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Sonar Enumeration of Pacific Salmon Escapement Into The Nushagak River, 2003

by

Chuck Brazil

June 2007

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Alaska Department of Fish and Game
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ABSTRACT

Hydroacoustic techniques were used to develop escapement estimates of sockeye *Oncorhynchus nerka*, Chinook *O. tshawytscha*, and chum salmon *O. keta*, for the Nushagak River in Bristol Bay, Alaska, from 07 June through 20 July, 2003. Estimates of species, age, sex, and size composition were derived from samples obtained with drift gillnets at the sonar site. Final escapement estimates through 20 July were 580,534 sockeye, 80,028 Chinook, and 295,413 chum salmon. Escapement run timing of sockeye salmon was 6-8 days earlier and Chinook salmon was similar to the 1990-2002 average. The major age classes estimated for sockeye salmon were ages 1.3 (84.8%) and 1.2 (6.1%) and the major age classes for Chinook salmon were comprised of ages 1.3 (44.1%), 1.2 (27.3%), and 1.4 (26.7%). During 2003 comparative studies on the Nushagak River were conducted using a standard range (SR) dual frequency identification sonar (DIDSON) to determine whether the DIDSON would be a viable replacement of Bendix sonars currently used to estimate salmon passage.

Key words: Pacific salmon, sonar, Nushagak River, Bristol Bay, escapement, estimation, fisheries management, *Oncorhynchus*.

INTRODUCTION

The purpose of this study is to estimate the escapement of three species of Pacific salmon *Oncorhynchus spp.* for the Nushagak River in Bristol Bay, Alaska: Chinook (*O. tshawytscha*), chum (*O. keta*), and sockeye (*O. nerka*) salmon. This project provides escapement estimates that are used to assess daily run strength and set escapement goal information that is critical to the management of local salmon fisheries.

Previously, coho and pink salmon were also assessed in late July and August, but with declining budgets, the project duration was reduced from around 20 August to 20 July. Although some pink and coho salmon may be present prior to July 20, their assessment is limited. On average, more than 96% of the sockeye, Chinook, and chum salmon passage occurs before 20 July.

In 1979, the Alaska Department of Fish and Game (ADF&G) examined the feasibility of using hydroacoustic (sonar) equipment on the Nushagak River and began developing techniques to estimate adult salmon abundance (McBride 1981). During subsequent years, the Nushagak River sonar project has evolved to provide daily escapement information important to the inseason management of commercial salmon fishing in the Nushagak District.

All hydroacoustic estimates in 2003 were made using Bendix¹ sonar equipment; however, the sonar project is currently in a state of transition. With the recent retirement of Al Menin, the engineer who designed, built, and maintained the Bendix sonar, the Bendix Corporation no longer manufactures nor supports these systems and there are limited replacements. In addition, the Bendix type sonar equipment has several limitations for estimating salmon escapement such as limited range, and inability to determine direction of travel (upstream or downstream). Further, signal processing occurs in short term memory with no storage mechanism for the raw signal and the system was designed to produce only a final count. Therefore, counts cannot be reviewed or reproduced later. These circumstances have led the ADF&G to conduct comparative studies to replace Bendix sonar systems on the Nushagak River.

In 2002, the ADF&G tested the feasibility of estimating migrating adult salmon in the Wood and Copper Rivers, using a standard range (SR) dual frequency identification sonar (DIDSON) to determine whether the DIDSON would be a viable replacement for the existing and older Bendix sonars (Maxwell and Gove 2002). DIDSON is a high frequency, multi-beam sonar with a

¹ Product names used in this report are included for scientific completeness but do not constitute a product endorsement.

unique acoustic lens system designed to focus the beam to create high-resolution images. Originally developed by the University of Washington Applied Physics Lab (APL) to allow divers to identify mines in turbid waters, the DIDSON creates video-like images (Belcher et al. 2001; Belcher et al. 2002).

During the 2003 field season, the standard DIDSON was deployed on the left bank (facing downriver) of the Nushagak River in a comparative study alongside the Bendix (Maxwell et al. *In prep*). The SR DIDSON operated at two frequencies, 1.80 MHz with range settings to 10 meters and 1.10 MHz with range settings to 36 meters, providing approximately the same coverage as the Bendix sonar counter. Additional comparisons of hydroacoustic estimates between the Bendix and DIDSON sonar systems will be made in future years.

OBJECTIVES

Project objectives in 2003 were to:

- 1) Estimate the number of adult sockeye, chum, and Chinook salmon in the Nushagak River from early June through 20 July such that the escapement estimates are within +/- 10% of the true value 90% of the time;
- 2) Estimate the proportion of each of the major age classes of sockeye salmon (1.2, 2.2, 1.3, 2.3) in the Nushagak River during three time strata (early, middle, and late) to within 5% of the true proportion 90% of the time;
- 3) Estimate the proportion of each of the major age classes of Chinook and chum salmon in the Nushagak River to within 5% of the true proportion 90% of the time;
- 4) Estimate the sex compositions of the escapements of sockeye, chum, and Chinook salmon in the Nushagak River; and
- 5) Estimate the mean length by age of the escapements of sockeye, chum, and Chinook salmon in the Nushagak River.

METHODS

STUDY SITE

The Nushagak River is located in southwestern Alaska and flows approximately 390 km from its headwaters to Bristol Bay (Figure 1). The Nushagak drainage has two main tributaries: the Nuyakuk River, draining Tikchik Lakes, which enter from the west, and the Mulchatna River, which flows into the Nushagak from the east. These rivers support large runs of five species of Pacific salmon (sockeye, Chinook, chum, pink, and coho) as well as several resident species that are harvested in commercial, sport and subsistence fisheries.

The project site was located on the lower Nushagak River, approximately 40 km upstream from the terminus of the Nushagak commercial fishing district and 4 km downstream from the village of Portage Creek (Figure 1). Almost the entire river is contained to one 300 m wide channel with the exception of one very small slough behind the camp. The site is influenced by tides that cause a reduction of current during high tide; however there is rarely a reversal of flow and there appears to be few fish milling in the area. Stock identification studies based on scale pattern

analysis (Robertson 1984) indicated that the majority (93%) of the fish migrating past Portage Creek were destined for the Nushagak, Mulchatna, or Nuyakuk Rivers. Therefore, very few fish migrating through the sonar are assumed to be stray fish from other rivers, which might migrate downstream later.

PROJECT DATES

Project operation dates have varied over the years. From 1982–2002, with the exception of 1992, operation dates extended from early June to at least 17 August each season. In 1992, the project terminated on 22 July due to budget shortfalls. Similarly, the project terminated on 20 July in 2003 because of declining budgets.

HYDROACOUSTIC ESTIMATES

The sonar equipment used for the estimation of the Nushagak salmon run from 1979 to 2003 (King and Tarbox 1989) consisted of an echo counter and transducer manufactured by Bendix Corporation, an oscilloscope, and a power supply (12 volt battery with solar panel). Both an inshore and offshore Bendix system was implemented on each bank of the river for a total of four systems. Inshore echo counters used a make/model that divided the counting range into 12 sectors; offshore counters divided the counting range into 16 sectors. All Bendix echo counters operate at 515 kHz with a pulse width of 100- μ s and alternate between a 2° and 4° beam size. Pulse repetition rate, counting range, and sensitivity were adjustable.

Placement of the transducers and counting ranges were determined by the river bottom contour. Slope changes in the river bottom contour required the deployment of 2 transducers (inshore and offshore) on each riverbank. Offshore transducers, located where the slope of the river bottom changed, were aimed perpendicular to the water flow and towards the middle of the river. Inshore transducers were deployed within 10 m of shore in water of sufficient depth for fish passage and counted out to the offshore transducer.

Transducers were mounted on metal tripods and aimed, with the aid of an oscilloscope, to ensonify the lower portion of the water column. The majority of the upstream migrating salmon are assumed to travel close to the river bottom due to reduction of water resistance. In a previous experiment, it was suggested that over 88% of the fish occupied the lower two-fifths of the water column at the Nushagak River sonar site (Minard 1985). Offshore transducers were aimed with remote-controlled pan and tilt rotators, whereas inshore transducers were aimed manually adjusting the angle of the transducer mounts on the tripods. A picket weir was constructed from the shore to just beyond the inshore transducer on both riverbanks to prevent fish from passing behind the transducers or within approximately 1 m of the transducer face, an area in which the system may not detect fish.

Pulse repetition rate was adjusted on each counter to maintain counting precision at $\pm 90\%$, using calibration procedures described by Minard and Frederickson (1983). Counters were calibrated by comparing the output counts recorded by the sonar counter to those recorded by a trained technician observing an oscilloscope pattern of the signal received by that counter. Counts from the oscilloscope were hand tallied for either a 10-min period or 100 counts whichever came first. At the end of the counting interval, the Oscilloscope count was divided by the Bendix count to yield a percent agreement between the two. If the percent agreement was less than 90% or greater than 110% the pulse repetition rate was adjusted until an acceptable percent agreement was achieved. Counters were calibrated throughout the day between 0600 and 2400 hours. Frequency of calibrations was somewhat dependent upon fish passage rates and the variability of fish swimming

speeds; there was at least one calibration per hour during periods of peak fish passage. Sonar count data were summarized by sector, counter location (inshore, offshore, left, or right bank), hour, and day to evaluate spatial and temporal distributions of sonar counts.

SPECIES COMPOSITION SAMPLING

Daily sonar counts were apportioned among salmon species based on species proportions in samples collected with 18.3-m (10 fathom) drift gillnets with mesh sizes of 20.6 cm (8.125 in), 15.2 cm (6.0 in), and 13.0 cm (5.125 in). All gillnets were composed of mono twist filament webbing dyed either Momoi shade #3 or Tairyo shade #T-14 (both were translucent light green). Twine size was dependent upon mesh size with 13.0-cm and 15.2-cm mesh gillnets having a Momoi #63 twine size, and 20.6-cm mesh gillnets having a Momoi #93 or equivalent twine size. Gillnet depth was 45 mesh (approximately 4–5 m deep) for the 13.0-cm mesh gillnets, 45 mesh for the 15.2-cm mesh gillnets, and 29 mesh (approximately 5-6 m deep) for the 20.6-cm mesh gillnets. Each gillnet was deep enough to fully sample the entire water column.

Sampling with gillnets occurred just downstream of the transducers so catches would represent the relative abundance of fish passing through the sonar beams. Because of the possibility that species composition was different between the inshore and offshore counting ranges, separate samples were collected. Inshore drifts with gillnets were started with one end on the bank, while offshore drifts were started with the near shore end of the net approximately the same distance from shore as the offshore transducer. For estimating species composition, four area strata were defined (1 = left inshore, 2 = left offshore, 3 = right inshore, 4 = right offshore).

Each gillnet mesh was fished for a minimum of two drifts inshore and two drifts offshore on each bank during each set of drifts. During the period of peak sockeye salmon passage (17 June–15 July), drift sessions were conducted three times daily: morning (0800–1100 hours), midday (1300–1600 hours), and evening (1800–2100 hours). Prior to 17 June and after 15 July, drift sessions were conducted twice daily: midmorning (0800–1100 hours) and early evening (1600–1900 hours). Drifts were not conducted at night because poor light conditions would make it impossible to maintain a drift within assigned strata. The maximum number of drifts conducted for each mesh size along each banks' inshore and offshore strata was six per day.

The data recorded for each gillnet drift included: (1) date, (2) drift session number (1=morning, 2=afternoon, 3=evening), (3) boat operator, (4) drift number sequentially ordered through season, (5) mesh size, (6) river bank (right or left), (7) location (LBI, left bank-inshore), (8) fishing time, (9) number and species of catch, (10) length of each fish caught: mideye to tail fork to nearest millimeter, and (11) sex as determined from external characteristics, (12) one scale was retained from each sockeye and chum salmon, (13) three scales from each Chinook salmon, and (14) time net start out and time net start in (to the nearest second).

SPECIES COMPOSITION ESTIMATES

Daily estimates of escapement by species were based on sonar count data and catch samples. Daily sonar counts were apportioned to species by bank and counting range. Catch per fathom-hour (CPUE) was estimated for all species of salmon from the four ensonified escapement sampling stations (#1–4) and was used to apportion sonar counts.

Escapement estimates are affected to some degree by the combination of mesh sizes used in apportioning sonar counts. Miller et al. (1994b) and Miller (1995) found no discernable size selectivity for sockeye, chum, or Chinook salmon with 13.0- and 15.2-cm mesh gillnets. The

20.6-cm mesh gillnet, however, tended to select for large sockeye and chum salmon. Therefore, only 13.0- and 15.2-cm mesh data were used to apportion sockeye and chum salmon, while data from all three mesh sizes (13.0-, 15.2-, and 20.6-cm) were used to apportion Chinook salmon (Brannian et al. 1995).

To estimate fishing effort, fishing time (FT) was measured in minutes and seconds and calculated for each drift by:

$$FT = RI - FD \quad (1)$$

where FD was the point in time when the net was fully deployed and RI was the point in time when net retrieval was initiated.

The number of fathom-hours (FH) was then calculated by:

$$FH = \frac{f FT}{60} \quad (2)$$

where f was net length in fathoms (generally 10).

CPUE for each salmon species (group) was based on a specific subset of gillnet mesh sizes, specified later in this report. CPUE for each species (i) on day j in strata k was calculated by summing the number caught (C_{ijkmn}) across mesh size (m) and drift (n):

$$CPUE_{ijk} = \frac{\sum_{m=1}^3 \sum_{n=1}^6 u_{im} C_{ijkmn}}{\sum_{m=1}^3 \sum_{n=1}^6 u_{im} FH_{jkmn}} \quad (3)$$

where u_{im} equals 1 if species i from mesh m is used to estimate species composition, and u_{im} equals 0 otherwise.

CPUE were cumulated across days to create a time (t) and area stratified estimate of species composition. The duration of a time stratum (report period) varied by strata and was specified as an input file. The minimum sample size for each time-area strata was 5 salmon. If less than 5 salmon were captured during a day in an area strata, catches from any gear type, from previous days were accumulated until 5 salmon were obtained from all gear types, to define a reporting period. There are J^{tk} days for period t and strata k . CPUE was used to estimate the proportion of species i in report period t and strata k :

$$CPUE_{itk} = \sum_{j=1}^{J^{tk}} CPUE_{ijk} \quad (4)$$

Estimates of the proportion (S_{itk}) of species i for report period t^k and area strata k were estimated by:

$$\hat{S}_{itk} = \frac{CPUE_{itk}}{\sum_{i=1}^5 CPUE_{itk}} \quad (5)$$

The variance of the \hat{S}_{itk} was estimated assuming that gillnet sampling gear was not selective and probability of capture was equal among the mesh sizes appropriate to a species. The number of each species caught was assumed to have a multinomial distribution. If sampling effort were constant among species, the sample size is equal to the total number of fish caught during the period. However, since a suite of gillnets was used, with 2, 2, and 3 gillnets fished for sockeye, chum, and Chinook salmon, respectively; catch was adjusted based on the relative sampling effort among species. The effective sample size (C_{tk}):

$$C_{tk} = \sum_{i=1}^5 \sum_{j=1}^{j^i} \sum_{m=1}^3 \sum_{n=1}^6 u_{im} C_{ijkmn} w_i \quad (6)$$

where $w_i = 1.0, 1.0, 0.67$ for sockeye, chum, and Chinook salmon, respectively.

The variance of the \hat{S}_{itk} was estimated by:

$$Var(\hat{S}_{itk}) = \frac{\hat{S}_{itk} (1 - \hat{S}_{itk})}{C_{tk} - 1} \quad (7)$$

ESCAPEMENT ESTIMATES

Sonar counts for each area strata (right and left bank, inshore and offshore) were apportioned to species for period t on a daily basis. Time period escapement estimates for each salmon species area strata (\hat{N}_{itk}) were based on estimates of species proportions (\hat{S}_{itk}) from escapement sampling and period sonar counts (\hat{n}_{itk}):

$$\hat{N}_{itk} = \hat{S}_{itk} \hat{n}_{itk} \quad (8)$$

Time period escapement (\hat{N}_{it}) by species will be estimated by summing area strata estimates:

$$\hat{N}_{it} = \sum_{k=1}^4 \hat{N}_{itk} \quad (9)$$

Since the Bendix counts continuously, there was no variance due to sampling, and counts are assumed to be known without error. Where n_{tk} was the sum of hourly counts during period t^k and its variance is zero.

The variance of \hat{N}_{ijk} is:

$$Var(\hat{N}_{ijk}) = \hat{n}_{ik}^2 Var(\hat{S}_{ik}) \quad (10)$$

The total variance, $V(\hat{N}_{it})$, across all strata is:

$$V(\hat{N}_{it}) = \sum_{k=1}^4 Var(\hat{N}_{ik}) \quad (11)$$

Cumulative numbers of salmon will be calculated by summing daily estimates, with its total variance equal to the sum of the daily variances.

AGE, SEX, AND SIZE SAMPLING

Age, sex, and length (ASL) data were collected from Chinook, sockeye, and chum salmon migrating past the sonar site. Prior to 1995, only sockeye and chum salmon captured with beach seines were sampled for ASL data to avoid size selectivity associated with gillnets (Miller et al. 1994a, 1994b; Miller 1995). In 1992, Miller (1994a) found that, of the suite of mesh sizes fished, the 13.0- and 15.2-cm mesh gillnets both had length frequency distributions (LFD) similar to the beach seine LFD, and that the 13.0-cm mesh gillnet sockeye salmon LFD most closely resembled that of the beach seine. In 1995, based on this information, sockeye salmon ASL data were collected from 13.0- and 15.2-cm mesh gillnets in addition to beach seines (Miller 1996). Beginning in 1996 and continuing through 2003, sockeye salmon ASL information was collected from 13.0-cm mesh gillnets and beach seines. As in the past, only chum salmon captured with beach seines and only sockeye and chum salmon caught in the apportionment strata (stations #1-4) were sampled for ASL data. Regardless of gear type, gillnet mesh size, or catch location, all Chinook salmon captured were sampled to increase the sample sizes for this species.

Age was determined by examining scales (Mosher 1968). Scales were collected from the left side of the fish approximately two rows above the lateral line in an area crossed by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). Because of the high rate of scale regeneration among Chinook salmon, 3 scales were collected from each fish. Only 1 scale per fish was collected from sockeye and chum salmon. Scales were mounted on gummed cards and impressions were made in cellulose acetate (Clutter and Whitesel 1956). European notation (Koo 1962) was used to record ages; numerals preceding the decimal refer to the number of freshwater annuli and numerals following the decimal refer to the number of marine annuli. Total age from time of egg deposition, or brood year, is the sum of these two numbers plus one to account for incubation time.

Sampling goals by species for the entire season were 1,200 sockeye, 500 Chinook, and 500 chum salmon. The desired level of accuracy was 0.10, and 0.05 was the desired level of precision. A sample size of 403 readable sockeye, Chinook, and chum scales would simultaneously estimate the major age classes within 5% of the true percentage 90% of the time (Thompson 1987). Sample sizes of 400 fish per strata for sockeye salmon, 500 per strata for Chinook and chum salmon were set to account for regenerated and unreadable scales. Three time strata (early, middle, and late) were desired for sockeye salmon; therefore, the goal for the season was set at 1,200.

Salmon were measured from the mideye to tail fork and lengths were recorded to the nearest millimeter. Sex was determined from external characteristics for sockeye and chum salmon. The sex of young Chinook salmon (age-1.1 and -1.2) was very difficult to determine from external characteristics. Because sex determination for many young Chinook salmon was difficult and subjective, we decided not to use the sex information collected from young Chinook salmon.

MIGRATORY TIMING

Average proportions of passage by day for sockeye, Chinook, and chum salmon were calculated using all years that sonar data were available. Average daily proportions (\bar{p}_j) were calculated by summing daily proportions (p_{ji}) for all years used and dividing by total number of years used (Y):

$$\bar{p}_j = \frac{\sum_{i=1}^Y p_{ji}}{Y} \quad (12)$$

Average cumulative proportions by day were calculated by summing the average daily proportions through time.

The 2003 runs by species were compared to their desired goals at the sonar site through time by applying historical migratory timing to the escapement goals. The average daily cumulative proportions for each species were multiplied by their respective escapement point goals (550,000 for sockeye salmon, and 75,000 for Chinook salmon). Currently, there is no escapement goal for chum salmon.

ENVIRONMENTAL DATA

Weather data was collected at approximately 0800 and 2000 hours each day. Precipitation was measured to the nearest millimeter using a Taylor Clear View rain gauge; air temperatures were measured to the nearest 0.1 C using an Oregon Scientific digital thermometer. Wind direction and velocity (km/h) were measured using a Weathertronics anemometer.

RESULTS

Hydroacoustic counting began in all strata on 7 June and ended 20 July. A total of 955,975 counts were recorded in 2003 (Table 1). Sonar count distribution by bank varied throughout the season with counts at the end of the season totaling 231,991 (24%) on the left bank and 723,984 (76%) on the right bank. The inshore strata accounted for the majority of all sonar counts; left bank inshore stratum accounted for 83% of all left bank counts, while the right bank stratum accounted for 94% of all right bank sonar counts (Appendices A1 through A4).

Chinook, sockeye, and chum salmon passage count distribution in the right bank inshore stratum sectors varied through time, with 77% of counts occurring in sectors 3 through 6, approximately 3.9 to 7.8 m from the transducer face (Figure 2; Appendix A1). Most counts on the left bank inshore stratum, 72%, occurred in sectors 3 through 6, approximately 4.8 to 7.8 m from the transducer face (Figure 4; Appendix A3). Peak daily passage in the right bank inshore stratum occurred on 23 June and in the left bank inshore stratum occurred on 25 June.

Most counts in both right and left bank offshore strata were observed in the first half of the offshore counting ranges with 94% of the offshore sonar counts occurring with 10.0 m of the transducer face and 98% of the left bank offshore sonar counts occurring with approximately 11.5 m of the transducer face (Figures 3 and 5; Appendices A2 and A4). Both banks had few counts at the end of the offshore counting ranges. The last 8 sectors of the right bank offshore accounted for 6% of the total right bank offshore counts, while the last 8 sectors of the left bank offshore accounted for 2% of the total left bank offshore counts. Peak passage in the right offshore stratum occurred 25 June, while peak passage in the left bank offshore stratum occurred 19 June.

Hourly fish passage varied within and among strata during this time period (Figures 6 and 7). Hourly fish passage during this time period was similar between the right bank inshore and offshore strata and passage appeared to be lowest during the late morning hours between 0900 and 1100 hours. Left bank inshore fish passage was lowest in the morning 0500 and peaked in the afternoon between 1500 and 1700 hours. Peak passage in the left bank offshore stratum occurred between 0600 and 0800 hours, with the lowest passage occurring between 1900 and 2400 hours.

A total of 2,568 gillnet drifts were completed in 2003. The duration of each gillnet drift was approximately 2.5 minutes. The 20.6-cm, 15.2-cm, and 13.0-cm mesh gillnets caught 383; 1,243; and 1,184 salmon, respectively (Table 2). The total gillnet catch of 2,810 fish was composed of 1,076 Chinook, 982 sockeye, and 752 chum salmon (Tables 3, 4, 5, and 6). Most salmon were caught in the right bank inshore stratum (726); followed by the left offshore (711), right offshore (700), and left inshore (673) strata.

The 13.0-cm gillnet caught the greatest number of sockeye salmon (462), followed by, 15.2-cm (427), and 20.6-cm (93) mesh gillnets. Chum salmon were caught predominantly in the 15.2-cm mesh gillnet (437), followed by the 13.0-cm mesh gillnet (279), and 20.6-cm mesh gillnet (36). Chinook salmon were captured predominantly in the 13.0-cm mesh (443), followed by the 15.2-cm mesh (379), and 20.6-cm mesh gillnet (254).

The overall salmon escapement estimate for Nushagak River in 2003 was 955,975 fish. This included an estimated 580,534 sockeye (Standard Error (SE)=8,236); 80,028 Chinook (SE=746); and 295,413 (SE=5,580) chum salmon (Table 7). Sockeye salmon were estimated passing the sonar site immediately following installation of the sonar equipment from 7 June through 20 July (Table 8). Peak daily sockeye salmon passage occurred from 22 June to 28 June with the largest daily passage of 78,962 occurring on 23 June. Chinook salmon were also counted passing the sonar site immediately following installation of the sonar equipment on 7 June (Table 9). Chinook salmon daily passage first peaked on 26 June with an estimated 6,053 Chinook salmon passing the sonar site. As with Chinook salmon, chum salmon were counted migrating past the sonar site the same day the sonar equipment was installed on 7 June (Table 10). Chum salmon first peaked on 22 June with an estimated 22,038 chum salmon passing the sonar site. A second larger peak of chum salmon occurred on 25 June with an estimated daily passage of 26,322.

Sockeye salmon age, sex, and length composition were estimated based on sampling 538 fish during the season (Table 11). The dominant age class was age-1.3 (84%; 1998 brood year), followed by age-1.2 (6%; 1999 brood year), age-0.3 (4%; 1999 brood year), and age 1.4 fish (2%; 1997 brood year). The sex composition of sockeye salmon was 53% males to 47% females. Mean length by age ranged from 451 mm for age 0.2 to 618 mm for age 1.4.

Chinook salmon age, sex and length composition were estimated based on sampling 689 during the season (Table 12). Three major age classes were present: age-1.2 (27%; 1999 brood year); age-1.3 (44%; 1998 brood year); and age-1.4 (26%; 1997 brood year). The sex composition of Chinook salmon was 70% males to 30% females. Mean length by age ranged from 437 mm for age-1.1 to 926 mm for age-1.5 Chinook salmon.

Chum salmon age, sex and length composition were estimated based on sampling 249 during the season (Table 13). The dominant age class was age-0.3 (80%; 1999 brood year), followed by age-0.4 (14%; 1998 brood year) chum salmon. The sex composition of chum salmon was 64% males to 36% females. Mean length by age ranged from 588 for age-0.2 to 688 mm for age-0.5 fish.

Sonar operations were not greatly affected by climatic conditions in 2003. Air temperature was near average throughout the season (Table 14; Appendix B1.).

DISCUSSION

The purpose of this study was to estimate the escapement of Pacific salmon into the Nushagak River using hydroacoustics. The 2003 season was operated similarly to years past and was successful in providing needed inseason escapement estimates to area managers during the season.

The primary objective (objective 1) of this study was achieved for sockeye, Chinook and chum salmon in 2003. The escapement estimate of 580,534 sockeye salmon had a 90% Confidence Interval (CI) of $\pm 13,425$ fish, which was within 2.3% of the escapement estimate. In addition, the escapement estimate of 580,534 sockeye salmon was within the biological escapement goal (BEG) range of 340,000 to 760,000 sockeye salmon. The run timing of sockeye salmon in 2003 was 6 to 8 days earlier than the 1990–2002 average timing (Table 8; Figure 8). The escapement estimate of 80,028 Chinook salmon had a 90% CI of $\pm 1,216$ fish, which was within 1.5% of the escapement estimate. In addition, the escapement estimate of 80,028 Chinook salmon exceeded the escapement goal of 75,000 fish. Cumulative Chinook salmon escapement run timing in 2003 was early compared to the 1990–2002 average timing (Table 9; Figure 9). The escapement estimate of 299,419 chum salmon had a 90% CI of $\pm 9,095$ fish, which was within 3.0% of the escapement estimate. There is no formal escapement goal for chum salmon in the Nushagak River, but the escapement estimate of 299,419 was below the historical management escapement objective (1986–1994) of 350,000. Cumulative chum salmon escapement in 2003 was below the 10-year (1990–1999) average and below the 2000–2002 average (Table 10; Figure 10).

Sampling efforts to estimate the age composition for sockeye salmon were not adequate to meet objective 2. A sample size goal for the season was set at 1,200 sockeye salmon with 400 fish sampled from three time strata (early, middle, and late). A total of 538 sockeye salmon were sampled during all of 2003. This was only 45% of the sampling goal of 1,200. Therefore, only one age composition estimate for the entire season was made for sockeye salmon in 2003. Sampling efforts should be increased in the future to adequately sample sockeye salmon to obtain age composition estimates for the early, middle, and late portions of the escapement. Sampling efforts to estimate the age composition for Chinook salmon were adequate to meet objective 3 for Chinook salmon. A sample size goal for Chinook salmon was set at 500 fish. A total of 689 Chinook salmon were sampled during 2003. Age composition estimates were made for all the

major age classes of Chinook salmon such that all the 90% CI's were within 5% of the age composition estimates. Sampling efforts to estimate the age composition for chum salmon were not adequate to meet objective 3 for chum salmon. A sample size goal for chum salmon was set at 500 fish. A total of 249 chum salmon were sampled during 2003. This was only 50% of the sampling goal for chum salmon. The age composition estimates had 90% CI's that were greater than 5% of the age composition estimates. Sampling efforts should be increased in the future to adequately sample chum salmon to obtain age composition estimates.

Estimates of the sex composition for sockeye, Chinook and chum salmon were made during 2003 (objective 4). The proportion of males (53%) and females (47%) were almost equal for sockeye salmon in 2003 (Table 11). However, we were not able to look at changes in the sex composition of sockeye salmon during the season because we were not able to obtain samples during the early, middle, and late portion of the escapement. There were more males than females in both the Chinook (70% males; 30% females; Table 12) and chum (64% males; 36% females; Table 13) salmon escapements during 2003.

Estimates of mean length at age by sex was made for sockeye, Chinook and chum salmon escapement during 2003 (objective 5). Males were larger than females for sockeye salmon (mean length: 580 mm, males; 562 mm, females; Table 11), and chum salmon (mean length: 607 mm, males; 564 mm, females; Table 13). However, males were smaller than females for Chinook salmon (mean length: 699 mm, males; 807 mm, females; Table 13).

New sample sizes to estimate species composition continued to be used in 2003. It was determined in 2002 that using a sample size of five fish to estimate species composition during a report period had minimal effects on the daily estimates and was less biased and more accurate (McKinley 2003). This method also had a tremendous advantage of providing almost daily estimates of escapement that did not change retroactively. Prior to 2002, a total of 100 salmon had to be caught prior to estimating species composition during a report period. This created a situation where preliminary species composition estimates were made over many days until 100 salmon were caught. After 100 salmon were caught, the preliminary species composition estimates were retroactively updated during the season. This created a situation where numerous changes were being made to the escapement estimates for all species during the season. With the implementation of the new apportionment report pooling of 5 fish, we were able to provide daily estimates to fishery managers and the public. This was a tremendous success and was much less confusing than in years past. The one downside to the reduction in sample size from 100 fish to 5 fish having to be caught during a report period was the increase in variance estimates for the species composition estimates.

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TABLES AND FIGURES

Table 1.—Daily inshore and offshore sonar counts by bank, Nushagak River sonar project, 2003.

Date	Left Bank		Right Bank	
	Inshore	Offshore	Inshore	Offshore
6/07	220	0	60	0
6/08	528	9	815	227
6/09	184	58	1,995	406
6/10	529	157	1,880	489
6/11	245	88	1,402	88
6/12	34	37	467	42
6/13	11	24	402	28
6/14	194	9	349	13
6/15	295	80	1,471	98
6/16	253	45	1,261	96
6/17	1,612	483	6,490	484
6/18	3,342	1,556	11,795	797
6/19	2,620	1,017	7,903	542
6/20	2,459	1,021	6,631	548
6/21	2,856	1,054	18,353	1,223
6/22	16,205	2,292	46,612	1,496
6/23	20,633	1,698	66,891	1,422
6/24	9,265	1,009	43,144	1,708
6/25	22,373	3,145	54,258	4,113
6/26	7,161	2,831	37,713	3,226
6/27	6,936	2,227	31,926	2,963
6/28	8,619	1,745	40,032	2,534
6/29	6,253	1,940	18,529	2,518
6/30	6,452	1,128	15,262	1,480
7/01	7,952	1,073	22,656	1,132
7/02	6,357	1,473	34,153	1,834
7/03	12,089	2,100	47,789	2,859
7/04	10,539	2,127	37,094	2,170
7/05	3,609	1,095	19,475	1,351
7/06	3,130	875	9,646	532
7/07	6,100	1,014	15,626	626
7/08	5,443	824	12,177	635
7/09	3,196	504	4,509	544
7/10	1,939	1,088	6,848	715
7/11	1,418	634	10,287	656
7/12	1,014	345	7,869	400
7/13	1,478	354	8,991	364
7/14	1,242	237	5,119	189
7/15	1,603	257	5,149	178
7/16	1,891	310	4,625	196
7/17	965	249	4,062	115
7/18	1,269	394	2,742	137
7/19	1,526	361	4,257	282
7/20	778	207	3,687	126
Total	192,817	39,174	682,402	41,582

Table 2.—Drift gillnet catch by mesh size and salmon species, Nushagak River sonar project, 2003.

Gillnet Mesh Size	Species	Drift Stratum Number			
		Left Bank		Right Bank	
		1 ^a	2 ^b	4 ^c	3 ^d
13.0-cm	Chinook	36	217	179	11
	Sockeye	166	18	51	227
	Chum	87	36	84	72
	Coho				
	Pink				
15.2-cm	Chinook	33	195	135	16
	Sockeye	158	28	61	180
	Chum	135	69	110	123
	Coho				
	Pink				
20.6-cm	Chinook	21	137	91	5
	Sockeye	29	6	3	55
	Chum	8	5	12	11
	Coho				
	Pink				
All Meshes	Chinook	90	549	405	32
	Sockeye	353	52	115	462
	Chum	230	110	206	206
	Coho				
	Pink				

^a Left bank inshore.

^b Left bank offshore.

^c Right bank inshore.

^d Right bank offshore.

Table 3.—Right bank inshore escapement sampling catch proportions by date, drift session, and salmon species, 10 June 10–18 July, 2003.

Date	Drift Session Number	Catch	Proportion of Catch					
			Chinook	Sockeye	Chum	Pink	Coho	Other
6/10	3	3	1.00	0	0	0	0	0
6/11	1	1	1.00	0	0	0	0	0
6/13	1	1	1.00	0	0	0	0	0
6/17	2	1	1.00	0	0	0	0	0
6/17	3	4	0	0.50	0.50	0	0	0
6/18	1	3	0.33	0.33	0.33	0	0	0
6/18	2	6	0.08	0.33	0.58	0	0	0
6/18	3	12	0.10	0.52	0.38	0	0	0
6/19	1	3	0	1.00	0	0	0	0
6/19	2	6	0.17	0.33	0.50	0	0	0
6/19	3	8	0.38	0.13	0.50	0	0	0
6/20	1	4	1.00	0	0	0	0	0
6/20	2	17	0.12	0.24	0.65	0	0	0
6/21	1	18	0.06	0.39	0.56	0	0	0
6/21	2	7	0	0.71	0.29	0	0	0
6/21	3	10	0	0.40	0.60	0	0	0
6/22	1	11	0	0.73	0.27	0	0	0
6/22	2	28	0	0.86	0.14	0	0	0
6/22	3	25	0	0.72	0.28	0	0	0
6/23	1	27	0.04	0.89	0.07	0	0	0
6/23	2	38	0.03	0.92	0.05	0	0	0
6/23	3	37	0	0.89	0.11	0	0	0
6/24	1	23	0	0.87	0.13	0	0	0
6/24	2	28	0.04	0.89	0.07	0	0	0
6/24	3	15	0.13	0.67	0.20	0	0	0
6/25	1	16	0	0.75	0.25	0	0	0
6/25	2	20	0.05	0.80	0.15	0	0	0
6/25	3	33	0.03	0.76	0.21	0	0	0
6/26	1	15	0.07	0.87	0.07	0	0	0
6/26	2	7	0	1.00	0	0	0	0
6/26	3	10	0	1.00	0	0	0	0
6/27	1	6	0	0.83	0.17	0	0	0
6/27	2	8	0	0.63	0.38	0	0	0
6/27	3	15	0	0.73	0.27	0	0	0
6/28	1	10	0	0.90	0.10	0	0	0
6/28	2	4	0	1.00	0	0	0	0
6/28	3	9	0	0.67	0.33	0	0	0
6/29	1	4	0	0.75	0.25	0	0	0
6/29	2	6	0	0.83	0.17	0	0	0
6/29	3	2	0	1.00	0	0	0	0
6/30	1	1	0	1.00	0	0	0	0
6/30	2	3	0	0.33	0.67	0	0	0

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Table 3.–Page 2 of 2.

Date	Drift Session Number	Catch	Proportion of Catch					
			Chinook	Sockeye	Chum	Pink	Coho	Other
7/01	1	15	0	0.60	0.40	0	0	0
7/01	2	4	0	0.75	0.25	0	0	0
7/02	1	4	0	0.25	0.75	0	0	0
7/02	2	10	0.10	0.30	0.60	0	0	0
7/02	3	2	0	0.50	0.50	0	0	0
7/03	1	10	0	0.70	0.30	0	0	0
7/03	2	10	0	0.80	0.20	0	0	0
7/03	3	4	0	1.00	0	0	0	0
7/04	1	2	0	1.00	0	0	0	0
7/04	2	3	0	1.00	0	0	0	0
7/04	3	4	0	1.00	0	0	0	0
7/05	1	1	0	1.00	0	0	0	0
7/05	2	9	0	0.56	0.44	0	0	0
7/05	3	6	0	0.50	0.50	0	0	0
7/06	1	7	0	0.14	0.86	0	0	0
7/06	3	5	0	0.80	0.20	0	0	0
7/07	1	3	0	0.33	0.67	0	0	0
7/07	2	1	0	0	1.00	0	0	0
7/07	3	1	0	0	1.00	0	0	0
7/08	1	1	0	0	1.00	0	0	0
7/08	2	12	0	0.42	0.58	0	0	0
7/08	3	8	0	0	1.00	0	0	0
7/09	1	5	0	0.60	0.40	0	0	0
7/09	2	7	0	0.29	0.71	0	0	0
7/10	1	1	0	0	1.00	0	0	0
7/10	2	6	0	0	1.00	0	0	0
7/10	3	3	0	0.67	0.33	0	0	0
7/11	1	4	0	0.75	0.25	0	0	0
7/11	3	3	0	0.67	0.33	0	0	0
7/12	1	12	0	0.17	0.83	0	0	0
7/12	2	3	0.33	0.67	0	0	0	0
7/12	3	5	0.40	0.40	0.20	0	0	0
7/13	2	1	0	1.00	0	0	0	0
7/13	3	5	0	0.60	0.40	0	0	0
7/14	1	1	0	1.00	0	0	0	0
7/14	2	1	0	0	1.00	0	0	0
7/16	1	3	0	0	1.00	0	0	0
7/16	3	3	0.33	0.67	0	0	0	0
7/17	1	6	0	0.17	0.83	0	0	0
7/17	3	2	0	0	1.00	0	0	0
7/18	3	2	0	0	1.00	0	0	0
Total		700	0.05	0.66	0.29	0	0	0

Table 4.—Right bank offshore escapement sampling catch proportions by date, drift session, and salmon species, 9 June–17 July, 2003.

Date	Drift Session Number	Catch	Proportion of Catch					
			Chinook	Sockeye	Chum	Pink	Coho	Other
6/09	3	5	0.80	0	0.20	0	0	0
6/10	1	1	1.00	0	0	0	0	0
6/10	3	3	1.00	0	0	0	0	0
6/12	1	1	1.00	0	0	0	0	0
6/15	3	4	1.00	0	0	0	0	0
6/16	3	2	0.50	0.50	0	0	0	0
6/17	2	2	0	1.00	0	0	0	0
6/17	3	11	0.73	0	0.27	0	0	0
6/18	1	5	0.80	0	0.20	0	0	0
6/18	2	6	0.50	0.50	0	0	0	0
6/18	3	8	0.63	0.13	0.25	0	0	0
6/19	1	1	0	1.00	0	0	0	0
6/19	2	2	0.50	0.50	0	0	0	0
6/19	3	6	0	0.83	0.17	0	0	0
6/20	1	6	0.50	0.50	0	0	0	0
6/20	2	3	1.00	0	0	0	0	0
6/20	3	5	1.00	0	0	0	0	0
6/21	1	8	0.88	0	0.13	0	0	0
6/21	2	6	0.83	0	0.17	0	0	0
6/21	3	9	0.56	0.11	0.33	0	0	0
6/22	1	5	0.60	0.20	0.20	0	0	0
6/22	2	17	0.65	0.06	0.29	0	0	0
6/22	3	26	0.38	0.12	0.50	0	0	0
6/23	1	7	0.86	0.14	0	0	0	0
6/23	2	8	0.88	0.13	0	0	0	0
6/23	3	10	0.40	0.30	0.30	0	0	0
6/24	1	7	0.71	0	0.29	0	0	0
6/24	2	6	1.00	0	0	0	0	0
6/24	3	13	0.85	0.08	0.08	0	0	0
6/25	1	11	0.91	0	0.09	0	0	0
6/25	2	22	0.50	0.18	0.32	0	0	0
6/25	3	13	0.54	0	0.46	0	0	0
6/26	1	9	0.89	0.11	0	0	0	0
6/26	2	12	1.00	0	0	0	0	0
6/26	3	19	0.74	0.26	0	0	0	0
6/27	1	16	0.75	0.19	0.06	0	0	0
6/27	2	14	0.86	0.07	0.07	0	0	0
6/27	3	20	0.60	0.20	0.20	0	0	0
6/28	1	12	1.00	0	0	0	0	0
6/28	2	8	0.75	0.25	0	0	0	0
6/28	3	23	0.52	0.22	0.26	0	0	0
6/29	1	12	0.25	0.42	0.33	0	0	0
6/29	2	6	0.83	0	0.17	0	0	0
6/29	3	11	0.73	0	0.27	0	0	0
6/30	1	5	1.00	0	0	0	0	0
6/30	2	12	0.42	0.08	0.50	0	0	0
6/30	3	18	0.28	0.17	0.56	0	0	0

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Table 4.–Page 2 of 2.

Date	Drift Session Number	Catch	Proportion of Catch					
			Chinook	Sockeye	Chum	Pink	Coho	Other
7/01	1	6	0.67	0.17	0.17	0	0	0
7/01	2	6	0.33	0.50	0.17	0	0	0
7/01	3	15	0.53	0.27	0.20	0	0	0
7/02	1	7	0.14	0.43	0.43	0	0	0
7/02	2	7	0.86	0	0.14	0	0	0
7/02	3	11	0.45	0.09	0.45	0	0	0
7/03	1	2	0.50	0	0.50	0	0	0
7/03	2	13	0.46	0.31	0.23	0	0	0
7/03	3	15	0.40	0.20	0.40	0	0	0
7/04	1	8	0.38	0.25	0.38	0	0	0
7/04	2	14	0.57	0.07	0.36	0	0	0
7/04	3	17	0.41	0.29	0.29	0	0	0
7/05	1	17	0.53	0.24	0.24	0	0	0
7/05	2	7	0	0.43	0.57	0	0	0
7/05	3	13	0.62	0.23	0.15	0	0	0
7/06	1	3	1.00	0	0	0	0	0
7/06	2	6	0.17	0.17	0.67	0	0	0
7/06	3	9	0.44	0	0.56	0	0	0
7/07	1	3	1.00	0	0	0	0	0
7/07	2	12	0.08	0.17	0.75	0	0	0
7/07	3	7	0	0.71	0.29	0	0	0
7/08	1	5	0.80	0	0.20	0	0	0
7/08	2	8	0.50	0.13	0.38	0	0	0
7/08	3	4	0	0	1.00	0	0	0
7/09	1	4	0	0.50	0.50	0	0	0
7/09	2	4	0	0.25	0.75	0	0	0
7/09	3	4	0.50	0.50	0	0	0	0
7/10	1	1	1.00	0	0	0	0	0
7/10	2	7	0.57	0	0.43	0	0	0
7/10	3	5	0.20	0	0.80	0	0	0
7/11	1	3	0.33	0	0.67	0	0	0
7/11	2	1	1.00	0	0	0	0	0
7/11	3	4	1.00	0	0	0	0	0
7/12	1	6	0.33	0	0.67	0	0	0
7/12	2	1	0	0	1.00	0	0	0
7/12	3	2	0.50	0	0.50	0	0	0
7/13	1	2	1.00	0	0	0	0	0
7/13	2	2	0	0	1.00	0	0	0
7/13	3	3	0	0	1.00	0	0	0
7/14	1	1	0	0	1.00	0	0	0
7/14	2	1	1.00	0	0	0	0	0
7/14	3	5	0	0.20	0.80	0	0	0
7/15	1	6	0.33	0	0.67	0	0	0
7/15	2	8	0.13	0	0.88	0	0	0
7/16	1	2	1.00	0	0	0	0	0
7/16	3	1	0	0	1.00	0	0	0
7/17	1	1	1.00	0	0	0	0	0
7/17	3	1	0	0	1.00	0	0	0
Total		726	0.56	0.16	0.28	0	0	0

Table 5.—Left bank inshore escapement sampling catch proportions by date, drift session, and salmon species, 9 June–18 July, 2003.

Date	Drift Session Number	Catch	Proportion of Catch					
			Chinook	Sockeye	Chum	Pink	Coho	Other
6/09	3	1	1.00	0	0	0	0	0
6/10	1	2	1.00	0	0	0	0	0
6/10	3	3	1.00	0	0	0	0	0
6/11	3	2	0	0	1.00	0	0	0
6/15	3	5	0.80	0.20	0	0	0	0
6/17	2	5	0.60	0.40	0	0	0	0
6/17	3	7	0.71	0.14	0.14	0	0	0
6/18	1	6	1.00	0	0	0	0	0
6/18	2	8	0.88	0.13	0	0	0	0
6/18	3	5	0.40	0.60	0	0	0	0
6/19	1	5	0.40	0.60	0	0	0	0
6/19	2	6	0.50	0	0.50	0	0	0
6/19	3	4	0.75	0	0.25	0	0	0
6/20	1	4	0.25	0.50	0.25	0	0	0
6/20	2	12	0.17	0.25	0.58	0	0	0
6/20	3	1	1.00	0	0	0	0	0
6/21	1	6	0.33	0.67	0	0	0	0
6/21	2	3	0.33	0.67	0	0	0	0
6/21	3	2	0	0	1.00	0	0	0
6/22	1	10	0.20	0.40	0.40	0	0	0
6/22	2	34	0.18	0.18	0.65	0	0	0
6/22	3	31	0.06	0.58	0.35	0	0	0
6/23	1	19	0	0.95	0.05	0	0	0
6/23	2	41	0.05	0.93	0.02	0	0	0
6/23	3	49	0.04	0.67	0.29	0	0	0
6/24	1	14	0	0.64	0.36	0	0	0
6/24	2	17	0.24	0.41	0.35	0	0	0
6/24	3	12	0	0.67	0.33	0	0	0
6/25	1	18	0.17	0.17	0.67	0	0	0
6/25	2	32	0.06	0.63	0.31	0	0	0
6/25	3	23	0.04	0.48	0.48	0	0	0
6/26	1	11	0.18	0.55	0.27	0	0	0
6/26	2	17	0	0.88	0.12	0	0	0
6/26	3	3	0	0	1.00	0	0	0
6/27	1	16	0.13	0.56	0.31	0	0	0
6/27	2	10	0	0.70	0.30	0	0	0
6/27	3	17	0	0.82	0.18	0	0	0
6/28	1	4	0.25	0.50	0.25	0	0	0
6/28	3	18	0	0.33	0.67	0	0	0
6/29	1	6	0	0.33	0.67	0	0	0
6/29	3	10	0	0.60	0.40	0	0	0
6/30	1	3	0.33	0.67	0	0	0	0
6/30	2	4	0	0.75	0.25	0	0	0
6/30	3	13	0	0.15	0.85	0	0	0

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Table 5.–Page 2 of 2.

Date	Drift Session Number	Catch	Proportion of Catch					
			Chinook	Sockeye	Chum	Pink	Coho	Other
7/01	1	4	0	0.50	0.50	0	0	0
7/01	2	3	0.33	0.67	0	0	0	0
7/02	1	4	0	0.75	0.25	0	0	0
7/02	2	5	0	0.80	0.20	0	0	0
7/02	3	5	0	1.00	0	0	0	0
7/03	1	3	0	0.67	0.33	0	0	0
7/03	2	4	0	1.00	0	0	0	0
7/03	3	1	0	1.00	0	0	0	0
7/04	1	4	0	0.25	0.75	0	0	0
7/04	2	12	0	0.42	0.58	0	0	0
7/04	3	6	0	1.00	0	0	0	0
7/05	1	2	0	1.00	0	0	0	0
7/05	2	1	0	1.00	0	0	0	0
7/05	3	2	0	1.00	0	0	0	0
7/06	1	1	0	0	1.00	0	0	0
7/06	3	1	0	1.00	0	0	0	0
7/07	1	1	1.00	0	0	0	0	0
7/07	2	3	0	0.33	0.67	0	0	0
7/07	3	12	0	0	1.00	0	0	0
7/08	2	7	0	0.43	0.57	0	0	0
7/08	3	1	0	1.00	0	0	0	0
7/09	1	1	0	0	1.00	0	0	0
7/09	2	10	0	0.60	0.40	0	0	0
7/10	1	1	1.00	0	0	0	0	0
7/10	2	8	0.13	0.50	0.38	0	0	0
7/10	3	10	0.20	0.50	0.30	0	0	0
7/11	1	5	0	1.00	0	0	0	0
7/11	2	4	0	0.25	0.75	0	0	0
7/11	3	11	0.27	0.36	0.36	0	0	0
7/12	1	7	0	0.43	0.57	0	0	0
7/12	2	1	0	0	1.00	0	0	0
7/12	3	1	0	0	1.00	0	0	0
7/13	1	3	0	0	1.00	0	0	0
7/14	1	1	1.00	0	0	0	0	0
7/15	1	1	0	0	1.00	0	0	0
7/15	2	1	0	1.00	0	0	0	0
7/16	1	2	0.50	0.50	0	0	0	0
7/17	3	3	0.33	0.33	0.33	0	0	0
7/18	1	2	0	1.00	0	0	0	0
Total		673	0.13	0.52	0.34	0	0	0

Table 6.—Left bank offshore escapement sampling catch proportions by date, drift session, and salmon species, 9 June–17 July, 2003.

Date	Drift Session Number	Catch	Proportion of Catch					
			Chinook	Sockeye	Chum	Pink	Coho	Other
6/10	1	4	0.75	0	0.25	0	0	0
6/15	3	3	0.67	0	0.33	0	0	0
6/17	2	4	1.00	0	0	0	0	0
6/17	3	9	1.00	0	0	0	0	0
6/18	1	2	1.00	0	0	0	0	0
6/18	2	5	0.60	0	0.40	0	0	0
6/18	3	5	0.40	0.40	0.20	0	0	0
6/19	1	2	1.00	0	0	0	0	0
6/19	2	2	1.00	0	0	0	0	0
6/19	3	1	0	0	1.00	0	0	0
6/20	1	7	1.00	0	0	0	0	0
6/20	2	1	1.00	0	0	0	0	0
6/20	3	3	1.00	0	0	0	0	0
6/21	1	8	0.50	0.13	0.38	0	0	0
6/21	2	7	0.86	0	0.14	0	0	0
6/21	3	7	0.43	0.29	0.29	0	0	0
6/22	1	11	1.00	0	0	0	0	0
6/22	2	14	0.50	0.07	0.43	0	0	0
6/22	3	10	0.40	0.10	0.50	0	0	0
6/23	1	7	1.00	0	0	0	0	0
6/23	2	4	0.75	0.25	0	0	0	0
6/23	3	5	0.40	0.40	0.20	0	0	0
6/24	1	3	0.67	0.33	0	0	0	0
6/24	2	12	0.33	0.25	0.42	0	0	0
6/24	3	9	0.11	0.78	0.11	0	0	0
6/25	1	19	0.74	0	0.26	0	0	0
6/25	2	17	0.59	0.24	0.18	0	0	0
6/25	3	17	0.65	0.18	0.18	0	0	0
6/26	1	16	0.88	0.06	0.06	0	0	0
6/26	2	17	1.00	0	0	0	0	0
6/26	3	21	0.86	0.14	0	0	0	0
6/27	1	22	1.00	0	0	0	0	0
6/27	2	27	1.00	0	0	0	0	0
6/27	3	17	1.00	0	0	0	0	0
6/28	1	19	1.00	0	0	0	0	0
6/28	2	14	0.64	0.07	0.29	0	0	0
6/28	3	16	0.75	0.06	0.19	0	0	0
6/29	1	23	0.87	0	0.13	0	0	0
6/29	2	17	0.82	0.06	0.12	0	0	0
6/29	3	18	0.94	0	0.06	0	0	0
6/30	1	17	1.00	0	0	0	0	0
6/30	2	11	0.91	0	0.09	0	0	0
6/30	3	11	0.73	0.09	0.18	0	0	0

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Table 6.–Page 2 of 3.

Date	Drift Session Number	Catch	Proportion of Catch					
			Chinook	Sockeye	Chum	Pink	Coho	Other
7/01	1	13	0.85	0	0.15	0	0	0
7/01	2	14	0.57	0.07	0.36	0	0	0
7/01	3	16	0.50	0.06	0.44	0	0	0
7/02	1	9	1.00	0	0	0	0	0
7/02	2	12	0.75	0.08	0.17	0	0	0
7/02	3	11	0.55	0.09	0.36	0	0	0
7/03	1	12	0.83	0.08	0.08	0	0	0
7/03	2	7	0.57	0.14	0.29	0	0	0
7/03	3	6	0.50	0.50	0	0	0	0
7/04	1	11	0.73	0.00	0.27	0	0	0
7/04	2	16	0.75	0.00	0.25	0	0	0
7/04	3	4	1.00	0	0	0	0	0
7/05	1	9	0.56	0	0.44	0	0	0
7/05	2	6	0.83	0	0.17	0	0	0
7/05	3	4	0.75	0	0.25	0	0	0
7/06	1	6	1.00	0	0	0	0	0
7/06	2	10	0.90	0.10	0	0	0	0
7/06	3	5	1.00	0	0	0	0	0
7/07	1	5	0.80	0	0.20	0	0	0
7/07	2	2	1.00	0		0	0	0
7/07	3	3	0.67	0	0.33	0	0	0
7/08	1	4	0.75	0	0.25	0	0	0
7/08	2	7	0.29	0.14	0.57	0	0	0
7/08	3	5	0.80	0.00	0.20	0	0	0
7/09	1	5	0.56	0.06	0.38	0	0	0
7/09	2	5	0.40	0.40	0.20	0	0	0
7/09	3	2	1.00	0	0	0	0	0
7/10	1	1	1.00	0	0	0	0	0
7/10	2	2	1.00	0	0	0	0	0
7/10	3	2	1.00	0	0	0	0	0
7/11	1	3	1.00	0	0	0	0	0
7/11	2	3	1.00	0	0	0	0	0
7/11	3	6	0.50	0	0.50	0	0	0
7/12	1	2	1.00	0	0	0	0	0
7/12	2	2	0	0.50	0.50	0	0	0
7/12	3	1	1.00	0	0	0	0	0
7/13	1	4	0.75	0	0.25	0	0	0
7/13	3	1	0	0	1.00	0	0	0
7/14	1	1	1.00	0	0	0	0	0

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Table 6.–Page 3 of 3.

Date	Drift Session Number	Catch	Proportion of Catch					
			Chinook	Sockeye	Chum	Pink	Coho	Other
7/15	2	8	1.00	0	0	0	0	0
7/16	1	10	0.71	0	0.29	0	0	0
7/16	2	2	1.00	0	0	0	0	0
7/17	1	5	0.74	0	0.26	0	0	0
7/17	2	8	0.82	0	0.18	0	0	0
7/18	1	5	0.5	0	0.5	0	0	0
7/18	2	3	1.00	0	0	0	0	0
7/19	1	3	1.00	0	0	0	0	0
7/19	3	9	1.00	0	0	0	0	0
7/20	1	7	1.00	0	0	0	0	0
7/21	1	1	1.00	0	0	0	0	0
7/21	3	1	0	0	1.0	0	0	0
7/15	1	1	1.00	0	0	0	0	0
7/16	1	1	1.00	0	0	0	0	0
7/17	3	4	0.50	0.50	0	0	0	0
7/18	1	1	1.00	0	0	0	0	0
Total		711	0.77	0.07	0.15	0	0	0

Table 7.—Final daily and cumulative escapement estimates by salmon species, Nushagak River sonar project, 2003.

Date	Sockeye		Chinook		Chum		Pink		Coho		Total	
	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
6/07	65	65	193	193	22	22	0	0	0	0	280	280
6/08	290	355	1,032	1,225	257	279	0	0	0	0	1,579	1,859
6/09	443	798	1,773	2,998	427	706	0	0	0	0	2,643	4,502
6/10	376	1,174	2,304	5,302	375	1,081	0	0	0	0	3,055	7,557
6/11	280	1,454	1,205	6,507	338	1,419	0	0	0	0	1,823	9,380
6/12	0	1,454	531	7,038	49	1,468	0	0	0	0	580	9,960
6/13	0	1,454	446	7,484	19	1,487	0	0	0	0	465	10,425
6/14	0	1,454	366	7,849	199	1,687	0	0	0	0	565	10,990
6/15	98	1,552	1,811	9,661	34	1,721	0	0	0	0	1,944	12,934
6/16	106	1,659	1,529	11,190	19	1,740	0	0	0	0	1,655	14,589
6/17	3,541	5,200	2,377	13,566	3,151	4,892	0	0	0	0	9,069	23,658
6/18	7,598	12,798	4,291	17,858	5,600	10,492	0	0	0	0	17,490	41,148
6/19	4,119	16,917	2,773	20,631	5,190	15,682	0	0	0	0	12,082	53,230
6/20	3,443	20,360	2,994	23,625	4,222	19,903	0	0	0	0	10,659	63,889
6/21	9,853	30,213	2,049	25,674	11,584	31,488	0	0	0	0	23,486	87,375
6/22	41,818	72,031	2,749	28,424	22,038	53,526	0	0	0	0	66,605	153,980
6/23	78,962	150,993	2,244	30,668	9,438	62,964	0	0	0	0	90,644	244,624
6/24	41,316	192,309	3,671	34,339	10,139	73,102	0	0	0	0	55,126	299,750
6/25	52,701	245,010	4,866	39,204	26,322	99,424	0	0	0	0	83,889	383,639
6/26	42,533	287,543	6,053	45,258	2,345	101,769	0	0	0	0	50,931	434,570
6/27	27,905	315,448	4,328	49,585	11,819	113,588	0	0	0	0	44,052	478,622
6/28	34,842	350,290	3,170	52,756	14,918	128,506	0	0	0	0	52,930	531,552
6/29	18,552	368,843	2,794	55,549	7,894	136,400	0	0	0	0	29,240	560,792
6/30	14,068	382,911	1,758	57,308	8,495	144,895	0	0	0	0	24,322	585,114

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Table 7.–Page 2 of 2.

Date	Sockeye		Chinook		Chum		Pink		Coho		Total	
	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
7/01	19,014	401,924	1,883	59,191	11,916	156,812	0	0	0	0	32,813	617,927
7/02	18,946	420,871	4,029	63,220	20,842	177,654	0	0	0	0	43,817	661,744
7/03	49,433	470,303	2,264	65,483	13,141	190,794	0	0	0	0	64,837	726,581
7/04	42,629	512,932	2,293	67,777	7,008	197,802	0	0	0	0	51,930	778,511
7/05	14,427	527,359	1,136	68,912	9,967	207,770	0	0	0	0	25,530	804,041
7/06	6,225	533,584	1,060	69,972	6,898	214,667	0	0	0	0	14,183	818,224
7/07	3,706	537,290	1,082	71,054	18,579	233,246	0	0	0	0	23,366	841,590
7/08	6,045	543,335	679	71,734	12,354	245,600	0	0	0	0	19,079	860,669
7/09	3,974	547,309	400	72,134	4,379	249,979	0	0	0	0	8,753	869,422
7/10	2,357	549,666	1,641	73,774	6,592	256,571	0	0	0	0	10,590	880,012
7/11	6,919	556,585	1,009	74,783	5,067	261,639	0	0	0	0	12,995	893,007
7/12	3,375	559,960	1,270	76,054	4,982	266,621	0	0	0	0	9,628	902,635
7/13	6,364	566,324	254	76,308	4,570	271,191	0	0	0	0	11,187	913,822
7/14	3,522	569,845	220	76,527	3,045	274,236	0	0	0	0	6,787	920,609
7/15	3,501	573,346	377	76,904	3,309	277,546	0	0	0	0	7,187	927,796
7/16	2,505	575,852	1,375	78,279	3,142	280,687	0	0	0	0	7,022	934,818
7/17	1,078	576,929	479	78,758	3,834	284,522	0	0	0	0	5,391	940,209
7/18	1,214	578,144	457	79,215	2,870	287,392	0	0	0	0	4,542	944,751
7/19	1,499	579,643	534	79,749	4,392	291,785	0	0	0	0	6,426	951,177
7/20	891	580,534	279	80,028	3,628	295,413	0	0	0	0	4,798	955,975
Total	580,534		80,028		295,413		0		0		955,975	

Table 8.—Sockeye salmon escapement estimates and average escapement percentage by date, Nushagak River, 1990–2003.

Date	Year														Average Percent ^a	
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Daily	Cum.
06/04				0											0.0	0.0
06/05		74		0											0.0	0.0
06/06	11	126		0											0.0	0.0
06/07	11	94		0										65	0.0	0.0
06/08	32	80		0		36							0	290	0.0	0.0
06/09	145	74	0	0	5	96	110	395	222	5			0	443	0.0	0.0
06/10	33	114	0	0	6	140	199	440	553	8	73		0	376	0.0	0.1
06/11	23	79	0	0	7	64	117	319	261	19	46		0	280	0.0	0.1
06/12	15	87	0	0	5	68	142	278	165	17	67	230	0	0	0.0	0.1
06/13	52	75	0	0	4	104	153	516	127	20	245	173	221	0	0.0	0.1
06/14	37	71	0	0	12	202	165	521	108	14	86	3,253	0	0	0.1	0.2
06/15	149	866	0	125	10	995	172	589	115	29	54	3,819	0	98	0.1	0.3
06/16	117	2,360	0	1,902	442	606	79	1,384	128	268	261	1,031	47	106	0.1	0.4
06/17	51	836	0	3,260	951	522	239	1,300	60	221	386	247	3	3,541	0.2	0.6
06/18	43	770	0	1,119	1,239	729	3,639	910	152	110	140	194	269	7,598	0.2	0.8
06/19	47	443	915	491	2,661	798	901	1,866	330	45	453	819	1,530	4,119	0.2	1.0
06/20	0	677	1,132	456	1,218	437	1,078	1,962	6,384	32	724	5,772	8,598	3,443	0.4	1.5
06/21	0	860	1,811	300	647	377	3,912	1,001	3,190	35	405	8,768	6,099	9,853	0.5	2.0
06/22	995	1,457	1,594	224	1,830	301	5,798	2,631	3,751	33	264	14,214	6,998	41,818	1.2	3.1
06/23	5,297	3,088	951	16,939	1,415	443	8,927	2,645	2,625	43	124	34,970	6,149	78,962	2.3	5.4
06/24	1,960	10,144	999	66,906	2,703	1,430	9,896	3,759	3,976	2,405	94	29,123	8,488	41,316	2.6	8.0
06/25	1,009	11,286	1,379	24,187	2,625	9,495	18,041	7,204	8,092	2,431	1,968	38,804	4,840	52,701	2.6	10.6
06/26	320	10,463	20,836	20,082	2,768	24,849	22,147	16,643	6,141	666	16,742	44,456	4,097	42,533	3.3	13.8
06/27	355	8,926	35,478	71,399	3,354	36,906	16,513	16,883	6,956	539	4,247	28,083	15,018	27,905	3.8	17.7
06/28	1,540	11,075	32,522	82,675	2,779	9,701	21,166	8,316	7,854	3,309	45,905	10,449	32,821	34,842	4.3	22.0
06/29	1,935	29,203	14,576	36,278	1,976	8,465	9,786	10,127	7,793	2,233	70,221	6,527	20,799	18,552	3.3	25.3
06/30	1,604	15,961	18,597	50,751	2,089	12,221	14,900	13,695	10,455	4,014	46,978	22,989	42,265	14,068	3.8	29.1

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Table 8.—Page 2 of 4.

Date	Year													Average Percent ^a		
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Daily	Cum.
07/01	9,858	62,496	12,759	37,845	3,143	16,971	19,093	25,312	6,262	9,217	30,858	50,353	14,095	19,014	4.5	33.6
07/02	85,624	30,292	5,701	21,457	12,185	8,510	21,304	24,776	10,675	42,891	13,997	39,027	16,136	18,946	4.9	38.5
07/03	55,341	88,577	3,239	76,757	41,736	10,376	40,175	13,902	37,050	44,770	13,110	85,925	4,484	49,433	7.9	46.4
07/04	23,207	100,822	19,927	66,723	51,759	7,911	27,231	17,175	52,668	33,122	15,431	127,463	6,760	42,629	8.3	54.8
07/05	8,977	35,766	22,121	44,078	23,759	3,097	29,537	6,006	116,872	35,790	6,656	60,521	5,315	14,427	5.8	60.6
07/06	34,852	4,094	63,871	25,266	22,208	6,548	19,431	14,090	72,184	29,267	4,479	32,314	7,548	6,225	4.8	65.4
07/07	314,041	2,228	71,122	14,559	22,030	12,049	24,920	14,301	20,985	24,132	2,530	30,063	9,636	3,706	8.0	73.3
07/08	56,812	1,641	36,090	12,452	18,918	48,281	17,535	12,874	25,902	9,572	2,535	11,410	10,991	6,045	3.8	77.1
07/09	10,124	1,306	12,242	6,289	30,097	24,353	14,260	14,221	12,095	6,973	3,630	15,791	22,223	3,974	2.5	79.6
07/10	4,864	1,809	9,580	4,837	128,121	5,606	11,098	12,039	4,647	5,081	5,121	17,238	14,826	2,357	3.2	82.8
07/11	2,752	3,342	89,913	2,764	22,288	8,590	9,794	6,161	7,003	5,816	2,581	8,273	9,110	6,919	2.6	85.4
07/12	7,528	4,810	173,110	2,678	11,051	3,930	11,307	20,575	3,664	4,873	5,086	6,604	5,593	3,375	3.7	89.1
07/13	6,579	2,073	17,703	2,725	8,748	1,780	14,442	26,312	1,317	2,011	41,229	4,814	4,584	6,364	2.0	91.1
07/14	3,799	2,984	8,591	3,239	6,121	1,231	10,546	15,542	1,114	2,914	27,279	6,326	4,029	3,522	1.4	92.5
07/15	3,165	2,185	4,679	2,161	2,858	1,088	7,112	9,620	834	5,174	4,694	7,171	3,955	3,501	0.8	93.3
07/16	2,129	3,716	3,525	2,436	3,451	1,453	7,542	4,630	898	3,622	4,880	8,297	3,631	2,505	0.7	94.0
07/17	1,953	6,206	2,895	3,824	14,088	1,230	3,874	9,264	435	2,784	3,903	5,340	4,255	1,078	0.9	94.9
07/18	1,319	7,250	1,559	1,891	11,342	656	14,891	6,472	275	3,367	3,771	7,388	464	1,214	0.9	95.7
07/19	845	7,552	1,417	1,803	5,247	632	18,421	4,085	309	2,449	2,562	7,647	658	1,499	0.8	96.5
07/20	883	3,914	1,433	908	4,015	607	7,282	2,419	577	2,437	2,157	4,081	1,016	891	0.5	97.0
07/21	1,206	2,408	2,016	776	3,419	443	3,877	2,515	758	2,770	2,294	3,126	1,383		0.4	97.4
07/22	2,785	3,854	825	554	2,741	753	7,491	2,303	1,143	3,193	1,812	6,315	1,097		0.5	97.8
07/23	3,579	2,516		501	3,081	522	7,905	4,245	412	2,540	1,986	979	845		0.4	98.3
07/24	3,278	575		455	2,797	869	7,182	3,084	260	2,033	2,332	784	714		0.3	98.6
07/25	483	16		363	6,579	1,579	534	1,861	289	1,574	1,421	165	1,183		0.2	98.8
07/26	572	15		44	6,159	1,201	485	1,895	616	1,933	238	179	334		0.2	99.0
07/27	600	16		35	6,420	197	861	1,157	429	1,183	291	144	0		0.2	99.2
07/28	788	62		23	2,058	360	348	1,340	855	864	1,202	83	0		0.1	99.3
07/29	1,204	224		27	2,440	56	454	1,126	829	343	1,027	34	0		0.1	99.4
07/30	1,220	102		28	186	70	1,024	4	536	260	827	51	1,842		0.1	99.5
07/31	763	33		21	286	53	259	6	631	270	183	201	331		0.0	100

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Table 8.—Page 3 of 4.

Date	Year													Average Percent ^a		
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Daily	Cum.
08/01	130	32		45	226	34	317	5	866	187	1,035	236	278		0.0	100
08/02	138	61		35	112	62	868	4	911	34	1,071	63	123		0.0	100
08/03	735	25		18	77	46	38	10	730	26	1,031	51	0		0.0	100
08/04	188	21		33	71	30	695	8	2,009	212	769	35	0		0.1	100
08/05	1,175	13		45	121	315	1,317	4	774	328	9	34	0		0.1	100
08/06	2,993	26		23	83	253	720	5	1,052	170		26	0		0.1	100
08/07	1,788	13		181	106	78	386	5	558	70		25	0		0.0	100
08/08	5,030	7		82	99	29	197	6	8	42		29	0		0.1	100
08/09	867	9		24	40	31	223	9	4	22		190	0		0.0	100
08/10	0	14		0	180	43	232	25	0	30		104	0		0.0	100
08/11	0	17		0	121	70	139	30	0	147		94	0			
08/12	0	22		0	0	33	83	20	0	99		104	0			
08/13	236	18		0	0	114	18	19	0	30		217	0			
08/14	177	24		0	0	54	16	20	0	21		135	0			
08/15	0	25		0	0	23	3	9	0	30		43	0			
08/16	0	8		0	0	25	7	4	0	22		28	0			
08/17	0	3		0	0	20	8	6	0	15		16	0			
08/18	0	5		0	0	36	17	4	0	23		17				
08/19	0	2		0	3	24	12	5	0	48		46				
08/20	0	3		0	2	0	9	7	0	222		16				
08/21	0	1		0	2	0	1	10	0	206						
08/22	0			0	3	0	5	33	0	74						
08/23	0			0	2	0	5	14	0	56						
08/24	0			0	1	0	2	7	0	49						
08/25	0			0	0	0	3	9	0	15						
08/26	0						15	5								
08/27	0						18	3								

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Table 8.—Page 4 of 4.

Date	Year													Average Percent ^a		
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Daily	Cum.
08/28	0						2	5								
08/29								4								
08/30								6								
08/31								24								
09/01								14								
Total	684,348	496,504	699,092	719,085	513,314	285,297	507,643	377,029	462,870	315,897	407,500	807,539	319,685	584,540		

^a Average percent of total annual escapement June 4 through August 10, 1990 - 2003.

Table 9.—Chinook salmon escapement estimates and average escapement percentage by date, Nushagak River, 1990–2003.

Date	Year														Average Percent ^a	
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Daily	Cum.
06/04				443												
06/05		106		585												
06/06	63	164		1,116											0.12	0.1
06/07	64	118		3,486										193	0.35	0.5
06/08	136	119		2,000		40							1,179	1,032	0.41	0.9
06/09	386	121	124	846	374	172	962	111	368	8			7,957	1,773	1.19	2.1
06/10	151	159	105	700	351	161	1,242	160	1,053	14	309		4,774	2,304	1.04	3.1
06/11	108	139	110	854	375	125	690	62	543	48	171		993	1,205	0.49	3.6
06/12	94	164	140	767	413	125	765	57	355	30	197	561	643	531	0.44	4.0
06/13	241	138	1,567	484	248	193	1,242	74	296	43	872	559	267	446	0.60	4.6
06/14	166	120	1,138	442	126	409	995	137	238	33	292	7,303	262	366	1.09	5.7
06/15	2,468	1,214	715	215	86	3,896	663	2,034	261	72	273	9,319	273	1,811	2.11	7.8
06/16	1,953	4,751	1,177	3,490	6,597	2,029	390	5,023	234	720	1,107	2,905	626	1,529	2.94	10.8
06/17	844	2,332	2,841	4,805	13,555	1,329	2,129	2,140	122	496	2,791	568	637	2,377	3.34	14.1
06/18	712	2,008	3,607	2,170	2,687	1,143	8,621	1,735	257	227	938	399	221	4,291	2.62	16.7
06/19	788	1,201	852	1,284	4,565	1,444	4,947	1,893	628	131	1,895	1,230	4,668	2,773	2.56	19.3
06/20	542	923	967	1,014	2,807	1,291	2,751	2,367	11,914	103	2,855	1,830	15,187	2,994	4.30	23.6
06/21	1,374	1,166	1,765	568	1,475	1,190	2,807	520	5,968	75	1,419	3,305	2,773	2,049	2.39	26.0
06/22	10,709	1,888	1,388	433	7,989	636	2,831	709	7,159	74	928	4,247	1,919	2,749	3.95	29.9
06/23	4,692	4,199	895	10,830	5,402	976	1,331	565	6,620	214	546	6,584	4,762	2,244	4.51	34.4
06/24	1,729	19,352	959	8,307	3,233	1,701	1,399	490	5,835	8,063	428	4,736	3,681	3,671	5.75	40.2
06/25	890	10,207	1,047	3,964	3,377	12,525	3,282	1,633	5,902	3,384	7,699	4,522	3,247	4,866	6.01	46.2
06/26	285	7,721	8,043	3,282	4,082	16,726	1,776	3,545	3,672	1,383	5,441	4,943	1,304	6,053	6.17	52.4
06/27	313	3,502	4,726	5,403	1,861	6,242	1,010	1,604	4,163	1,065	1,098	3,738	1,385	4,328	3.65	56.0
06/28	264	4,555	4,428	6,410	1,315	3,175	1,411	770	1,426	896	2,412	1,772	492	3,170	2.94	58.9
06/29	332	10,129	5,354	2,879	1,045	2,630	225	615	1,610	425	2,291	1,113	1,982	2,794	3.02	62.0
06/30	283	5,290	7,036	3,499	957	3,195	297	1,091	1,631	507	2,451	3,242	1,835	1,758	2.99	65.0

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Table 9.—Page 2 of 3.

Date	Year														Average Percent ^a	
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Daily	Cum.
07/01	1,428	1,884	5,534	4,790	974	3,110	325	1,732	738	2,251	3,354	3,784	1,281	1,883	2.99	67.9
07/02	5,317	1,081	1,704	2,845	4,378	1,888	1,222	1,642	1,014	10,203	1,560	1,718	2,111	4,029	3.68	71.6
07/03	2,350	1,326	1,207	3,370	3,319	2,117	616	1,230	3,806	2,137	1,767	2,213	1,549	2,264	2.65	74.3
07/04	1,857	2,517	2,254	2,607	2,016	1,281	371	630	4,218	2,689	2,162	2,883	685	2,293	2.57	76.8
07/05	724	1,431	2,563	1,772	2,319	839	294	258	4,327	4,344	874	1,225	1,303	1,136	2.12	79.0
07/06	1,171	1,316	3,300	1,573	2,153	762	195	364	3,588	3,161	820	821	2,146	1,060	2.03	81.0
07/07	2,579	664	1,683	1,228	1,758	1,845	401	387	4,762	2,663	610	945	1,921	1,082	2.04	83.0
07/08	10,211	518	1,482	1,530	1,463	3,337	719	285	5,712	1,304	535	904	2,068	679	2.78	85.8
07/09	2,301	379	1,538	1,054	1,519	1,869	513	630	2,739	1,252	414	929	784	400	1.47	87.3
07/10	1,636	398	1,243	1,037	3,061	1,096	547	526	3,579	948	414	1,125	1,398	1,641	1.69	89.0
07/11	433	791	2,568	739	1,496	1,444	563	226	5,359	992	238	651	676	1,009	1.55	90.5
07/12	643	1,397	2,774	683	1,026	962	439	462	2,787	818	334	525	692	1,270	1.34	91.8
07/13	619	390	1,823	555	932	516	477	921	1,624	675	951	367	569	254	0.96	92.8
07/14	447	468	1,074	627	764	261	325	1,099	1,292	713	1,252	446	940	220	0.90	93.7
07/15	179	386	725	392	411	223	415	629	844	903	391	1,005	688	377	0.68	94.4
07/16	157	543	698	455	461	332	333	260	555	818	408	1,309	467	1,375	0.74	95.1
07/17	281	838	512	533	1,016	255	141	606	427	719	291	990	444	479	0.68	95.8
07/18	243	953	431	321	693	154	254	413	256	1,051	297	1,048	785	457	0.66	96.5
07/19	25	1,117	317	311	295	162	510	197	275	767	308	1,015	462	534	0.57	97.0
07/20	30	637	211	208	365	135	306	126	429	853	203	592	391	279	0.43	97.5
07/21	51	531	177	141	303	122	262	124	731	956	181	421	426		0.40	97.9
07/22	114	1,245	46	73	401	228	83	98	1,115	823	181	743	363		0.50	98.4
07/23	127	580		106	370	134	83	148	357	606	111	462	220		0.30	98.7
07/24	131	177		99	242	225	34	135	200	591	87	342	349		0.24	98.9
07/25	364	19		94	403	196	35	56	147	395	68	162	154		0.19	99.1
07/26	208	20		27	351	155	40	67	310	561	33	162	355		0.21	99.3
07/27	94	18		21	317	23	116	31	242	236	55	134	62		0.12	99.4
07/28	531	62		19	74	24	122	46	342	237	198	85	578		0.21	99.6
07/29	37	244		16	47	31	133	42	386	127	466	60	300		0.17	99.8
07/30	22	207		20	29	33	173	0	254	76	72	57	59		0.09	99.9
07/31	12	47		9	16	28	70	0	275	57	136	215	274		0.10	100

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Table 9.—Page 3 of 3.

Date	Year														Average Percent ^a	
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Daily	Cum.
08/01	0	34		11	18	15	31	0	368	62	339	199	34			
08/02	46	64		16	25	36	42	0	388	16	370	56	124			
08/03	0	31		17	9	20	36	0	1,365	25	323	57	324			
08/04	0	23		25	10	10	16	0	1,289	80	156	36	290			
08/05	0	18		33	0	96	28	0	297	84	0	42	504			
08/06	0	28		13	0	103	21	0	386	23		39	0			
08/07	0	12		101	0	43	18	0	276	8		30	13			
08/08	0	8		48	0	12	10	0	91	5		45	122			
08/09	0	11		17	0	14	16	0	48	4		260	103			
08/10	0	27		0	0	17	19	0	2	7		117	60			
08/11	0	28		0	0	25	3	0	1	15		94	0			
08/12	0	28		0	0	9	2	0	2	7		435	0			
08/13	0	14		0	0	29	1	0	2	8		293	0			
08/14	0	9		0	0	15	1	0	1	6		133	0			
08/15	0	8		0	0	6	0	0	1	3		52	0			
08/16	0	16		0	0	7	0	0	4	6		31	0			
08/17	0	7		0	0	7	0	0	17	4		30	0			
08/18	0	7		0	0	11	0	0	8	5		29				
08/19	0	3		0	0	7	0	0	2	4		42				
08/20	0	4		0	0	0	0	0	1	4		41				
08/21	0	1		0	0	0	0	0	1	3						
08/22	0			0	0	0	0	0	0	4						
08/23	0			0	0	0	0	0	0	6						
08/24	0			0	0	0	0	0	0	4						
08/25	0			0	0	0	0	0	0	1						
Total	67,935	108,333	86,832	101,798	99,942	89,612	56,119	44,699	121,491	66,329	60,372	96,277	91,145	84,034		

^a Average percent of total annual escapement June 6 through July 31, 1990 - 2003.

Table 10.—Chum salmon escapement estimates and average escapement percentage by date, Nushagak River, 1990–2003.

Date	Year															Average Percent ^a	
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Daily	Cum.	
06/04				187											0.0	0.0	
06/05		110		195											0.0	0.0	
06/06	35	183		664											0.0	0.0	
06/07	36	144		937										22	0.0	0.1	
06/08	88	124		627		88							3,953	257	0.1	0.2	
06/09	322	119	253	477	362	258	1,547	68	139	29			23,653	427	0.7	0.9	
06/10	94	170	275	304	255	324	2,312	74	345	61	529		29,067	375	0.9	1.8	
06/11	66	124	178	393	367	175	1,333	45	197	177	410		9,472	338	0.3	2.1	
06/12	51	135	245	281	442	186	1,589	39	130	139	552	1,065	4,133	49	0.2	2.4	
06/13	149	117	2,377	170	318	293	1,992	74	112	136	1,743	928	3,500	19	0.3	2.7	
06/14	104	112	1,719	176	183	595	1,958	88	84	91	665	14,597	2,297	199	0.6	3.3	
06/15	2,191	1,211	993	170	213	3,125	2,023	412	88	217	369	17,824	2,199	34	0.8	4.1	
06/16	1,691	3,354	2,308	1,878	5,901	1,884	968	1,034	107	1,876	2,236	5,249	941	19	0.8	4.8	
06/17	747	1,169	6,097	2,786	20,237	1,472	3,508	587	46	1,642	4,290	1,137	757	3,151	1.2	6.0	
06/18	618	1,024	7,379	1,213	6,514	1,757	21,909	426	134	838	1,117	872	1,749	5,600	1.3	7.4	
06/19	665	627	2,014	659	15,354	1,967	12,684	609	388	314	3,804	3,290	25,505	5,190	1.9	9.2	
06/20	1,627	941	2,552	605	7,312	1,275	10,515	713	8,457	200	6,188	8,841	39,254	4,222	2.4	11.6	
06/21	4,766	1,190	4,256	422	4,009	1,111	11,063	222	3,504	243	3,382	14,457	6,047	11,584	1.7	13.3	
06/22	61,168	2,159	3,587	336	27,174	818	14,955	597	12,299	221	2,326	20,765	4,945	22,038	4.5	17.8	
06/23	13,549	4,678	2,177	8,003	18,933	1,168	7,758	501	12,064	279	1,054	36,113	23,275	9,438	3.6	21.4	
06/24	5,180	37,121	2,302	21,400	16,333	3,151	8,448	508	9,284	14,887	889	28,633	27,489	10,139	4.8	26.1	
06/25	2,668	13,765	2,926	7,538	15,897	22,478	22,596	1,401	15,723	7,766	15,690	29,192	7,190	26,322	4.9	31.1	
06/26	787	12,980	70,205	5,265	17,462	50,089	7,325	3,059	12,443	2,396	14,334	32,744	5,278	2,345	6.1	37.2	
06/27	942	10,142	30,632	23,140	9,175	18,394	13,954	2,381	14,011	2,154	3,637	12,037	31,537	11,819	4.7	41.9	
06/28	152	12,072	16,697	23,874	7,725	7,509	15,147	1,335	5,526	7,766	11,077	4,762	16,033	14,918	3.7	45.6	
06/29	190	20,662	12,895	5,421	5,530	6,426	2,515	1,254	5,588	3,275	17,056	2,991	10,109	7,894	2.6	48.2	
06/30	137	11,025	15,892	9,468	5,566	8,561	4,155	4,876	7,341	5,508	18,172	10,062	11,425	8,495	3.1	51.3	

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Table 10.—Page 2 of 3.

Date	Year														Average Percent ^a	
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Daily	Cum.
07/01	37,878	5,882	11,160	10,034	7,442	10,535	7,901	10,755	3,962	29,784	4,925	15,712	20,870	11,916	4.9	56.2
07/02	28,403	4,831	9,766	7,751	46,488	6,408	8,992	8,532	6,624	58,420	2,261	7,876	6,360	20,842	5.8	61.9
07/03	23,937	20,793	5,105	16,516	16,785	7,832	9,843	3,064	27,448	10,626	2,180	19,047	10,603	13,141	4.8	66.8
07/04	6,148	57,022	3,530	19,039	11,018	4,351	5,053	1,249	21,653	16,369	2,445	28,512	4,164	7,008	4.8	71.6
07/05	2,364	17,481	3,769	6,358	16,547	1,910	1,256	413	24,007	25,340	948	26,953	6,631	9,967	3.7	75.3
07/06	19,729	1,546	6,620	4,392	8,063	3,392	1,759	1,084	21,323	11,083	693	14,630	3,718	6,898	2.7	78.0
07/07	19,224	936	13,819	2,819	7,176	7,703	1,674	642	18,917	8,004	430	14,176	5,104	18,579	3.1	81.1
07/08	28,154	739	5,901	2,712	5,729	18,750	2,366	201	23,583	3,437	415	12,882	3,715	12,354	3.1	84.2
07/09	6,448	559	3,023	4,578	14,793	5,325	1,909	1,336	11,201	2,541	524	18,939	2,048	4,379	2.0	86.2
07/10	10,333	780	2,362	3,690	22,801	2,097	1,430	665	5,645	2,244	677	19,411	5,257	6,592	2.2	88.3
07/11	3,337	1,366	19,174	2,098	6,060	2,989	855	308	8,801	2,437	314	9,898	2,752	5,067	1.7	90.0
07/12	2,854	1,706	14,505	1,612	3,270	1,639	898	1,207	4,537	2,084	627	7,687	3,561	4,982	1.3	91.3
07/13	2,472	1,580	6,202	1,600	2,667	819	1,068	3,580	1,588	969	3,505	5,841	5,112	4,570	1.1	92.4
07/14	1,035	2,223	3,027	2,696	2,369	507	803	2,042	1,165	1,247	3,875	8,119	9,838	3,045	1.1	93.5
07/15	564	1,646	1,603	1,995	1,117	449	654	1,204	647	1,892	687	9,892	4,468	3,309	0.8	94.3
07/16	436	2,752	1,351	2,263	1,340	638	669	611	597	1,483	705	11,582	3,365	3,142	0.8	95.1
07/17	612	4,559	1,225	3,409	5,197	523	242	1,321	343	1,157	626	8,079	5,868	3,834	1.0	96.0
07/18	496	5,325	614	1,719	2,675	283	817	748	209	1,609	616	10,033	4,859	2,870	0.8	96.8
07/23	2,872	1,973		475	769	245	352	330	302	1,039	301	4,995	1,566	4,392	0.5	97.4
07/24	2,703	471		433	688	384	325	291	171	1,010	343	3,779	1,203	3,628	0.4	97.8
07/25	2,641	67		359	1,652	428	240	140	169	730	221	1,181	4,260		0.3	98.1
07/26	2,495	68		13	1,759	337	227	156	343	1,011	79	1,242	2,986		0.3	98.3
07/27	2,265	73		15	1,828	35	440	76	245	579	95	1,008	1,937		0.2	98.6
07/28	4,130	256		13	642	68	263	95	436	454	403	597	636		0.2	98.8
07/29	601	978		8	114	27	350	90	418	200	359	245	1,098		0.1	98.9
07/30	525	376		9	173	35	633		272	145	269	349	969		0.1	99.0
07/31	318	153		10	196	26	199		313	154	177	1,440	2,546		0.1	99.1

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Table 10.—Page 3 of 3.

Date	Year													Average Percent ^a		
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Daily	Cum.
08/01	447	161		29	218	10	35		377	110	336	1,608	1,870		0.1	99.3
08/02	46	334		10	102	23	398		438	26	353	442	1,133		0.1	99.3
08/03	269	149		11	44	11	170		1,099	24	328	347	1,523		0.1	99.4
08/04	557	123		12	40	16	126		1,398	114	433	246	15		0.1	99.5
08/05	828	79		15	38	197	285		257	152	89	249	78		0.1	99.6
08/06	3,290	159		10	40	133	126		343	59	16	199	43		0.1	99.7
08/07	1,863	92		126	123	36	67		212	23	12	201	0		0.1	99.8
08/08	5,102	48		60	53	8	40		39	15	9	244	0		0.1	99.9
08/09	896	61		16	2	8	47		20	10	6	1,494	0		0.1	100
08/10	0	70			13	27	50			13	8	858	0		0.0	100
08/11	0	82			473	46	19			46	6	738	0			
08/12	0	122			33	26	10			28	7	1,209	0			
08/13	297	114			16	62	1			16	12	2,032	0			
08/14	199	166			17	23	1			10	8	1,139	0			
08/15	47	177			14	11				9	5	399	0			
08/16	16	32			10	9				8	5	253	0			
08/17	97	13			11	8				6	6	186	0			
08/18	97	25			8	6				9		182	0			
08/19	68	12			21	9				16		388	0			
08/20		13			17					51		266	0			
08/21		4			26					47			0			
08/22					25					19						
08/23					16					17						
08/24					12					13						
08/25					1					4						
Total	329,096	277,617	304,699	217,480	379,981	215,498	226,839	64,437	301,108	241,106	143,859	526,346	423,968	299,419		

^a Average percent of total annual escapement June 4 through August 10, 1990 - 2003.

Table 11.—Age, sex, and size (length in mm) composition of sockeye salmon escapement, Nushagak River, 2003.

	Age Group							Total	
	0.2	0.3	1.2	0.4	1.3	2.2	1.4		2.3
<u>Sample period: June 7 - July 20</u>									
Males	1,079	9,712	28,056	1,079	249,263	2,158	8,632	7,553	307,532
Percent	0.19	1.67	4.83	0.19	42.94	0.37	1.49	1.3	52.97
Std. Error	0.26	0.76	1.27	0.26	2.94	0.36	0.72	0.67	
Sample Size	1	9	26	1	231	2	8	7	285
Mean Length	451	567	511	604	586	571	624	609	580
Std. Error		13	14		3	70	8	7	3
Sample Size	1	9	26	1	231	2	8	7	285
Females		14,028	7,553		242,789	1,079	3,237	4,316	273,002
Percent		2.42	1.30		41.82	0.19	0.56	0.74	47.03
Std. Error		0.97	0.71		3.11	0.27	0.47	0.54	
Sample Size		13	7		225	1	3	4	253
Mean Length		564	487		564	487	602	564	562
Std. Error		5	17		2		14	21	2
Sample Size		13	7		225	1	3	4	253
Both Sexes	1,079	23,740	35,609	1,079	492,052	3,237	11,869	11,869	580,534
Std. Error	2	387	620	2	10,342	39	176	176	10,371
Percent	0.19	4.09	6.13	0.19	84.76	0.56	2.04	2.04	100.00
Std. Error		0.85	1.04		1.55	0.32	0.61	0.61	
Sample Size	1	22	33	1	456	3	11	11	538
Mean Length	451	566	506	604	575	543	618	593	572
Std. Error		6	12		2	70	7	9	2
Sample Size	1	22	33	1	456	3	11	11	538

Table 12.—Age, sex, and size (length in mm) composition of Chinook salmon escapement, Nushagak River, 2003.

	Age Group						Total
	1.1	1.2	1.3	1.4	1.5	1.6	
<u>Sample period: June 7 - July 20</u>							
Males	116	19,630	24,973	10,337	813		55,869
Percent	0.14	24.53	31.21	12.92	1.02		69.81
Std. Error	0.17	1.96	2.11	1.53	0.46		
Sample Size	1	169	215	89	7		481
Mean Length	437	580	736	821	942		699
Std. Error		6	7	12	64		4
Sample Size	1	169	215	89	7		481
Females		2,207	10,337	11,034	465	116	24,159
Percent		2.76	12.92	13.79	0.58	0.14	30.19
Std. Error		1.14	2.11		0.48	0.24	
Sample Size		19	89	95	4	1	208
Mean Length		634	786	857	897	870	807
Std. Error		32	6	5	19		5
Sample Size		19	89	95	4	1	208
Both Sexes	116	21,837	35,310	21,371	1,278	116	80,028
Std. Error	0	423	745	412	13	0	950
Percent	0.14	27.29	44.12	26.7	1.60	0.14	100.00
Std. Error	0.14	1.70	1.89	1.69	0.48	0.14	
Sample Size	1	188	304	184	11	1	689
Mean Length	437	585	751	840	926	870	732
Std. Error		6	6	6	41		3
Sample Size	1	188	304	184	11	1	689

Table 13.—Age, sex, and size (length in mm) composition of chum salmon escapement, Nushagak River, 2003.

	Age Group					Total
	0.3	0.4	1.3	0.5	1.4	
<u>Sample period: June 7 - July 20</u>						
Males	148,301	32,033	7,118	1,186	1,186	189,824
Percent	50.2	10.84	2.41	0.40	0.40	64.26
Std. Error	3.97	2.47	1.22	0.50	0.50	
Sample Size	125	27	6	1	1	160
Mean Length	604	623	587	688	581	607
Std. Error	3	6	12			2
Sample Size	125	27	6	1	1	160
Females	90,166	11,864	3,559			105,589
Percent	30.52	4.02	1.20			35.74
Std. Error	4.91	2.09	1.16			
Sample Size	76	10	3			89
Mean Length	561	586	589			564
Std. Error	5	8	14			4
Sample Size	76	10	3			89
Both Sexes	238,467	43,897	10,677	1,186	1,186	295,413
Std. Error	7,480	1,286	229	5	5	7,593
Percent	80.72	14.86	3.61	0.40	0.40	100.00
Std. Error	2.51	2.26	1.18	0.40	0.40	
Sample Size	201	37	9	1	1	249
Mean Length	588	613	587	688	581	592
Std. Error	3	5	9			2
Sample Size	201	37	9	1	1	249

Table 14.—Average air and water temperatures at the Nushagak River sonar project during June, July and August 1986–2003.

Year	Average Air Temperature (°C)			Average Water Temperature (°C)		
	June	July	August	June	July	August
1986	11.4	12.7	11.0	14.3	12.5	10.0
1987	10.5	14.2	13.1	9.5	12.1	13.1
1988	12.5	14.7	12.6	11.1	14.8	13.7
1989	11.5	14.0	14.8	10.4	14.9	15.6
1990	12.1	13.7	12.3	11.7	14.8	14.1
1991	12.1	14.1	13.1	11.6	14.7	14.3
1992	12.3	12.8	^a	10.7	11.7	^a
1993	11.7	14.0	11.9	12.5	15.4	14.3
1994	11.3	11.8	11.7	12.8	12.8	14.6
1995	12.3	13.3	11.0	10.5	14.5	13.0
1996	11.2	12.8	11.5	12.0	14.3	13.2
1997	13.6	15.0	12.5	14.3	16.6	14.6
1998	10.7	12.9	11.4	9.1	13.2	13.2
1999	11.6	14.1	11.3	11.1	13.6	13.1
2000	11.9	12.7	13.0	11.2	13.7	13.3
2001	11.0	10.8	12.1	11.2	13.7	13.3
2002	13.0	13.3	14.6	11.7	14.2	15.8
2003	11.4	13.5	^a	13.0	14.2	^a
<hr/>						
1986-2002 Min	10.5	10.8	11.0	9.1	11.7	10.0
1986-2002 Max	13.6	15.0	14.8	14.3	16.6	15.8
1986-2002 Average	11.8	13.3	12.4	11.5	14.0	13.7

^a Project not operated in August.



Figure 1.—Nushagak River sonar site, Bristol Bay.

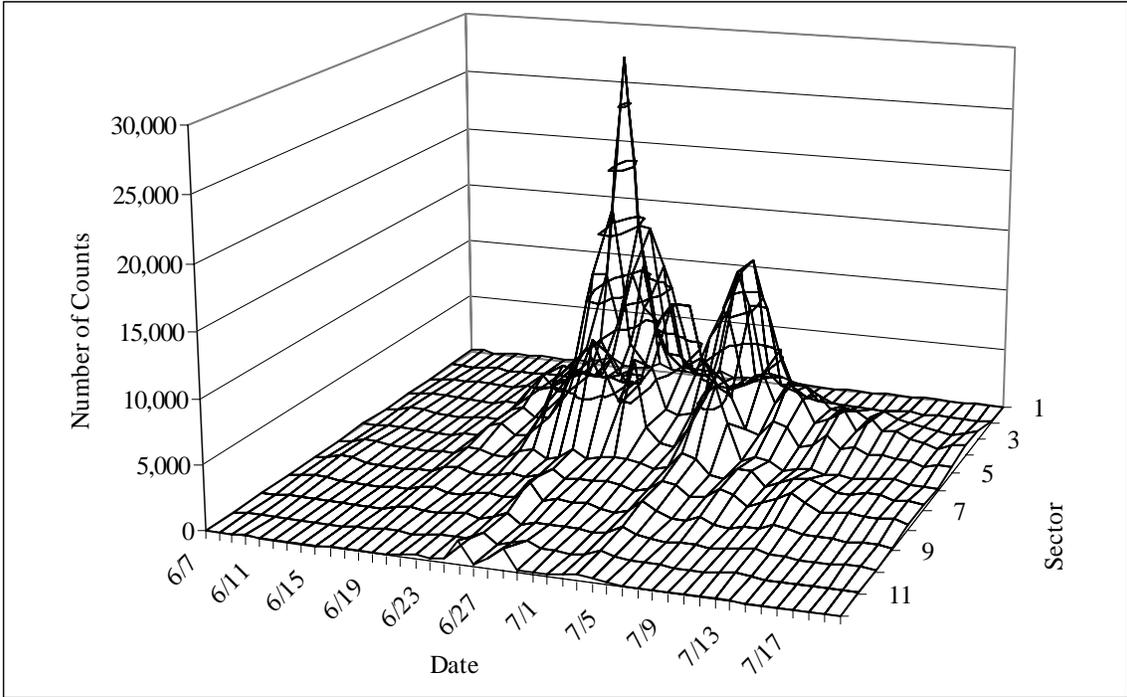


Figure 2.—Sonar counts by day and sector, right bank inshore, Nushagak River sonar project, 7 June–20 July 2003.

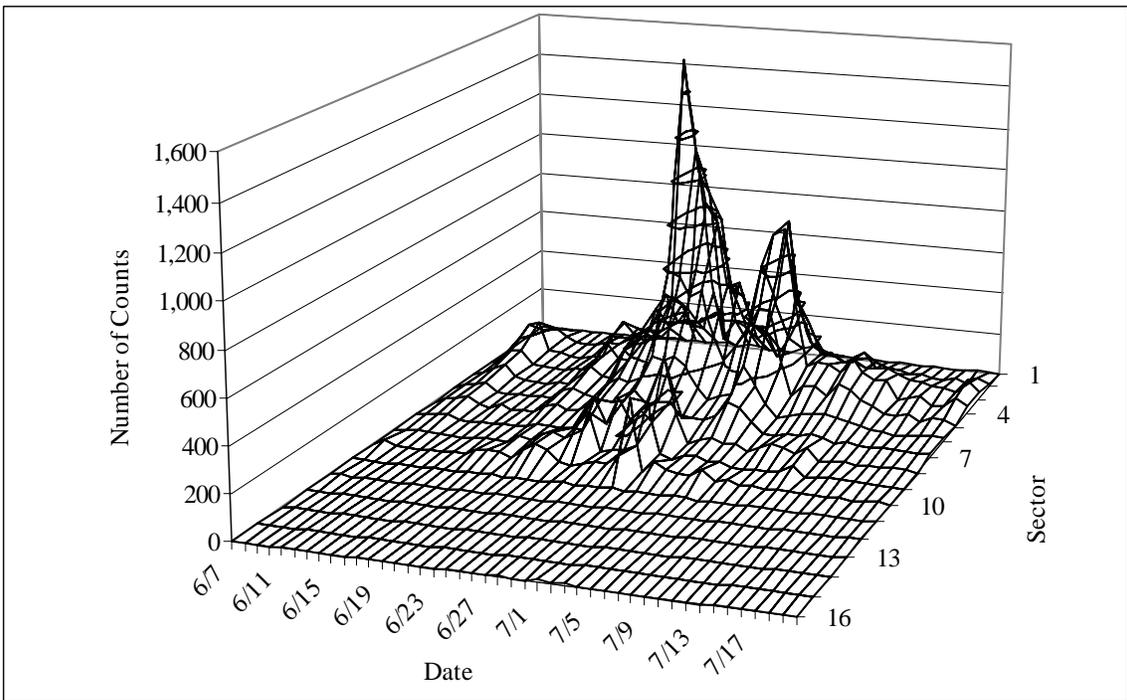


Figure 3.—Sonar counts by day and sector, right bank offshore, Nushagak River sonar project, 7 June–20 July 2003.

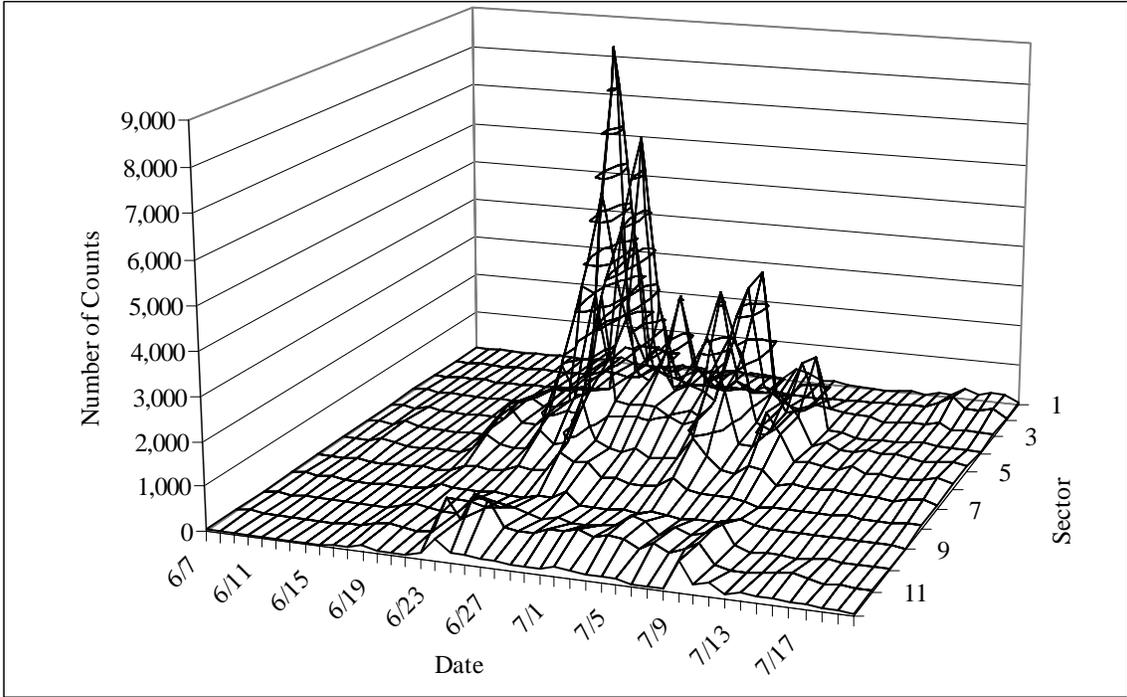


Figure 4.—Sonar counts by day and sector, left bank inshore, Nushagak River sonar project, 7 June–20 July 2003.

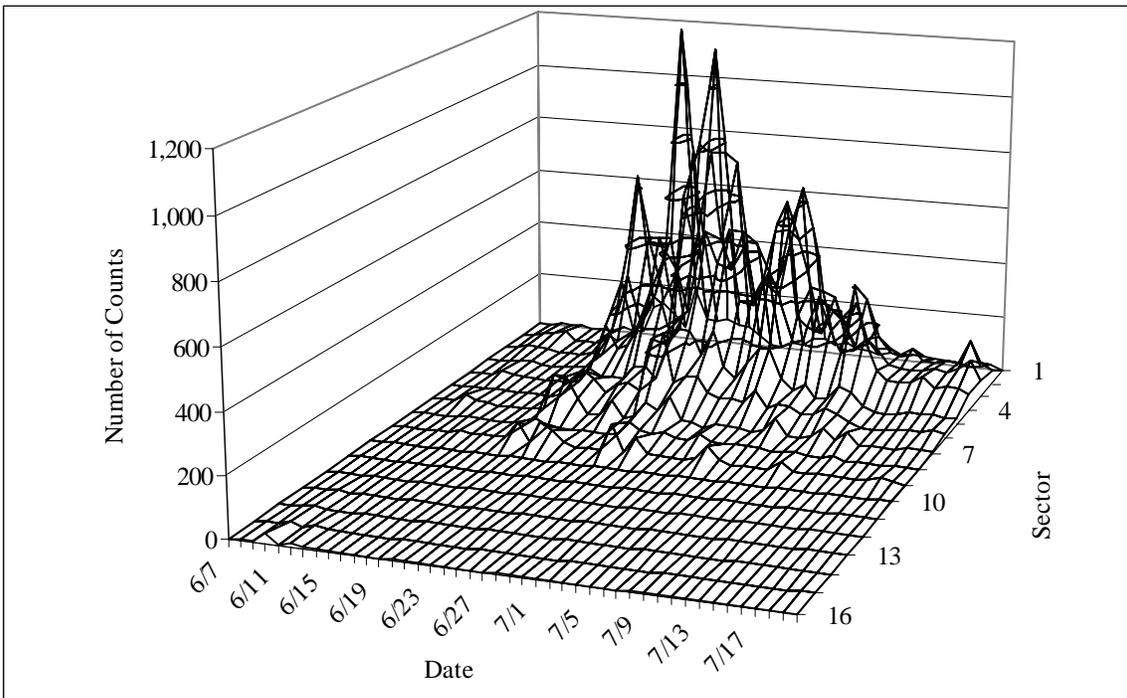


Figure 5.—Sonar counts by day and sector, left bank offshore, Nushagak River sonar project, 7 June–20 July 2003.

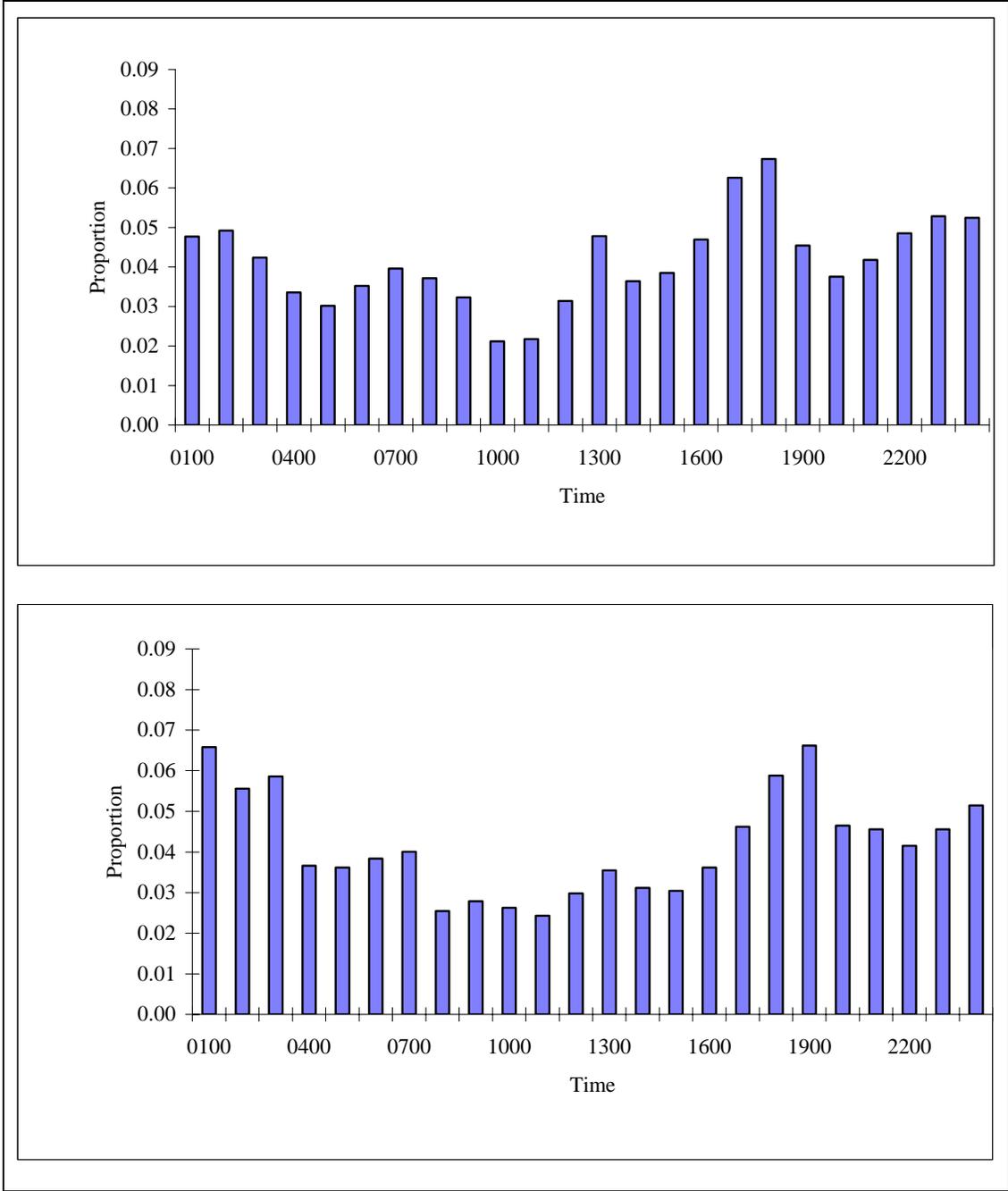


Figure 6.—Average proportion of total sonar counts by hour for the right bank inshore (top) and offshore (bottom), Nushagak River sonar project, 7 June–20 July 2003.

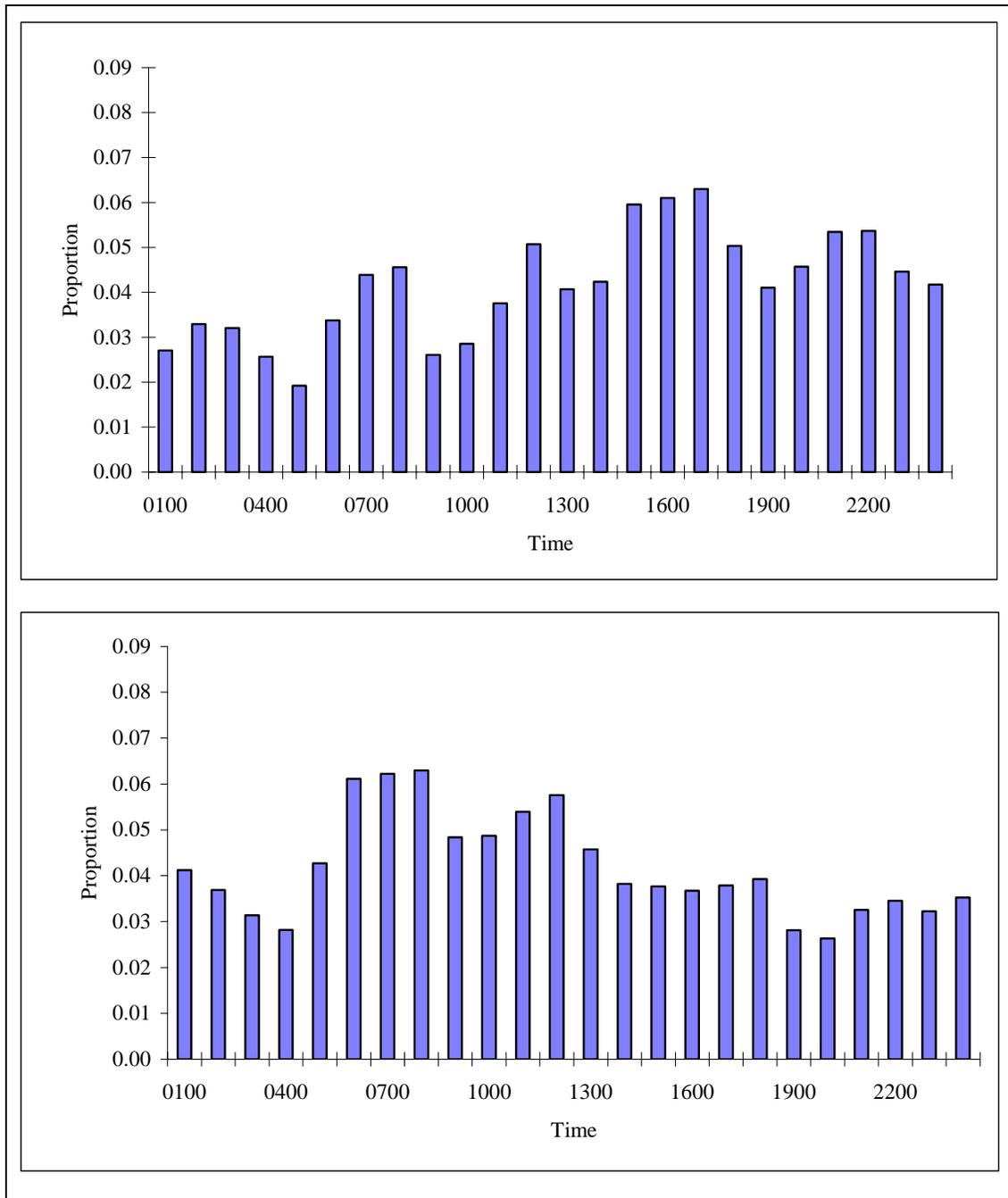


Figure 7.—Average proportion of total sonar counts by hour for the left bank inshore (top) and offshore (bottom), Nushagak River sonar project, 7 June–20 July 2003.

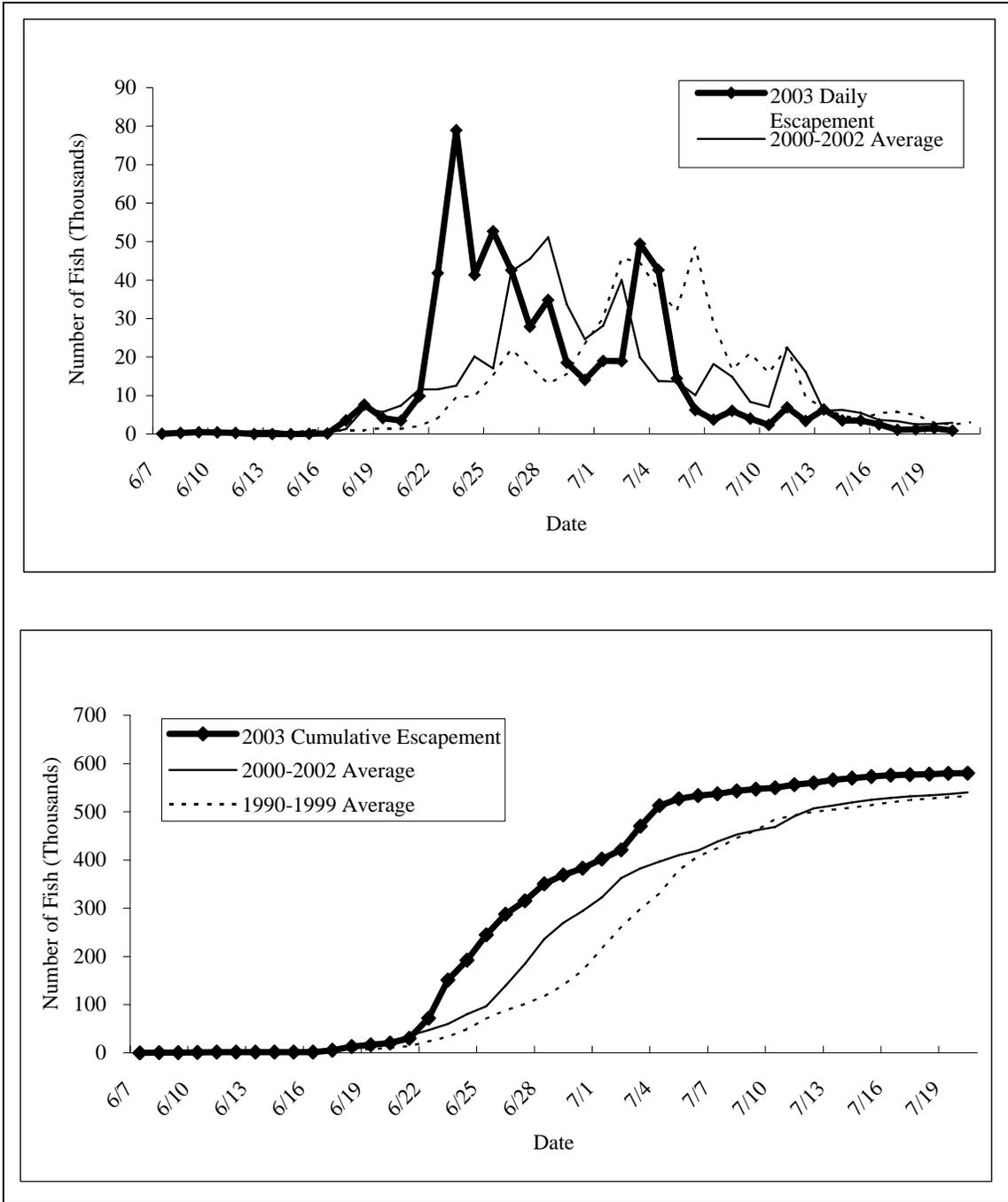


Figure 8.—Daily (top) and cumulative (bottom) escapement for sockeye salmon, Nushagak River sonar project, 7 June–20 July 2003.

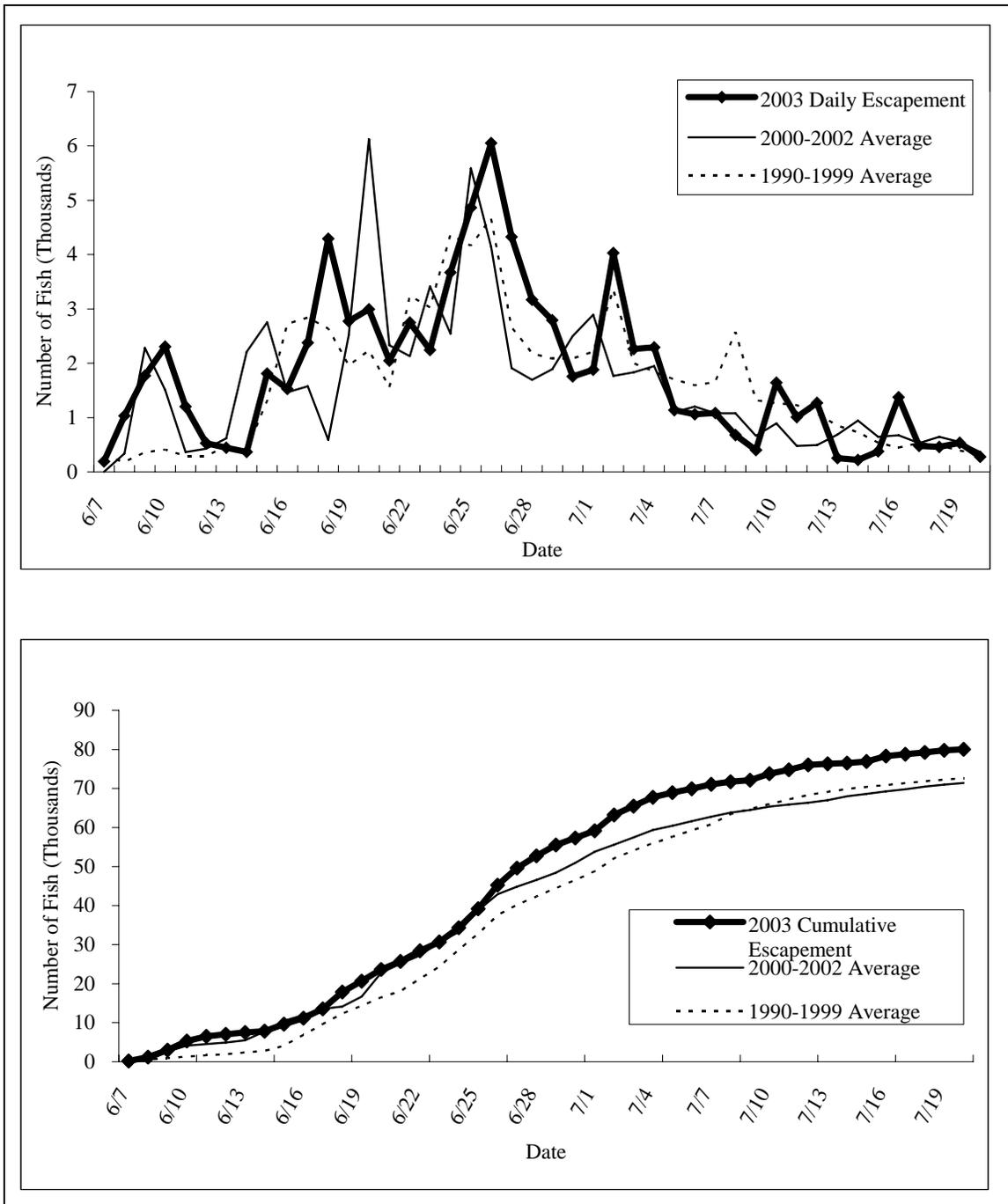


Figure 9.—Daily (top) and cumulative (bottom) escapement timing for Chinook salmon, Nushagak River sonar project, 7 June–20 July 2003.

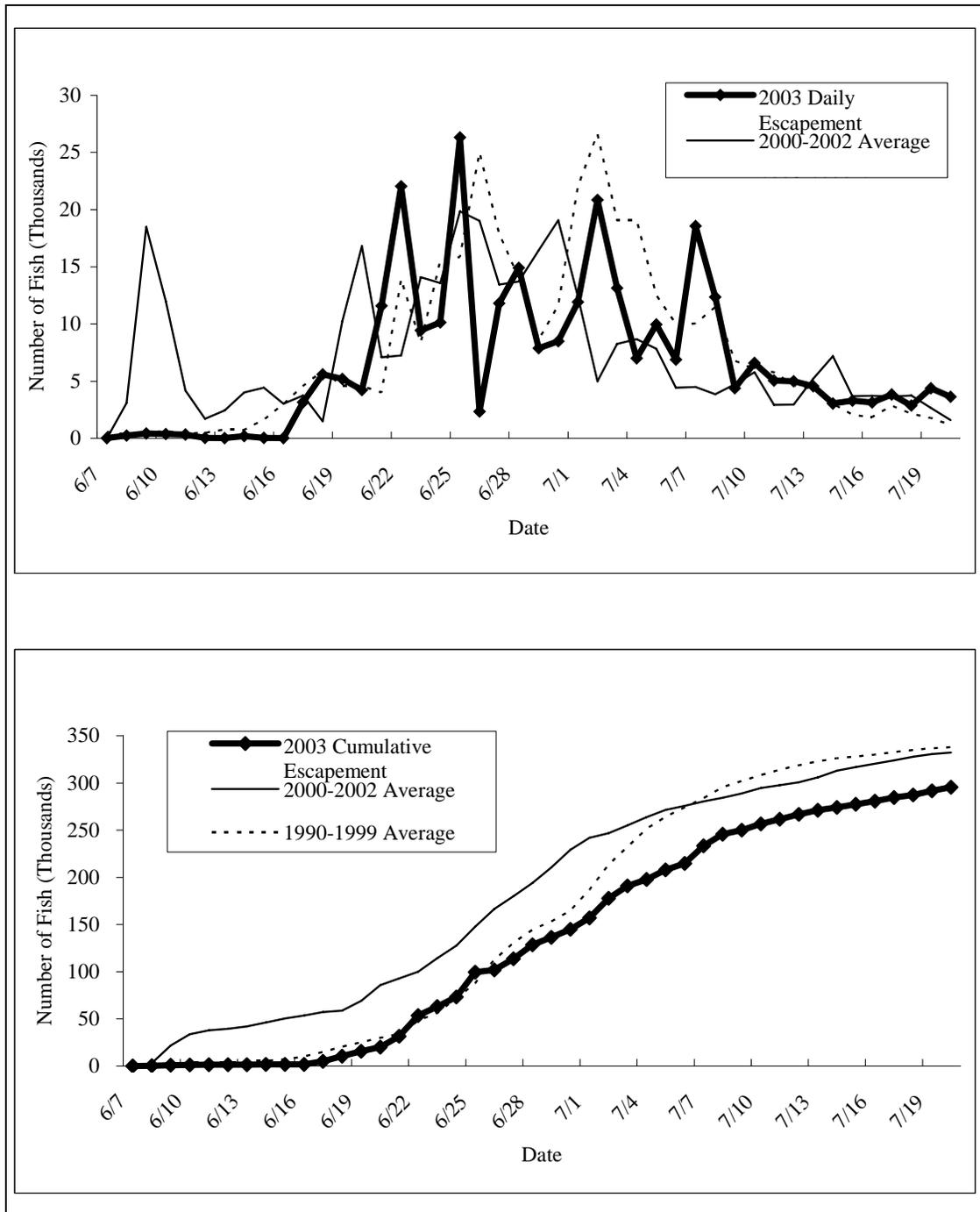


Figure 10.—Daily (top) and cumulative (bottom) escapement timing for chum salmon, Nushagak River sonar project, 7 June–20 July 2003.

APPENDIX A

Appendix A1.—Sonar counts by date and sector, right bank inshore strata, Nushagak sonar project, 2003.

Date	Sector												Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12		
6/07	56	13	5	3	1	2	1	1	2	0	0	1	85	85
6/08	149	73	67	39	44	49	55	111	78	55	45	50	815	900
6/09	41	17	117	210	281	183	416	374	180	65	42	69	1,995	2,895
6/10	90	41	67	112	327	148	337	333	156	101	54	114	1,880	4,775
6/11	267	116	198	132	130	67	120	122	58	26	89	77	1,402	6,177
6/12	48	35	102	46	42	15	38	40	32	17	27	25	467	6,644
6/13	194	25	32	51	36	9	5	6	8	13	11	12	402	7,046
6/14	145	39	50	26	28	21	10	9	5	3	5	7	348	7,394
6/15	108	51	269	269	145	179	163	105	81	62	25	14	1,471	8,865
6/16	173	28	161	189	105	164	132	94	71	53	36	55	1,261	10,126
6/17	102	76	338	1,690	1,084	1,177	651	574	408	209	83	98	6,490	16,616
6/18	369	539	2,369	2,902	1,470	1,493	679	613	560	370	262	169	11,795	28,411
6/19	782	399	2,231	1,677	789	609	386	313	198	243	184	92	7,903	36,314
6/20	211	286	1,787	1,770	860	636	330	206	169	206	86	84	6,631	42,945
6/21	132	701	4,961	5,131	2,580	2,458	833	437	354	362	212	192	18,353	61,298
6/22	185	3,531	16,292	11,877	5,791	5,319	1,113	731	506	475	357	435	46,612	107,910
6/23	633	10,526	28,969	11,948	7,086	5,591	585	452	316	220	260	305	66,891	174,801
6/24	304	5,306	15,041	8,163	4,742	6,481	730	739	565	404	339	330	43,144	217,945
6/25	170	3,073	14,898	12,146	6,501	9,056	1,627	1,325	1,862	840	924	1,836	54,258	272,203
6/26	141	2,911	11,778	9,488	4,352	6,365	948	728	387	161	178	276	37,713	309,916
6/27	91	1,555	8,819	8,330	4,585	4,120	1,159	814	804	408	413	828	31,926	341,842
6/28	491	1,508	8,614	9,993	5,882	7,908	1,309	858	640	435	761	1,633	40,032	381,874
6/29	71	766	4,301	4,720	2,563	2,396	1,221	968	706	365	218	234	18,529	400,403
6/30	169	464	3,253	4,682	2,224	1,300	1,066	767	461	377	227	272	15,262	415,665

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Appendix A1.–Page 2 of 2.

Date	Sector												Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12		
7/01	199	1,003	8,423	7,577	2,512	1,101	664	464	207	218	138	150	22,656	438,321
7/02	412	1,870	11,965	10,038	3,967	2,639	1,074	717	448	387	305	331	34,153	472,474
7/03	540	2,167	12,970	13,139	6,377	5,448	2,219	1,495	1,344	963	628	499	47,789	520,263
7/04	229	1,216	9,178	10,481	4,268	6,530	1,940	1,255	708	542	322	425	37,094	557,357
7/05	64	961	5,591	4,984	1,735	3,595	767	569	328	360	281	240	19,475	576,832
7/06	70	562	2,739	2,602	1,254	644	566	583	211	157	166	92	9,646	586,478
7/07	41	257	2,966	4,510	2,544	1,094	1,444	1,415	667	349	215	124	15,626	602,104
7/08	62	235	2,213	3,231	2,223	929	1,450	1,130	298	211	138	57	12,177	614,281
7/09	59	151	1,115	1,358	648	227	309	234	144	122	85	57	4,509	618,790
7/10	29	131	1,034	1,802	1,053	414	817	759	347	274	131	57	6,848	625,638
7/11	42	131	1,253	2,843	2,020	572	1,209	1,204	434	358	154	67	10,287	635,925
7/12	25	93	578	1,100	916	321	1,312	1,757	770	589	317	91	7,869	643,794
7/13	56	177	1,417	2,338	1,244	408	1,062	1,163	572	307	161	86	8,991	652,785
7/14	136	174	876	1,328	720	229	510	561	261	187	97	40	5,119	657,904
7/15	99	105	757	1,434	754	273	542	656	267	131	90	41	5,149	663,053
7/16	36	91	447	823	683	497	813	727	240	139	90	39	4,625	667,678
7/17	25	50	338	721	639	545	769	620	163	105	54	33	4,062	671,740
7/18	25	29	133	336	310	266	507	580	279	154	72	51	2,742	674,482
7/19	64	64	418	771	545	291	652	706	319	228	112	87	4,257	678,739
7/20	20	151	678	827	498	281	491	398	144	93	51	55	3,687	682,426
Total	7,356	41,699	189,811	167,841	86,563	82,056	33,038	27,721	16,767	11,354	8,456	9,842	682,426	

Appendix A2.—Sonar counts by date and sector, right bank offshore strata, Nushagak sonar project, 2003.

Date	Sector																Daily Total	Cumulative Total	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
6/07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/08	1	31	63	25	23	20	19	13	4	20	0	6	0	0	0	2	227	227	
6/09	6	57	141	69	50	32	28	13	4	6	0	0	0	0	0	0	406	633	
6/10	0	65	155	82	70	48	45	23	1	0	0	0	0	0	0	0	489	1,122	
6/11	0	32	18	10	15	3	10	0	0	0	0	0	0	0	0	0	88	1,210	
6/12	0	7	20	10	1	3	1	0	0	0	0	0	0	0	0	0	42	1,252	
6/13	1	1	1	2	1	1	18	3	0	0	0	0	0	0	0	0	28	1,280	
6/14	2	4	1	0	0	0	0	0	3	3	0	0	0	0	0	0	13	1,293	
6/15	7	25	18	18	11	5	2	2	4	6	0	0	0	0	0	0	98	1,391	
6/16	2	18	19	14	8	5	4	0	1	25	0	0	0	0	0	0	96	1,487	
6/17	4	61	126	79	79	49	33	10	5	37	1	0	0	0	0	0	484	1,971	
6/18	3	110	202	166	109	63	55	28	34	27	0	0	0	0	0	0	797	2,768	
6/19	4	107	146	91	63	42	25	21	19	10	12	1	1	0	0	0	542	3,310	
6/20	11	73	121	82	60	31	39	18	57	56	0	0	0	0	0	0	548	3,858	
6/21	4	132	292	225	197	99	92	25	72	85	0	0	0	0	0	0	1,223	5,081	
6/22	18	258	360	248	232	132	95	25	56	69	2	0	0	0	1	0	1,496	6,577	
6/23	7	161	228	246	254	125	96	175	114	14	2	0	0	0	0	0	1,422	7,999	
6/24	16	144	308	424	303	142	106	64	186	10	3	0	0	0	1	1	1,708	9,707	
6/25	15	329	961	1557	607	255	161	192	7	18	10	0	0	1	0	0	4,113	13,820	
6/26	7	108	885	1141	585	246	96	93	20	39	4	0	0	0	1	1	3,226	17,046	
6/27	22	201	755	888	490	272	120	146	24	31	3	1	0	1	6	3	2,963	20,009	
6/28	12	177	433	799	528	226	119	97	50	73	4	1	0	1	2	12	2,534	22,543	
6/29	4	122	391	492	318	125	53	405	257	340	11	0	0	0	0	0	2,518	25,061	
6/30	5	160	261	521	205	73	60	140	28	20	4	0	0	0	2	1	1,480	26,541	

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Date	Sector																Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
7/1	3	48	206	330	279	102	52	11	6	69	11	0	0	1	4	10	1,132	27,673
7/2	27	137	376	606	361	122	84	40	35	38	5	0	0	0	1	2	1,834	29,507
7/3	48	275	773	763	466	253	147	47	39	29	6	0	0	0	4	9	2,859	32,366
7/4	8	132	383	799	467	171	127	32	16	26	7	0	0	1	1	0	2,170	34,536
7/5	1	91	297	460	225	88	68	32	22	56	5	0	0	2	4	0	1,351	35,887
7/6	5	83	146	149	71	31	22	5	5	15	0	0	0	0	0	0	532	36,419
7/7	4	47	159	170	122	44	20	29	2	24	2	0	0	0	1	2	626	37,045
7/8	8	58	111	164	129	60	32	58	8	6	1	0	0	0	0	0	635	37,680
7/9	6	30	135	131	84	64	33	45	4	12	0	0	0	0	0	0	544	38,224
7/10	0	31	178	211	146	71	44	19	7	4	2	0	0	0	2	0	715	38,939
7/11	4	39	132	151	121	59	36	57	47	8	1	0	0	0	1	0	656	39,595
7/12	3	32	104	117	79	43	15	1	0	5	0	0	0	0	1	0	400	39,995
7/13	2	23	83	123	65	31	27	4	1	4	1	0	0	0	0	0	364	40,359
7/14	1	27	57	34	25	19	11	8	6	1	0	0	0	0	0	0	189	40,548
7/15	1	10	56	47	29	13	11	3	7	1	0	0	0	0	0	0	178	40,726
7/16	0	14	45	62	41	7	15	4	4	3	1	0	0	0	0	0	196	40,922
7/17	0	21	36	16	13	10	11	6	2	0	0	0	0	0	0	0	115	41,037
7/18	4	5	27	27	31	19	16	7	0	1	0	0	0	0	0	0	137	41,174
7/19	1	37	87	72	35	25	14	3	2	6	0	0	0	0	0	0	282	41,456
7/20	0	9	34	34	11	21	15	0	0	1	0	0	0	0	1	0	126	41,582
Total	278	3,534	9,333	11,659	7,014	3,256	2,084	1,912	1,168	1,208	109	21	14	21	48	59	41,582	

Appendix A3.—Sonar counts by date and sector, left bank inshore strata, Nushagak sonar project, 2003.

Date	Sector												Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12		
6/07	1	4	6	66	42	23	34	11	9	6	7	11	220	220
6/08	4	5	25	72	72	52	35	22	58	51	72	45	513	733
6/09	1	13	21	17	27	14	33	15	15	4	13	11	184	917
6/10	2	0	12	39	83	134	122	74	39	7	11	6	529	1,446
6/11	3	3	40	42	41	28	38	13	12	6	12	7	245	1,691
6/12	2	1	4	1	6	7	4	2	3	0	0	4	34	1,725
6/13	2	2	2	0	1	0	1	2	0	1	0	0	11	1,736
6/14	26	41	17	20	21	7	18	8	3	8	15	10	194	1,930
6/15	6	18	30	36	39	42	34	31	12	12	19	16	295	2,225
6/16	10	7	24	40	26	25	25	15	4	9	27	41	253	2,478
6/17	26	23	40	190	427	440	141	59	68	54	98	46	1,612	4,090
6/18	43	22	70	426	642	814	516	172	199	175	149	114	3,342	7,432
6/19	157	151	111	413	421	444	327	191	118	109	135	43	2,620	10,052
6/20	48	148	144	527	477	395	229	172	136	60	82	41	2,459	12,511
6/21	34	86	134	491	643	641	282	191	121	71	110	52	2,856	15,367
6/22	10	134	2,466	5,471	3,486	1,948	776	344	172	356	904	138	16,205	31,572
6/23	31	426	4,460	9,105	3,367	1,249	447	283	82	264	462	457	20,633	52,205
6/24	113	255	886	2,469	1,709	1,302	555	305	115	297	1,054	205	9,265	61,470
6/25	17	178	2,419	6,865	5,029	3,709	1,608	782	181	375	996	214	22,373	83,843
6/26	19	57	365	1,705	1,540	1,215	676	582	158	274	407	163	7,161	91,004
6/27	11	59	453	1,713	1,362	1,169	526	602	340	176	347	178	6,936	97,940
6/28	88	43	889	3,105	1,752	1,191	482	295	70	244	351	109	8,619	106,559
6/29	56	93	483	1,483	1,174	1,203	584	333	70	153	474	147	6,253	112,812
6/30	29	66	402	2,164	1,371	991	380	213	56	143	503	134	6,452	119,264

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Appendix A3.—Page 2 of 2.

Date	Sector												Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12		
7/01	26	78	729	3,309	1,258	845	415	218	91	197	550	236	7,952	127,216
7/02	32	50	467	2,197	1,018	958	488	259	61	229	419	179	6,357	133,573
7/03	322	104	624	3,480	2,665	2,112	963	485	156	518	535	125	12,089	145,662
7/04	245	83	401	3,877	2,211	1,721	611	257	97	426	490	120	10,539	156,201
7/05	93	43	216	1,053	611	511	288	180	51	123	319	121	3,609	159,810
7/06	99	28	147	505	441	495	264	168	64	378	475	66	3,130	162,940
7/07	63	56	310	1,753	1,225	1,344	490	194	76	232	307	50	6,100	169,040
7/08	44	54	284	1,908	882	856	413	142	62	318	432	48	5,443	174,483
7/09	33	95	210	150	195	212	105	39	215	637	595	710	3,196	177,679
7/10	21	78	174	155	302	288	189	84	138	116	179	215	1,939	179,618
7/11	10	116	153	54	188	211	148	73	53	23	92	297	1,418	181,036
7/12	64	87	71	45	142	158	103	78	57	32	79	98	1,014	182,050
7/13	22	130	100	67	244	281	170	75	61	29	129	170	1,478	183,528
7/14	67	127	131	69	169	149	108	36	43	20	185	138	1,242	184,770
7/15	72	288	122	88	223	155	92	77	80	53	196	157	1,603	186,373
7/16	266	442	222	149	173	117	84	36	42	87	142	131	1,891	188,264
7/17	127	170	69	51	127	119	61	29	34	24	40	114	965	189,229
7/18	220	182	97	42	154	158	111	58	30	37	95	85	1,269	190,498
7/19	194	243	79	75	196	225	173	94	57	30	63	97	1,526	192,024
7/20	47	68	71	35	144	152	77	55	22	22	34	51	778	192,802
Total	2,807	4,359	18,183	55,526	36,331	28,116	13,233	7,362	3,540	6,396	11,615	5,412	192,802	

Appendix A4.—Sonar counts by date and sector, left bank offshore strata, Nushagak sonar project, 2003.

Date	Sector																Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
6/07																		
6/08	0	6	2	0	0	0	1	0	0	0	0	0	0	0	0	0	973	973
6/09	8	19	16	0	1	4	1	0	1	0	0	0	1	2	2	3	1,432	2,405
6/10	5	24	15	4	18	3	28	0	0	0	0	0	4	7	15	34	306	2,711
6/11	12	34	11	9	9	4	9	0	0	0	0	0	0	0	0	0	100	2,811
6/12	1	1	2	2	1	0	4	7	0	0	0	0	0	0	8	11	158	2,969
6/13	2	5	1	0	0	0	0	1	9	0	0	0	0	0	0	6	93	3,062
6/14	0	2	1	3	1	0	0	0	1	0	0	0	0	0	0	1	137	3,199
6/15	17	38	11	5	2	0	0	0	7	0	0	0	0	0	0	0	110	3,309
6/16	6	14	8	8	1	0	1	0	7	0	0	0	0	0	0	0	84	3,393
6/17	16	268	102	53	9	10	9	3	13	0	0	0	0	0	0	0	78	3,471
6/18	106	644	291	177	58	55	134	28	62	1	0	0	0	0	0	0	1,934	5,405
6/19	130	423	108	89	35	104	128	0	0	0	0	0	0	0	0	0	3,804	9,209
6/20	84	427	159	109	38	76	57	0	71	0	0	0	0	0	0	0	1,275	10,484
6/21	42	427	259	201	37	33	5	0	50	0	0	0	0	0	0	0	889	11,373
6/22	191	1,195	423	310	85	65	10	0	13	0	0	0	0	0	0	0	1,014	12,387
6/23	80	759	352	274	90	79	64	0	0	0	0	0	0	0	0	0	1,855	14,242
6/24	80	450	205	158	51	54	7	0	4	0	0	0	0	0	0	0	1,856	16,098
6/25	91	1,133	819	669	174	243	14	0	2	0	0	0	0	0	0	0	486	16,584
6/26	75	758	795	479	241	268	70	53	92	0	0	0	0	0	0	0	987	17,571
6/27	70	728	482	547	232	94	46	28	0	0	0	0	0	0	0	0	1,566	19,137
6/28	41	440	377	440	154	121	96	19	57	0	0	0	0	0	0	0	1,092	20,229
6/29	10	432	515	567	240	123	22	28	3	0	0	0	0	0	0	0	1,722	21,951
6/30	8	337	250	312	117	74	17	13	0	0	0	0	0	0	0	0	933	22,884

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Date	Sector																Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
7/01	23	249	339	311	80	56	4	11	0	0	0	0	0	0	0	0	966	23,850
7/02	23	450	340	400	139	64	22	35	0	0	0	0	0	0	0	0	782	24,632
7/03	51	655	537	572	193	53	18	12	9	0	0	0	0	0	0	0	338	24,970
7/04	52	510	505	683	199	97	14	13	54	0	0	0	0	0	0	0	448	25,418
7/05	37	280	338	271	96	41	3	18	11	0	0	0	0	0	0	0	583	26,001
7/06	46	263	171	243	61	60	17	14	0	0	0	0	0	0	0	0	1,549	27,550
7/07	28	162	256	350	83	56	65	14	0	0	0	0	0	0	0	0	738	28,288
7/08	23	249	237	237	40	29	9	0	0	0	0	0	0	0	0	0	660	28,948
7/09	12	121	125	159	41	37	3	6	0	0	0	0	0	0	0	0	545	29,493
7/10	22	134	314	409	90	65	12	12	30	0	0	0	0	0	0	0	534	30,027
7/11	16	92	139	219	73	48	45	0	2	0	0	0	0	0	0	0	786	30,813
7/12	26	74	82	106	28	19	8	2	0	0	0	0	0	0	0	0	505	31,318
7/13	23	97	73	77	13	4	44	15	8	0	0	0	0	0	0	0	661	31,979
7/14	17	62	67	72	10	5	1	0	3	0	0	0	0	0	0	0	483	32,462
7/15	16	58	77	76	15	7	3	2	3	0	0	0	0	0	0	0	382	32,844
7/16	12	70	85	102	28	12	1	0	0	0	0	0	0	0	0	0	317	33,161
7/17	1	61	76	69	20	14	1	0	7	0	0	0	0	0	0	0	319	33,480
7/18	3	150	95	80	25	13	9	0	19	0	0	0	0	0	0	0	216	33,696
7/19	22	70	126	77	21	27	10	0	8	0	0	0	0	0	0	0	294	33,990
7/20	1	45	57	58	20	20	5	1	0	0	0	0	0	0	0	0	320	34,310
Total	1,530	12,418	9,246	8,991	2,874	2,143	1,024	343	555	11	11	12	18	23	40	71	34,310	

APPENDIX B

Appendix B1.—Daily climatological observations, Nushagak River sonar project, 2003.

Date	Cloud Cover ^{a,b}		Wind Direction & Velocity (k/hr) ^b		Air Temperature (°C) ^b		Water Temperature (°C) ^b		Precipitation (mm) ^{b,c}	Water Color
	800	2000	800	2000	800	2000	800	2000		
6/12	5	3	Var	Var	n	n	n	n	1	Light Brown
6/14	5	1	Calm	S 10	n	n	n	n	0	Light Brown
6/15	4	1	SW 5-7	SW	n	15.5	n	15.5	0	Light Brown
6/16	4	3	SW 10-15	SW	14.5	14.5	14.5	14.5	0	Light Brown
6/17	1	3	N	SW	n	14.0	n	14.0	0	Light Brown
6/18	4	2	Calm	SW 5-7	14.0	14.5	14.0	14.5	0	Light Brown
6/19	3	1	S	SW 10	14.0	14.5	14.0	14.5	0	Light Brown
6/20	4	4	E	SW	12.5	13.0	12.5	13.0	0	Light Brown
6/21	4	1	Calm	S 5-10	12.0	13.5	12.0	13.5	0°	Light Brown
6/22	3	2	Calm	W 5	12.0	14.0	12.0	14.0	0	Light Brown
6/23	4	4	E 5-10	Calm	12.5	13.0	12.5	13.0	n	Light Brown
6/24	4	1	E 10-15	NE 5-10	12.0	12.5	12.0	12.5	0°	Light Brown
6/25	4	3	Calm	S 5	10.3	13.5	10.3	13.5	0	Light Brown
6/26	4	3	Calm	E 5	10.2	12.0	10.2	12.0	0°	Light Brown
6/27	4	3	Calm	E 5	n	13.0	n	13.0	0°	Light Brown
6/28	2	4	Calm	S 2	12.0	13.5	12.0	13.5	0°	Light Brown
6/29	4	5	Calm	Calm	12.0	13.0	12.0	13.0	0°	Light Brown
6/30	4	4	S 5-10	SW 10	12.5	13.5	12.5	13.5	0°	Light Brown
7/01	4	4	S 5-10	SW 20	11.5	13.0	11.5	13.0	0°	Light Brown
7/02	3	3	S 5-10	SW 15	11.5	12.0	11.5	12.0	0	Light Brown
7/03	1	1	SW 20	S 5-10	11.5	13.0	11.5	13.0	0	Light Brown
7/04	4	1	S 5-10	Calm	13.0	14.0	13.0	14.0	0	Light Brown
7/05	4	3	Calm	SW 5-7	12.0	13.5	12.0	13.5	0°	Light Brown
7/06	4	2	S 5-10	Calm	12.0	13.0	12.0	13.0	0	Light Brown
7/07	3	1	S 5-10	N 5	12.0	15.5	12.0	15.5	0	Light Brown
7/08	1	2	Calm	S 5	14.0	15.0	14.0	15.0	0	Light Brown
7/09	4	4	SW 5-7	S 5-10	16.0	16.0	16.0	16.0	0	Light Brown
7/10	4	4	SW 10-15	S 5	15.0	14.5	15.0	14.5	0	Light Brown
7/11	4	4	Calm	SW 5-7	14.0	14.0	14.0	14.0	0°	Light Brown
7/12	2	1	Calm	Calm	14.0	16.0	14.0	16.0	0	Light Brown
7/13	1	1	Calm	SW 5	14.5	17.5	14.5	17.5	0	Light Brown
7/14	1	1	S 12	S 20	14.5	17.0	14.5	17.0	0	Light Brown
7/15	n	1	b	S 5-10	n	19.0	n	19.0	0	Light Brown

-continued-

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Date	Cloud Cover ^{a,b}		Wind Direction & Velocity (k/hr) ^b		Air Temperature (°C) ^b		Water Temperature (°C) ^b		Precipitation (mm) ^{b,c}	Water Color
	800	2000	800	2000	800	2000	800	2000		
7/16	4	4	S 10	S 2	n	16.0	n	16	0	Light Brown
7/17	4	4	Calm	S 10	15.0	15.0	15.0	15.0	10	Light Brown
7/18	3	1	E 5-10	Calm	13.0	15.0	13.0	15.0	0	Light Brown
7/19	2	1	Calm	Calm	13.0	16.0	13.0	16.0	0	Light Brown
7/18	3	1	calm	N 5	11.2	18.4	13.0	15.0	1	Light Brown
7/19	4	4	calm	calm	12.2	14.5	16.0	15.0	4	Light Brown

- ^a 1 = cloud cover is less than 1/10 of sky;
 2 = cloud cover not more than 1/2 of sky;
 3 = cloud cover is more than 1/2 of sky;
 4 = clouds completely cover the sky; and
 5 = fog or thick haze.

^b No observation made.

^c Precipitation is less than 1.0mm.