Alaska Fisheries Technical Report Number 64

Estimation of late run sockeye and coho salmon escapement in the Clark River, a tributary to Chignik Lake, Alaska Peninsula National Wildlife Refuge, 2002

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Key words: sockeye salmon, subsistence, radio telemetry, escapement, run timing, Chignik, Clark River, Alaska Peninsula, Refuge

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Abstract.- Sockeye salmon *Oncorhynchus nerka* in the Chignik Lake system are an important species for commercial and subsistence harvest. In recent years, subsistence fishers in the Chignik area have had difficulty harvesting enough fish and are concerned that the runs have declined and may be over-exploited by the commercial fishery. This project was initiated to address these concerns, and the objectives were to estimate the escapement of late run sockeye and coho *O. kisutch* salmon in the Clark River, estimate the escapement of Clark River sockeye salmon that pass the Chignik weir from August until the weir is removed in early September, and to determine the run timing of Clark River sockeye salmon past the Chignik weir in August and September. Stream walking surveys were used to generate area-under-the-curve estimates for Clark River escapement. Radio transmitters were implanted in a sample of sockeye salmon passing the Chignik weir in proportion to the run in August and September to estimate area-specific escapements and to examine run timing past the weir. Ninety-six sockeye salmon were implanted with transmitters in 2002, and 81% were successfully tracked to final locations. Seventy-four percent of tagged fish were found in Chignik Lake and the Clark River, which corresponds to an escapement estimate of 76,469 sockeye salmon that passed the Chignik weir in August and early September. Only five radio-tagged sockeye salmon migrated up the Clark River in 2002; all five fish were tagged after 21 August and moved up the Clark River after 10 October. Logistical problems and high water prevented the successful completion of stream walking surveys on the Clark River in 2002.

Introduction

Subsistence fishers from Chignik, Chignik Lagoon, and Chignik Lake target late run sockeye salmon *Oncorhynchus nerka* in Chignik Lake, and approximately 10,000 sockeye salmon are harvested in the subsistence fishery each year (Owen et al. 2000). Although subsistence harvest is not allowed within the Clark River, a tributary to Chignik Lake, late run sockeye salmon originating from this drainage are important to local subsistence

users as the primary fish used for drying. Subsistence fishing for Clark River late run sockeye salmon begins in late September and continues until freeze up. Although the earlier sockeye salmon runs destined for Chignik and Black lakes are fairly large, local subsistence fishermen favor the late run fish since they preserve better than sockeye salmon caught earlier in the season.

The Alaska Department of Fish and Game (ADFG) operates a weir on the Chignik River 4.5 km upstream from the entrance of the Chignik River into the Chignik Lagoon. The Chignik weir is used to estimate escapement within the Chignik Lake/Black Lake system and to provide in-season management of the commercial fisheries (Owen et al. 2000). Since the weir is pulled in early September, it only provides a drainage-wide escapement estimate prior to the date the weir is pulled, and does not include fish that enter the system in September and later. The ADFG also conducts aerial surveys of the tributaries to Chignik Lake until early September, but after that date there is no directed escapement monitoring of the Clark River stock.

The ADFG currently manages the Chignik Lake/Black Lake sockeye salmon fishery based on two different runs: an early run that is destined for Black Lake, and a later run that spawn in Chignik Lake and its tributaries. The ADFG uses scale pattern analysis and run-timing to differentiate the Black Lake and Chignik Lake stocks (Owen et al. 2000). Escapement goals at the Chignik weir are a total of 400,000 early run Black Lake sockeye salmon past the weir by 30 June and a total of 250,000 late run Chignik Lake sockeye salmon past the weir: 200,000 prior to 30 July and 50,000 after 30 July (Owen et al. 2000).

The Chignik Lake/Black Lake system supports a viable commercial salmon fishery, primarily targeting sockeye salmon with an average value of over $10 million (1992 - 2001 average value, George Pappas, ADFG Chignik Area Management Biologist, personal communication). Sockeye salmon are the most important species for subsistence harvest by local residents. Areas important to subsistence fishers in Chignik Lake include Hatchery Beach and the lake near the mouth of the Clark River and Home Creek.

Recently, subsistence fishers in the Chignik area have expressed concern that the late run Clark River stock has declined and that they are having a difficult time harvesting their subsistence fish. They are concerned that not enough fish are reaching the spawning grounds and that overall productivity might be decreasing. They are also concerned that the commercial fishery may be harvesting too many fish and question whether or not the 50,000 sockeye salmon allowed past the Chignik weir in August are available for subsistence harvest. The U. S. Fish and Wildlife Service (USFWS) King Salmon Fish and Wildlife Field Office initiated this project to address these subsistence concerns. The objectives of this monitoring project were to:

1. Estimate the total escapement of late run sockeye and coho *O. kisutch* salmon in the Clark River.

2. Estimate the escapement of Clark River sockeye salmon that pass the Chignik weir beginning in August until the weir is removed in early September.

3. Determine the run timing of Clark River sockeye salmon past the Chignik weir in August and September.

Methods

Study Area

The Chignik lake system is located on the South Alaska Peninsula about 270 km southwest of Kodiak Island, and is within the boundaries of the Alaska Peninsula National Wildlife Refuge (Figure 1). The system consists of two lakes: Black Lake and Chignik Lake, both of which are completely freshwater. Black Lake (the upper lake) has a maximum depth of 6 m, a surface area of 43 km^2, and an elevation of approximately 15 m above sea level (Narver 1968). The bottom is composed mainly of sand and silt, with organic detritus prevalent near the outlet of the lake and in the northeast corner (Narver 1968). Chignik Lake has a maximum depth of 64 m, surface area of 24 km^2, and an elevation of 5 m above sea level (Narver 1968). The bottom of Chignik Lake is dominated by rubble and boulders interspersed with gravel, silt, and organic deposits (Narver 1968).

In addition to sockeye salmon, the Chignik lake system also supports runs of chinook *O. tshawytscha*, coho, pink *O. gorbuscha*, and chum *O. keta* salmon. Dolly Varden *Salvelinus malma* also pass the Chignik weir in large numbers and are present throughout the system (Owen et al. 2000).

Telemetry and Run Timing

Tagging of sockeye salmon was accomplished at the Chignik weir facilities of the ADFG. A trap box installed by ADFG in the center of the weir was used to capture migrant fish, and ADFG personnel provided assistance in tagging fish. Cylindrical esophageal tags with external whip antennas were implanted in sockeye salmon in proportion to the run past the Chignik weir. Transmitters, manufactured by Advanced Telemetry System, Inc. (Model No. F1835), were encapsulated in a biologically inert polypropylene copolymer and weighed 13 g. Transmitters measured 40 mm in length with a diameter of 17 mm, and each had a 346 mm stainless steel nylon coated whip antenna. One hundred

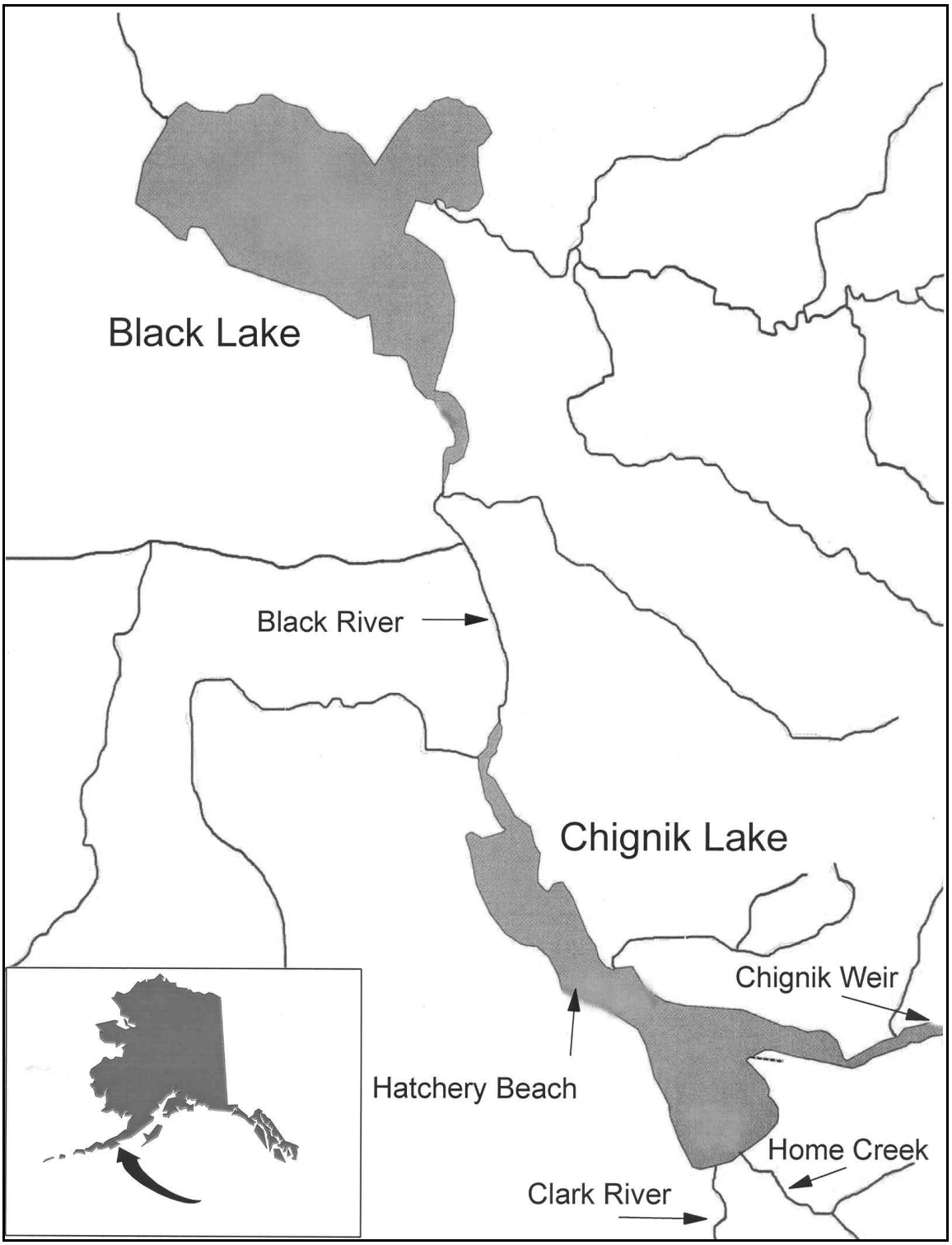

Figure 1. Chignik Lake study area, Alaska Peninsula National Wildlife Refuge, Alaska.

unique frequencies were used between 164.000 and 165.500 MHz, and all tags had a constant pulse rate of 60 pulses per minute.

Beginning on 31 July, one transmitter was deployed for every 1,000 sockeye salmon that passed the Chignik weir. The previous day's weir passage estimate was used to determine the number of tags to deploy each day. Transmitters were dipped in a glycerin solution to provide lubrication, and were gently forced down the throat of sockeye salmon to the stomach using a plunger. Care was taken to avoid puncturing the stomach. Tagged sockeye salmon were then released above the weir and observed for any negative effects of handling. Training was provided to the field crews, and dead fish recovered at the Chignik weir were used for practice prior to tagging live fish.

Radio-tagged sockeye salmon were tracked throughout the Chignik Lake system using a variety of methods. Two remote receiver sites with data loggers were established: one near the mouth of the Clark River and one near the mouth of Home Creek (Figure 1). These sites were established such that a sockeye salmon migrating up the Clark River would only be detected by the receiver at the Clark River site; sockeye salmon migrating up Home Creek would only be detected by the receiver at the Home Creek site. Sites were also situated so that sockeye salmon still in Chignik Lake would not be detected by either remote receiver, and both sites were located below suitable spawning gravels in each stream. A radio transmitter was deployed at each remote site to act as a reference transmitter that allowed us to monitor the proper operation of the receiver and data logger between visits to the remote sites. Data were downloaded from the remote data loggers every 10 to 14 days throughout the survey period.

Sockeye salmon implanted with transmitters were also tracked throughout the Chignik Lake area from a small boat (Figure 2). A portable receiver and antenna were used, and at numerous sites throughout the system, the receiver was allowed to scan through all tag frequencies for 4 s on each frequency. The boat surveys were scheduled daily (weather permitting) from mid-August to mid-September when personnel were on-site in Chignik Lake. After 15 September, a tracking event was scheduled every 10 to 14 days. The transmitter frequency, location, signal strength, and direction of signal for each transmitter detected was recorded on pre-printed forms. Three aerial searches were also conducted covering the entire Chignik Lake/Black Lake watershed at a survey height of 150 m and a speed of 165 km/h.

For sockeye salmon that passed the Chignik weir in August and early September, escapements to areas within and outside of Chignik Lake were estimated as

$$E = Np$$

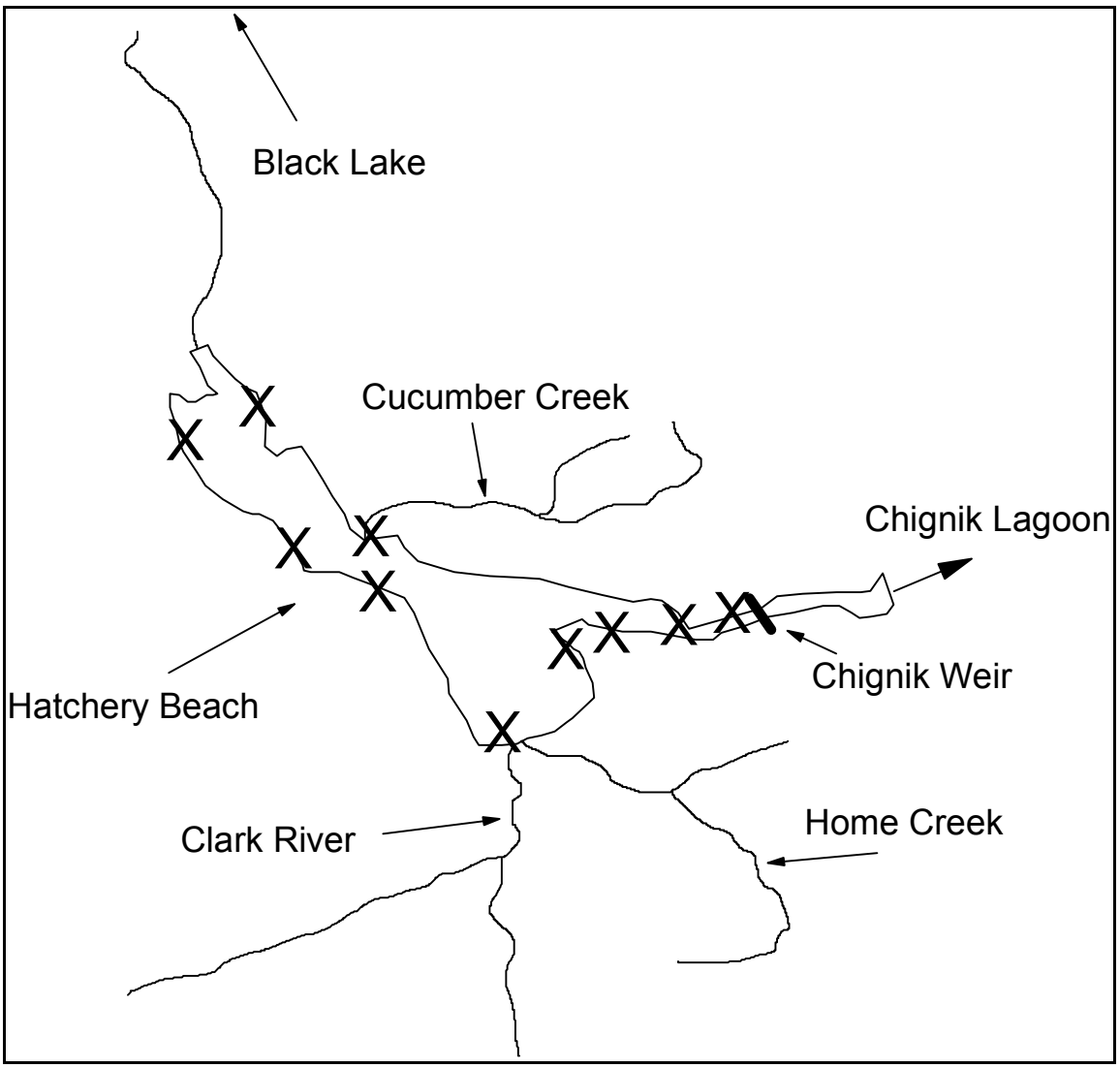

Figure 2. Map of Chignik Lake showing locations (**X**) established to track fish implanted with radio transmitters from a small boat.

with a variance of

$$V(E) = N^2\left(\frac{p(1-p)}{n-1}\right)$$

where : E = the area-specific escapement estimate
N = the total escapement estimate of sockeye salmon past the Chignik weir (30 July - 4 September)
p = the proportion of radio tagged fish recovered in each area (r/n)
r = the number of radio-tagged fish recovered in each area
n = the total number of sockeye salmon tagged at the weir.

Only sockeye salmon that were successfully tracked were included in the escapement analysis. Multiple detections in a single area, movement patterns of individual fish in Chignik Lake, and best professional judgement were used to determine the final location of transmitters. Confidence in final tag location was rated as low, medium, and high for the different escapement areas in the Chignik lake system according to the following criteria. For sockeye salmon detected in terminal spawning tributaries, any detection in that tributary corresponded to a high degree of confidence that the fish actually spawned there. For fish detected in the main rivers (Chignik River and Black River), a single detection represented a low degree of confidence, two detections spaced throughout the season represented a medium degree of confidence, and multiple detections at different locations in the river represented a high degree of confidence that the fish spawned in the river or a nearby tributary. Sockeye salmon detected in areas within Chignik Lake were assigned a low confidence if only one or two detections occurred in the lake over the entire survey period, but the fish was not detected anywhere else. A medium degree of confidence was assigned if two or more detections occurred in a given area, and detections were recorded in nearby areas. A high degree of confidence was assigned to sockeye salmon that were detected consistently in the same area in Chignik Lake throughout the season.

Run timing of Clark River sockeye salmon was investigated by using tracking information. The remote data loggers recorded when individual fish moved past the Clark River site. Once the unique tag frequencies were known, it could then be determined when those individual fish had been tagged at the Chignik weir. A *G*-test of independence (Sokal and Rohlf 1981) was used to examine if availability of sockeye salmon for subsistence harvest changed through the tagging season. Results were considered significant at $p < 0.05$.

Age, Sex, and Length Data

Data collected on sockeye salmon age, sex, and length were stratified *a posteriori* into approximately 10 day periods (Table 1; Thompson 1992). Fish were collected at the

Table 1. Strata (time periods) used for analysis of Chignik weir sockeye salmon biological data.

Stratum	Dates
1	July 31 - August 9
2	August 10 - August 19
3	August 20 - August 29
4	August 30 - September 11

Chignik weir in a trap box located in the middle of the weir, and were handled in the water in a padded cradle. All sockeye salmon implanted with radio transmitters were measured to the nearest mm (mid-eye to fork length) and the sex of the fish was determined from external characteristics when possible. Three scales from each sockeye salmon were removed from the preferred area on the left side (Jearld 1983), cleaned, and mounted on gummed scale cards. Scales were pressed on-site at the Chignik weir by ADFG and USFWS personnel, and USFWS personnel aged the scales. Standards and guidelines of Mosher (1968) were used in aging scales. Salmon ages are reported according to the European method described by Jearld (1983) and Mosher (1968), where the number of winters the fish spent in fresh water and in the ocean are separated by a decimal.

Clark River Escapement Monitoring

Foot surveys were scheduled at two-week intervals beginning in mid-September and ending in December on the Clark River to count adult sockeye and coho salmon. Surveys began at the mouth and proceeded upstream in all waters of the Clark River accessible to adult salmon. Observers selected the route that maximized the visibility of salmon with respect to the angle of the sun, water clarity, and wind. Surveyors wore polarized glasses to reduce water surface glare. When oxbows, side channels, and backwaters were encountered, one observer maintained the count from a stationary position on the main channel while the other observer counted fish in the off-channel habitat. The Clark River was divided into approximately 1 km transects, and data were recorded for each transect. Data recorded included: number and species of fish observed, time, water clarity (excellent, good, or poor), lighting conditions (sun, partial overcast, overcast), and wind generated surface turbulence (calm, moderate, rough).

Results

Telemetry and Run Timing

A total of 96 transmitters were deployed in sockeye salmon passing the Chignik weir in 2002; two transmitters were defective and not deployed, and two transmitters were used as reference transmitters at the remote sites. Tags were deployed in proportion to the run beginning on 31 July until the weir was pulled on 4 September (Figure 3). Three additional tags remained after the weir was removed, and these were deployed in sockeye salmon collected by drifting a gill net to capture fish on 11 September. Seventy-eight of the 96 tagged fish (81%) were successfully tracked in the Chignik Lake system (Table 2). Five fish expelled the transmitters in front of the Chignik weir; six tagged fish were never detected, and seven tagged fish were not detected after they left the Chignik River and had unknown final locations (Table 2).

Twenty-seven surveys were conducted by boat in the Chignik Lake system from 17 August to 3 December. Three aerial searches were conducted covering the entire study area, and one foot survey was conducted above the Clark River site (Table 3). The number of tags detected for each survey ranged from two on 8 October when tracking was only conducted on Clark Beach to 37 during the 3 September aerial survey. Later detections during aerial surveys in October and December were considerably lower than the September aerial survey because for the later flights, transmitters whose locations were known were eliminated from the receiver scan in order to minimize scan time while flying. For example, the five transmitters detected in the Chignik River during the 6 October boat survey (those were determined to be expelled tags) were eliminated from the scan on the 9 October flight; transmitters that were located in the West Fork on the 9 October aerial survey were eliminated from the scan for the 11 December aerial survey (Table 3). The 3 September flight was scanning for all 100 frequencies; the 9 October aerial survey was scanning for 75 frequencies, and the 11 December aerial survey was scanning for 56 frequencies.

Of the fish successfully tracked, 58 (74%) were determined to be within Chignik Lake and the Clark River, and 20 (26%) were in areas outside of Chignik Lake (Table 4; Figure 4). The numbers of tags recovered in the different areas correspond to escapement estimates of 76,469 sockeye salmon that passed the Chignik weir in August within Chignik Lake and the Clark River, and 26,369 that were outside of Chignik Lake (Table 4). The *G*-test of independence indicated that migration to areas within or outside of Chignik Lake was independent of stratum ($G = 1.22$; $p > 0.74$; $df = 3$); sockeye salmon passing the Chignik weir in August migrated to areas within or outside of Chignik Lake independent of when they passed the weir (Table 5). Due to small sample sizes of recovered tags in some locations, escapement estimates were not generated for individual areas reported in Table 4, as confidence intervals often included zero. Appendix A contains summary data for individual sockeye salmon implanted with radio transmitters.

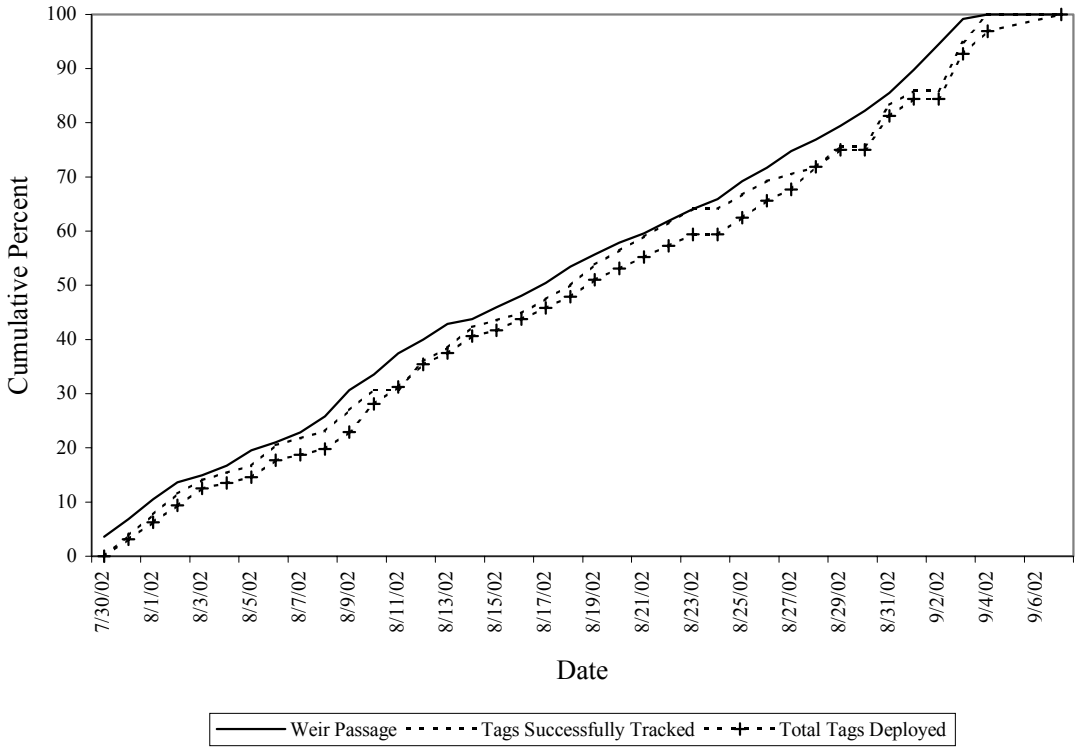

Figure 3. Cumulative percent sockeye salmon escapement at the Chignik weir, and cumulative percent of tags successfully tracked and deployed, 2002.

Table 2. Fate of sockeye salmon (percentages in parentheses) implanted with radio transmitters at the Chignik weir, 2002.

Stratum	Number implanted	Successfully tracked	Transmitter expelled	Never detected	Unknown final location[a]
1	22	21 (95.5)	0	1 (4.5)	0
2	27	21 (77.8)	4 (14.8)	1 (3.7)	1 (3.7)
3	23	17 (73.9)	1 (4.4)	2 (8.7)	3 (13.0)
4	24	19 (79.2)	0	2 (8.3)	3 (12.5)
Total:	96	78 (81.3)	5 (5.2)	6 (6.2)	7 (7.3)

[a] Fish were tracked through the Chignik River, but were not found again after leaving the river.

Table 3. Summary of tracking effort in the Chignik Lake system, 2002.

Date	Search Type	Search Area	Number of Tags Detected
17 August	Boat	Chignik River/Chignik Lake	15
18 August	Boat	Chignik River/Chignik Lake	18
19 August	Boat	Chignik River/Chignik Lake	20
20 August	Boat	Chignik River	11
21 August	Boat	Chignik River/Chignik Lake	13
22 August	Boat	Chignik River/Chignik Lake	15
23 August	Boat	Chignik River/Chignik Lake	24
24 August	Boat	Clark Beach	3
26 August	Boat	Chignik River/Chignik Lake	21
27 August	Boat	Chignik River/Chignik Lake	18
28 August	Boat	Chignik River/Chignik Lake	23
29 August	Boat	Chignik River/Chignik Lake	26
30 August	Boat	Chignik Lake and Black Lake	10
3 September	Aerial	Entire Area	37
3 September	Boat	Chignik River/Chignik Lake	14
4 September	Boat	Chignik River and Clark Beach	14
5 September	Boat	Chignik River/Chignik Lake	18
6 September	Boat	Chignik River/Chignik Lake	17
9 September	Boat	Hatchery Beach	7
11 September	Boat	Chignik Lake	15
12 September	Boat	Chignik River	7
13 September	Boat	Clark Beach	8
18 September	Boat	Clark Beach	8
3 October	Boat	Chignik Lake	21

Table 3. Continued.

Date	Search Type	Search Area	Number of Tags Detected
6 October	Boat	Chignik River	5
8 October	Boat	Clark Beach	2
9 October	Aerial	Entire Area	18[a]
26 October	Boat	Chignik Lake	7
13 November	Foot	Clark River above site	5
3 December	Boat	Chignik River/Chignik Lake	14
11 December	Aerial	Entire Area	15[a]

[a] Transmitters with known locations were deleted from receiver scan in order to minimize scan time during flights.

Table 4. Proportional escapement estimates and standard errors (SE) within and outside of Chignik Lake based on final transmitter locations for sockeye salmon tagged at the Chignik weir, 2002.

Final Location	Number of transmitters	Proportion of Sample	Escapement	SE
Within Chignik Lake				
Clark Beach	14	0.18	--	--
Clark River	5	0.06	--	--
Cucumber Beach	1	0.01	--	--
Hatchery Beach	36	0.46	--	--
Upper Chignik Lake	2	0.03	--	--
Total:	58	0.74	76,469	5,117
Outside of Chignik Lake				
Chignik River	1	0.01	--	--
Delta[a]	4	0.05	--	--
Black River	5	0.06	--	--
Bearskin Creek	1	0.01	--	--
West Fork	4	0.05	--	--
Chiaktuak Creek	3	0.04	--	--
Alec River	2	0.03	--	--
Total:	20	0.26	26,369	5,117

[a] Delta refers to delta formed by the Black River flowing into Chignik Lake.

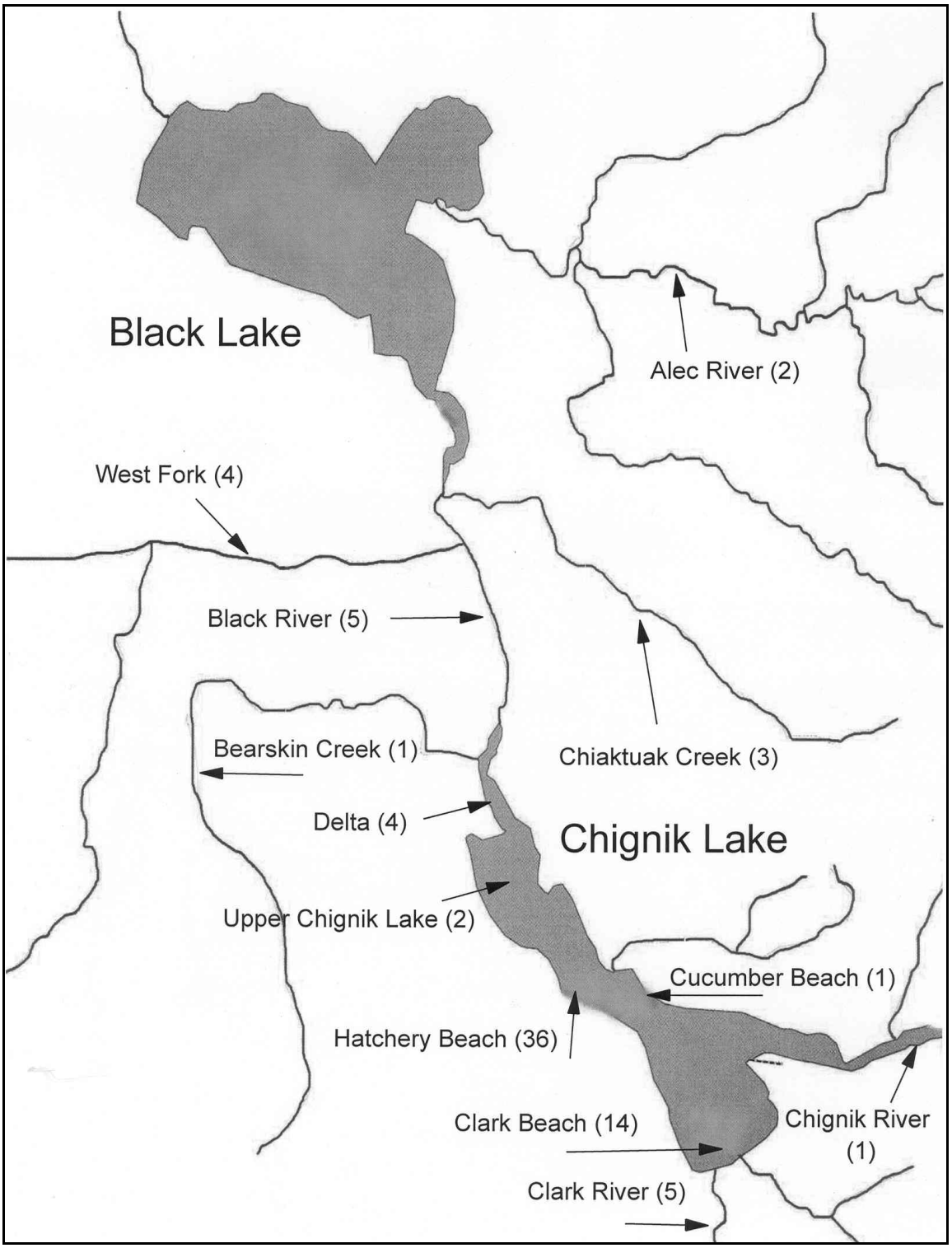

Figure 4. Final locations and numbers (in parentheses) of sockeye salmon implanted with radio transmitters at the Chignik weir, 2002.

Table 5. Number and proportion of tagged fish, and standard errors (SE) within or outside of Chignik Lake by stratum for sockeye salmon tagged at the Chignik weir, 2002.

	Within Chignik Lake		Outside of Chignik Lake		
Stratum	Number of tagged fish	Proportion	Number of tagged fish	Proportion	SE
1	14	0.67	7	0.33	0.11
2	16	0.76	5	0.24	0.10
3	14	0.82	3	0.18	0.10
4	14	0.74	5	0.26	0.10
Total:	58	0.74	20	0.26	0.05

Appendix B summarizes confidence in the assignment of final locations to individual sockeye salmon tracked in 2002. Final locations in terminal spawning tributaries were all assigned with a high degree of confidence. Most sockeye salmon detected in the Black River and the Delta were assigned locations with a low degree of confidence (67%). Most sockeye salmon detected in Chignik Lake were assigned locations with medium (28%) or high (30%) degrees of confidence, and 42% of Chignik Lake fish were assigned locations with a low degree of confidence, primarily due to single detections throughout the season.

Five radio tagged sockeye salmon moved up the Clark River to spawn, corresponding to 6% of the total August run (Table 4). All fish that migrated up the Clark River were tagged at the Chignik weir after 21 August, and four of the five were tagged after 29 August (Table 6). Four of the five fish that moved past the Clark River site were males, and all fish moved past the remote data logger site after 10 October (Table 6).

Remote data logger sites on the Clark River and Home Creek were established on 31 July and were maintained through late fall. Problems were encountered during the 2002 field season with both sites, mainly due to bear activity. The Home Creek site was nonfunctional for two periods: 26 September – 6 October, and 24 – 26 October. The Home Creek site was pulled after 26 October when it became inundated with flood waters. The Clark River site was nonfunctional on six occasions: 14 August, 30 August – 4 September, 19 September, 6 – 7 October, 19 – 26 October, and after 20 November. The Clark River site was pulled on 3 December. No radio-tagged fish were detected at the Home Creek site, and four radio-tagged fish were detected by the Clark River site. The

Table 6. History of radio-tagged sockeye salmon that migrated up the Clark River, 2002.

Transmitter Frequency	Sex	Age	Length (mm)	Tag Date	Date Past Site
165.021	Male	2.3	535	21 August	11 October
164.314	Male	1.2	530	29 August	10 October
164.442	Male	1.3	524	31 August	13 October
164.718	Female	2.3	635	3 September	13 November[a]
164.185	Male	1.4	550	4 September	17 October

[a] This fish was detected from a ground search above Clark River site after an equipment failure, so its actual date past the site may be earlier than 13 November.

foot survey above the Clark River site on 13 November and the final aerial survey on 11 December concentrated on determining if fish had moved above the site during periods when it was nonfunctional, and the 13 November foot survey did find one fish above the site that the remote equipment did not detect. This fish likely moved past the Clark River site during the period from 19 - 26 October, as the other four fish that moved past the site all moved past in the previous week (Table 6).

Age, Sex, and Length Data

A total of 102,838 sockeye salmon were estimated to have passed the Chignik weir during our sampling period from 30 July through 4 September (ADFG, unpublished data). The total escapement estimate for sockeye salmon during the entire season was 708,520 fish (ADFG, unpublished data). The Chignik weir was removed on 4 September. A total of 96 sockeye salmon were implanted with radio transmitters and sampled for age, sex, and length data. The sex composition varied by strata from 41% female in stratum 2 to 71% female in stratum 4, with an overall average of 56% female (Table 7). Six different age classes were sampled, with 1.3 (44%) and 2.3 (36%) being the most common (Table 8). Mean lengths varied by age class, with fish that spent the most years in the ocean being the largest. Females ranged in length between 450 and 635 mm, and males ranged in length between 427 and 660 mm (Table 9; Figure 5).

Table 7. Estimated sex composition and standard errors (SE) of sockeye salmon sampled by stratum at the Chignik weir, 2002.

	Sample			Percent		
Stratum	n	Male	Female	Male	Female	SE
1	22	10	12	45	55	10.9
2	27	16	11	59	41	9.6
2	23	9	14	39	61	10.4
4	24	7	17	29	71	9.5
Total	96	42	54	44	56	5.0

Table 8. Sample sizes (*n*), estimated age composition (%), and standard errors (SE) of sockeye salmon by stratum sampled at the Chignik weir, 2002.

	1.2			1.3			1.4			2.2			2.3			2.4		
Stratum	*n*	%	% SE	*n*	%	% SE	*n*	%	% SE	*n*	%	% SE	*n*	%	% SE	*n*	%	% SE
1	1	4.8	4.8	11	52.4	11.2	0	0.0	0.0	0	0.0	0.0	9	42.9	11.1	0	0.0	0.0
2	1	3.7	3.7	14	51.9	9.8	2	7.4	5.1	1	3.7	3.7	9	33.3	9.2	0	0.0	0.0
3	4	21.1	9.6	7	36.8	11.4	0	0.0	0.0	1	5.3	5.3	7	36.8	11.4	0	0.0	0.0
4	1	5.0	5.0	6	30	10.5	3	15.0	8.2	2	10.0	6.9	6	30.0	10.5	2	10.0	6.9
Total:	7	8.0	2.9	38	43.7	5.3	5	5.7	2.5	4	4.6	2.3	31	35.6	5.2	2	2.3	1.6

Table 9. Average, standard error (SE), range, and sample size of lengths (mm) by age class taken from sockeye salmon at the Chignik weir, 2002.

	Age Class					
	1.2	1.3	1.4	2.2	2.3	2.4
Females						
Mean Length	493	570	564	505	585	601
SE	23.1	4.3	4.0	14.9	6.7	6.0
Range	450 - 529	530 - 605	560 - 568	470 - 530	518 - 635	595 - 607
Sample Size	3	18	2	4	20	2
Males						
Mean Length	486	584	620	--	594	--
SE	24.0	7.6	35.1	--	7.4	--
Range	427 - 530	495 - 630	550 - 660	--	535 - 619	--
Sample Size	4	20	3	0	11	0
All Fish						
Mean Length	489	578	598	505	588	601
SE	15.6	4.6	23.7	14.9	5.0	6.0
Range	427 - 530	495 - 630	550 - 660	470 - 530	518 - 635	595 - 607
Sample Size	7	38	5	4	31	2

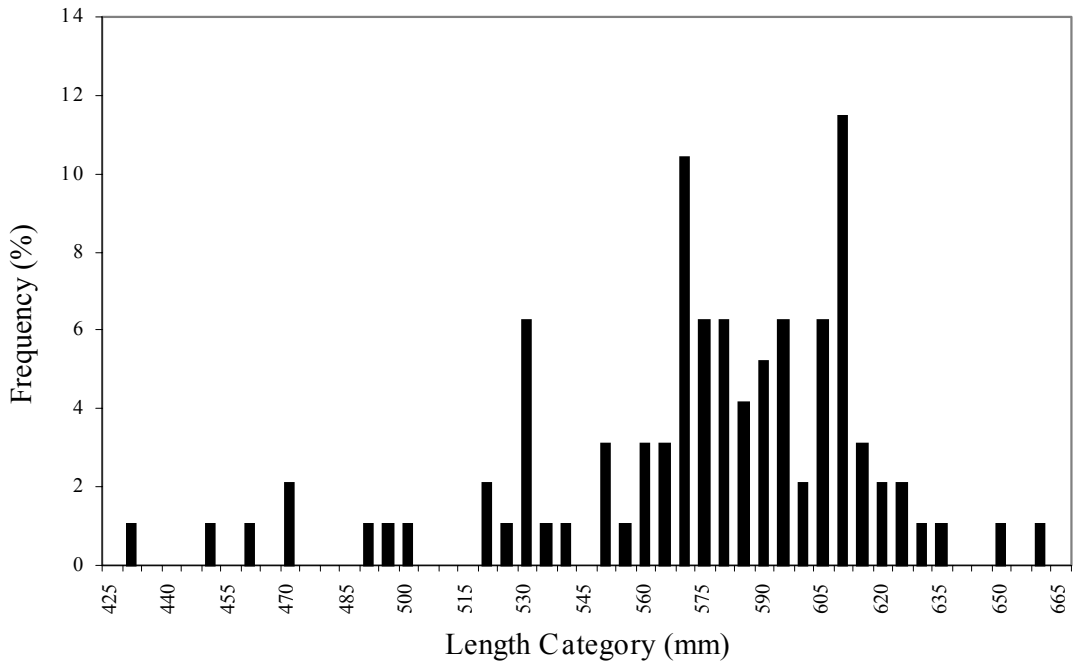

Figure 5. Length-frequency distribution of sockeye salmon implanted with radio transmitters at the Chignik weir, 2002.

Clark River Escapement Monitoring

There was considerable difficulty in estimating sockeye and coho salmon escapement in the Clark River in 2002. Training for the local hires from Chignik Lake was provided on 16 September which included setting up reaches on the Clark River, identifying and enumerating salmon, and proper recording of data and observation conditions. The initial training also included walking the lower 4.5 km of the Clark River, and 4,400 sockeye salmon were observed. After the initial training, logistical difficulties and high water events prevented the local hires from accomplishing the objective; no foot surveys were completed on the Clark River in 2002.

Discussion

Five sockeye salmon expelled their transmitters at the weir in 2002 (5% tag loss). This number is similar to other studies using esophageal tags on sockeye salmon. Ramstad and Woody (*In press*) had 98% tag retention over a 33 d observation period for sockeye salmon implanted with different sized esophageal tags. Ramstad and Woody (*In press*) found that fish size could have been a factor in their one observed tag loss, as the fish that

regurgitated its tag was one of the smallest in their study group (fork length 586 mm). Four of the five sockeye salmon that regurgitated their tags in this study were less than 580 mm in length (mid-eye-to-fork length, Appendix A). Another factor that could have influenced tag retention might have been poor tagging technique. Numerous personnel (both USFWS and ADFG) tagged fish during the course of this project, and lack of adequate training or practice may have been a factor. Three of the five fish that expelled their tags were tagged within two days of each other (Table 10). All sockeye salmon tagged by Ramstad and Woody (*In press*) were tagged by the same person over the course of a three year experiment.

Six sockeye salmon were never detected following their successful release above the weir. The tags were functional when the fish were released, although they may have become defective soon after release. We did find two tags that became defective prior to implanting into fish, although it is unlikely that all six were defective. These six fish may have experienced a behavioral response to the tagging event, and could have migrated back to salt water following tagging. The seven fish whose locations were unknown were tracked successfully through the Chignik River before entering Chignik Lake, but were never located once they exited the Chignik River. We believe they did exit the Chignik River, as they were no longer detected in the river. These fish may have been too deep to detect whenever a search was being conducted, and were thus never detected after leaving the river. They also may have been harvested by subsistence fishers or predators, but their final locations remain unknown.

The assumptions necessary to estimate proportional escapement to different areas in the Chignik Lake/Black Lake system include: 1) no selectivity, relative to final tag location, of fish tagged at the weir, 2) final tag locations are correctly identified, and 3) tracking of fish is independent of location. We attempted to meet the first assumption by deploying tags in proportion to abundance. Although there was a slight time lag in the abundance estimate used for deploying tags and the actual deployment of tags, this effect was minimal (Figure 3). The confidence associated with the final tag locations (Assumption #2) is outlined in the Methods section and summarized in Appendix B for individual fish. In general, we are confident of our ability to identify final locations of fish in tributary streams, but not as confident for fish within Chignik Lake and the Black River (including the Delta). This is primarily due to the differences in tracking conditions in the different areas (Assumption #3), and to the lack of focused effort in tracking fish above the lake. In Chignik Lake, the size and depth of the lake made it possible for a tagged fish to escape detection on any given occasion by being either too deep in the lake to detect or in areas that were not our focus for tracking. If all tagged fish in Chignik Lake were equally vulnerable to detection on all occasions, Table 3 would include more detections per tracking event within the lake. Tracking effort within Chignik Lake was equal for all occasions, except when weather prevented accessing certain areas (Table 3). The low confidence for final locations in the Black River is primarily due to the infrequent surveys

Table 10. Tag dates and numbers of sockeye salmon tagged at the Chignik weir that were not successfully tracked, 2002.

Tag Date	Expelled	Never Detected	Unknown Final Location[a]
7/31	--	--	--
8/1	--	--	--
8/2	--	--	--
8/3	--	1	--
8/4	--	--	--
8/5	--	--	--
8/6	--	--	--
8/7	--	--	--
8/8	--	--	--
8/9	--	--	--
8/10	1	1	--
8/11	2	--	1
8/12	--	--	--
8/13	--	--	--
8/14	--	--	--
8/15	--	--	--
8/16	1	--	--
8/17	--	--	--
8/18	--	--	--
8/19	--	--	--
8/20	--	--	--
8/21	--	--	--
8/22	--	--	--
8/23	--	--	--
8/25	--	--	1
8/26	1	--	--
8/27	--	--	1
8/28	--	2	1
8/29	--	--	--
8/31	--	--	--
9/1	--	--	1
9/3	--	1	--
9/4	--	--	--
9/11	--	1	2
Total:	5	6	7

[a] These fish were tracked in the Chignik River, but were not found again after leaving the river.

of the Black River tributaries. Only four surveys were conducted on the Black River, and only the three aerial surveys covered the entire drainage (Table 3). Effort in 2002 was focused on Chignik Lake, as that is where subsistence harvest occurs.

There were few apparent trends in the run timing of sockeye salmon past the Chignik weir in August and early September. Fish that migrated to areas within Chignik Lake moved past the weir uniformly throughout August (Table 11). Sockeye salmon that ended up in areas outside of Chignik Lake also moved past the Chignik weir throughout August (Table 12). No apparent trends were evident based on age (Table 13) or sex (Table 14) of sockeye salmon. One exception to this generality was the four sockeye salmon that ended up in the West Fork: all were tagged at the weir on or before 4 August (Table 12).

Another exception was the sockeye salmon that migrated up the Clark River. All five sockeye salmon that ended up in the Clark River were tagged after 21 August, and four of the five were tagged after 29 August (Tables 9 and 11). All five Clark River fish also moved past the remote data logger site after 10 October (Table 9), so it appears that they spent a minimum of one month in Chignik Lake before migrating up the Clark River to spawn. As the stream walking surveys were unsuccessful this year, it is unknown whether or not the run up the Clark River in mid-October is the beginning, peak, or end of the run. Sockeye salmon were observed in the Clark River throughout the season in 2002; fish were observed in the river at the end of July when the remote sites were being set up, over 4,000 sockeye salmon were counted in the lower 4.5 km of the Clark River in mid-September when the stream walking surveys began, and sockeye salmon were observed in the river during the final aerial survey in mid-December. Without additional information from the stream walking surveys, it is difficult to determine whether or not the sockeye salmon tagged at the end of August and early September represent the entire run of Clark River fish, or just the beginning of the run. From the 2002 data, it appears that the late run of Clark River sockeye salmon are just entering the system as the Chignik weir is being removed in early September.

The distribution of radio-tagged sockeye salmon in 2002 correlates well with the current scale pattern analysis model used by ADFG for in-season management at the Chignik weir. The scale pattern analysis model relies on differential growth between juvenile sockeye salmon rearing in Black Lake and those rearing in Chignik Lake; sockeye salmon fry rearing in Black Lake emerge earlier and grow at a faster rate than fry rearing in Chignik Lake (Owen et al. 2000). Currently, ADFG manages the Chignik weir escapement after 30 July assuming approximately 100% of the sockeye salmon are destined for Chignik Lake (Owen et al. 2000). Based on our results in 2002, only three of the 78 sockeye salmon successfully tracked to final locations would have reared outside of Chignik Lake as juveniles: the two fish in the Alec River and the one fish that spawned in the Chignik River (Table 4; Figure 4).

Table 11. Tag dates and final locations of sockeye salmon tagged at the Chignik weir that were within Chignik Lake and the Clark River, 2002.

Tag Date	Clark Beach	Clark River	Cucumber Beach	Hatchery Beach	Upper Chignik Lake
7/31	2	--	--	--	--
8/1	--	--	--	--	--
8/2	1	--	--	1	--
8/3	--	--	--	1	--
8/4	--	--	--	--	--
8/5	1	--	--	--	--
8/6	1	--	--	2	--
8/7	--	--	--	1	--
8/8	--	--	--	1	--
8/9	--	--	--	3	--
8/10	--	--	--	2	--
8/11	--	--	--	--	--
8/12	--	--	--	3	--
8/13	1	--	--	--	--
8/14	1	--	--	2	--
8/15	--	--	--	1	--
8/16	--	--	--	1	--
8/17	1	--	--	--	--
8/18	1	--	--	1	--
8/19	--	--	--	2	--
8/20	--	--	--	2	--
8/21	--	1	--	--	--
8/22	--	--	1	--	1
8/23	1	--	--	--	--
8/25	--	--	--	2	--
8/26	--	--	--	1	1
8/27	--	--	--	1	--
8/28	--	--	--	--	--
8/29	--	1	--	2	--
8/31	3	1	--	1	--
9/1	--	--	--	2	--
9/3	1	1	--	1	--
9/4	--	1	--	3	--
9/11	--	--	--	--	--
Total:	14	5	1	36	2

Table 12. Tag dates and final locations of sockeye salmon tagged at the Chignik weir that were outside of Chignik Lake, 2002.

Tag Date	Alec River	Bearskin Creek	Delta	Chiaktuak Creek	Chignik River	Black River	West Fork
7/31	--	--	--	--	--	--	1
8/1	--	--	--	2	--	1	--
8/2	--	--	--	--	--	--	1
8/3	--	--	--	--	--	--	1
8/4	--	--	--	--	--	--	1
8/5	--	--	--	--	--	--	--
8/6	--	--	--	--	--	--	--
8/7	--	--	--	--	--	--	--
8/8	--	--	--	--	--	--	--
8/9	--	--	--	--	--	--	--
8/10	--	--	1	--	--	--	--
8/11	--	--	--	--	--	--	--
8/12	--	--	--	1	--	--	--
8/13	--	--	--	--	--	1	--
8/14	--	--	--	--	--	--	--
8/15	--	--	--	--	--	--	--
8/16	--	--	--	--	--	--	--
8/17	--	--	1	--	--	--	--
8/18	--	--	--	--	--	--	--
8/19	--	--	--	--	1	--	--
8/20	--	--	--	--	--	--	--
8/21	--	--	--	--	--	1	--
8/22	--	--	--	--	--	--	--
8/23	1	--	--	--	--	--	--
8/25	--	--	--	--	--	--	--
8/26	--	--	--	--	--	--	--
8/27	--	--	--	--	--	--	--
8/28	--	--	--	--	--	1	--
8/29	--	--	--	--	--	--	--
8/31	--	--	1	--	--	--	--
9/1	--	--	--	--	--	--	--
9/3	1	1	1	--	--	1	--
9/4	--	--	--	--	--	--	--
9/11	--	--	--	--	--	--	--
Total:	2	1	4	3	1	5	4

Table 13. Age composition by location for sockeye salmon tagged at the Chignik weir, 2002.

	Age						
Final Location	Unreadable	1.2	1.3	1.4	2.2	2.3	2.4
Clark Beach	--	1	5	1	1	6	--
Clark River	--	1	1	1	--	2	--
Cucumber Beach	--	--	1	--	--	--	--
Hatchery Beach	5	1	14	2	--	12	2
Upper Chignik Lake	--	2	--	--	--	--	--
Alec River	2	--	--	--	--	--	--
Bearskin Creek	--	--	1	--	--	--	--
Delta	--	--	2	1	--	1	--
Chiaktuak Creek	--	1	1	--	--	1	--
Chignik River	--	--	--	--	--	1	--
Black River	--	--	2	--	--	3	--
West Fork	--	--	4	--	--	--	--
Expelled	--	1	2	--	2	--	--
Never Detected	1	--	2	--	1	2	--
Unknown	1	--	3	--	--	3	--
Total:	9	7	38	5	4	31	2

Table 14. Sex composition by location for sockeye salmon tagged at the Chignik weir, 2002.

	Sex	
Final Location	Female	Male
Clark Beach	8	6
Clark River	1	4
Cucumber Beach	--	1
Hatchery Beach	19	17
Upper Chignik Lake	2	--
Alec River	2	--
Bearskin Creek	--	1
Delta	3	1
Chiaktuak Creek	1	2
Chignik River	1	--
Black River	3	2
West Fork	3	1
Expelled	3	2
Never Detected	4	2
Unknown	4	3
Total:	54	42

In general, the age composition for sockeye salmon in Black Lake is typically dominated by ages 1.3 and 1.2 fish, and the Chignik Lake run by ages 2.3 and 2.2 fish (Owen et al. 2000). Although age 1.3 fish early in the season are primarily believed to be destined for Black Lake, age 1.3 are common in Chignik Lake. In 1984, age 1.3 fish represented 45.3% of the estimated Chignik Lake total escapement, and age 2.3 fish represented 44.8% of the estimated Chignik Lake total escapement (Conrad and Ruggerone 1985). Owen et al. (2000) also report similar contributions of age 1.3 and 2.3 sockeye salmon to the total Chignik Lake escapement in some years, and the percent composition of the 1.3 and 2.3 age classes are variable between years (Table 15). In 2002, age 1.3 (43.7%) and 2.3 (35.6%) sockeye salmon made up the majority of the fish tagged with radio transmitters (total of 79%, Table 8), and these two age classes have been found to represent over 90% of the total catch and escapement for the Chignik Lake system in some years (Conrad and Ruggerone 1985). All but one of those fish would be considered part of the Chignik Lake run by ADFG; the two fish that spawned in the Alec River both had scales that were unreadable, leaving the one fish that spawned in the Chignik River (age 2.3, Table 13). Data for the actual ADFG post-season analysis of scale samples were not available at the time of this report, so comparisons with the overall age composition of the sockeye salmon run past the Chignik weir in August and early September were not possible.

High water caused problems for the project after mid-October. After 15 October, water levels came up considerably in Chignik Lake and the Clark River making it difficult to access the remote sites and also to safely wade the Clark River to do stream walking surveys. As mentioned, the high water also flooded the remote site on Home Creek. It is unknown what effect the high water may have had on the sockeye salmon runs in Chignik Lake and the Clark River. The high water may have also contributed to the difficulty of subsistence fishers in harvesting sufficient numbers of sockeye salmon in 2002. As water levels in Chignik Lake were elevated after mid-October, traditional gill nets that the fishermen use may not have been fishing deep enough to successfully entangle sockeye salmon.

An actual escapement estimate for the Clark River run is planned for the fall of 2003. Stream walk surveys will begin in mid-August and run through mid-December so that the entire run may be estimated. The stream walk surveys will also identify any peaks in the run. Logistical issues have been resolved so that next year the surveys will be prepared for any problems that may arise.

Table 15. Numbers and percent composition of age 1.3 and 2.3 sockeye salmon in relation to the total estimated Chignik Lake escapement, 1985-1990. Adapted from Owen et al. (2000).

		Age 1.3		Age 2.3	
Brood Year	Total Escapement	Escapement	Percent	Escapement	Percent
1985	890,039	174,283	19.6	501,843	56.4
1986	1,240,139	345,786	27.9	497,777	40.1
1987	1,902,342	457,744	24.1	1,037,042	54.5
1988	702,692	295,438	42.0	206,346	29.4
1989	1,886,492	273,461	14.5	1,202,092	63.7
1990	1,074,421	366,364	34.1	463,728	43.2

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Appendix A. Tag date, sex, length (mm), age, tag frequency, and final location for sockeye salmon tagged at the Chignik weir, 2002.

Fish #	Tag Date	Stratum	Sex	Length (mm)	Age	Tag Frequency	Final Location
1	7/31	1	F	583	1.3	164.504	West Fork
2	7/31	1	M	587	2.3	164.335	Clark Beach
3	7/31	1	F	588	2.3	165.105	Clark Beach
4	8/1	1	M	427	1.2	164.844	Chiaktuak Creek
5	8/1	1	F	560	1.3	164.414	Black River
6	8/1	1	F	593	2.3	164.894	Chiaktuak Creek
7	8/2	1	F	547	1.3	164.156	West Fork
8	8/2	1	F	552	2.3	164.586	Clark Beach
9	8/2	1	F	564	2.3	165.212	Hatchery Beach
10	8/3	1	M	571	2.3	164.953	Hatchery Beach
11	8/3	1	F	518	2.3	165.006	Never Detected
12	8/3	1	F	595	1.3	165.113	West Fork
13	8/4	1	M	576	1.3	164.045	West Fork
14	8/5	1	M	610	2.3	164.903	Clark Beach
15	8/6	1	M	608	Unreadable	165.043	Hatchery Beach
16	8/6	1	M	575	1.3	165.133	Clark Beach
17	8/6	1	F	565	1.3	164.165	Hatchery Beach
18	8/7	1	F	530	1.3	165.055	Hatchery Beach
19	8/8	1	M	615	2.3	164.204	Hatchery Beach
20	8/9	1	F	568	1.3	164.243	Hatchery Beach
21	8/9	1	M	570	1.3	164.514	Hatchery Beach
22	8/9	1	M	607	1.3	165.084	Hatchery Beach
23	8/10	2	M	602	1.3	164.544	Never Detected
24	8/10	2	F	556	1.3	164.755	Delta
25	8/10	2	M	608	1.3	164.433	Expelled
26	8/10	2	F	573	2.3	165.183	Hatchery Beach
27	8/10	2	M	608	1.3	164.094	Hatchery Beach
28	8/11	2	M	590	1.3	165.864	Unknown
29	8/11	2	F	575	1.3	164.913	Expelled
30	8/11	2	F	490	2.2	164.285	Expelled
31	8/12	2	F	575	1.3	165.142	Hatchery Beach
32	8/12	2	M	540	1.3	164.033	Chiaktuak Creek
33	8/12	2	M	597	1.3	164.194	Hatchery Beach
34	8/12	2	M	619	2.3	164.994	Hatchery Beach
35	8/13	2	M	613	2.3	164.455	Black River
36	8/13	2	M	562	1.3	164.665	Clark Beach
37	8/14	2	M	603	2.3	164.484	Hatchery Beach

Appendix A. Continued.

Fish #	Tag Date	Stratum	Sex	Length (mm)	Age	Tag Frequency	Final Location
38	8/14	2	M	660	1.4	165.192	Hatchery Beach
39	8/14	2	F	560	1.4	164.055	Clark Beach
40	8/15	2	M	595	2.3	165.242	Hatchery Beach
41	8/16	2	M	580	1.3	164.834	Hatchery Beach
42	8/16	2	M	468	1.2	164.343	Expelled
43	8/17	2	F	568	2.3	164.785	Clark Beach
44	8/17	2	F	548	1.3	164.305	Delta
45	8/18	2	M	578	1.3	164.464	Clark Beach
46	8/18	2	F	593	1.3	165.163	Hatchery Beach
47	8/19	2	M	585	2.3	165.153	Hatchery Beach
48	8/19	2	F	590	2.3	164.064	Hatchery Beach
49	8/19	2	F	585	2.3	164.385	Lower River
50	8/20	3	F	605	2.3	164.815	Hatchery Beach
51	8/20	3	F	570	1.3	164.144	Hatchery Beach
52	8/21	3	F	530	2.3	164.254	Black River
53	8/21	3	M	535	2.3	165.021	Clark River
54	8/22	3	M	590	1.3	165.033	Cucumber Beach
55	8/22	3	F	500	1.2	164.935	Upper Chignik Lake
56	8/23	3	M	495	1.3	164.116	Clark Beach
57	8/23	3	F	580	Unreadable	164.605	Alec River
58	8/25	3	F	573	1.3	165.233	Unknown
59	8/25	3	F	568	1.3	164.654	Hatchery Beach
60	8/25	3	F	601	2.3	164.136	Hatchery Beach
61	8/26	3	F	450	1.2	164.394	Upper Chignik Lake
62	8/26	3	F	459	Unreadable	164.634	Hatchery Beach
63	8/26	3	F	470	2.2	164.864	Expelled
64	8/27	3	M	610	1.3	164.404	Unknown
65	8/27	3	M	570	Unreadable	164.703	Hatchery Beach
66	8/28	3	F	610	2.3	164	Never Detected
67	8/28	3	M	615	1.3	164.563	Black River
68	8/28	3	F	610	2.3	164.764	Unknown
69	8/28	3	M	610	Unreadable	164.793	Never Detected
70	8/29	3	F	570	2.3	164.264	Hatchery Beach
71	8/29	3	M	530	1.2	164.314	Clark River
72	8/29	3	M	520	1.2	164.853	Hatchery Beach
73	8/31	4	F	623	2.3	164.015	Delta
74	8/31	4	F	529	1.2	164.083	Clark Beach
75	8/31	4	M	524	1.3	164.442	Clark River

Appendix A. Continued.

Fish #	Tag Date	Stratum	Sex	Length (mm)	Age	Tag Frequency	Final Location
76	8/31	4	F	568	1.4	164.534	Hatchery Beach
77	8/31	4	F	605	1.3	164.744	Clark Beach
78	8/31	4	F	529	2.2	165.092	Clark Beach
79	9/1	4	F	607	2.4	164.215	Hatchery Beach
80	9/1	4	M	601	2.3	164.365	Unknown
81	9/1	4	F	569	Unreadable	164.555	Hatchery Beach
82	9/3	4	F	620	2.3	164.355	Clark Beach
83	9/3	4	M	625	1.3	164.594	Hatchery Beach
84	9/3	4	M	650	1.4	164.614	Delta
85	9/3	4	F	580	2.3	164.643	Black River
86	9/3	4	F	585	1.3	164.683	Never Detected
87	9/3	4	F	635	2.3	164.718	Clark River
88	9/3	4	F	600	Unreadable	164.733	Alec River
89	9/3	4	M	630	1.3	164.884	Bearskin Creek
90	9/4	4	M	550	1.4	164.185	Clark River
91	9/4	4	F	595	2.4	164.494	Hatchery Beach
92	9/4	4	F	570	1.3	164.695	Hatchery Beach
93	9/4	4	M	595	Unreadable	164.965	Hatchery Beach
94	9/11	4	F	530	2.2	164.234	Never Detected
95	9/11	4	F	580	2.3	164.803	Unknown
96	9/11	4	F	610	Unreadable	164.983	Unknown

Appendix B. Summary of tag detections and confidence in assigning final locations to sockeye salmon tagged with radio transmitters in 2002.

Tag Frequency	Tag Date	Final Location	Detections at Final Location	Confidence
Terminal spawning tributaries				
164.605	23-Aug-02	Alec River	1	High
164.733	3-Sep-02	Alec River	2	High
164.884	3-Sep-02	Bearskin	1	High
164.033	12-Aug-02	Chiaktuak Creek	2	High
164.844	1-Aug-02	Chiaktuak Creek	2	High
164.894	1-Aug-02	Chiaktuak Creek	2	High
164.045	4-Aug-02	West Fork	1	High
164.156	2-Aug-02	West Fork	1	High
164.504	31-Jul-02	West Fork	1	High
165.113	3-Aug-02	West Fork	1	High
164.185	4-Sep-02	Clark River	2	High
164.314	29-Aug-02	Clark River	2	High
164.442	31-Aug-02	Clark River	2	High
164.718	3-Sep-02	Clark River	1	High
165.021	21-Aug-02	Clark River	2	High
Main river areas				
164.385	19-Aug-02	Chignik River	9	High
164.455	13-Aug-02	Black River	1	Low
164.643	3-Sep-02	Black River	1	Low
164.254	21-Aug-02	Black River	2	Medium
164.414	1-Aug-02	Black River	2	Medium
164.563	28-Aug-02	Black River	2	Medium
164.015	31-Aug-02	Delta	1	Low
164.305	17-Aug-02	Delta	1	Low
164.614	3-Sep-02	Delta	1	Low
164.755	10-Aug-02	Delta	1	Low
Chignik Lake				
164.083	31-Aug-02	Clark Beach	1	Low
164.335	31-Jul-02	Clark Beach	1	Low
164.355	3-Sep-02	Clark Beach	1	Low
164.665	13-Aug-02	Clark Beach	1	Low
164.903	5-Aug-02	Clark Beach	1	Low
165.092	31-Aug-02	Clark Beach	1	Low
164.116	23-Aug-02	Clark Beach	2	Medium

Appendix B. continued.

Tag Frequency	Tag Date	Final Location	Detections at Final Location	Confidence
165.105	31-Jul-02	Clark Beach	2	Medium
164.055	14-Aug-02	Clark Beach	11	High
164.464	18-Aug-02	Clark Beach	5	High
164.586	2-Aug-02	Clark Beach	9	High
164.744	31-Aug-02	Clark Beach	4	High
164.785	17-Aug-02	Clark Beach	5	High
165.133	6-Aug-02	Clark Beach	5	High
164.144	20-Aug-02	Hatchery Beach	1	Low
164.194	12-Aug-02	Hatchery Beach	1	Low
164.215	1-Sep-02	Hatchery Beach	2	Low
164.264	29-Aug-02	Hatchery Beach	1	Low
164.494	4-Sep-02	Hatchery Beach	1	Low
164.514	9-Aug-02	Hatchery Beach	1	Low
164.534	31-Aug-02	Hatchery Beach	1	Low
164.555	1-Sep-02	Hatchery Beach	2	Low
164.594	3-Sep-02	Hatchery Beach	1	Low
164.695	4-Sep-02	Hatchery Beach	1	Low
164.703	27-Aug-02	Hatchery Beach	1	Low
165.192	14-Aug-02	Hatchery Beach	1	Low
165.212	2-Aug-02	Hatchery Beach	1	Low
165.242	15-Aug-02	Hatchery Beach	1	Low
164.094	10-Aug-02	Hatchery Beach	2	Medium
164.165	6-Aug-02	Hatchery Beach	2	Medium
164.484	14-Aug-02	Hatchery Beach	3	Medium
164.634	26-Aug-02	Hatchery Beach	2	Medium
164.815	20-Aug-02	Hatchery Beach	3	Medium
164.853	29-Aug-02	Hatchery Beach	2	Medium
164.965	4-Sep-02	Hatchery Beach	3	Medium
164.994	12-Aug-02	Hatchery Beach	2	Medium
165.055	7-Aug-02	Hatchery Beach	2	Medium
165.084	9-Aug-02	Hatchery Beach	2	Medium
165.142	12-Aug-02	Hatchery Beach	2	Medium
165.153	19-Aug-02	Hatchery Beach	3	Medium
164.064	19-Aug-02	Hatchery Beach	8	High
164.136	25-Aug-02	Hatchery Beach	5	High
164.204	8-Aug-02	Hatchery Beach	4	High

Appendix B. continued.

Tag Frequency	Tag Date	Final Location	Detections at Final Location	Confidence
164.243	9-Aug-02	Hatchery Beach	2	High
164.654	25-Aug-02	Hatchery Beach	6	High
164.834	16-Aug-02	Hatchery Beach	4	High
164.953	3-Aug-02	Hatchery Beach	9	High
165.043	6-Aug-02	Hatchery Beach	10	High
165.163	18-Aug-02	Hatchery Beach	6	High
165.184	10-Aug-02	Hatchery Beach	4	High
165.033	22-Aug-02	Cucumber Beach	1	Low
164.935	22-Aug-02	Upper Chignik Lake	1	Low
164.394	26-Aug-02	Upper Chignik Lake	3	Medium