An Estimate of Spiridon Lake Sockeye Salmon Commercially Harvested Within the Southwest Afognak Section and Northwest Kodiak District, 1997

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INTRODUCTION

Accurate assignment of salmon catches to stock or system of origin is necessary for evaluation of productivity trends, estimating smolt-to-adult survival, and preseason forecasting. For the purpose of estimating stock specific sockeye salmon *Oncorhynchus nerka* production within the Kodiak Management Area (KMA), a comprehensive salmon catch and escapement sampling program was initiated in 1985. A subsequent run reconstruction program initially focused on four major Kodiak sockeye salmon systems, including Karluk, Ayakulik, Upper Station, and Frazer (Barrett and Nelson 1995; Swanton 1992). It was anticipated that the enhancement project at Spiridon Lake would be realizing its first substantial sockeye salmon run (>100,000 fish) in 1994, which was expected to be harvested in traditional fishing areas along the westside of Kodiak Island. In order to maintain consistency in run reconstruction programs for wild stocks as well as quantify the harvest of Spiridon Lake sockeye salmon, a stock identification program was implemented (Nelson and Barrett 1994).

Scale pattern analysis (SPA) along with visual identification of freshwater growth patterns of various age classes have been employed since 1994 to estimate the contribution of Spiridon Lake sockeye salmon to the Kodiak's westside commercial catches (Nelson and Swanton 1997, Nelson and Swanton 1996a, Nelson and Barrett 1994). Stock identification based on SPA assumes that genetically or environmentally influenced growth patterns differ between stocks and that these differences may be detectable in the scales of fish. The objective of using SPA is to develop a statistical model that accurately classifies individual scales from known stocks within mixed stock fisheries samples. The freshwater scale pattern of Spiridon Lake sockeye salmon has remained consistent and easily distinguishable, lending itself to this approach.

During 1994, based on visual freshwater scale pattern identification, an estimated 263,750 Spiridon sockeye salmon contributed to Northwest (NW) Kodiak and Southwest (SW) Kodiak Districts catches (Nelson and Barrett 1994). SPA was incorporated in conjunction with visual scale pattern identification in 1995, resulting in a Spiridon sockeye salmon harvest estimate of 96,705 fish (Nelson and Swanton 1996a). In both 1994 and 1995, over 98% of the estimated Spiridon bound harvest occurred in the NW Kodiak District. The migration and run timing of the Spiridon Lake stock appeared to be similar to that of the Upper Station late run brood stock source (Nelson and Swanton 1996a). Tagging experiments conducted in 1981 as well as Spiridon catch estimates from 1994 - 1995, suggest that a majority of the Upper Station late run migrates from north to south along Kodiak Island's westside peaking in mid to late August (Nelson and Swanton 1996a, Nelson and Barrett 1994, Tyler et al. 1986). In 1996, the Spiridon Lake stock identification program evaluated sockeye harvested in the SW Afognak Section rather than the SW Kodiak District due to negligible estimates of Spiridon bound fish in the SW Kodiak District during 1994 and 1995 (Nelson and Swanton 1997). An estimated 386,956 Spiridon Lake sockeye salmon were harvested in the SW Afognak Section and NW Kodiak District combined during 1996, of which 98% were harvested in the NW Kodiak District.

Unlike the migration timing, the age composition of Spiridon Lake sockeye salmon does not appear to be consistent with the brood stock source. In 1994, 1995, and 1996, 1.2 was the dominant age class of sockeye salmon sampled in the Spiridon Lake Terminal Harvest Area (SLTHA), while the majority of Upper Station late run sockeye salmon were classified as age 2.2 fish.

This report serves to summarize the fourth annual Spiridon Lake sockeye salmon run reconstruction study (Nelson and Barrett 1994; Nelson and Swanton 1996a; Nelson and Swanton 1997). The objectives of this study were threefold: to estimate the number of Spiridon Lake sockeye salmon harvested in the SW Afognak Section and NW Kodiak District during 1997; monitor run timing based on commercial harvest estimates; and finally, to compare and quantify annual freshwater growth of Spiridon Lake sockeye salmon from scales collected from 1994 through 1997.

METHODS

Study Area

Spiridon Lake, located in the Central Section of the NW Kodiak District, is the third largest lake (9.6 km long, 1.6 km maximum width) on Kodiak Island (Figure 1). Prior to 1991, a series of barrier falls prevented access to the lake outlet and precluded the presence of anadromous fish (Kyle et al. 1990). The introduction of sockeye salmon fry to Spiridon Lake coupled with the construction of a smolt bypass system has resulted in harvestable runs since 1994 (Honnold 1997). In 1993, the Alaska Board of Fisheries (BOF) adopted the Spiridon Lake Sockeye Salmon Management Plan (5 AAC 18.366). In accordance with this plan, the Spiridon Lake sockeye run is intended to be harvested primarily in traditional commercial fishing areas of the NW Kodiak District during openings directed on local stocks (ADF&G 1996a). The remainder is to be taken in an exclusive purse seine and beach seine area in Telrod Cove within Spiridon Bay identified as the Spiridon Lake Terminal Harvest Area (SLTHA; Figures 2 and 3).

The catch areas and time frame considered for this study (SW Afognak Section and NW Kodiak District; post 11 July) were based on spatial and temporal Spiridon Lake sockeye salmon harvest estimates from 1994 through 1996 (Nelson and Barrett 1994; Nelson and Swanton 1996a; Nelson and Swanton 1997).

Stock Selection

Selection of sockeye stocks to include in this analysis was based on historic run timing within the commercial catch areas of interest, and evaluation of the 1997 sockeye escapement age composition estimates. All major Kodiak sockeye stocks potentially present in the SW Afognak Section or NW Kodiak Districts post 11 July, with an age 1.2 or 2.2 escapement component of greater than 10% within any given week were considered.

Escapement Sampling

Sockeye salmon escapements were sampled weekly for age (scales) at four weir sites in the KMA (ADF&G 1996b). These systems included Karluk, Ayakulik, Frazer, and Upper Station (Figure 1). Terminal catches were sampled weekly in the SLTHA (statistical area 254-50; Figures 2 and 3) and were assumed to represent returning Spiridon Lake sockeye salmon. The targeted sample size was 240 fish per system per week (Nelson and Swanton 1996b).

Commercial Catch Sampling

During July and August, commercial sockeye salmon catches were sampled for age (scales) at processing facilities in the Port of Kodiak, Uganik, and Larsen Bay with a targeted sample size of 600 fish per week from the following areas (Figure 1):

Afognak District (Figure 4)
- Southwest Afognak Section (Statistical Areas 251-10 through 251-20);

Northwest Kodiak District (Figure 4)
- Central Section
  - Uganik Catch Area (Statistical Areas 253-11 through 253-35); and
  - Uyak Catch Area (Statistical Areas 254-10 through 254-40).

Age Designation of Catches and Escapements

All scales, when possible, were collected from the preferred area of each fish following procedures outlined in INPFC (1963). Scales were mounted on gum cards and impressions were made on cellulose acetate (Clutter and Whitesel 1956). Fish ages were assigned by examining scale impressions for annual growth increments using a microfiche reader fitted with a 48X lens following designation criteria established by Mosher (1968). Ages were recorded on sampling forms using European notation (Koo 1962) where a decimal separates the number of winters spent in freshwater (after emergence) from the number of winters spent in saltwater. The total age includes an additional year representing the time between egg deposition and emergence of fry.

Age composition estimates of stock specific escapements and catches by area were assigned based on scale samples collected. Catch-at-age by area and day was estimated by multiplying the daily age composition of a particular sample by the daily catch from the corresponding catch area. Age composition of the catch from days not sampled was estimated using linear interpolation between sampling events (Blackburn 1993). Estimated age composition of escapements from major Kodiak systems followed similar procedures.

In order to address age bias, 400 sockeye salmon scales (100 per system) representing Karluk late run, Ayakulik, and Upper Station late run sockeye salmon escapements, and SLTHA sockeye salmon catch (scale cards randomly selected) were classified by a second certified scale reader. Tests of symmetry were performed for each system according to methods developed by Bowker (1948) and described in Hoenig et al. 1994. Precision of the primary scale reader was tested by re-aging the same scales selected for the tests of symmetry and percent agreement was calculated.

Scale Pattern Analysis and Stock Composition Estimation

The primary age class found in the SLTHA (age 1.2) was not present in any other major stock in sufficient numbers to be sampled. Age 2.2 scales, which represented about 30% of the Spiridon terminal harvest, were subsampled for measurement from each selected stock. The target subsample size was 200 scales from each "known" stock for establishing standards (Cook 1982). Scales were

selected throughout the escapement (post 11 July) based on the weekly proportion of age 2.2 fish present in the sample.

Mixed stock fishery samples ("unknowns") meeting the selection criteria had a minimum desired subsample size of 30 and a maximum of 100 scales per harvest area and week. Scale measurements were obtained by starting with the first scale of the selected age class within the weekly sample and continuing until all scales suitable for measurement had been exhausted or the sample size was met.

Freshwater scale measurement data were collected using the Biosonics[1] optical pattern recognition system (OPRS), integrating a compound microscope, ocular lens, frame grabber, digitizing tablet, and microcomputer.

Measurement procedures consisted of:

1) placing acetate cards with scale impressions on a glass stage of an Olympus BH-2 microscope;

2) focusing the appropriate impression under a 4X objective lens and 1.5 magnification changer;

3) transferring the scale image to a Sony HR Trinitron monitor via video camera;

4) establishing a horizontal reference line below the scale focus through the reticulated region;

5) identifying the measurement initiation point located at the center of the scale focus;

6) drawing a line from the initiation point off an axes perpendicular to the reference line to the last circulus of the freshwater portion of the scale;

7) measuring incremental distances from the center of the focus to the outside edge of each circulus; and

8) saving measurement data to a unique computer file.

All scale measurements were specific to a single age class (age 2.2). Scales with poorly defined images, those resorbed at the outer margin (adding to the uncertainty of age classification), or those collected from a non-preferred region of the fish (Clutter and Whitesel 1956) were not measured.

OPRS scale measures were transformed into individual variable format using a BASIC program, REFORM1 (written by Larry Greer, Alaska Department of Fish and Game, Kodiak, AK). Variables constructed were circuli counts (C.C.) and incremental distances (I.D.), which start at the scale focus and end with the last circulus of the freshwater growth. The maximum number of variables included for model development was constrained to the fewest number of circuli counted from any of the "known" stocks (e.g., if a "known" stock had one scale with only 10 circuli, then the maximum number of potential variables describing the freshwater growth of all "known" stocks would be 11; one circuli count variable and 10 incremental distance variables).

[1] Use of a company's name does not constitute endorsement.

A linear discriminate function (LDF; Fisher 1936) was developed to classify unknown mixed stock fishery samples to stock of origin (Dillon and Goldstein 1984). Assumptions associated with using both SPA and the LDF were (1) all probable stocks contributing to the commercial fishery samples were represented in the model; (2) scale variables from each stock were multivariate normal; and (3) variance-covariance matrices between groups were equal. Testing multivariate data for normality is difficult in practice and for practical purposes, testing for marginal frequency distributions of the observations on each variable may be sufficient (Johnson and Wichern 1998). Evaluation of univariate normality was assessed using frequency histograms for all variables of each stock considered. Once variables were screened for normality, stepwise discriminant analysis was performed by forward, backward, and stepwise methods to select a subset of variables that would produce good discrimination. Accuracy of the model in correctly classifying individuals to actual stock of origin was determined by the "leaving-one-out" approach of Lachenbruch (1967). Stock composition estimates for unknown samples (by area and time period) were corrected for misclassification error using the matrix correction approach of Cook and Lord (1978), with 90% confidence coefficients calculated using the variance formula of Pella and Robertson (1979). Confidence coefficients for the four stock model were generated assuming a chi-square distribution. All discriminant modeling was completed using PROC DISCRIM (SAS Institute 1987).

Spiridon Catch Assignment

Two methods were used to estimate number of age 2.2 Spiridon Lake sockeye salmon harvested in the SW Afognak Section and Uyak and Uganik catch area. The first method utilized the age 2.2 stock composition estimates for unknown samples by area and time period determined using scale pattern analysis (SPA). The second method relied on the weekly ratio of age 1.2 to age 2.2 sockeye salmon in the SLTHA. Both methods assumed that all age 1.2 fish harvested in the SW Afognak Section and NW Kodiak District were returning Spiridon sockeye salmon as no other major Kodiak system had an age 1.2 component greater than 5%. Sockeye salmon catch numbers by area were obtained from the Alaska Department of Fish and Game (ADF&G) fish ticket database on 1 June 1998 and age composition estimates were assigned by catch area.

Method 1 (SPA)

Apportionment of the age 2.2 component of the commercial catch by week within each of the aforementioned commercial fishing areas was accomplished by multiplying the estimated weekly age 2.2 component of the catch by the weekly SPA stock composition estimate of Spiridon Lake age 2.2 sockeye salmon. During weeks when stock composition estimates were not available (no catch sample collected), the mean of adjacent weekly stock composition estimates was used. The harvest of age classes other than 1.2 and 2.2 was not estimated as "other" minor age classes represented less than 10% of the Spiridon Lake sockeye salmon run as illustrated by terminal harvests in Telrod Cove.

Method 2 (Age Composition Ratio)

Using this method, the estimate of age 2.2 fish was based on the weekly ratio of age 1.2 to age 2.2 sockeye salmon in the SLTHA. For the SW Afognak Section and Uganik catch area, the SLTHA ratio from the following week was applied to account for migration time, while similar weekly ratios were used in the Uyak catch area. As in Method 1, the harvest of age classes other than 1.2

and 2.2 was not estimated as "other" minor age classes represented less than 10% of the Spiridon sockeye salmon run. In addition, the primary "other" age class returning to the SLTHA was 1.1, which may have been associated with gear selectivity in the mixed gear fisheries in the Uganik and Uyak catch areas.

The weekly ratio of age 1.2 fish to age 2.2 fish in the SLTHA was estimated using the following formula:

$$RS_i = \frac{E12_i}{E22_i} \tag{1}$$

The age 2.2 Spiridon Lake sockeye salmon contribution to the SW Afognak Section and Uganik catch area was estimated using the following formula:

$$\hat{C}s22_{ij} = \frac{\hat{C}s12_{ij}}{RS_{i+1}} \tag{2}$$

The age 2.2 Spiridon Lake sockeye salmon contribution to the Uyak catch area was estimated using the following formula:

$$\hat{C}s22_{ij} = \frac{\hat{C}s12_{ij}}{RS_i} \tag{3}$$

where:

i = sampling week;

j = catch area;

RS_i = the ratio of age 1.2 fish to age 2.2 fish in the SLTHA area during week i;

$E12_i$ = the number of fish sampled in the SLTHA classified as age 1.2 during week i;

$E22_i$ = the number of fish sampled in the SLTHA classified as age 2.2 during week i;

$\hat{C}s22_{ij}$ = the estimated number of age 2.2 Spirdon fish in the catch during week i in catch area j;

$\hat{C}s12_{ij}$ = the estimated number of age 1.2 Spiridon fish in the catch during week i in catch area j.

Freshwater Growth Comparison

A single-factor ANOVA was computed (Microsoft Excel[2] 5.0, 1985-1994) to compare annual freshwater scale growth of age 1.2 Spiridon Lake sockeye salmon among years (1994 - 1997). Scale measures were obtained by starting with the first age 1.2 scale within the sample and continuing until 100 age 1.2 scales suitable for measurement had been met. A single scale reader collected all measurements and scale data collection followed procedures described previously. The studentized range test (T Method; Devore 1995) was used to identify significant differences in a

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multiple comparison analysis between yearly freshwater growth while maintaining an α value of 0.05. This test was performed only if the value of the computed F statistic in the ANOVA was significant.

RESULTS

Stock Selection

Sockeye salmon stocks meeting the run timing criteria included Karluk late run, Ayakulik, and Upper Station late run. While these stocks contained small proportions of age 1.2 fish, age 2.2 fish represented 13% to 46% of the escapement (Appendix A.1. - A.3.). A total of 1,060 readable scales were collected from Karluk late run escapement; the age 1.2 component was less than 1% and age 2.2 fish represented about 13% of the escapement (40,281 fish; Appendix A.1.). Of the 854 Ayakulik sockeye escapement scales collected post 11 July, age 1.2 sockeye composed about 1% of the escapement and age 2.2 contributed 35% (39,899 fish; Appendix A.2.). The Upper Station late run age composition estimates were based on 1,294 readable scales. Age 1.2 fish represented 5% of the escapement while age 2.2 was the primary age class (46%, 105,825; Appendix A.3.).

Age Composition Estimates of Selected Catches

Based on commercial catch sampling efforts in the SW Afognak Section and Uganik and Uyak catch areas, between 11% and 14% of the overall commercial harvest in each of the three catch areas were estimated to be age 1.2 fish (Appendix A.4. – A.6.). A total of 343 sockeye salmon were sampled from the SW Afognak Section post 11 July. Age 1.2 represented 13.1% of the catch and 21.4% the catch was estimated to be age 2.2 (Appendix A.4.). Of the 1,835 scales collected from the Uganik area post 11 July, age 1.2 fish represented 14% of the catch and age 2.2 was the dominant age class (32.6%) (Appendix A.5.). For the Uyak commercial catch area, 3,119 fish were sampled during the study period. Age 1.2 represented 10.8% of the catch and age 2.2 was the dominant age class (32.2%) salmon catch post-11 July (Appendix A.6).

Harvests within the SLTHA were sampled from 26 July through 10 September. Overall, age 1.2 fish represented an estimated 62.6% of the catch followed by age 2.2 fish which contributed an additional 29.3% (Appendix A.7.). In addition, age 1.1 was the primary age class harvested in the SLTHA during week 31 (7/26-8/01).

Evaluation of age classification bias resulted in an overall agreement between the two readers of 97%. Although agreement was high, six tests of symmetry were performed to determine if there were systematic differences between readers in either fresh or ocean age classification or if disagreement could be attributed to simple random error. In all cases, the hypothesis of symmetry could not be rejected (α=0.05) and there is no reason to believe these two age readers would produce differing age composition results for these systems during 1997.

Similarly, post season evaluation of precision of the primary reader (reaging the same scales selected for evaluation of bias) resulted in an overall agreement of 99%, ranging from 98%

(Spiridon Lake and Karluk late run) to 100% (Ayakulik), suggesting that the primary reader classified ages consistently throughout the 1997 season.

Stock Separation Model

The age 2.2 Spiridon Lake standard was constructed using SLTHA catch samples collected from 29 July through 10 September. The Karluk late run, Ayakulik, and Upper Station late run age 2.2 standards were constructed from weir samples collected post 11 July.

All scale measurement variables were approximately univariate normal for each stock (Karluk late run, Ayakulik, Upper Station late run, and Spiridon). The mean number of freshwater circuli for Spiridon was 26.5 (SD=2.38) compared to 22.4 (SD) for Upper Station, 19.0 (SD) for Karluk, and 17.9 (SD) for Ayakulik stocks (Appendix B.1). Similarly, Spiridon total freshwater scale growth (average = 364 sample units) was larger than the other selected systems (Appendix B.2 – B.6.). The maximum number of variables included for model development constrained to the fewest number of circuli counted from any of the "known stocks" was 14 (number of circuli plus 13 incremental distance measurements). Descriptive statistics for age 2.2 scale variables 1 through 13 from Spiridon, Karluk late run, Ayakulik and Upper Station late run stocks can be found in Appendix B.1.

Following stepwise analysis, a four stock linear discriminant model was developed that included eight variables. The model incorporated 200 age 2.2 scales each measured from Spiridon and Upper Station late run, 91 scales from Karluk late run, and 168 from Ayakulik. The overall mean classification accuracy was 77.69%, with an individual classification accuracy of 87.50% for the Spiridon stock (Table 1).

Stock Composition Estimates

Scale samples from the SW Afognak Section were limited during weeks 30 and 34 and unavailable during weeks 32 and 33. Samples were pooled and the stock composition estimate of 8.1% was used to describe the age 2.2 Spiridon contribution to the SW Afognak Section from 19-25 July and 2-22 August (Table 2). No estimates were necessary for this area during week 31 because there was no harvest due to a price dispute.

Age 2.2 Spiridon stock composition estimates derived for the Uganik catch area spanned the time period 19 July through 29 August (Table 2). The Spiridon stock composition estimates ranged from 35% during week 30 to 48% during weeks 34 and 35. The mean stock composition estimate from week 30 and week 32 was used to represent the stock composition estimate for week 31 and samples from week 34 and 35 were pooled due to the limited sample collected during week 34.

In the Uyak catch area, the age 2.2 Spiridon stock composition estimate was 2.4% during week 29, increased steadily reaching 33.8% by week 34, and dropped slightly to 22.7% during week 35 (Table 2).

Estimated Spiridon Sockeye Salmon Catch

Method 1 (SPA)

In 1997, attributing all age 1.2 fish and using SPA of age 2.2 fish, an estimated 163,450 Spiridon sockeye salmon were harvested in the SW Afognak Section and NW Kodiak District combined (Table 3; Figure 5). The largest component of the catch (39%; 64,483 fish) occurred in the SLTHA followed by an additional 49,776 fish (30%) harvested in the Uyak catch area (254-10 to 254-40). An estimated 46,598 (29%) Spiridon bound sockeye salmon were harvested in the Uganik catch area (253-11 to 253-35) and 2,594 (2%) fish were caught within the SW Afognak Section.

About 35% (56,479 fish) of the total estimated Spiridon harvest were age 1.2 fish from the SW Afognak Section and Uganik and Uyak catch areas. These fish were assigned to Spiridon under the assumption that all age 1.2 fish harvested in these areas were bound for Spiridon. An additional 42,488 fish were assigned form these areas to Spiridon based on the age 2.2 stock composition estimates, and the remaining 64,483 fish were harvested in the SLTHA (all ages combined; Table 3).

Method 2 (Age Composition Ratio)

Using the weekly ratio of age 1.2 to age 2.2 fish in the SLTHA, an estimated total of 145,245 Spiridon sockeye salmon were harvested in the SW Afognak Section and NW Kodiak District combined during 1997 (Table 4; Figure 5). The largest component of the catch (45%; 64,483 fish) occurred in the SLTHA in Telrod Cove followed by an additional 43,918 fish (30%) harvested in the Uyak catch area (254-10 to 40). An estimated 33,497 (23%) Spiridon bound sockeye salmon were harvested in the Uganik Bay catch area (253-11 to 35) and 3,348 fish (2%) were caught within the SW Afognak Section (Table 4; Figure 5).

About 39% (56,479 fish) of the total estimated Spiridon harvest were age 1.2 fish from the SW Afognak Section and Uganik and Uyak catch areas automatically assigned under the assumption that all age 1.2 fish harvested in these areas were bound for Spiridon. An additional 24,283 age 2.2 fish were assigned from these areas to Spiridon based on the terminal harvest weekly ratio of age 1.2 to 2.2 fish, and the remaining 64,483 fish were harvested in the SLTHA (all ages combined; Table 5).

Spiridon Estimated Run Timing

Peak run timing based on commercial catches varied by area, however similar results were obtained using both methods. Peak catches occurred from 16-22 August in the SW Afognak Section and Uyak and Uganik catch areas, and 30 August to 5 September in the SLTHA (Tables 3 and 5; Figures 6-9). Both methods used to estimate the Spiridon sockeye salmon run resulted in similar overall timing with the peak of the Spiridon run occurring during week 34 (16-22 August) which mirrors the Upper Station brood stock escapement run timing (1978-1997 average; Figures 10-11).

Freshwater Growth

The ANOVA indicated that Spiridon sockeye freshwater scale growth measurements collected from 1994 through 1997 were significantly different among years ($p < 0.0001$). Further analysis (studentized range test) indicated that there was no significant difference in freshwater scale growth between 1994 and 1995 or between 1994 and 1997. However, the multiple comparison procedure results showed 1996 annual freshwater scale growth to be significantly less than that in 1994, 1995, and 1997 ($p < 0.05$). In addition, Spiridon annual freshwater scale growth during 1995 was significantly less than that in 1997 ($p < 0.05$).

DISCUSSION

The methods employed to generate stock contribution estimates for the Spiridon Lake sockeye stock continue to evolve as this program matures. There are several limitations and associated bias with both methods employed to estimate the 1997 Spiridon sockeye salmon harvest. Both methods rely on the assumption that all age 1.2 fish harvested in the SW Afognak Section and Uyak and Uganik catch areas were bound for Spiridon. Based on 1997 sockeye escapement age composition estimates, other stocks contributed to the 1.2 component of these catches; however, they were probably a minor component. In addition, both methods only estimate the age 1.2 and 2.2 component of the Spiridon run and, as is illustrated by the SLTHA age composition estimates, other age classes were present in minor quantities.

Other possible sources of error in assessing the total number of adult Spiridon sockeye salmon using either method include: (1) fish of Spiridon origin may have been harvested in areas not considered as part of this study; and (2) fish of Spiridon origin may have been harvested during weeks that were not sampled and for which stock composition estimates were not determined. Potential numbers associated with these errors, however, are likely negligible relative to the estimated Spiridon run numbers presented in this report.

One major assumption associated with the scale pattern discriminant analysis method (Method 1) is that all groups (stocks), which may be present in the samples of unknown composition, are represented in the classification model. If all groups (stocks) present in the sample are not represented, the unrepresented individuals are misclassified to one of the other groups in the model. There is no "other" category. If the number of individuals from unrepresented groups is rare, the classification results are not severely effected. However, in this study, it seems that there were a large number of such individuals as is evidenced by the higher proportion of estimated Spiridon age 2.2 fish in westside catches than that which was found in the SLTHA. In other words, there were probably a number of age 2.2 fish from other minor stocks not included in the analysis and these fish were misclassified to Spiridon. For example, using SPA (Method 1), during week 33, 50% of the estimated Spiridon bound Uganik harvest was age 2.2 compared to 19% in the SLTHA. Similarly, during week 34, 63% of the estimated Spiridon bound Uganik harvest were age 2.2 compared to 21% in the SLTHA. Based on the assumption that the age composition of Spiridon sockeye salmon migrating along the westside of Kodiak should be similar to those found in the SLTHA, the age 2.2 component of the catch was clearly overestimated. Due to the uncertainty associated with the 1997 scale pattern methodology, it is likely that the ratio method (Method 2) result is a more defensible estimate.

The resulting 1997 Spiridon Lake sockeye salmon harvest estimate of 145,245 was slightly less than the preseason forecast (164,000), which was based on smolt population estimates from 1994 and 1995 and adult harvest age composition from 1994 through 1996 (Geiger et al. 1997). This harvest was larger than the estimated Spiridon run (96,705) in 1995 and less than the 1994 (263,750) and 1996 (386,956) run estimates (Figure 5). In all years, the majority of the Spiridon return was harvested in sections composing the NW Kodiak District. In both 1996 and 1997 the estimated harvest of Spiridon bound sockeye salmon within the SW Afognak Section was minimal (2%) relative to the overall catch.

Between 33% and 45% of the total Spiridon sockeye harvest in 1994-1997 occurred in the SLTHA. In 1997, unlike 1995 and 1996, the proportion of Spiridon sockeye harvested in the Uyak catch areas was slightly larger than the proportion harvested in the Uganik catch area (Figure 5).

Spiridon Lake run timing continues to mirror the run timing of the Upper Station late run brood stock (Figure 10). During 1994, 1995, and 1997, peak catches corresponded to timing of the brood stock source. Weekly catch estimates by area clearly suggest that a majority of this run migrates from north to south along the westside of Kodiak Island which is consistent with Nelson and Barrett (1994), Nelson and Swanton (1996a), Nelson and Swanton (1997), and results from 1981 tagging experiments (Tyler et al. 1986). This is not surprising given that run timing is considered to be a conservative genetic trait central to the long-term success of a salmon stock.

In 1997, Saltery Lake sockeye salmon were used as the primary brood source for fry stocking at Spiridon Lake (Honnold 1997). Saltery Lake sockeye salmon run timing is about 4-5 weeks earlier than Upper Station late run timing (Barrett and Nelson 1994). The central 90% of the Upper Station late run occurs from 29 July to 3 September with the peak run timing taking place during the third week in August, whereas Saltery has a late June through early August run timing with the peak of the run occurring in mid to late July. It is anticipated that the timing of the Saltery Lake stock returns to the SLTHA may reduce the incidental harvest of pink and chum salmon stocks bound to the nearby Spiridon River. Conversely, it may prove problematic for reconstructing the 1998 Spiridon Lake sockeye run given that a multitude of sockeye stocks, both local and non-local, have similar run timing. Approximately 49% of the Saltery run occurs during the 6-25 July period, during which time Upper Cook Inlet (UCI) stocks have a strong potential for being within KMA waters (Barrett and Nelson 1994). To date, non-local stocks have not been considered in the Spiridon stock separation methodology because the Upper Station late run peaks at a time when over 80% of UCI sockeye escapement has been enumerated (D. Waltemyer, Alaska Department of Fish and Game, Soldotna, personal communication).

With the introduction of the Saltery Lake brood stock, it may be necessary to examine alternate run reconstruction methods. For example, the application of otolith thermal marking has been successful in tracking distribution of fish and estimating their contribution to fisheries throughout Alaska. Accordingly, this technology is considered to be a timely and cost-effective management tool for identifying specific stocks in mixed stock fishery catches (Hagen et al. 1995). The implementation of thermal marking in the Kodiak Management Area, specifically the Saltery Lake brood stocked in Spiridon Lake, is being explored by the Kodiak Regional Aquaculture Association (L. Malloy, Kodiak Regional Aquaculture Association, Kodiak, personal communication).

Based on 1994-1997 returns to Spiridon (sampled from the commercial fishery in the SLTHA) the sibling relationship (age 1.2 to 1.3) does not appear to be consistent with the Upper Station brood stock source. Various mechanisms have been associated with age at maturity including genetic inheritance, environmental influences, and maternal effects (Bradford and Peterman 1987). Enhanced freshwater environmental factors can positively affect size at smolting, which in many stocks is inversely correlated with ocean age at maturity. Although the age structure of returning Saltery sockeye salmon varies slightly from year to year, there is usually a large component of 3-ocean fish. For example, in 1997, about 78% of the escapement samples collected were classified as age 0.3, 1.3 or 2.3. Regardless, it seems likely that the favorable freshwater conditions at Spiridon will have a similar effect on Saltery fry, resulting in a large 2-ocean, rather than 3-ocean component.

Although there are not enough data at present to determine a trend, the annual freshwater growth of Spiridon sockeye salmon does not appear to be decreasing. Spiridon freshwater growth in 1996, as measured by incremental scale measures, was significantly less than previous years (1994 and 1995) pointing to potential biological changes which maybe occurring within the freshwater environment. However, freshwater scale growth measured in 1997 indicated that there was no significant difference in freshwater scale growth between 1994 and 1997, even though these fish were the result of a fry stocking level of 5.7 million fry compared to 3.3 million which produced the majority of the 1994 run. In order to evaluate increasing stocking densities coupled with the lack of yearly nutrient inputs, annual freshwater growth as reflected in scales should continue to be monitored and rigorously analyzed.

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Table 1. Number of observations and percent classification, by stock, of age 2.2 sockeye salmon using a linear discriminant function.

Actual Stock		Classification by Stock				Total
		Ayakulik	Karluk late run	Spiridon	Station I	
Ayakulik	number	144	18	0	6	168
	percent	**85.71**	10.71	0.00	3.57	100.0
Karluk late run	number	26	49	1	15	91
	percent	28.57	**53.85**	1.10	16.48	100.0
Spiridon	number	1	3	175	21	200
	percent	0.50	1.50	**87.50**	10.50	100.0
Upper Station late run	number	7	29	20	144	200
	percent	3.50	14.50	10.00	**72.00**	100.0

Mean Classif 77.69

Table 2. Estimated contribution of Spiridon age 1.2 and 2.2 sockeye salmon to the SW Afognak Section, Uganik and Uyak catch areas by area and week 1997, using scale pattern analysis, 1997 (Method 1).

Catch Area		Catch				SPA Sample		Age 2.2 Stock Composition Estimates			
Week	Dates	Total	1.2	2.2	other	Date	Size	Percent	90%cc	2.2	Total[d]
SW Afognak (251 - 10 - 20)											
30	7/19-7/25	5,826	514	1,476	3,836	7/23-7/2	38 [a]	8.1%	0.14	120	634
31	7/26-8/01	0									
32	8/02-8/08	528	72	109	347			8.1%	0.14	9	81
33	8/09-8/15	5,173	785	992	3,396			8.1%	0.14	80	865
34	8/16-8/22	5,623	933	1,003	3,687	8/18	14	8.1%	0.14	81	1,014
35	8/23-8/29		no sample collected								
Area Total		17,150	2,304	3,580	11,266		52			290	2,594
Uganik (253 - 11 - 35)											
30	7/19-7/25	28,769	4,183	6,075	18,511	7/24	76	35%	0.17	2,102	6,285
31	7/26-8/01	10,299	1,654	2,867	5,778			41% [b]	0.17	1,173	2,827
32	8/02-8/08	22,114	3,584	7,028	11,502	8/5-8/6	83	47%	0.18	3,317	6,901
33	8/09-8/15	32,987	4,647	11,284	17,056	8/11-8/1	79	41%	0.17	4,672	9,319
34	8/16-8/22	46,572	5,430	19,703	21,439	8/20	13 [c]	48%	0.15	9,398	14,828
35	8/23-8/29	13,780	3,471	6,220	4,089	8/23-8/2	97	48%	0.15	2,967	6,438
Area Total		154,521	22,969	53,177	78,375		348			23,629	46,598
Uyak (254 - 10 - 40)											
30	7/19-7/25	44,261	2,938	9,775	31,548	7/19-7/2	100	2.4%	0.05	235	3,173
31	7/26-8/01	28,807	2,371	5,345	21,091	7/29	56	17.2%	0.15	919	3,290
32	8/02-8/08	44,018	4,004	9,125	30,889	8/5	60	15.5%	0.15	1,414	5,418
33	8/09-8/15	60,744	7,656	18,388	34,700	8/13	98	10.8%	0.11	1,986	9,642
34	8/16-8/22	67,084	9,870	29,449	27,765	8/17-8/1	99	33.8%	0.15	9,954	19,824
35	8/23-8/29	33,738	4,367	17,893	11,478	8/25	100	22.7%	0.14	4,062	8,429
Area Total		278,652	31,206	89,975	157,471		513			18,570	49,776
SLTHA (254 - 50)											
31	7/26-8/01	2,247	754	441	1,052						
32	8/02-8/08	879	471	252	156						
33	8/09-8/15	4,404	2,902	855	647						
34	8/16-8/22	13,067	9,126	2,695	1,246						
35	8/23-8/29	10,939	6,608	3,471	860						
36	8/30-9/05	15,882	9,813	5,417	652						
37	9/06-9/12	13,891	8,696	4,706	489						
38	9/13-9/19	3,174	1,989	1,071	114						
Area Total		64,483	40,359	18,908	5,216						64,483
Combined Total		514,806	96,838	165,640	252,328					42,488	163,450

[a] Samples collected during weeks 30 and 32 were combined to perform analysis.

[b] No sample was collected during week 31; composition estimates from weeks 30 and 32 were averaged.

[c] Samples collected during weeks 34 and 35 were combined to perform analysis.

[d] Estimated total harvest of age 1.2 and 2.2 fish assigned to Spiridon.

Table 3. Estimated number of Spiridon Lake sockeye salmon harvested by area and week 1997, using scale pattern analysis (Method 1).

Catch week	Dates	Catch Area: SW Afognak (251-10-20) 1.2	2.2	total	Uganik (253-11-35) 1.2	2.2	total	Uyak (254-10-40) 1.2	2.2	total	SLTHA (254-50) 1.2	2.2	other[a]	total	Grand Total
29	7/12-7/18														0
30	7/19-7/25	514	120	634	4,183	2,102	6,285	2,938	235	3,173					10,091
31	7/26-8/01	0	0	0	1,654	1,173	2,827	2,371	919	3,290	754	441	1,052	2,247	8,364
32	8/02-8/08	72	9	81	3,584	3,317	6,901	4,004	1,414	5,418	471	252	156	879	13,279
33	8/09-8/15	785	80	865	4,647	4,672	9,319	7,656	1,986	9,642	2,902	855	647	4,404	24,230
34	8/16-8/22	933	81	1,014	5,430	9,398	14,828	9,870	9,954	19,824	9,126	2,695	1,246	13,067	48,733
35	8/23-8/29				3,471	2,967	6,438	4,367	4,062	8,429	6,608	3,471	860	10,939	25,806
36	8/30-9/05										9,813	5,417	652	15,882	15,882
37	9/06-9/12										8,696	4,706	489	13,891	13,891
38	9/13-9/19										1,989	1,071	114	3,174	3,174
Area Total		2,304	290	2,594	22,969	23,629	46,598	31,206	18,570	49,776	40,359	18,908	5,216	64,483	163,450

[a] "Other" includes all age classes other than age 1.2. and 2.2.

Table 4. Estimated contribution of Spiridon age 1.2 and 2.2 sockeye salmon to the SW Afognak Section, Uganik and Uyak catch areas by area and week 1997, using the weekly ratio of age 1.2 to 2.2 fish in the SLTHA (Method 2).

Catch Area		Catch			Assigned to Spiridon			
Week	Dates	Total	1.2	2.2	1.2	2.2	Total	RS[a]
SW Afognak (251 - 10 - 20)								
29	7/12-7/18	no sample collected						
30	7/19-7/25	5,826	514	1,476	514	301	815	1.7
31	7/26-8/01	0			0	0	0	1.9
32	8/02-8/08	528	72	109	72	21	93	3.4
33	8/09-8/15	5,173	785	992	785	232	1,017	3.4
34	8/16-8/22	5,623	933	1,003	933	490	1,423	1.9
35	8/23-8/29	no sample collected						
Area Total		17,150	2,304	3,580	2,304	1,044	3,348	
Uganik (253 - 11 - 35)								
29	7/12-7/18	no sample collected						
30	7/19-7/25	28,769	4,183	6,075	4,183	2,447	6,630	1.7
31	7/26-8/01	10,299	1,654	2,867	1,654	885	2,539	1.9
32	8/02-8/08	22,114	3,584	7,028	3,584	1,056	4,640	3.4
33	8/09-8/15	32,987	4,647	11,284	4,647	1,372	6,019	3.4
34	8/16-8/22	46,572	5,430	19,703	5,430	2,852	8,282	1.9
35	8/23-8/29	13,780	3,471	6,220	3,471	1,916	5,387	1.8
Area Total		154,521	22,969	53,177	22,969	10,528	33,497	
Uyak (254 - 10 - 40)								
29	7/12-7/18							
30	7/19-7/25	44,261	2,938	9,775	2,938	1,718	4,656	1.7
31	7/26-8/01	28,807	2,371	5,345	2,371	1,387	3,758	1.7
32	8/02-8/08	44,018	4,004	9,125	4,004	2,142	6,146	1.9
33	8/09-8/15	60,744	7,656	18,388	7,656	2,256	9,912	3.4
34	8/16-8/22	67,084	9,870	29,449	9,870	2,915	12,785	3.4
35	8/23-8/29	33,738	4,367	17,893	4,367	2,294	6,661	1.9
Area Total		278,652	31,206	89,975	31,206	12,712	43,918	
SLTHA (254 - 50)[b]								
31	7/26-8/01	2,247	754	441	754	441	2,247	1.7
32	8/02-8/08	879	471	252	471	252	879	1.9
33	8/09-8/15	4,404	2,902	855	2,902	855	4,404	3.4
34	8/16-8/22	13,067	9,126	2,695	9,126	2,695	13,067	3.4
35	8/23-8/29	10,939	6,608	3,471	6,608	3,471	10,939	1.9
36	8/30-9/05	15,882	9,813	5,417	9,813	5,417	15,882	1.8
37	9/06-9/12	13,891	8,696	4,706	8,696	4,706	13,891	1.8
38	9/13-9/19	3,174	1,989	1,071	1,989	1,071	3,174	1.9
Area Total		64,483	40,359	18,908	40,359	18,908	64,483	
Combined Total		514,806	96,838	165,640	96,838	43,191	145,245	

[a] RS represents the weekly ratio of age 1.2 to age 2.2. fish in the SLTHA.

[b] The entire sockeye salmon harvest (all age classes) in the SLTHA is assigned to Spiridon.

[c] Estimated harvest assigned to Spiridon.

Table 5. Estimated number of Spiridon Lake sockeye salmon harvested by area and week 1997, using the weekly ratio of age 1.2 to 2.2 fish in the SLTHA (Method 2).

Catch week	Dates	Catch Area: SW Afognak (251-10-20) 1.2	2.2	total	Uganik (253-11-35) 1.2	2.2	total	Uyak (254-10-40) 1.2	2.2	total	SLTHA (254-50) 1.2	other[a]	total	Grand Total
29	7/12-7/18													
30	7/19-7/25	514	301	815	4,183	2,447	6,630	2,938	1,718	4,656				12,101
31	7/26-8/01	0	0	0	1,654	885	2,539	2,371	1,387	3,758	754	1,493	2,247	8,544
32	8/02-8/08	72	21	93	3,584	1,056	4,640	4,004	2,142	6,146	471	408	879	11,758
33	8/09-8/15	785	232	1,017	4,647	1,372	6,019	7,656	2,256	9,912	2,902	1,502	4,404	21,352
34	8/16-8/22	933	490	1,423	5,430	2,852	8,282	9,870	2,915	12,785	9,126	3,941	13,067	35,557
35	8/23-8/29				3,471	1,916	5,387	4,367	2,294	6,661	6,608	4,331	10,939	22,987
36	8/30-9/05										9,813	6,069	15,882	15,882
37	9/06-9/12										8,696	5,195	13,891	13,891
38	9/13-9/19										1,989	1,185	3,174	3,174
Area Total		2,304	1,044	3,348	22,969	10,528	33,497	31,206	12,712	43,918	40,359	24,124	64,483	145,245

[a] "Other" includes all age classes other than age 1.2.

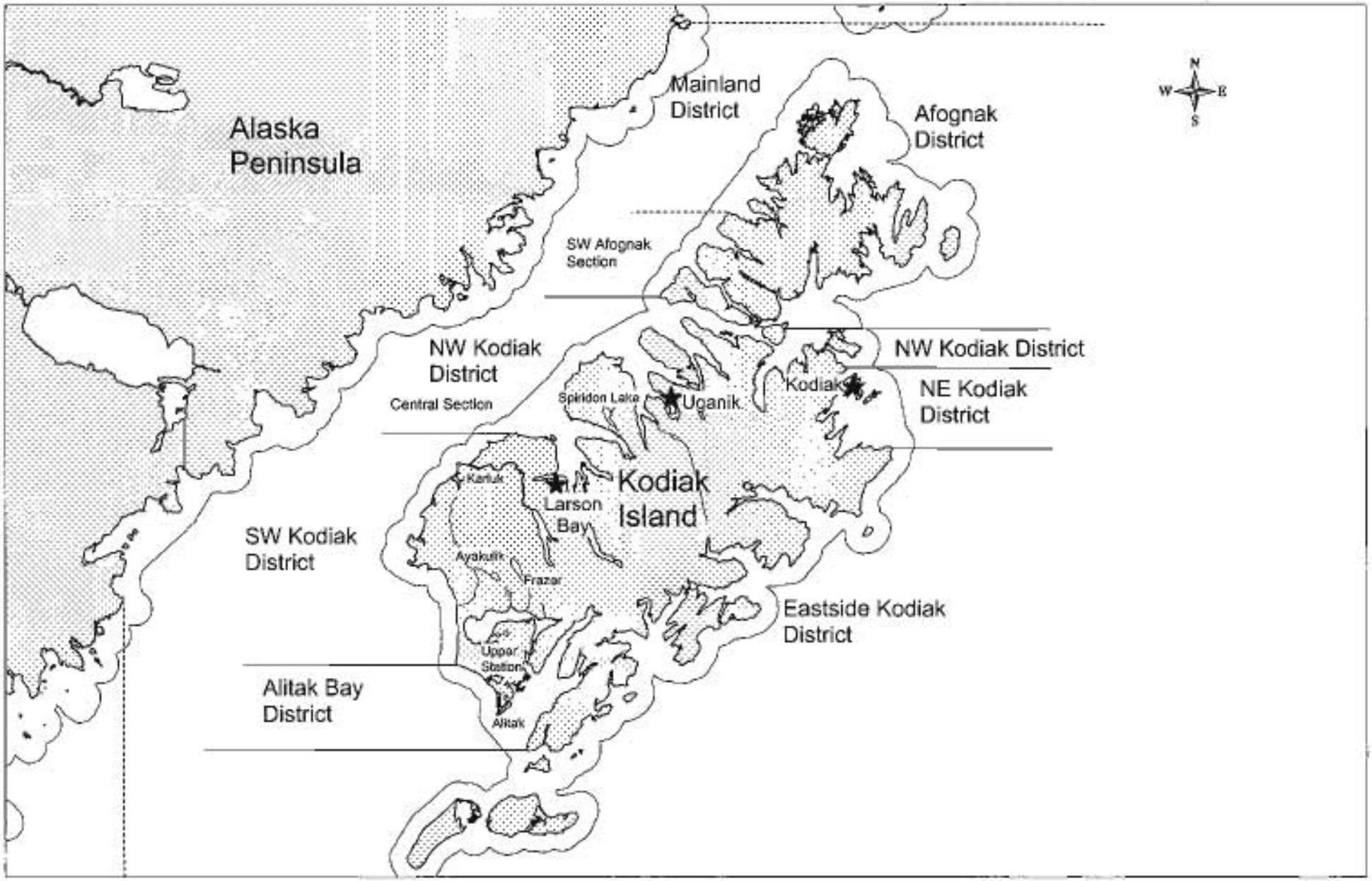


Figure 1. Map of the Kodiak Management Area showing fishing districts and major sockeye systems including Spiridon Lake.

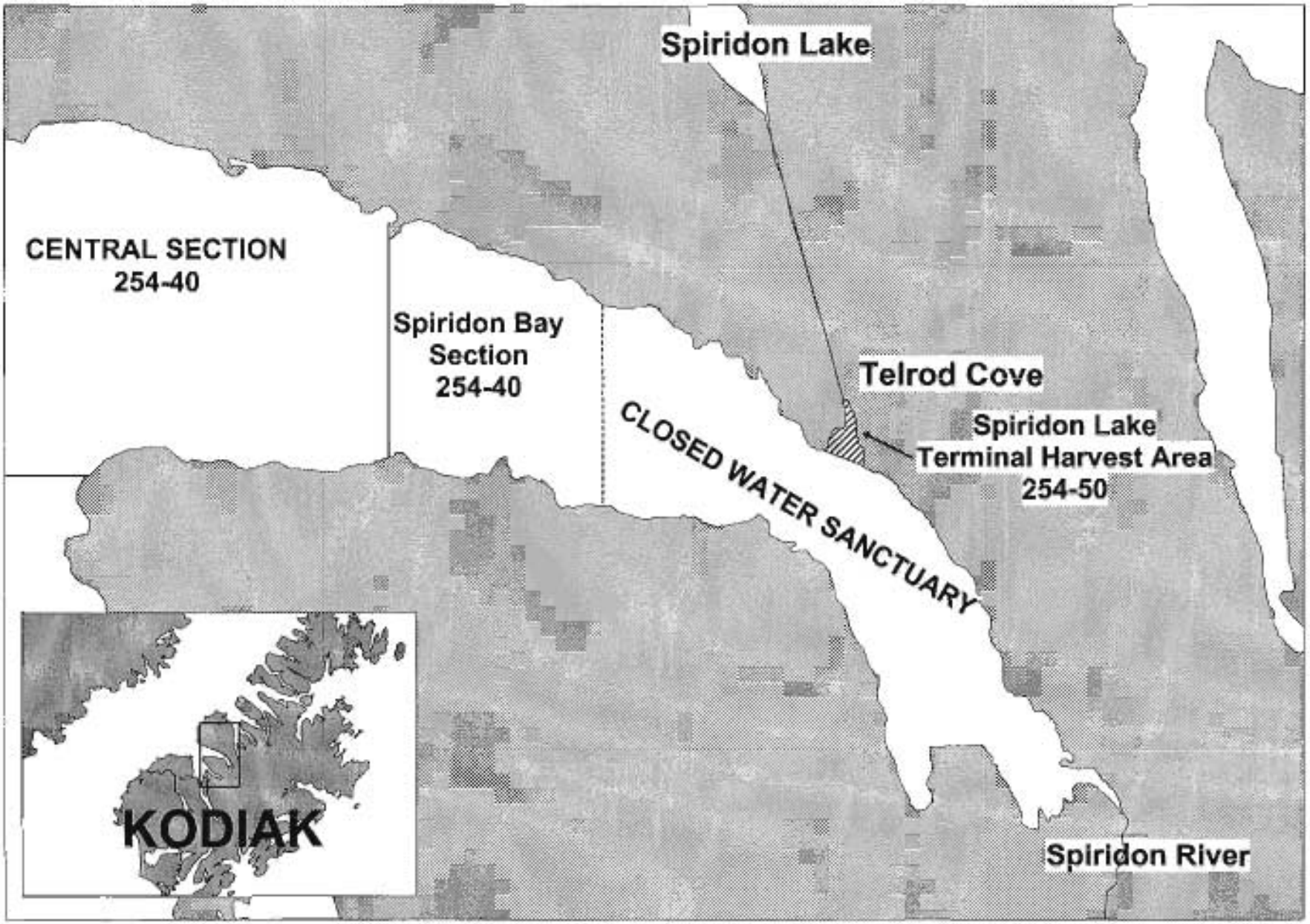


Figure 2. Map identifying the approximate boundaries of the Spiridon Lake Terminal harvest Area in Telrod Cove.

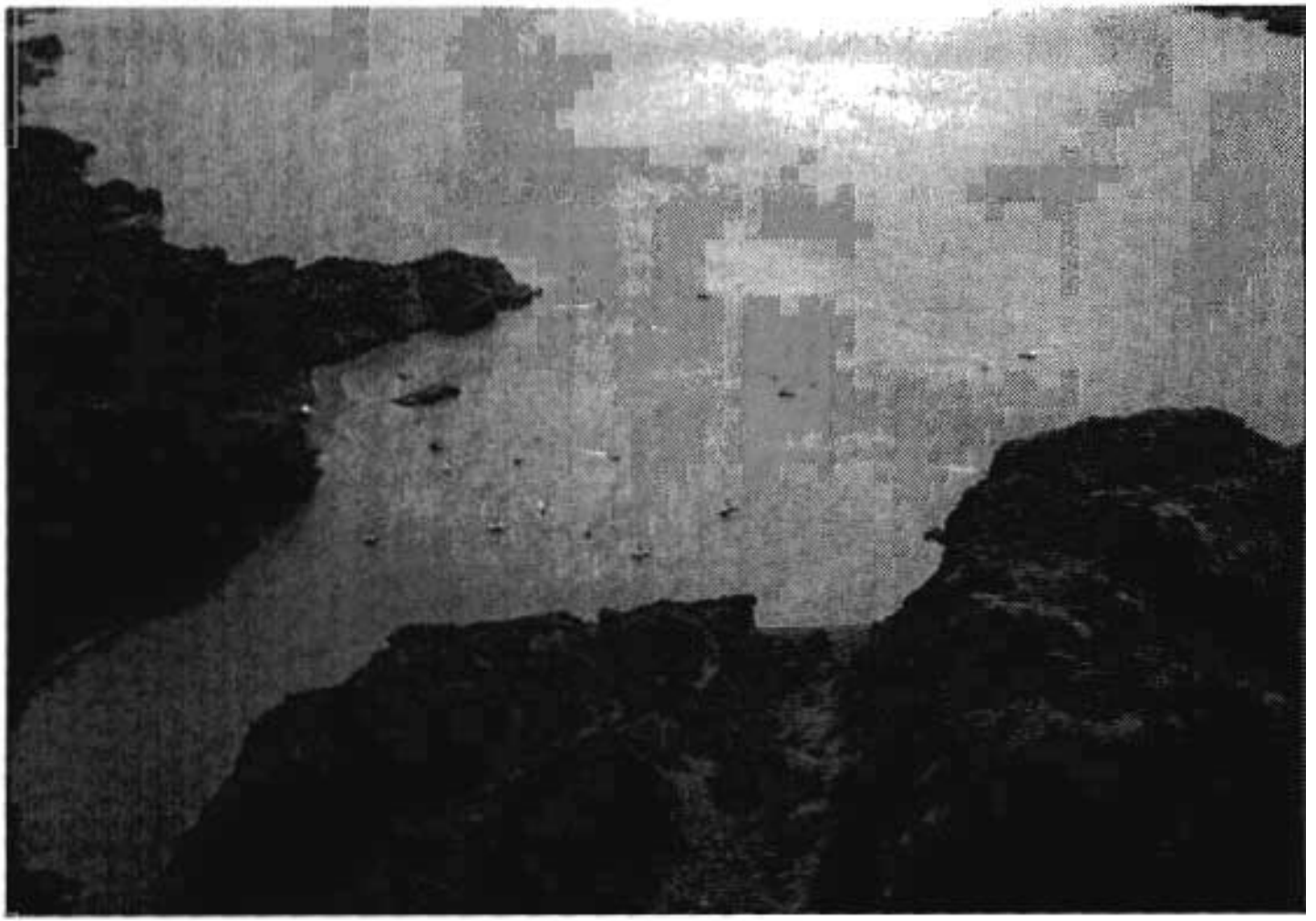


Figure 3. Photograph of the Spiridon Lake Terminal Harvest Area at Telrod Cove.

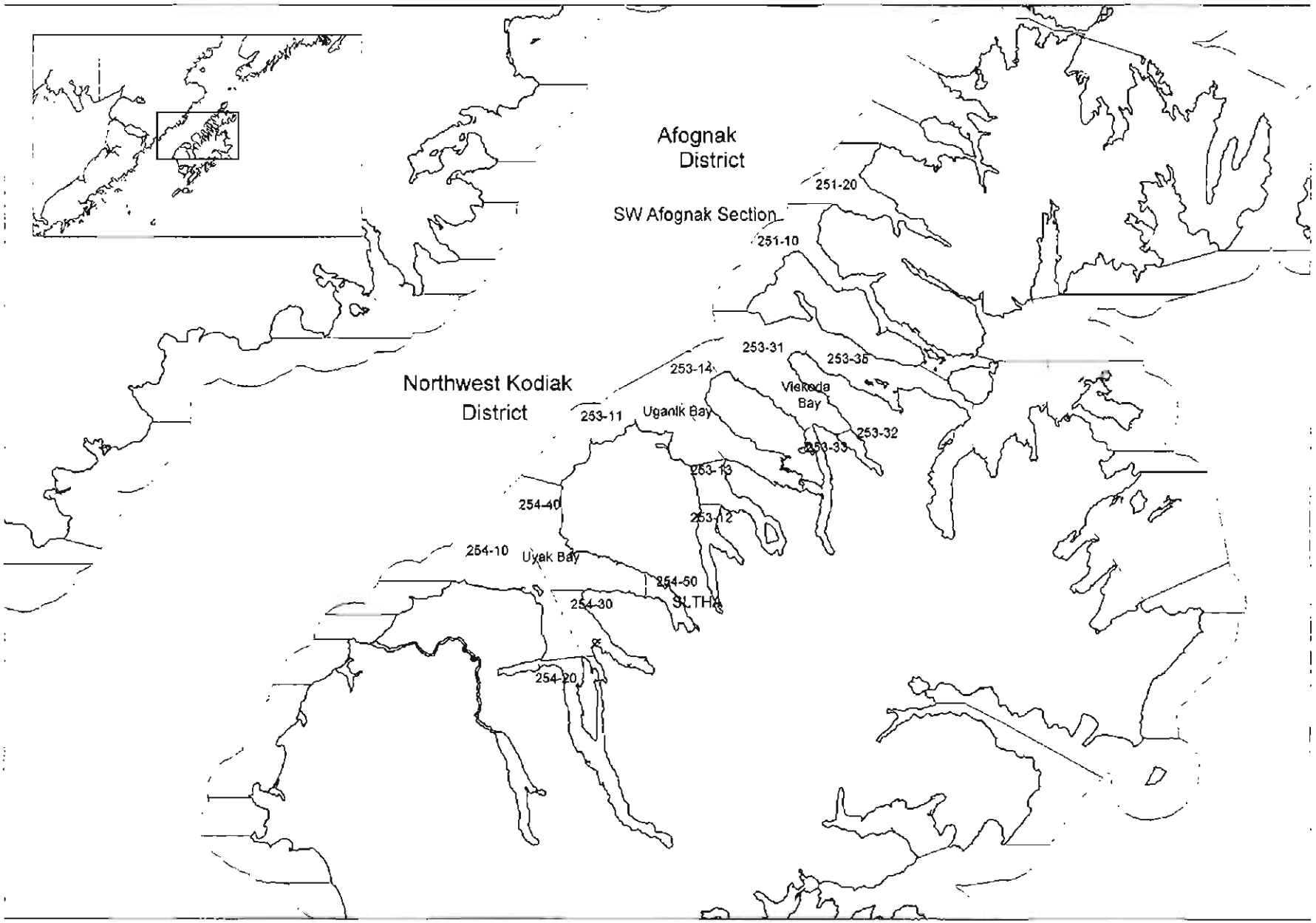


Figure 4. Map of the study area identifying the SW Afognak Section, Uganik and Uyak catch areas, and the SLTHA.

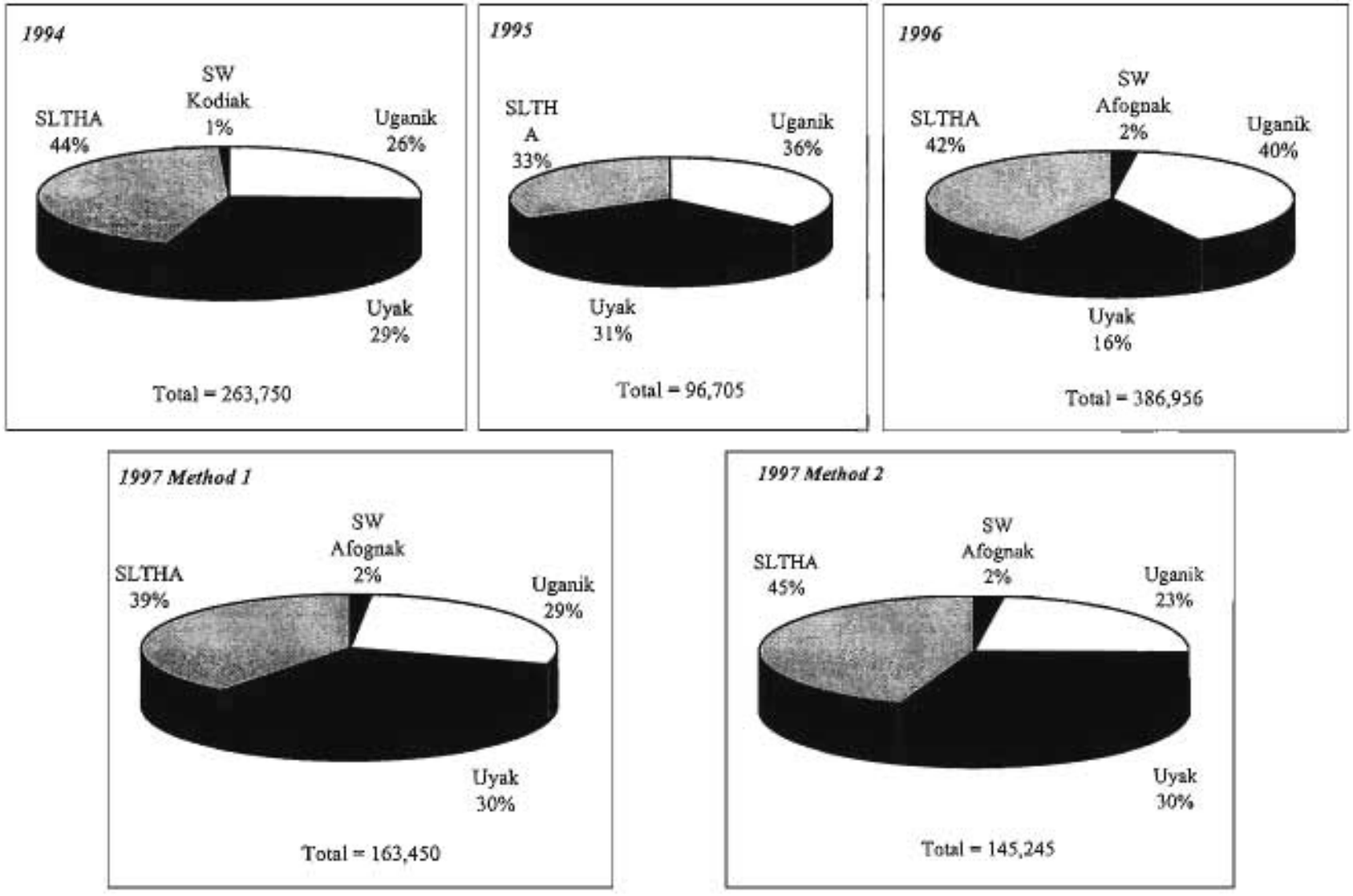


Figure 5. Estimated percentage of Spiridon sockeye salmon harvested by area and year, 1994 - 1996, and 1997 estimates using two methods.

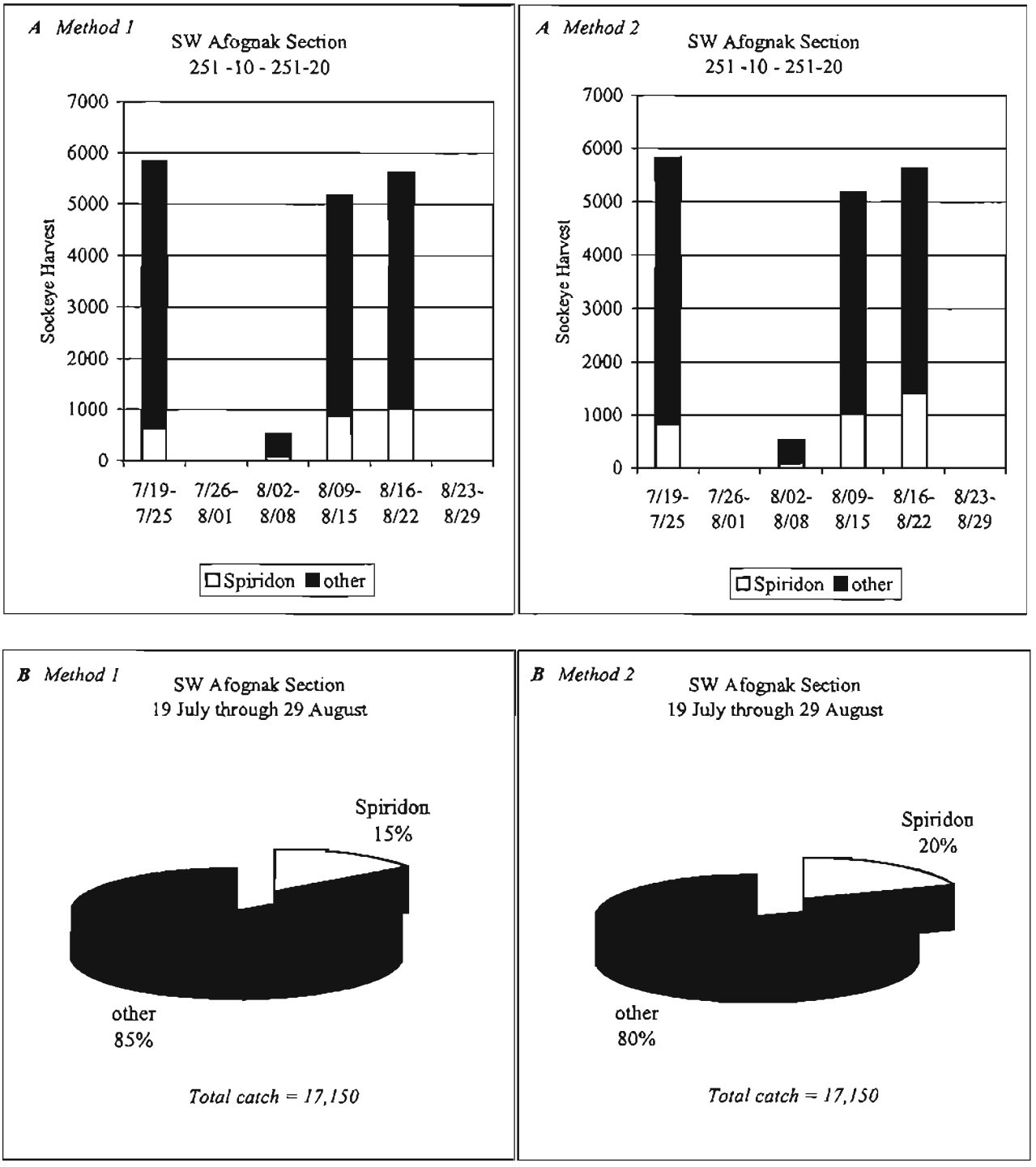


Figure 6. Estimated weekly number (A) and overall percentage (B) of Spiridon sockeye salmon harvested in the SW Afognak Section, 19 July through 29 August 1997 using two

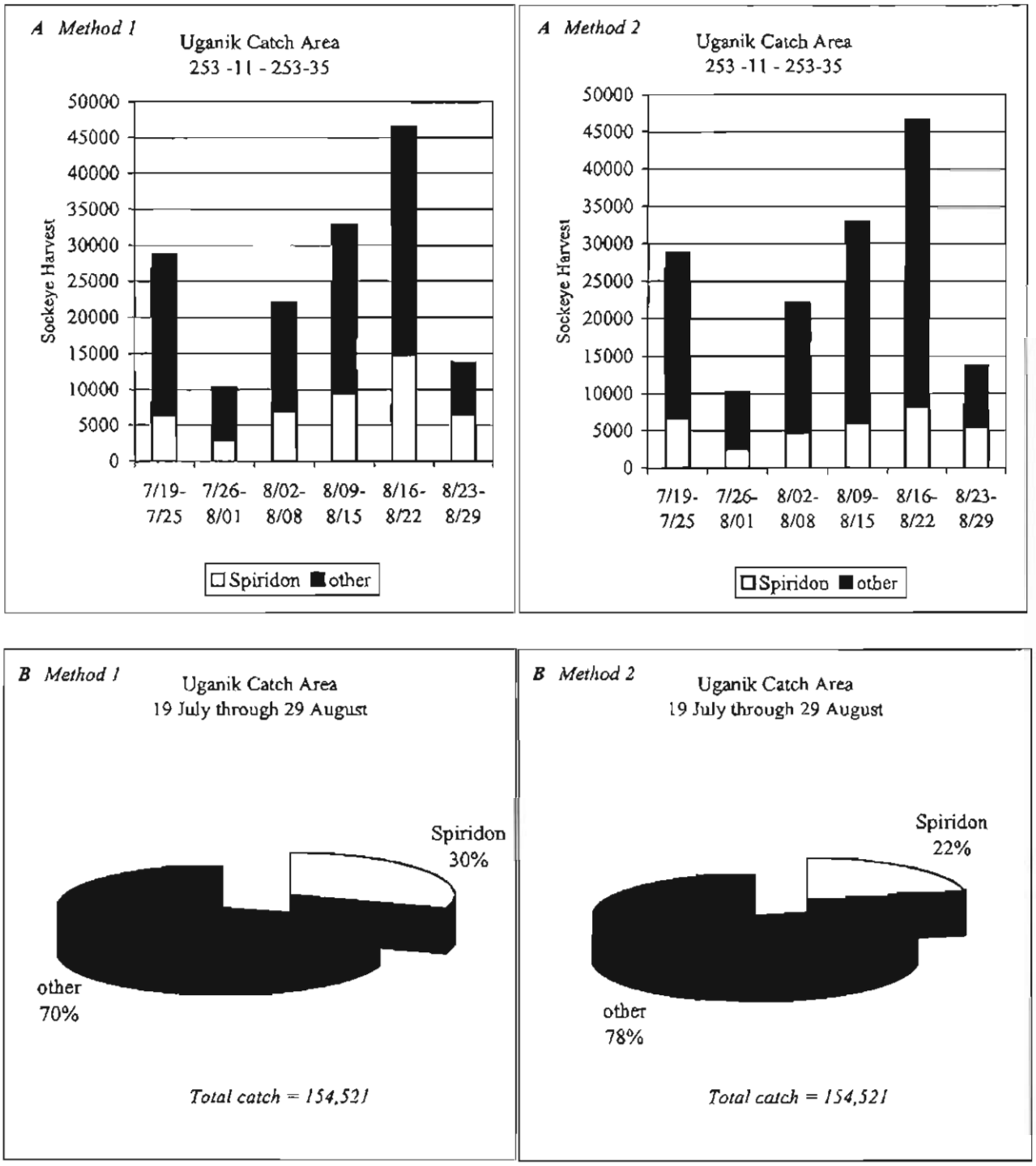


Figure 7. Estimated weekly number (A) and overall percentage (B) of Spiridon sockeye salmon harvested in the Uganik catch area, 19 July through 29 August 1997 using two methods.

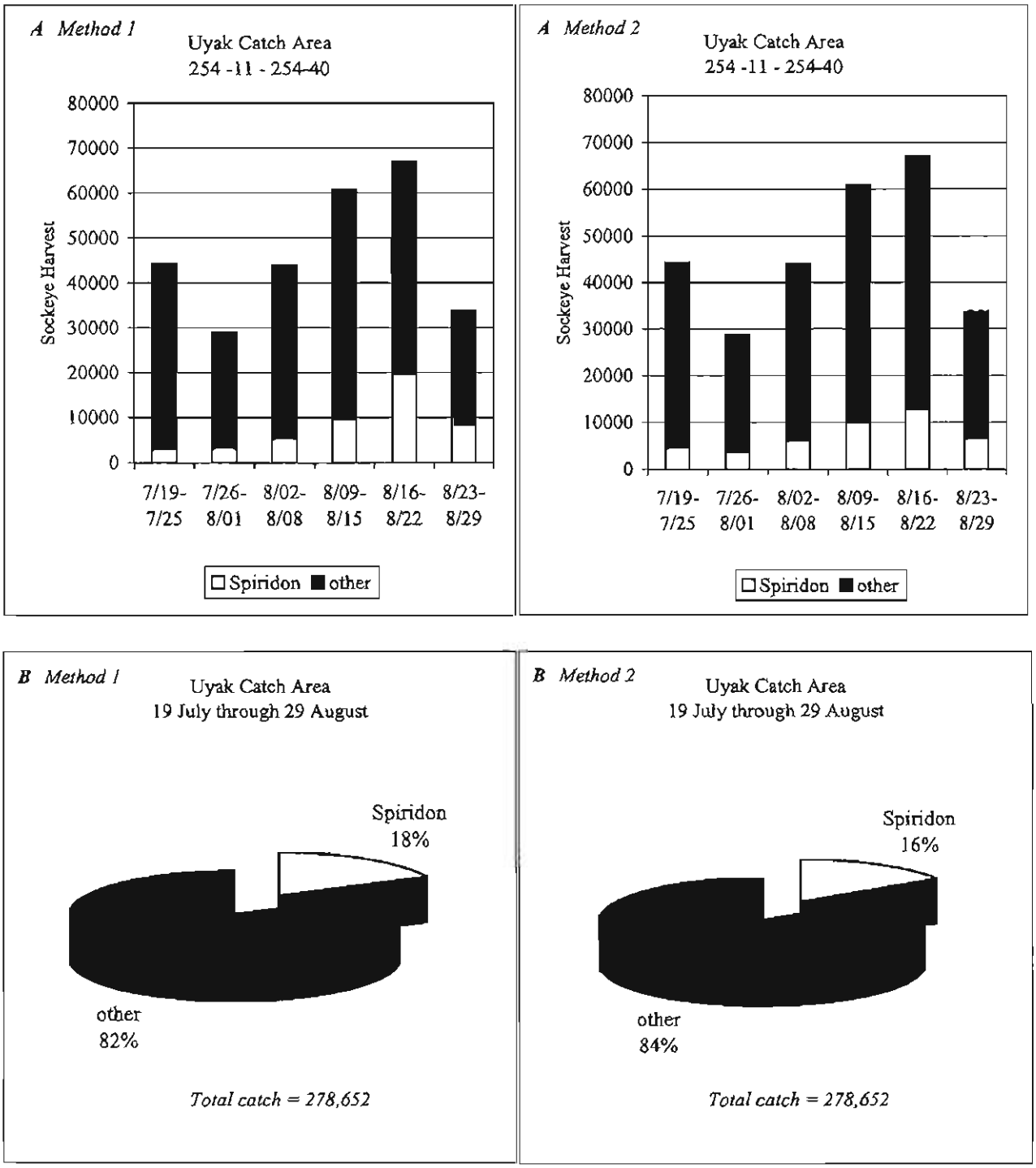


Figure 8. Estimated weekly number (A) and overall percentage (B) of Spiridon sockeye salmon harvested in the Uyak Catch Area, 19 July through 29 August 1997 using two methods.

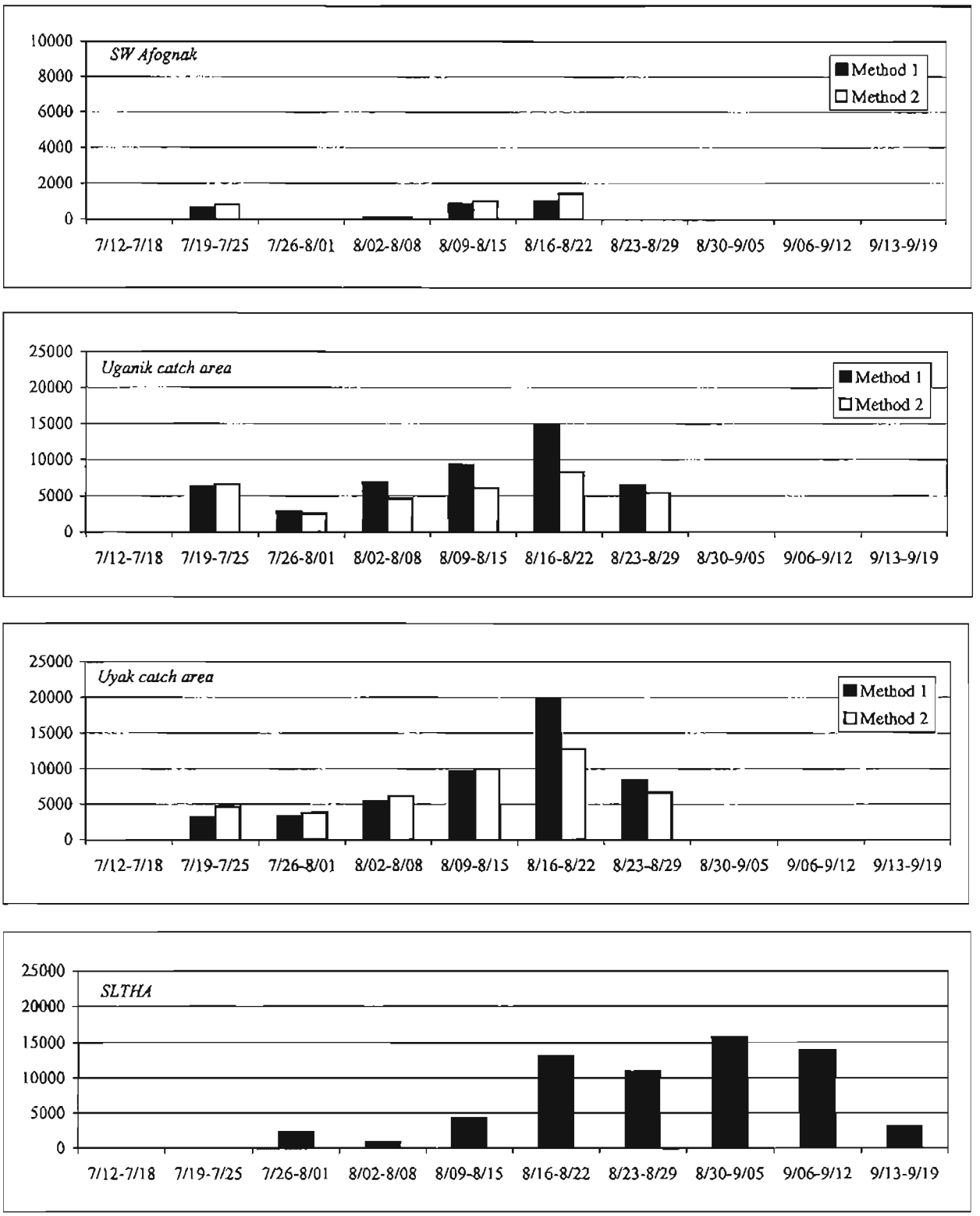


Figure 9. Estimated number of Spiridon sockeye salmon harvested by area and week 1997 using two methods.
NOTE: Vertical axes are scaled differently.

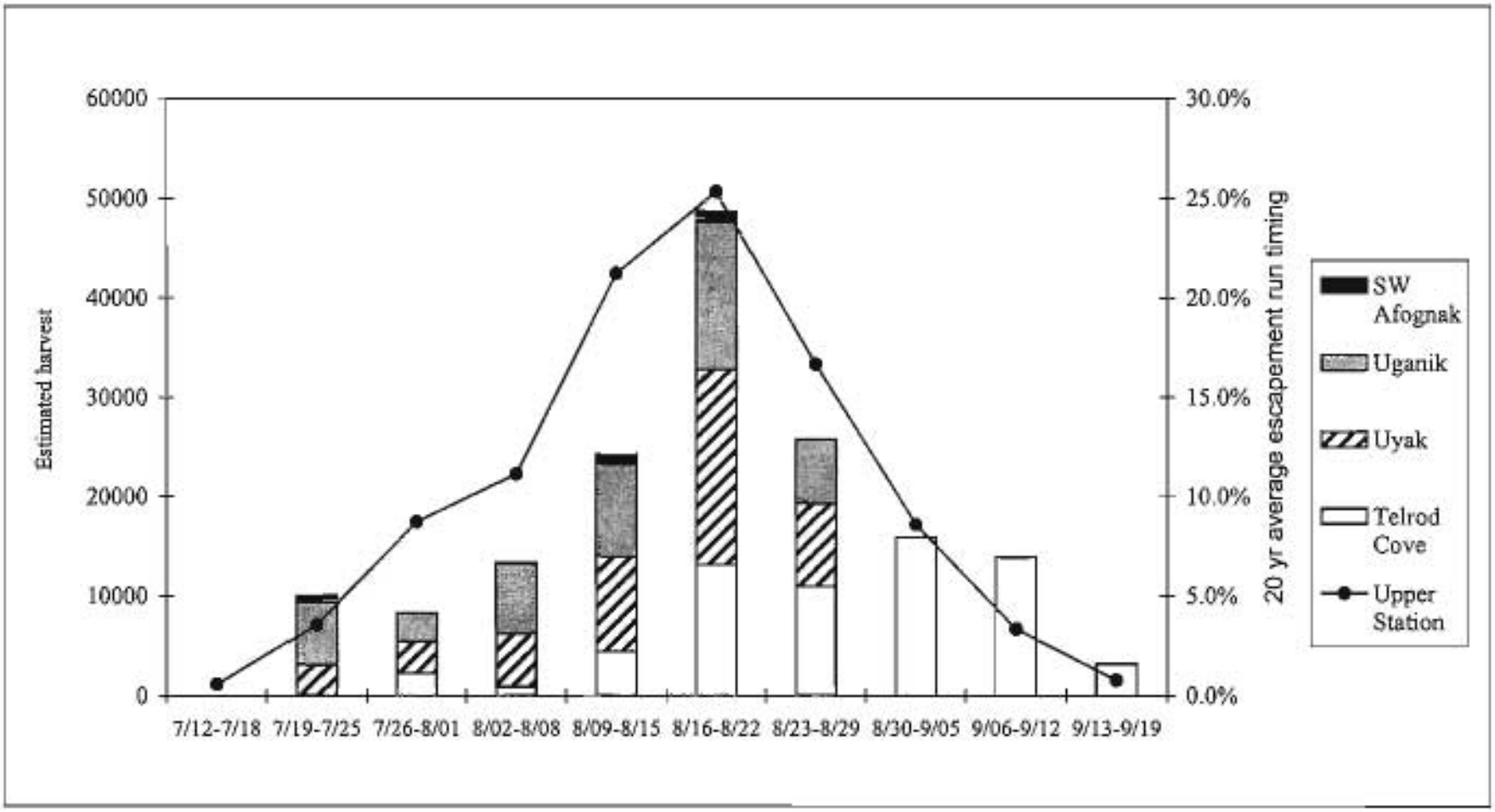


Figure 10. A comparison of the 1997 Spiridon run timing based on harvest estimates (using Method 1), and Upper Station late run sockeye salmon escapement timing (1978-1997 average percent).

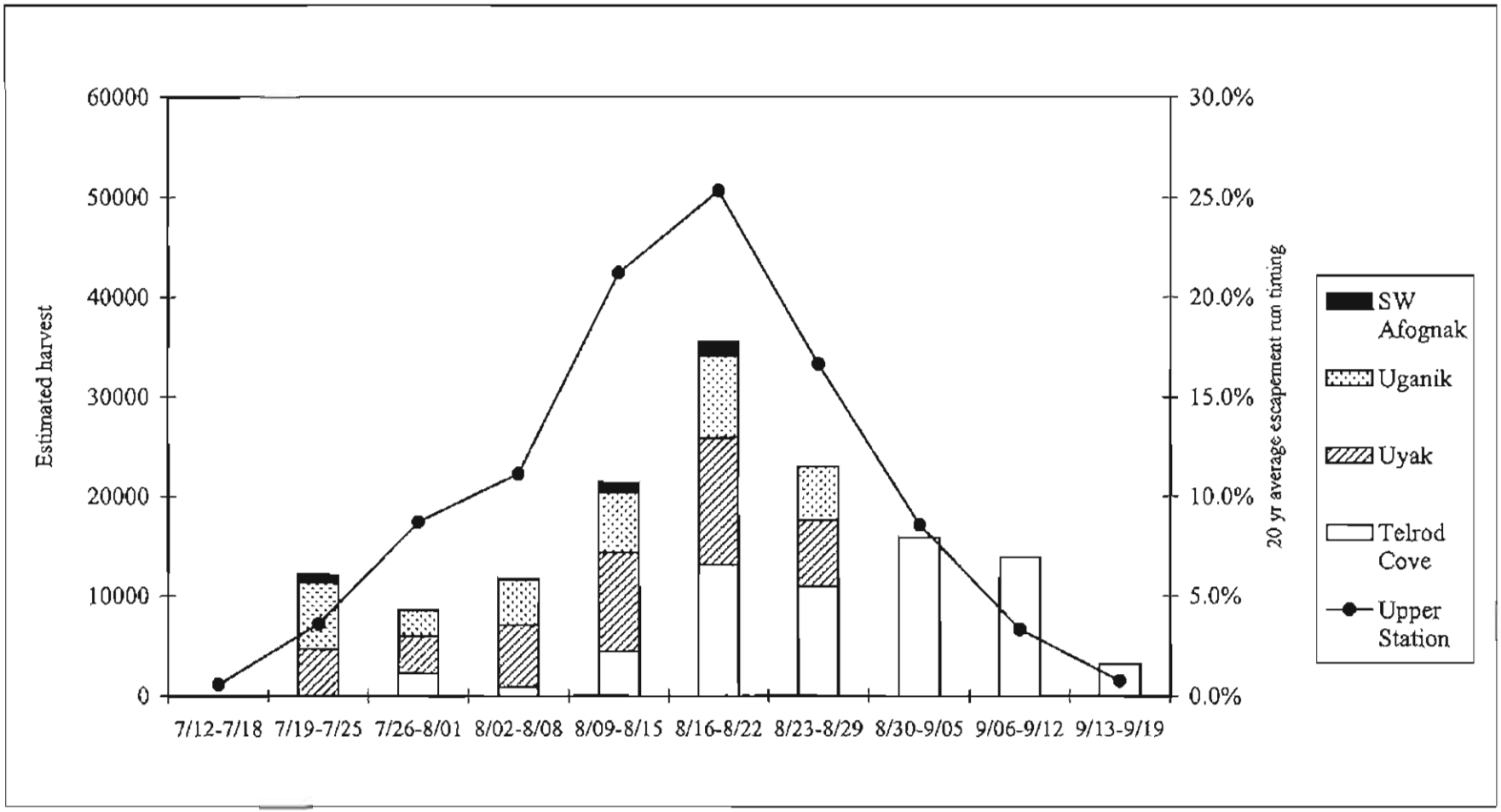


Figure 11. A comparison of the 1997 Spiridon run timing based on harvest estimates (using Method 2), and Upper Station late run sockeye salmon escapement timing (1978-1997 average percent).

APPENDIX

Appendix A.1. Estimated age composition of Karluk late run sockeye salmon escapement by week, 22 July through 25 September 1997.

Week	Sample Size		Ages 1.1	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	2.4	3.3	4.2	Total[a]
30	106	Percent	0.0	0.0	1.1	10.6	10.0	11.9	1.9	0.0	38.9	12.7	0.0	12.6	0.1	100
(7/22-7/25)		Numbers	0	0	66	629	592	702	114	0	2,298	752	0	745	6	5,903
31	137	Percent	0.1	0.0	2.1	12.9	13.4	10.4	1.8	0.0	44.9	5.0	0.0	8.9	0.6	100
(7/26-8/01)		Numbers	21	0	409	2,542	2,630	2,034	358	0	8,825	975	0	1,747	112	19,652
32	152	Percent	0.6	0.0	2.3	15.9	12.3	13.8	0.3	0.0	39.7	7.0	0.0	8.0	0.1	100
(8/02-8/08)		Numbers	80	0	323	2,193	1,702	1,902	37	0	5,476	969	0	1,111	12	13,805
33	145	Percent	0.6	0.0	4.3	15.7	9.8	18.2	0.1	0.1	37.2	5.7	0.1	8.1	0.0	100
(8/09-8/15)		Numbers	52	0	363	1,318	822	1,530	12	6	3,127	478	6	682	0	8,396
34	139	Percent	0.2	0.0	3.4	14.3	8.4	23.2	1.1	0.5	32.3	8.7	0.5	7.5	0.0	100
(8/16-8/22)		Numbers	10	0	175	734	431	1,196	54	27	1,662	446	27	385	0	5,148
35	56	Percent	0.0	0.1	0.2	5.6	0.3	14.3	1.6	0.0	47.1	14.4	0.0	14.6	1.6	100
(8/23-8/29)		Numbers	0	12	38	910	52	2,343	268	4	7,697	2,348	4	2,392	261	16,328
36	104	Percent	0.0	0.7	1.3	4.9	0.7	11.6	0.6	0.0	43.6	16.4	0.0	19.7	0.5	100
(8/30-9/05)		Numbers	0	497	944	3,601	522	8,568	447	0	32,292	12,173	25	14,559	397	74,025
37	108	Percent	0.0	0.9	0.3	2.1	1.5	9.3	1.5	0.0	45.4	19.5	0.6	18.7	0.0	100
(9/06-9/12)		Numbers	0	544	182	1,265	901	5,496	907	0	26,739	11,475	357	11,031	0	58,896
38	113	Percent	0.0	0.9	0.0	0.9	0.9	15.0	1.8	0.0	42.5	24.8	0.0	13.3	0.0	100
(9/13-9/19)		Numbers	0	658	0	658	658	11,180	1,315	0	31,567	18,414	0	9,865	0	74,313
39	0	Percent	0.0	0.9	0.0	0.9	0.9	15.0	1.8	0.0	42.5	24.8	0.0	13.3	0.0	100
(9/20-9/26)		Numbers	0	314	0	314	314	5,330	627	0	15,050	8,779	0	4,703	0	35,431
Total	1,060	Percent	0.1	0.6	0.8	4.5	2.8	12.9	1.3	0.0	43.2	18.2	0.1	15.1	0.3	100
		Numbers	163	2,025	2,500	14,164	8,624	40,281	4,139	37	134,733	56,809	419	47,220	788	311,897

[a] Totals may not add exactly due to rounding.

Appendix A.2. Estimated age composition of Ayakulik sockeye salmon escapement by week, 12 July through 30 August 1997.

Week	Sample Size		Ages												Total[a]
			0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	3.3	
29	202	Percent	0.0	15.0	0.0	0.4	6.1	0.0	3.1	31.7	0.0	0.0	39.9	3.5	0.1	100
(7/12-7/18)		Numbers	0	2,755	0	80	1,124	0	576	5,824	9	9	7,340	650	12	18,380
30	195	Percent	0.0	17.4	0.0	0.5	6.6	0.0	1.7	32.2	0.4	0.4	39.3	1.4	0.0	100
(7/19-7/25)		Numbers	0	2,429	0	73	919	0	235	4,486	61	51	5,473	196	0	13,923
31	203	Percent	0.0	22.1	0.1	1.0	5.8	0.0	2.1	29.9	1.6	0.0	36.1	1.3	0.0	100
(7/26-8/01)		Numbers	0	7,485	26	350	1,974	0	699	10,108	531	12	12,187	428	0	33,800
32	195	Percent	0.0	9.2	0.4	1.5	3.7	0.0	1.1	40.0	0.4	0.0	42.9	0.8	0.0	100
(8/02-8/08)		Numbers	0	1,385	60	230	565	0	165	6,027	60	0	6,467	115	0	15,075
33	59	Percent	0.0	5.1	0.0	1.7	8.4	0.0	3.4	42.4	1.7	0.0	35.7	1.7	0.0	100
(8/09-8/15)		Numbers	0	338	0	112	555	0	222	2,794	111	0	2,354	111	0	6,597
34	0	Percent	0.0	5.1	0.0	1.7	8.5	0.0	3.4	42.4	1.7	0.0	35.6	1.7	0.0	100
(8/16-8/22)		Numbers	0	884	0	295	1,473	0	589	7,363	295	0	6,185	295	0	17,376
35-36	0	Percent	0.0	5.1	0.0	1.7	8.5	0.0	3.4	42.4	1.7	0.0	35.6	1.7	0.0	100
(8/23-8/30)		Numbers	0	396	0	132	659	0	264	3,297	132	0	2,769	132	0	7,781
Total	854	Percent	0.0	13.9	0.1	1.1	6.4	0.0	2.4	35.3	1.1	0.1	37.9	1.7	0.0	100
		Numbers	0	15,672	86	1,272	7,269	0	2,750	39,899	1,199	72	42,775	1,927	12	112,932

[a] Totals may not add exactly due to rounding.

Appendix A.3. Estimated age composition of Upper Station late run sockeye salmon escapement by week, 16 July through 11 September 1997.

Week	Sample Size		Ages 0.1	0.2	1.1	0.3	1.2	2.1	1.3	2.2	2.3	3.3	Total[a]
29	0	Percent	0.0	1.9	2.8	6.6	9.4	6.1	3.8	38.7	30.2	0.5	100.0
(7/16-7/18)		Numbers	0	21	31	73	105	68	42	429	335	5	1,110
30	212	Percent	0.0	2.3	2.7	9.4	9.1	5.3	3.7	36.7	30.2	0.4	100.0
(7/19-7/25)		Numbers	0	71	84	289	279	163	114	1,124	925	12	3,061
31	168	Percent	0.0	4.9	2.3	29.6	8.0	1.4	3.6	28.9	21.2	0.0	100.0
(7/26-8/01)		Numbers	0	346	164	2,095	569	101	258	2,050	1,500	0	7,083
32	186	Percent	0.0	6.8	3.2	38.4	8.7	5.2	2.9	32.6	2.2	0.0	100.0
(8/02-8/08)		Numbers	0	664	309	3,726	842	502	284	3,161	211	0	9,698
33	169	Percent	0.0	5.5	4.2	27.1	6.8	13.9	1.4	39.8	1.3	0.0	100.0
(8/09-8/15)		Numbers	0	1,454	1,128	7,234	1,821	3,700	373	10,598	343	0	26,650
34	184	Percent	0.0	1.7	2.7	28.8	3.5	13.8	1.3	46.9	1.4	0.0	100.0
(8/16-8/22)		Numbers	0	1,228	1,893	20,504	2,500	9,838	924	33,425	998	0	71,310
35	182	Percent	0.1	0.6	2.5	22.1	3.4	17.0	0.6	51.3	2.7	0.0	100.0
(8/23-8/29)		Numbers	49	458	2,027	18,098	2,751	13,947	478	42,048	2,186	0	82,043
36	193	Percent	0.4	2.6	3.9	10.0	9.6	28.8	0.1	44.1	0.5	0.0	100.0
(8/30-9/05)		Numbers	86	518	754	1,961	1,875	5,621	16	8,614	95	0	19,539
37	0	Percent	0.5	3.1	4.1	7.8	10.9	31.1	0.0	42.5	0.0	0.0	100.0
(9/06-9/11)		Numbers	53	320	427	800	1,121	3,202	0	4,376	0	0	10,299
Total	1,294	Percent	0.1	2.2	3.0	23.7	5.1	16.1	1.1	45.9	2.9	0.0	100.0
		Numbers	188	5,080	6,817	54,780	11,863	37,142	2,489	105,825	6,593	17	230,793

[a] Totals may not add exactly due to rounding.

Appendix A.4. Estimated age composition of Southwest Afognak Section (251-10 - 251-20) sockeye salmon catch by week, post 11 July 1997.

Week	Sample Size		Ages													Total[a]
			1.1	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	2.4	3.3	4.2	
29	0	Percent	3.1	0.6	7.7	3.2	12.9	28.8	0.1	0.3	32.5	6.6	0.1	3.9	0.1	100
(7/12-7/18)		Numbers	53	10	129	53	215	481	2	5	543	111	1	66	1	1,669
30	224	Percent	4.3	0.5	8.8	3.9	12.1	25.3	0	0.4	31.8	8.3	0	4.4	0	100
(7/19-7/25)		Numbers	253	27	514	230	707	1,476	1	25	1,851	484	0	257	0	5,826
32	0	Percent	1.8	0.2	13.7	2.1	27.5	20.6	0	0.2	27.3	4.9	0	1.8	0	100
(8/02-8/08)		Numbers	9	1	72	11	145	109	0	1	144	26	0	9	0	528
33	0	Percent	0.9	0.1	15.2	1.5	32.5	19.2	0	0.1	25.9	3.8	0	0.9	0	100
(8/09-8/15)		Numbers	48	5	785	78	1,679	992	0	5	1,339	194	0	48	0	5,173
34	119	Percent	0.1	0	16.6	0.9	37.1	17.8	0	0	24.6	2.7	0	0.1	0	100
(8/16-8/22)		Numbers	7	1	933	52	2,088	1,003	0	1	1,381	151	0	7	0	5,623
35	0	Percent	0	0	16.8	0.8	37.8	17.6	0	0	24.4	2.5	0	0	0	100
(8/23-8/29)		Numbers	0	0	135	7	304	142	0	0	196	20	0	0	0	805
Total	343	Percent	1.9	0.2	13.1	2.2	26.2	21.4	0.0	0.2	27.8	5.0	0.0	2.0	0.0	100.0
		Numbers	370	44	2,568	431	5,138	4,203	3	37	5,454	986	1	387	1	19,624

[a] Totals may not add exactly due to rounding.

Appendix A.5. Estimated age composition of Uganik and Viekoda Bays and Kupreanof Straights (253-11 - 253-35) sockeye salmon catch by week, post 11 July 1997.

Week	Sample Size		Ages																	Total[a]
			0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	3.3	4.2	4.3	
29	0	Percent	0.0	0.2	0.2	2.2	8.2	0.2	0.1	20.7	20.6	0.0	0.1	42.3	2.0	0.0	0.0	2.9	0.0	0.2	100
(7/12-7/18)		Numbers	0	52	35	499	1,884	46	28	4,769	4,760	0	17	9,762	470	0	0	680	0	57	23,058
30	557	Percent	0.0	0.5	0.3	3.3	14.5	0.2	0.0	17.3	21.1	0.0	0.2	36.1	3.2	0.0	0.0	3.2	0.0	0.0	100
(7/19-7/25)		Numbers	0	144	96	937	4,183	52	4	4,991	6,075	0	48	10,378	932	0	0	920	0	9	28,769
31	0	Percent	0.1	0.6	0.4	2.8	16.1	0.5	0.0	19.1	27.8	0.0	0.2	26.7	3.5	0.0	0.0	2.0	0.1	0.0	100
(7/26-8/01)		Numbers	14	66	44	293	1,654	50	0	1,967	2,867	0	22	2,745	362	0	0	202	14	0	10,299
32	417	Percent	0.2	0.6	0.4	2.3	16.2	0.7	0.0	21.2	31.8	0.0	0.2	21.1	3.5	0.0	0.0	1.3	0.3	0.0	100
(8/02-8/08)		Numbers	39	137	94	510	3,584	148	0	4,691	7,028	9	52	4,677	779	0	9	289	67	0	22,114
33	429	Percent	0.0	0.2	0.2	1.2	14.1	0.6	0.0	20.9	34.2	0.2	0.2	19.7	6.5	0.0	0.2	1.4	0.5	0.0	100
(8/09-8/15)		Numbers	5	71	66	387	4,647	184	0	6,890	11,284	57	61	6,486	2,147	0	57	471	174	0	32,987
34	42	Percent	0.0	0.0	0.1	0.4	11.7	0.2	0.0	10.9	42.3	0.1	0.1	18.5	15.0	0.0	0.1	0.5	0.1	0.0	100
(8/16-8/22)		Numbers	0	23	29	163	5,430	109	0	5,084	19,703	50	29	8,631	7,001	7	29	215	68	0	46,572
35	390	Percent	0.0	0.0	0.2	1.0	25.2	1.4	0.0	8.8	45.1	1.0	0.2	8.0	7.3	0.2	0.2	1.2	0.0	0.0	100
(8/23-8/29)		Numbers	0	0	33	131	3,471	197	0	1,218	6,220	131	33	1,108	1,009	33	33	164	0	0	13,780
Total	1,835	Percent	0.0	0.3	0.2	1.6	14.0	0.4	0.0	16.7	32.6	0.1	0.1	24.7	7.2	0.0	0.1	1.7	0.2	0.0	100.0
		Numbers	58	493	397	2,920	24,853	786	32	29,610	57,937	247	262	43,787	12,700	40	128	2,941	323	66	177,579

[a] Totals may not add exactly due to rounding.

Appendix A.6. Estimated age composition of Uyak Bay (254-10 - 254-40) sockeye salmon catch by week, post 11 July 1997.

Week	Sample Size		Ages														Total[a]
			0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	2.4	3.3	4.2	4.3	
29	487	Percent	0.0	0.0	1.4	5.0	0.2	15.8	30.8	0.0	0.0	38.8	2.4	0.0	5.6	0.0	0.0	100
(7/12-7/18)		Numbers	5	0	239	870	32	2,743	5,350	0	0	6,732	417	4	967	0	1	17,360
30	461	Percent	0.4	0.0	5.7	6.6	0.0	23.9	22.1	0.0	0.0	33.0	1.7	0.2	6.3	0.0	0.0	100
(7/19-7/25)		Numbers	188	0	2,523	2,938	13	10,557	9,775	0	11	14,625	750	94	2,777	11	0	44,261
31	449	Percent	0.4	0.0	6.9	8.2	0.2	20.3	18.6	0.0	0.2	32.7	4.8	0.2	7.3	0.2	0.0	100
(7/26-8/01)		Numbers	128	0	1,999	2,371	49	5,857	5,345	0	49	9,417	1,384	49	2,109	49	0	28,807
32	459	Percent	0.4	0.0	6.3	9.1	0.0	23.8	20.7	0.0	0.1	28.7	5.3	0.0	5.5	0.1	0.0	100
(8/02-8/08)		Numbers	186	0	2,785	4,004	15	10,460	9,125	14	22	12,632	2,321	15	2,416	22	0	44,018
33	452	Percent	0.2	0.0	4.9	12.6	0.1	16.1	30.3	0.3	0.2	23.6	6.7	0.0	4.8	0.2	0.0	100
(8/09-8/15)		Numbers	150	11	2,970	7,656	78	9,753	18,388	198	99	14,341	4,076	0	2,926	99	0	60,744
34	393	Percent	0.3	0.4	3.8	14.7	2.4	11.6	43.9	0.2	0.0	14.1	7.0	0.0	1.6	0.0	0.0	100
(8/16-8/22)		Numbers	211	286	2,543	9,870	1,589	7,792	29,449	134	5	9,442	4,667	0	1,091	5	0	67,084
35	418	Percent	1.1	0.9	4.2	12.9	4.1	5.0	53.0	0.7	0.0	9.5	7.1	0.0	1.4	0.0	0.0	100
(8/23-8/29)		Numbers	366	301	1,429	4,367	1,373	1,693	17,893	220	0	3,197	2,412	0	487	0	0	33,738
Total	3,119	Percent	0.4	0.2	4.9	10.8	1.1	16.5	32.2	0.2	0.1	23.8	5.4	0.1	4.3	0.1	0.0	100.0
		Numbers	1,234	598	14,488	32,076	3,149	48,855	95,325	566	186	70,386	16,027	162	12,773	186	1	296,012

[a] Totals may not add exactly due to rounding.

Appendix A.7. Estimated age composition of Spiridon Bay Terminal Harvest Area (254-50) sockeye salmon catch, by

Week	Sample Size		Ages 1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	Total[a]
31	158	Percent	44.3	33.5	0.6	1.9	19.6	0.0	0.0	0.0	100
(7/26-8/01)		Numbers	996	754	14	43	441	0	0	0	2,247
32	228	Percent	9.3	53.6	2.1	5.4	28.6	0.3	0.3	0.3	100
(8/02-8/08)		Numbers	81	471	18	48	252	3	3	3	879
33	164	Percent	7.9	65.9	2.8	3.7	19.4	0.1	0.1	0.1	100
(8/09-8/15)		Numbers	347	2,902	125	162	855	4	4	4	4,404
34	563	Percent	2.2	69.8	4.0	3.2	20.6	0.0	0.1	0.0	100
(8/16-8/22)		Numbers	281	9,126	529	419	2,695	0	17	0	13,067
35	262	Percent	0.6	60.4	4.1	3.1	31.7	0.0	0.0	0.0	100
(8/23-8/29)		Numbers	70	6,608	451	338	3,471	0	1	0	10,939
36	162	Percent	0.1	61.8	1.9	2.1	34.1	0.0	0.0	0.0	100
(8/30-9/05)		Numbers	20	9,813	304	328	5,417	0	0	0	15,882
37	166	Percent	0.0	62.6	2.2	1.3	33.9	0.0	0.0	0.0	100
(9/06-9/12)		Numbers	0	8,696	307	182	4,706	0	0	0	13,891
38	0	Percent	0.0	62.7	2.4	1.2	33.7	0.0	0.0	0.0	100
(9/13-9/19)		Numbers	0	1,989	76	38	1,071	0	0	0	3,174
Total	1,703	Percent	2.8	62.6	2.8	2.4	29.3	0.0	0.0	0.0	100
		Numbers	1,795	40,359	1,824	1,558	18,908	7	25	7	64,483

[a] Totals may not add exactly due to rounding.

Appendix A.8. Length composition of Spiridon Bay Terminal Harvest Area (254-50) sockeye salmon catch, weeks 31 through 37, 1997.

	Ages								
	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	Total
Females									
Mean Length	418	523	567	432	541	570			529
SE	-	1	5	30	2	42			1
Range	418-418	437-587	526-612	403-462	418-597	529-612			403-612
Sample Size	1	640	28	2	229	2	0	0	902
Males									
Mean Length	369	533	590	427	559		500	546	513
SE	2	2	8	4	2		-	-	3
Range	338-440	420-611	512-641	358-479	448-633		500-500	546-546	338-641
Sample Size	111	401	26	47	207	0	1	1	794
All Fish									
Mean Length	370	527	578	427	550	570	500	546	521
SE	2	1	5	4	1	42	-	-	1
Range	338-440	420-611	512-641	358-479	418-633	529-612	500-500	546-546	338-641
Sample Size	112	1,041	54	49	436	2	1	1	1,696

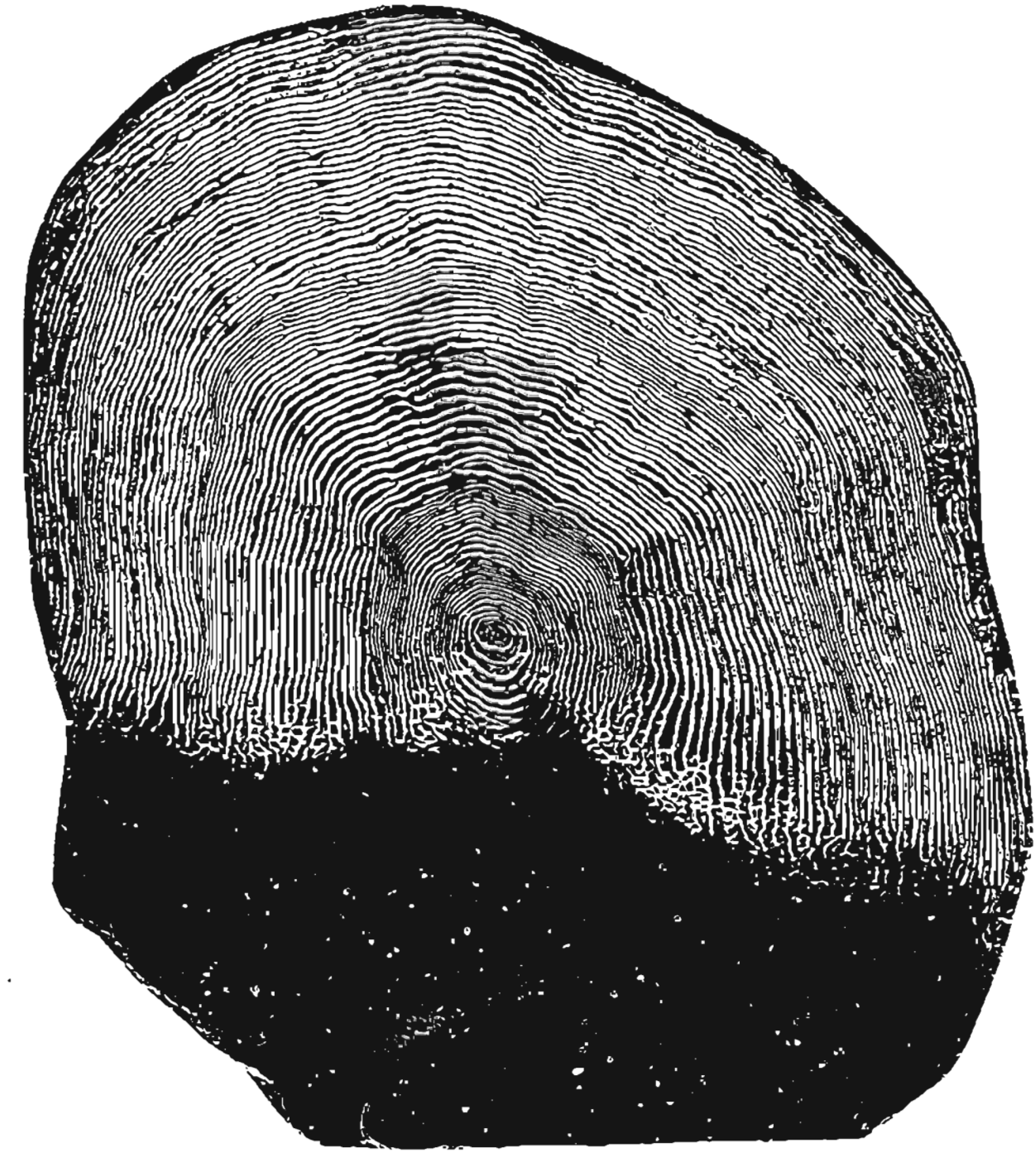
Appendix B.1. Descriptive statistics for age- 2.2 scale variables from Spiridon, Karluk late run, Ayakulik and Upper Station late run stocks, 1997.

Freshwater Variable[a]		*Stock*							
		Spiridon n = 200		Karluk late run n = 91		Ayakulik n = 168		Upper Station late run n = 200	
number	name	mean	SD	mean	SD	mean	SD	mean	SD
1	circuli counts	26.5	2.38	19.0	2.28	17.9	1.82	22.4	1.85
2	1st I.D.	33.1	5.52	35.3	7.36	31.9	5.60	36.1	5.32
3	2nd I.D.	49.4	6.11	51.8	9.56	46.2	6.83	52.1	6.31
4	3rd I.D.	64.9	6.69	67.3	12.20	58.9	8.05	67.6	7.58
5	4th I.D.	79.0	7.19	82.0	14.17	69.7	8.78	81.6	8.78
6	5th I.D.	92.0	7.83	94.8	16.07	79.8	9.70	94.6	9.78
7	6th I.D.	104.0	8.25	107.5	17.90	89.6	10.34	107.0	10.46
8	7th I.D.	115.0	8.82	119.3	18.93	99.1	11.02	118.8	11.41
9	8th I.D.	125.9	9.68	130.6	19.68	109.7	11.70	130.4	12.30
10	9th I.D.	136.3	10.25	141.4	20.16	121.3	12.52	141.9	12.68
11	10th I.D.	146.7	10.94	152.2	20.82	133.9	13.33	152.8	13.03
12	11th I.D.	157.9	11.72	164.1	21.43	147.0	13.78	163.8	13.09
13	12th I.D.	169.8	12.61	176.7	21.61	159.6	14.10	175.6	13.42
14	13th I.D.	183.0	14.08	190.0	22.22	172.1	14.70	188.3	13.79

[a] Incremental distances (ID) for variables 2-13 were measured from the focus to the outside edge of each circulus in sample units which can be converted to metric units.

Appendix B.2. Summary of scale measurement data by system, 1997.

		System			
		Spiridon	Karluk late run	Ayakulik	Upper Station late run
Sample Time Strata		7/29 - 9/10	7/21 - 9/13	7/21 - 8/10	7/20 - 9/2
n		200	89	168	200
Total Number of freshwater circuli					
	max	32	24	23	27
	min	19	13	13	17
	avg.	26.5	19.0	17.9	22.4
	var	5.6759	5.2025	3.3165	3.4102
	SD	2.3824	2.2809	1.8211	1.8467
	cv	0.0901	0.1198	0.1019	0.0826
Total age 2.2 freshwater growth					
	max	404	353	327	370
	min	274	182	162	238
	avg.	364.03	262.17	226.03	303.22
	var	761.9086	925.4599	698.1967	697.5666
	SD	27.6027	30.4214	26.4234	26.4115
	cv	0.0758	0.1160	0.1169	0.0871



Appendix B.3. Scale pattern of age 2.2 sockeye salmon collected from the Spiridon Lake Terminal Harvest Area (SLTHA) harvest, 3 August 1997.

Appendix B.4. Scale pattern of age 2.2 sockeye salmon collected at the Karluk weir, 22 August 1997.

Appendix B.5. Scale pattern of age 2.2 sockeye salmon collected at the Ayakulik weir, 21 July 1997.

Appendix B.6. Scale pattern of age 2.2 sockeye salmon collected at the Upper Station weir, 20 July 1997.