classes are smaller than those from 1997 except for the 2.2 age class which shows no significant change. The 1.1 and 2.1 ages show the most change but this is likely a

result of size selectivity of the net that was used and the sample size of only two age 1.1 and only a single age 2.1 captured in the 1997 sample.

	Average length by age-class, mm						
Age:	***0.3***	***1.1***	***1.2***	***1.3***	***2.1***	***2.2***	***2.3***
1998	na	353	491	545	338	497	548
1997	535	365	504	554	380	496	557

DISCUSSION

Conclusions

The limited scope of the investigation for 1998 limits the strength of any statement concerning escapement trends. It appears that the escapement was roughly equivalent to that of 1997 and might have been slightly greater. The peak lake spawner population is estimated to have occurred on or about September 17, this may have been earlier than the 1997 peak by about nine days.

The 1998 estimate rates an even lower status than the "best guess" of 1997 since it is derived from that estimate by using a single point estimate for the 1998 peak lake population. The only new data for estimating the population for 1998 are point estimates of the population of the lake on two dates. These dates bracket the date of the highest point estimate of 1997 so as to target the lake population near its peak. There were 19 days between these two population estimates. The higher of the two, 1,371 is selected to represent the peak lake population but fitting of normal curves (Figure 1) to the data shows that the peak population may have approached 1,580 during the gap between sample trips. This would result in a total estimate of 7,663 instead of 6,649. Additional point estimates are needed before this modeling approach can be relied upon.

The design of this population estimation study includes the assumption that the counted fraction of the population will be the same for the study-area as for the non study-area. This is not necessarily a valid assumption since the physical characteristics differ greatly between the two areas. Also the concentration of fish differs greatly between the two areas which could effect the accuracy of visual counting. The error from undercounting increases as the numbers being counted increases (Jones, et al. 1998). The distribution of sockeye salmon between the study area and the non-study area remained remarkably consistent for each of the sampling trips. The study-area which constitutes roughly 5% of the shoreline contained 57% of the visually counted salmon. The study area features wide, shallow, gravel bottomed zones with high concentrations of sockeye salmon. There are also cut banks at some of the sample locations that conceal spawning activity underneath. It appears to be the prime location for concentrated spawning activity. Some of the densely populated spawning areas were too shallow to allow the boat to motor any closer to shore than about 40 meters. Salmon were scattered out this distance and beyond. The boat must pass through the loosely congregated salmon and this causes some amount of scattering and darting back and forth. In these situations it is difficult to say if all fish get counted, or to say that fish are not counted twice on occasion.

The non study-area is roughly 95% of the lake shore and it generally has very different physical characteristics and a much lower density of sockeye salmon than the designated study area. These

qualities likely effect the counted fraction of the sockeye salmon present there. Much of the shoreline in the non study-area has a bottom that descends rapidly to a depth beyond visibility. The bottom is littered with logs, woody debris, and occasional growths of aquatic vegetation. In most areas the boat can be maneuvered 20 meters or less, out and parallel to shore, and all visible lake bottom is in view on one side of the boat. When salmon are encountered they are usually in very small numbers and are easily counted without confusion. There are some wide shallow areas at the east end of the lake where the bottom is made up of mud and silt and no salmon were observed there. An area named “Clyde's Hole” on the north shoreline (areas 12 and 13 from the 1997 study) is the same type of habitat as the study area and is located along the shoreline a few hundred yards east of the edge of our established study area. It is an area that would be easily seined and sampled and harbors good concentrations of spawners. The area is not contiguous with the other shores that were sampled and exceeded our needs and ability to be included in the study area. If there were fewer fish available, or if there were more personnel, or if the trip was longer, then this would be a logical area to include as part of the study area.

There are two potential population segments which are not accounted for by the present study design these are: 1) deep lake spawners and, 2) outlet stream spawners. Any salmon that remain at depths where they cannot be visually counted and that do not enter the shallow areas of the study-area where they may be included in the mark-recapture study are neglected in this study. At a few locations sockeye salmon were observed exhibiting spawning behavior at a depth of about 8 to 10 meters which is near the limit of visibility depending on viewing conditions. Similarly, any sockeye salmon that may remain to spawn in the three miles of outlet stream are not included in this study design.

Future Investigations

A continuing interest in the Sitkoh Lake sockeye salmon population requires at least one season of intensive investigation to improve the integrity of these estimations. A study is needed that includes some or all of the following objectives:

1. Define the suitability and accuracy of the spawning area mark-recapture study design as executed in 1997 and1998.
2. Index the spawning ground mark-recapture study design as used in 1997 and 1998 to weir results (including mark-recapture estimation from marks applied at the weir also).
3. Estimate the residence time of sockeye salmon on the spawning grounds at Sitkoh Lake.
4. Determine if there is a population of deep spawners in the lake that are not available for visual surveys or mark-recapture studies.
5. Determine any outlet stream population segment that may be unrecognized by present studies.

One approach toward these objectives would include operating a weir in conjunction with an independent spawning grounds mark-recapture study as performed in 1997 and 1998. With the ability to produce separate estimates for the population via each technique the effectiveness of the present study design could be evaluated. The marking at the weir could include individual identifiers such that residence time on the spawning grounds could be established. This would broaden the estimation options available in the future to include the Jolly-Seber method (Seber 1982). A weir could be situated at the outlet of the lake so that the lake could be readily accessible for frequent spawning ground sampling activities. The outlet stream would be walked and inspected for sockeye salmon spawning activity periodically. A thorough investigation would produce information valuable for the re-evaluation of previous studies and would improve the ability to make sound estimates in the future.

LITERATURE CITED

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

Kelly, M. S. and R. P. Josephson. 1997. Sitkoh Creek weir results June 8 to September 7, 1996. Alaska Department of Fish and Game, Regional Information Report IJ97-05, Juneau, Alaska.

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

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

Table 1. Sitkoh Lake 1998, Sockeye Salmon Survey Count Summary.

Trip 1 -	*Surveyor*	*Study Area (nv)*	*Non-study Area*
	KC	392	306
		453	
		396	
	RB	359	288
		352	
		374	
Average of counts:		388	297
Lake Total (Nv):		685	

Trip 2 -	*Surveyor*	*Study Area (nv)*	*Non-study Area*
	CF	338	294
		363	
	KC	480	301
		379	
	RB	352	262
		368	
Average of counts:		380	286
Lake Total (Nv):		666	

Table 2. Mark-Recapture Data.

	Marks Applied	*Catch Examined For Marks*	*Recovered Marks*
	M	C	R
Trip 1 -	410	214	113
Trip 2 -	283	386	178

Table 3. Population estimates.

The Petersen Estimates Of Study Area Population (Np):	
Trip 1 -	776
Trip 2 -	614
The Expansion Factor (Ef=Np/nv):	
Trip 1 -	2.00
Trip 2 -	1.61
Point Estimate Of Lake Population (Nv * Ef):	
Trip 1 -	**1,371**
Trip 2 -	**1,075**

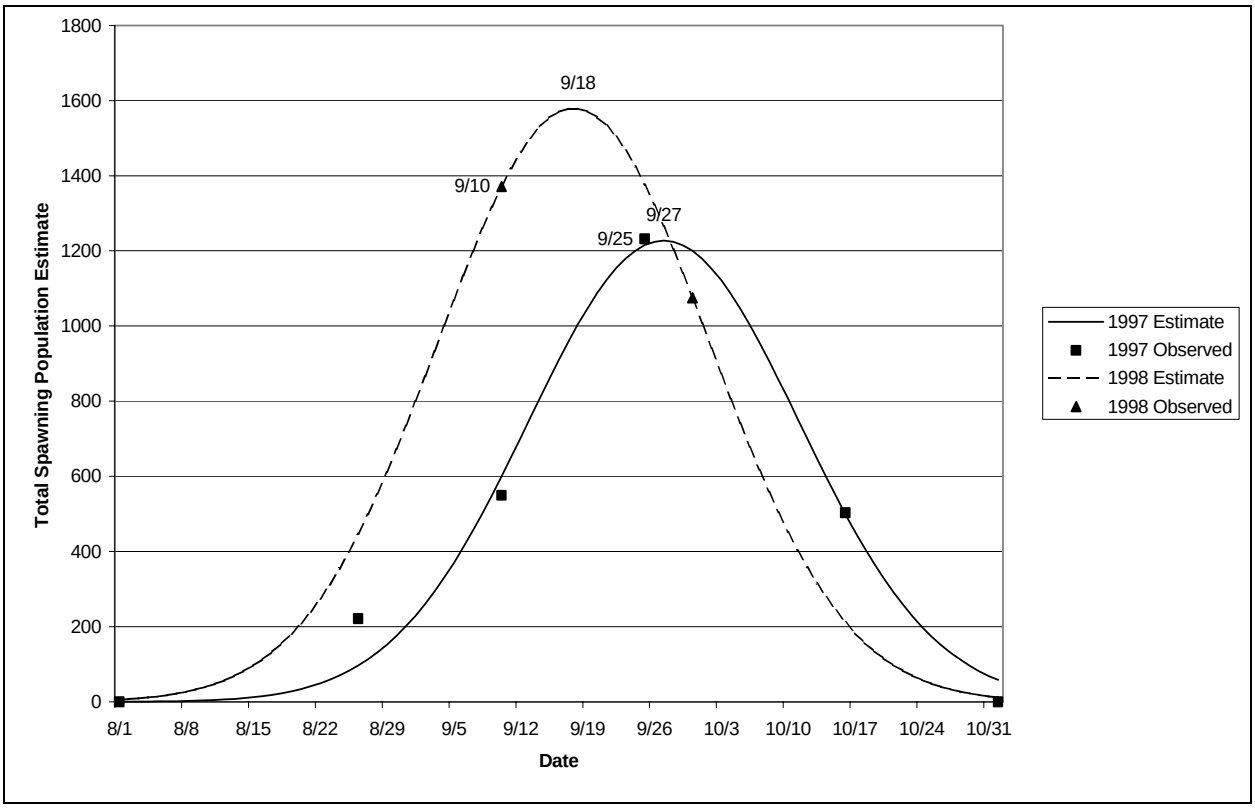

Figure 1. Total spawning population estimate of Sitkoh Lake sockeye.

Appendix A. Sitkoh Lake mark-recapture data, 1998.

Trip 1
Marking Phase

Date	Time	Location	Set #	New Fish (Given Marks)	Fish Not Marked	Total Catch
9-Sep	11:00	3	1	89	9	98
9-Sep	16:00	4	2	85	3	88
9-Sep	17:30	6	3	60	2	62
9-Sep	18:30	7	4	48	0	48
10-Sep	9:00	9	5	57	4	61
10-Sep	10:00	10	6	31	1	32
10-Sep	11:00	10	7	11	0	11
10-Sep	13:00	11	8	22	1	23
10-Sep	13:30	10.5	9	7	1	8
Totals				410	21	431

Trip 1
Recovery Phase

Date	Time	Location	Set #	Recaptures From This Trip	New Fish (Given Marks)	Fish Not Marked	Total Catch
10-Sep	15:30	3	9	30	35	0	65
10-Sep	16:15	4,5	10	21	10	0	31
10-Sep	17:15	6	11	14	24	0	38
10-Sep	17:30	7	12	18	9	0	27
10-Sep	17:45	8	13	3	11	0	14
10-Sep	18:00	9	14	13	5	0	18
10-Sep	18:30	10	15	6	5	0	11
10-Sep	19:00	11	16	8	2	0	10
Totals				113	101	0	214

Trip 2
Marking Phase

Date	Time	Location	Set #	Recaptures From First Trip	New Fish (Given Marks)	Fish Not Marked	Total Catch
28-Sep	15:30	2,3	1	5	65	1	71
29-Sep	10:00	4	2	2	65	0	67
29-Sep	12:00	8,9,10	3	9	28	2	39
29-Sep	15:00	11	4	1	17	0	18
29-Sep	15:50	7	5	3	38	0	41
29-Sep	17:15	6	6	1	70	0	71
							0
Totals				21	283	3	307

Trip 2
Recapture Phase

Date	Time	Location	Set #	Second Capture Recaptures	Recaptures From First Trip	Recaptures From This Trip	New Fish (Given Marks)	Fish Not Marked	Total Catch
30-Sep	10:00	2	1	0	2	27	29	0	58
30-Sep	10:30	3	2	0	0	8	26	0	34
30-Sep	10:45	4	3	2	6	37	31	1	77
30-Sep	11:30	6	4	0	3	45	31	0	79
30-Sep	13:00	11	5	0	0	13	8	0	21
30-Sep	13:15	8,9,10	6	0	3	22	26	0	51
30-Sep	13:30	7	7	4	7	26	35	0	72
30-Sep	14:00	5	8	0	2	4	75	0	81
Totals				6	23	182	261	1	473
Totals for sets 1-7:				6	21	178	186	1	392

Appendix B. Age composition of sockeye salmon in the District 113-59-004 (Sitkoh Lake) escapement by sex, 1998.

	Brood Year and Age Class						
	1995	1994	1994	1993	1993	1992	
	1.1	1.2	2.1	1.3	2.2	2.3	Total
Male							
Sample Size	21	86	4	115		2	228
Percent	4.0	20.6	0.8	30.0		0.4	55.7
Std. Error	0.8	2.1	0.4	2.4		0.3	2.6
Female							
Sample Size		81		92	5	2	180
Percent		19.8		22.8	1.3	0.4	44.3
Std. Error		2.1		2.2	0.6	0.3	2.6
All Fish							
Sample Size	21	168	4	208	5	4	410
Percent	4.0	40.4	0.8	52.8	1.3	0.8	100.0
Std. Error	0.8	2.5	0.4	2.5	0.6	0.4	

Appendix C. Length composition of sockeye salmon in the District 113-59-004 (Sitkoh Lake) escapement by sex, 1998.

	Brood Year and Age Class						
	1995	1994	1994	1993	1993	1992	
	1.1	1.2	2.1	1.3	2.2	2.3	Total
Male							
Avg. Length	353	496	338	552		551	514
Std. Error	3.3	1.9	9.4	1.7		11.5	4.2
Sample Size	21	86	4	115		2	228
Female							
Avg. Length		487		535	497	545	512
Std. Error		1.8		2.0	6.1	19.5	2.3
Sample Size		81		91	5	2	179
All Fish							
Avg. Length	353	491	338	545	497	548	513
Std. Error	3.3	1.4	9.4	1.4	6.1	9.4	2.6
Sample size	21	167	4	206	5	4	407