ABUNDANCE, AGE, SEX, AND SIZE STATISTICS FOR PACIFIC HERRING IN LOWER COOK INLET, 2000-2003

By

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ABSTRACT

This report summarizes and archives abundance, age, sex, and size composition data collected from Pacific herring (*Clupea pallasi)* in the Kamishak Bay and Southern districts of Lower Cook Inlet during 2000-2003. In the Kamishak Bay District, aerial surveyors typically flew 13-16 surveys between 17 April-9 June to estimate the abundance and distribution of herring schools and milted shoreline. Inclement weather sometimes caused gaps in survey coverage and created turbid water conditions that compromised surveyors' ability to see fish. Except in 2000, when only one vessel survey occurred, commercial seine vessels were chartered to collect early- and late-season herring samples to characterize the age, sex, and size composition of Kamishak Bay herring and index their abundance. Despite a complete closure of the commercial fishery, aerial surveyors documented a declining trend in biomass during 2000-2003. Surveyors observed 0.3-2.4 km (0.2-1.5 miles) of milted shoreline during 2000-2003, further evidence that Kamishak Bay herring are in low abundance. Over 15,000 Kamishak Bay herring were sampled for age, sex, and size during 2000-2003. Although recruitment was not sufficient to bring the Kamishak herring abundance back above the threshold for a commercial fishery, the 1996 and 1999-year classes stood out as being relatively strong. The age-4 cohort comprised over 46% of the herring sampled in 2003. Herring weights-at-age, which had been on a diminishing trend, appeared to stabilize by 2002 and increase slightly in 2003.

Aerial surveyors typically flew four to eight surveys between 24 April-7 June to estimate the abundance and distribution of herring schools in the Southern District. Inclement weather did not typically affect survey conditions in the Southern District. Commercial seine vessels were chartered to collect herring samples in Kachemak Bay in 2000, 2001, and 2003. Similar to Kamishak Bay, aerial surveyors documented a generally declining trend of abundance in Kachemak Bay, estimating 6,500 tonnes (7,200 tons) in 2000 and 500 tonnes (600 tons) in 2003. Despite the relatively large biomass observed in 2000, surveyors did not observe any milted shoreline in Kachemak Bay during 2000-2003. However, the 2003 vessel survey documented active spawn on Glacier Spit on 9 May. Over 1,700 Kachemak Bay herring were sampled for age, sex, and size during 2000-2003. Similar to Kamishak Bay results, the 1999 cohort dominated the Kachemak Bay samples, with age-4 fish comprising over 60% of the herring sampled in 2003.

KEY WORDS: Abundance, age, *Clupea pallasi*, harvest, Kamishak Bay District, length, Lower Cook Inlet, Pacific herring, run biomass, sex, Southern District, weight

INTRODUCTION

This report presents abundance, age, sex and size data from herring samples collected during the 2000-2003 spawning migrations into the Kamishak Bay and Southern Districts of the Lower Cook Inlet management area, Alaska (Figures 1 and 2). Herring that spawn in Kamishak Bay purportedly migrate into Shelikof Strait, part of the adjacent Kodiak Management Area (KMA); during the winter (Johnson et al. unpublished manuscript). A management plan for Kamishak Bay herring stocks was adopted by the Alaska Board of Fisheries (BOF) in 1992 limiting the spring sac roe fishery in Kamishak Bay to 18% and the fall food/bait fishery in Shelikof Strait to 2% of the preseason forecast of spawning biomass. A revised Kamishak Bay District Herring Management Plan (KBDHMP) was approved by the BOF in 2001 reducing the maximum harvest rate during the spring sac roe fishery in Kamishak Bay to 13.5%, and the fall food/bait fishery in Shelikof Strait to 1.5%, of the preseason forecasted spawning biomass. The 2001 changes to the KBDHMP also reduced the minimum spawning biomass threshold from 8,000 to 6,000 tons.

The commercial purse seine fishery in Kamishak Bay for herring sac roe began in 1973. Entry into this fishery was limited in 1978, when 75 permits were issued (Schroeder 1989). This fishery was closed between 1980 and 1985, and again from 1999 to present, because of low herring population abundance. The KMA food/bait herring fishery began in 1912 and rapidly expanded during the early-1920's as a late summer and fall fishery for fishmeal as well as some salted food and bait products (Gretsch 2003). Presently, the Shelikof Strait food/bait fishery is primarily a fall and winter fishery producing frozen bait for local longline and crab vessels (Gretsch 2003). Commercial fishing for herring in the Southern District began in 1914. Gillnets were used until purse seines were introduced in 1923. This fishery supported eight salteries during its peak, between 1924 and 1926, before the herring population collapsed. The population appeared to recover by the late 1960's and the Southern District was reopened in 1969 for a commercial sac roe herring fishery. Unfortunately, the herring population declined to very low abundance levels again in 1980 and, since that time, the Southern District has been reopened for a sac roe fishery only during 1989.

The Alaska Department of Fish and Game (ADF&G) began documenting Lower Cook Inlet herring catches in 1961. Catch sampling for age, weight, length, and sex, (AWL) data did not begin until 1971. In-season assessment of the spawning population began in 1978 with a program of aerial surveys to estimate biomass and test fishing to estimate age, sex and size composition (Appendices A-E). Annual summaries of catch and run biomass estimates are published in Lower Cook Inlet Annual Management Reports (e.g., Hammarstrom and Dickson 2003). The 1971-1987 AWL data was summarized by Schroeder (1989). Sampling data after 1987 have been annually reported by Yuen et al. (1989, 1990, 1991, 1994a), and Yuen and Bucher (1994a,b). Aerial survey and AWL data have been incorporated into age-structured-analysis (ASA) models to generate preseason forecasts of spawning biomass since 1994 (Yuen et al. 1994b, Bechtol and Brannian 1996, Otis and Bechtol 1997, Otis 2000).

During 2000, the Kamishak herring spawning biomass fell below the threshold for a commercial

fishery. Since then, there have been no commercial or cost recovery harvests in the District. Consequently, the department contracts out a commercial seine vessel and crew to conduct early- and late-season surveys. These surveys provide the department with the means to collect age, sex, and size information to monitor stock status and generate forecasts. Because this report presents data from four field seasons, sections of the results will be stratified by year.

METHODS

Biomass Estimates

Run or spawning biomass refers to the herring population estimated to be on the spawning grounds between mid-April and mid-June. These herring are considered recruited into the spawning population and available for sac roe harvest. The fishing fleet typically achieves catch limits by early-May. Escapement biomass refers to the portion of the population that was estimated to have spawned. This estimate is obtained by subtracting the harvest from the run biomass. Harvest estimates are obtained directly from harvest receipts often referred to as fish tickets, which document each sale made by a permitted fisher.

Aerial surveys are flown in a single engine fixed-wing aircraft (Cessna-185[2], Cessna 305 Birddog) at an altitude of about 457 m (1,500 ft). Although surveys may be flown at different tide stages, the best water clarity and visibility of herring schools usually occurs during the three or four-hour period following low slack tide. Aerial surveyors rated on a scale of 1 to 5 the survey conditions encountered during each flight based on the following criteria (Otis and Bechtol 1999): 1=excellent- calm, no glare, very easy to spot schools, 2=good- light ripple, uneven lighting, easy to spot schools, 3=fair- light chop, some glare or shadows, relatively easy to spot schools, 4=poor- rough seas, strong glare, difficult to spot schools, and 5=unsatisfactory.

During each flight, surveyors recorded surface area and location of each herring school, extent and location of milt, and survey conditions on standard index maps (Otis and Bechtol 1999). Herring school surface areas are transformed into biomass estimates using the following conversion factors: 1.38 tonnes/7 m^2 (1.52 tons/538 ft^2) for water depths < 4.9 m (16 ft); 2.33 tonnes/7 m^2 (2.56 tons/538 ft^2) for depths between 4.9 m and 7.9 m (16 and 26 ft); and 2.57 tonnes/7 m^2 (2.83 tons/538 ft^2) for depths > 7.9 m (26 ft). These conversion factors have been obtained by capturing individual schools with purse seines after surface area estimates were made by aerial surveyors in Bristol Bay (Lebida and Whitmore 1985).

Generally, daily biomass estimates were combined during the season to produce an annual run biomass estimate. If more than one survey was flown on the same day, only data from the survey having the greatest biomass estimate was included as part of the run biomass estimate. Daily

[2] Use of product names does not constitute endorsement by ADF&G, but serves to document methods and equipment used.

biomass estimates were added together to calculate run biomass only if herring schools appeared to be spawning and leaving the survey area each day. If herring schools appeared to be remaining in the survey area for several days, only peak surveys that were considered to represent "new" biomass were added together to calculate run biomass.

Water turbidity and inclement weather frequently obscured visibility and created gaps in survey coverage making it difficult for surveyors in the Kamishak Bay District to obtain the comprehensive series of daily biomass estimates necessary to estimate run biomasses. Therefore, we also estimated run biomass post-season by using the ASA model to hindcast the run based on the most current estimates of age composition, survival, and initial cohort abundance. Survey conditions were generally good during 2000-2003 and we were able to estimate run biomass based on aerial surveys during each of these years.

Age, Weight, Length, and Sex Composition

Source of Samples

Kamishak Bay age composition data are typically placed into two strata: one for samples obtained solely from commercial fishery and cost recovery harvests, used to represent the catch age composition, and the other from all harvest and testfish samples combined, used to represent the total run age composition. Commercial catch samples are generally dip-netted from the pursed seines of fishing vessels waiting for a tender to pump herring from their nets immediately after the fishery closes. Since no commercial or cost recovery harvests occurred during 2000-2003, the data reported here represent the total run age composition only. Test fishing was done from commercial purse seine vessels that were chartered by ADF&G to collect samples during specified times in specified areas. Due to budget constraints, late-season (> 7 May) testfish samples were not collected in 2000.

All herring samples were packaged in plastic bags (approx. 15 kg) and flown to the Homer ADF&G office laboratory for processing. If the total number of herring obtained was greater than the number required for a sampling stratum, each 15-kg bag was subsampled by dumping the same proportion from all of the 15-kg bags into a common sink and processing every herring in the sink. This procedure was repeated until the required number of herring had been sampled. All samples were quickly processed upon their arrival in Homer to provide timely age composition information for use in inseason management decisions.

Sample Sizes

The number of herring, n, for each sample was chosen such that all age i proportions, p, within a multinomial distribution of k age groups were simultaneously estimated within a specified distance, d, of their true population age proportions, π_i, with probability α of making a type I error:

$$P\{\bigcap_{i=1}^{k} | p_i - \pi_i | \leq d\} \geq 1 - \alpha \ , \qquad \textbf{(1)}$$

where d and α were both chosen to be 0.05, and P was the probability of the hypothesis. Thompson (1987) calculated a maximum sample size of 510 for a worst-case scenario when three age classes were present in equal proportions and $d = \alpha = 0.05$. Smaller sample sizes would be required to achieve the same level of precision in cases where $k \neq 3$ or age class proportions were unequal. We attempted to collect 663 herring for each sample: 510 herring in case the worst-case scenario occurred plus a 30% allowance for herring, which could not be aged. However, biological data was not obtained from all 663 herring in a sample. Instead, a minimum number of herring was chosen from each sample, equal to the value of n that satisfied the following:

$$\sum_{i=3}^{16} 2\left[1 - \phi\left(\frac{d\sqrt{n}}{\sqrt{(p_i(1 - p_i))}} \right) \right] < 0.05 \ , \qquad \textbf{(2)}$$

where each p_i was the *a priori* age proportion for age-*i* herring, based on the age composition of about 300 herring from the sample, and Φ was the area under the standard normal distribution curve. After n herring, based on results of equation 2, had been aged, equation 3 was recalculated, using the p_i values obtained, to determine whether additional herring from the sample needed to be processed to meet chosen levels of d and α.

Individual samples from the same or adjacent days for which age compositions which were not significantly different (P>0.05), based on results of Chi-square tests of independence (Snedecor and Cochran 1967), were combined.

Sex, Length, and Age Determination

Either extruding eggs or sperm from ripe individuals or inspection of gonads of green or spent individuals determined sex of each herring sampled. The standard length (SL) of individual herring was determined by measuring to the nearest mm the distance from the tip of the snout to the end of the hypural plate. Individual herring were also weighed to the nearest g. Standard errors for lengths and weights of each age class were estimated using procedures for stratified random sampling described by Snedecor and Cochran (1967):

$$SE = \sqrt{\Sigma(\frac{C_h}{C})^2(\frac{s_h^2}{n_h})} \ , \qquad \textbf{(3)}$$

where C = herring catch, h = stratum or sample, s_h^2 = sample variance, and n_h = sample size.

One scale was removed from each herring for ageing. We tried to take scales from the left side of each herring in the area above the pectoral fin and three or four scales posterior of the operculum. If no scales, or only regenerated scales, were present in this area, a scale was taken from the same area on the right side of the herring. If no scales, or only regenerated scales, were present in this area, the herring was not included in the sample. Each scale removed was cleaned, dipped in a 10% mucilage solution and positioned sculptured side up on a labeled glass slides. Each glass slide held a maximum of 20 scales. Scales on slides were viewed at 29X magnification using a microfiche reader. The number of annuli per scale was counted to determine age. After use, all scales were archived in labeled slide storage boxes.

RESULTS

2000

Kamishak Bay District

Thirteen aerial surveys were flown between 17 April and 9 June 2000 (Table 1). Similar to last year, but unlike the previous six years, inclement weather did not significantly interrupt aerial surveys in 2000. A single, 13-day gap occurred between 12 May and 25 May (Table 1). Survey conditions were generally considered good to fair in 2000. For the third year in a row, the average survey condition rating was 2.4. Herring were first observed on 26 April in the Chenik/Nordyke index area and were continually observed in high abundance in Southern areas of the District throughout the spawning season. Beginning on 5 May, when 1,513 tonnes (1,668 tons) were documented in Iniskin Bay, herring were also consistently observed in abundance in northern areas of the District.

Aerial surveyors saw a cumulative total of 9,527 tonnes (10,502 tons) of herring in 2000 (Table 1), slightly less than 1999's observations, but considerably more than the preseason forecast of 5,742 tonnes (6,330 tons, Otis 1999). Summing the four peak daily observations that stood out as "new" biomass in 2000 resulted in an estimate of 7,364 tonnes (8,117 tons). The single peak daily biomass estimate of 2,343 tonnes (2,583 tons) was observed in the Kamishak, Nordyke, and Douglas index areas on 5 June. A similarly large biomass of 2,104 tonnes (2,319 tons) was observed on 25 May in the Kamishak, Iniskin, and Oil Bay index areas.

Despite observing a large biomass in 2000, only three observations of spawn were documented, resulting in just 1.0 km (0.6 miles) of milted shoreline (Table 1). The spawning observations were made on 28 April and 5 May when the average daily surface water temperatures were 2.4 C and 4.5 C, respectively (Appendix F). The 2000 aerial estimates of the shoreline extent of milt were the second lowest on record. This index of spawner abundance has never been considered robust given the ephemeral nature of spawn evidence along the storm-ridden coastline of Kamishak Bay and the inconsistent schedule of aerial surveys. However, the low incidence of

spawning observations in 2000 was surprising given the fairly comprehensive schedule of aerial surveys and large observed biomass. Because survey coverage was comprehensive in 2000, we used the sum of the inseason peak daily estimates of run biomass (7,364 tonnes), as opposed to the preseason forecast or ASA hindcast, to represent the 2000 run biomass.

Because the Kamishak herring spawning biomass had declined below the threshold for a commercial fishery, the fishery was closed and no commercial or cost recovery samples were collected in 2000. However, over 2,000 herring were collected during the early-season testfish survey, resulting in 1,976 readable scales (Table 2). Age, sex, and size composition data from the seven testfish samples collected in 2000 are summarized in Tables 3 to 9. These samples were weighted by the biomass (i.e. school size) they represented before being pooled to estimate total run age composition and weight-at-age. Age-4 and age-7 herring from the 1996 and 1993-year classes comprised 25% and 23% of the 2000 test fishery samples, respectively. The mean weight of all herring sampled in 2000 was 169 g (SD=61 g, Figure 3).

Southern District

Eight aerial surveys were flown in the Southern District between 2 May and 6 June 2000 (Table 2). An accumulative total of 6,519 tonnes (7,186 tons) of herring was observed. Although surveys were evenly spaced 4-6 days apart, it's likely that same-area observations on consecutive surveys constituted repeated sighting of the same schools since no spawning was observed. Thus, we report the single peak survey count of 1,556 tonnes (1,723 tons) as a conservative estimate of the 2000 Southern District herring biomass. A chartered seine vessel made one set in 2000 to sample Southern District herring for age, sex, and size composition, collecting 466 herring off Glacier Spit on 6 May (Table 11). Age-6 and age-7 herring dominated this sample, comprising 32.3% and 34.8% of the catch, respectively (Table 12). Commercial fishing was not allowed in the Southern District in 2000.

2001

Kamishak Bay District

Fifteen aerial surveys were flown in the Kamishak Bay District between 17 April and 8 June 2001 (Table 13). Inclement weather in the Kamishak Bay District did not significantly affect aerial surveys. Survey flights were flown every 2-4 days with one 8 day gap occurring between 30 April and 8 May (Table 3). Aerial survey conditions were generally considered to be fair with an average survey condition rating of 2.8 (range 2-4), slightly worse than in 2000. Herring were first observed on 23 April in the Cottonwood/Illiamna and Bruin/Amakdedori index areas.

The cumulative estimate for all index areas was 3,111 tonnes (3,430 tons); approximately 33% of the 2000 end of season biomass estimate (Table 13). This cumulative estimate was also

considerably lower than the preseason forecast of 10,298 tonnes (11,352 tons, Otis 2000). The peak biomass estimate occurred on 27 April and was 1,169 tonnes (1,289 tons), nearly 2.5 times larger than the next highest estimate of 468 tonnes (516 tons) that occurred on 8 May. The peak count was observed in the Cottonwood/Illiamna, Ursus Cove, Fortification Bluff, Bruin/Amakdedori, and Chenik/Nordyke index areas.

Only five observations of spawn were documented in 2001 totaling 2.1 kilometers (1.3 miles) of milted shoreline. These spawning events occurred on 23 April, 30 April and 11 May (Table 13) when the average daily surface water temperature was 4.2 C, 5.5 C, and 5.2 C, respectively, at the nearest thermograph station (Nordyke Island) (Appendix F).

There were no commercial fishery or cost recovery harvests in 2001. However, the department contracted an independent fishing vessel and crew to conduct two separate surveys to obtain biological samples to characterize the age, sex and size composition of the spawning biomass. The early-season survey ran from 24 April until 2 May and the late-season survey ran from 14 May to 22 May. Samples were collected from six schools during the early-season survey resulting in 2,736 herring being aged (Table 2). The late-season test fishery produced three samples composing a total of 1,376 herring. The AWL data collected from these samples are summarized in Tables 14 through 22. These samples were weighted by the biomass (i.e. school size) they represented before being pooled to estimate total run age composition and weight-at-age. Age-5 and age-4 herring from the 1996 and 1997-year classes comprised 39% and 29% of the 2001 test fishery samples, respectively. The mean weight of herring sampled during the early season in 2001 was 165 g (SD=45 g), while late-season spawners averaged 131 g (SD=39 g, Figure 4).

Southern District

Seven aerial surveys were flown in the Southern District between 24 April and 23 May. Aerial surveyors observed 1,249 tonnes (1,377 tons) of herring and zero spawning events in 2001 (Table 23). Aerial survey conditions ranged between 1 and 3 and the average survey condition (1.7) was considered very good. The first observation of herring and the peak count in 2001 occurred on 30 April in the Mud Bay and Tutka Bay Index Areas. The single peak survey occurred on 30 April when 718 tonnes of herring were observed in the Tutka Bay and Mud Bay Index Areas.

On 10 May, a chartered fishing vessel collected over 900 herring samples from Glacier Spit and Rusty's Lagoon to characterize each school's age, sex, and size composition (Table 11). The Glacier Spit sample (n=467) was composed of 39.2% males and 60.8% females, the overall mean weight was 151 g and the mean length was 222 mm (Table 24). The Rusty's Lagoon sample (n=437) was comprised of 46.7% male herring, and 53.3% female herring that had an overall mean weight of 127 g and a mean length of 213 mm (Table 25). Commercial fishing was not allowed in the Southern District in 2001.

2002

Kamishak Bay District

Sixteen aerial surveys were flown between 19 April and 7 June 2002 (Table 26). Similar to 2001, flights were usually 2 to 5 days apart and survey conditions were generally fair resulting in an overall rating of 2.8. The first herring observation was not made until 26 April when 2 tonnes (1 ton) were reported in the Chinitna/Dry Bay Index Area. The cumulative estimate of herring for all index areas in 2002 was 3,400 tonnes (3,748 tons). This estimate was slightly more than 2001's estimate and considerably lower than the preseason forecast of 8,183 tonnes (9,020.2 tons, Otis 2001). Summing the four peak daily biomass observations in 2002 resulted in an estimate of 1,495 tonnes (1,647 tons). Only three spawning events were documented in the Kamishak Bay District resulting in 0.3 km (0.2 miles) of milted shoreline, the lowest on record. Temperature data from 2002 were compromised because one thermograph was lost and the other was set improperly resulting in bogus data (Appendix F).

There were no commercial fishery or cost recovery harvests in 2002. However, 5,725 herring were collected during vessel surveys to characterize age, sex, size, and gonad maturity of the Kamishak Bay spawning biomass (Table 2). Seven samples (3,320 fish) were collected during the early-season survey and six samples (2,405 fish) were collected during the late-season surveys. All AWL data collected from these samples are summarized in Tables 27 through 39. These samples were weighted by the biomass (i.e. school size) they represented before being pooled to estimate total run age composition and weight-at-age. Age-3 and age-6 herring from the 1999 and 1996-year classes comprised 42% and 21% of the 2002 test fishery samples, respectively. The mean weight of herring sampled during the early season in 2002 was 177 g (SD=56 g), while late-season spawners averaged 142 g (SD=64 g, Figure 5).

Southern District

Eight aerial surveys were flown in the Southern District between 2 May and 7 June 2002. Aerial surveyors observed 2,696 tonnes (2,971 tons) of herring and zero spawning events in 2002 (Table 6). Aerial surveys conditions ranged between 2 and 3 and the average survey condition (2.1) was considered good (Table 40). The first observation of herring occurred on 7 May with a sighting of 27 tonnes (30 tons) in the Mallard and Glacier Spit Index Areas. The peak count of 1,117 tonnes (1,231 tons) occurred on 21 May and included schools observed in the Mud Bay, Bear Cove, Mallard Bay, Glacier Spit, Peterson/China Poot Bay, and Tutka Bay Index Areas. No commercial, cost recovery or testfish harvests occurred in the Southern District in 2002. Consequently, no age, sex, size or gonad maturity information is available.

2003

Kamishak Bay District

Thirteen aerial surveys were flown in the Kamishak Bay District between 17 April and 2 June 2003 (Table 41). Similar to 2002, the average survey condition was 2.8, and ranged from 1 to 4. Surveys were generally flown every 2-4 days; however, inclement weather caused two six-day gaps in survey coverage (6-12 May and 22-28 May). Herring were first observed on 25 April, when 27 tonnes (30 tons) were documented in the Bruin/Amakdedori Index Area.

The cumulative biomass estimate for all index areas was 1,758 tonnes (1,938 tons). This estimate was considerably lower than the preseason forecast of 4,328 tonnes (4,771 tons). The early-season biomass estimate (829 tonnes; 914 tons) composed 47% of the entire season's spawning biomass, while the late-season estimate of 930 tonnes (1,025 tons) made up the balance (53%). The five peak counts amounted to 1,535 tonnes (1,692 tons).

Aerial observers documented three independent spawning events totaling 2.4 km (1.5 mi). These spawning events occurred on 28 April, 12 May, and 22 May 2003. The temperature data collected on 22 May was 9.0 C. There were no temperature data collected the other two days spawning occurred.

As in the previous 3 years, no commercial or cost recovery harvests occurred in 2003. However, 3,307 herring were collected during the early- (26 April-3 May) and late-season (13-20 May) vessel surveys (Table 9). All AWL data collected from these samples are summarized in Tables 42 through 49. Age-4 herring dominated both the early- (35%) and late-season (54%) samples. The mean weight of Kamishak Bay herring sampled during the early season in 2003 was 174 g (SD=49 g), while late-season spawners averaged 127 g (SD=40 g, Figure 6).

Southern District

Four aerial surveys were flown in the Southern District between 6 and 29 May 2003 (Table 50). An accumulative total of 506 tonnes (558 tons) of herring was observed. Surveys were evenly spaced 7-9 days apart, and survey conditions were generally considered good (mean=1.8). The single peak survey count was 166 tonnes on 29 May. A chartered seine vessel made one set in 2003 to sample Southern District herring for age, sex, and size composition, collecting 468 herring off Glacier Spit on 9 May. The vessel skipper and ADF&G observer reported seeing large schools of herring and spawning activity along Glacier Spit on 9 May, suggesting the aerial survey estimates of biomass and spawning were conservative in 2003. Age-4 herring dominated the 9-May sample, composing 77.6% of the catch (Table 51). Commercial fishing was not allowed in the Southern District in 2003.

DISCUSSION

In order to successfully track the status of Kamishak Bay herring, the Department relies upon aerial surveys to acquire a spawner abundance index and vessel surveys to estimate the age, sex, and size composition of spawning fish. These data become the principal inputs to the age structured assessment (ASA) model the Department uses to forecast the following years abundance and determine if surplus fish are available for commercial harvest (e.g., Otis 2000).

Aerial survey coverage and conditions were generally considered fair-to-good during 2000-2003. Consequently, the observed decline in abundance of herring, despite a complete closure of the commercial fishery, suggests Kamishak Bay has not experienced a strong recruitment event for over a decade. This contrasts sharply with nearby Gulf of Alaska herring stocks (e.g., Prince William Sound and west side Kodiak Island), which experienced recent population growth due primarily to the strength of the 1999-year class that returned in great abundance as age-4 fish in 2003 (personal communications with Steve Moffitt, ADF&G-Cordova and Kevin Brennan, ADF&G-Kodiak). While this cohort also strongly dominated samples collected in Kamishak Bay in 2003, its absolute abundance was not enough to significantly enhance Kamishak Bay's stock status.

It is worth noting that aerial surveyors documented a substantial increase in the Kamishak Bay herring biomass in 1999 and 2000 (Table 52). Approximately half of the 11,300 tonnes accumulatively observed in 1999 were sighted late in the season while flying salmon surveys. Observers documented over 5,500 tonnes of herring in and around McNeil Cove on 24 June. However, spawning was not observed and the schools were gone within a few days. Before the schools departed, salmon fishermen in the area fulfilled our request to snag a few dozen herring. The fishermen reported that all sampled fish were immature and of the same size, about 140-180 mm, suggesting that they were likely age-2. Consequently, we were expecting to see a large return of age-3 herring in 2000 as first time spawners. Indeed, aerial observers did document a similarly large biomass in 2000 (> 9,500 tonnes), however, we were not able to conduct a late-season charter to verify that age-3 herring made up the bulk of the biomass observed. Age-3 herring composed only 8% of the early-season samples. The biomass level dropped back down in 2001 (3,111 tonnes) and age-4 herring composed just 29% of all the samples collected, suggesting that the large biomasses observed in 1999 and 2000 did not recruit to the Kamishak Bay stock.

As has been the case during most previous years (e.g., Otis et al. 1998), the AWL samples we collected in 2001-2003 revealed distinct differences between early- and late- season spawners. Once again, the age structure of sampled fish shifted from older/larger repeat spawners to younger/smaller recruit-aged fish by mid-May. The mean weight of early-season spawners was considerably higher than late-season spawners, but not just because early-season spawners tended to be older; the mean weight of late-season spawners was lighter for every age class. Other researchers have reported on herring stocks that exhibit discrete spawning waves where larger fish spawn first and smaller fish spawn in subsequent waves (Hay 1985, Lambert 1987, and Ware and Tanasichuk 1989). Lambert (1987) attributed the decline in size over time to

shifts in the age composition towards younger fish. Ware and Tanasichuk (1989) suggested that the instantaneous maturation rate (k) of herring is size dependent and therefore there is a biological basis for large fish spawning first. Rajasilta (1992) also believed that size mattered in determining spawning timing and showed that gonad weight and spawning timing are correlated to fat content, suggesting that spawning timing may be dictated, in part, by feeding conditions prior to spawning.

Kamishak Bay herring have exhibited a somewhat cyclic weight-at-age trend. The lowest overall mean weight recorded, as well as the lowest mean weights-at-age for most age classes, occurred in 1978 (Appendix E). An era of increasing mean weights began slowly around 1979. Mean weights increased more quickly beginning in 1985 until reaching their peak around 1995, after which they fell sharply until 2000 and then began slowly ascending again. Although overall mean weights can be strongly influenced by age composition, a cyclic weight trend is still apparent when this confounding variable is removed and just the mean weights-at-age are considered. This weight-at-age trend appears to be density-independent since the two low mean weight periods coincide with low population size. It's possible that the weight-at-age trend is instead driven by environmental factors such as the quality and quantity of available food. If this is true, it may also help to explain why recruitment has been so poor recently while the weights-at-age have been low. If food is not readily available when herring larvae absorb their yolk sac, they may experience increased mortality (Cushing 1990).

Rajasilta's (1992) work linking gonad weight and spawning timing to fat content may help explain an observed trend towards later onset of spawning in Kamishak Bay in recent years. During the early-mid 1990's the first wave of herring spawning frequently occurred prior to April 25, even when water temperatures were around 3.0 C. In recent years, spawning often hasn't begun until 5-10 days later, even when the water temperature was above 5.0 C. It will be interesting to see if the onset of spawning gets earlier in the coming years as weights-at-age continue to get heavier. The fact that the current spawning population is dominated by recruit aged herring could also explain why the onset of spawning is 5-10 days later now than it was in the early-mid 1990's when there was a greater proportion of older fish. Lambert (1987) also suggested that the age structure of the spawning population may influence spawning timing since younger, recruit aged herring spawn later than older, repeat spawners.

Although catch-age analysis models like the ASA model integrate several heterogeneous sources of stock information and have the ability to track the relative strengths of co-occurring year classes against one another, they still rely heavily upon dependable abundance scaling indices to tune their other inputs (Deriso et al. 1985). Aerial survey can be a very efficient and effective means of tracking herring abundance if surveys occur frequently and water clarity is high. Unfortunately, inclement weather in Kamishak Bay frequently compromises both of these criteria. Extended gaps in survey coverage occur during persistent spring storms. These gaps in survey coverage increase the likelihood that observers could miss a major spawning event, especially when the gaps coincide with traditional peaks of spawning. The same storms that preclude survey flights also frequently stir up sediments in Kamishak Bay diminishing water clarity to the extent that observers have a very difficult time spotting herring schools. Examples of these occasions are easily found when comparing aerial survey results with commercial landings from the mid 1990's (Otis et al 1998). During 1992-1996, an average of 1,885 tonnes

(2,078 tons) of herring were harvested in the Kamishak Bay sac-roe fishery that observers had not seen from the air prior to the fishery. Along with survey gaps and high turbidity, herring migration behavior may also contribute to the challenge of spotting herring schools prior to the onset of spawning. Nøttestad et al. (1996) found that Norwegian spring-spawning herring schools immigrating to spawning grounds swam much deeper than spawning, feeding, or emigrating schools.

Given the difficulties facing aerial surveyors in Kamishak Bay, we have considered several other options for acquiring reliable estimates of herring abundance. Compact airborne spectrographic imaging (CASI) equipment has been used successfully in Canada (Borstad et al. 1992, Nakashima and Borstad 1997) and Alaska (Funk et al. 1995) to enhance the resolution and quantify the surface area of forage fish schools observed from the air. Unfortunately, Kamishak Bay's persistent turbid water conditions would likely impede CASI's ability to improve upon our current aerial survey program (personal communication, Gary Borstad, G.A. Borstad Assoc. Ltd., British Columbia). High turbidity would also limit the effectiveness of Light Detecting and Ranging (LIDAR) technology that is being evaluated for use in observing and quantifying schools of forage fish from the air (personal communication, Evelyn Brown, Univ. of Alaska-Fairbanks).

Egg deposition surveys have also been used in Alaska (Funk 1994) and the Pacific Northwest (Schweigert and Stocker 1988, Burton 1991) to calculate estimates of total spawning biomass. Egg-deposition data are generally collected by divers working in intertidal and shallow sub-tidal waters. Because of the high risk and monetary cost associated with conducting dive surveys in Kamishak Bay, the Department investigated the feasibility of doing egg deposition surveys on foot during low tide (Yuen 1993). Yuen's (1993) intertidal surveys covered only a small portion of the total area spawned, however his area-specific spawning biomass estimates still required broad confidence intervals due to the high variability associated with the limited number of transects surveyors were able to sample during each low tide cycle. Given that the timing and distribution of herring spawning is protracted, it would be very labor intensive to obtain enough samples to generate a viable spawner abundance estimate for all of Kamishak Bay using intertidal foot surveys. For this reason, and because foot surveys wouldn't account for sub-tidal spawning, the Department has not pursued this approach any further.

Hydroacoustic surveys, especially those using echo-integration to estimate absolute abundance, are an effective means for monitoring herring stock status in some areas of Alaska. Unfortunately, virtually the entire coastline of Kamishak Bay within 1-2 km of shore is less than 20 m deep. Water depth is frequently less than 10 m deep and reefs are abundant in areas where herring traditionally spawn. These conditions make it very difficult to conduct quantitative hydroacoustic surveys; especially using a towed transducer. The vessel surveys we conduct are primarily intended to sample the spawning population to estimate age, sex, and size composition. However, given the difficulty of seeing fish from the air during turbid water conditions, hydroacoustic observations by chartered vessels are used as another anecdotal index of herring abundance. The abundance indices available to us (e.g. aerial survey biomass estimates, miles-of-spawn estimated by aerial surveyors, and hydroacoustic observations by chartered seine vessels), all indicate that Kamishak Bay herring continue to be in low abundance. It may be several more years before the stock rebounds and a commercial fishery can be considered.

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Table 1. Herring biomass estimates by area and date, Kamishak Bay District, Lower Cook Inlet, 2000. DNS indicates that an area within the district was not surveyed during that flight.

Flight No.	Date	Time	Survey Rating	Spawn Sightings No.	Spawn Sightings Length	Chinitna/ Dry Bays	Oil Bay	Iniskin Bay	Cottonwood/ Iliamna	Ursus Cove	Fortification Bluff	Bruin/ Amakdedori	Chenik/ Nordyke	Kamishak Bay	Douglas Reef	Augustine Island	Silver Beach	Daily Total
									Estimated Biomass by Index Area									
					mi.						Biomass Estimates in Tons							
1	17-Apr	11:10	3	0	0	DNS	0	0	0	0	0	0	0	0	0	DNS	DNS	0
2	24-Apr	10:45	2	0	0	0	0	0	0	0	0	0	0	0	0	DNS	DNS	0
3	26-Apr	16:00	2	0	0	0	0	0	0	0	0	5	44	0	0	DNS	DNS	49
4	28-Apr	9:20	2	1	0.25	0	0	0	0	8	0	37	65	11	0	DNS	DNS	121
5	1-May	9:45	3	0	0	0	0	0	0	219	254	415	172	101	0	DNS	DNS	1,162
6	5-May	10:10	2	2	0.375	0	0	1,668	0	15	28	337	5	0	0	DNS	DNS	2,053
7	8-May	10:30	2	0	0	0	0	301	0	11	23	0	157	71	14	DNS	DNS	577
8	12-May	10:25	3	0	0	8	15	0	0	0	28	0	0	10	2	DNS	DNS	63
9	25-May	9:50	2	0	0	95	290	653	3	90	27	105	267	746	42	DNS	DNS	2,319
10	30-May	9:45	3	0	0	13	0	166	11	0	35	106	408	3	2	DNS	DNS	744
11	2-Jun	10:05	2	0	0	0	56	660	34	43	3	0	5	2	0	DNS	DNS	802
12	5-Jun	10:35	2	0	0	0	0	0	283	15	0	110	754	1,025	396	DNS	DNS	2,583
13	9-Jun	9:25	3	0	0	0	0	12	0	0	18	0	0	0	0	DNS	DNS	30
	Totals		2.4	3	0.6	116	361	3,461	330	401	417	1,115	1,877	1,969	455	DNS	DNS	10,502
					km						Biomass Estimates in Tonnes							
1	17-Apr	11:10	3	0	0	DNS	0	0	0	0	0	0	0	0	0	DNS	DNS	0
2	24-Apr	10:45	2	0	0	0	0	0	0	0	0	0	0	0	0	DNS	DNS	0
3	26-Apr	16:00	2	0	0	0	0	0	0	0	0	4	40	0	0	DNS	DNS	44
4	28-Apr	9:20	2	1	0.4	0	0	0	0	7	0	34	59	10	0	DNS	DNS	109
5	1-May	9:45	3	0	0	0	0	0	0	199	231	377	156	92	0	DNS	DNS	1,054
6	5-May	10:10	2	2	0.6	0	0	1,513	0	14	26	306	4	0	0	DNS	DNS	1,862
7	8-May	10:30	2	0	0	0	0	273	0	10	21	0	143	65	12	DNS	DNS	524
8	12-May	10:25	3	0	0	7	14	0	0	0	26	0	0	9	1	DNS	DNS	57
9	25-May	9:50	2	0	0	87	263	593	3	82	25	95	242	677	38	DNS	DNS	2,104
10	30-May	9:45	3	0	0	12	0	151	10	0	32	97	370	3	1	DNS	DNS	675
11	2-Jun	10:05	2	0	0	0	51	599	31	39	3	0	4	1	0	DNS	DNS	728
12	5-Jun	10:35	2	0	0	0	0	0	256	14	0	100	684	930	359	DNS	DNS	2,343
13	9-Jun	9:25	3	0	0	0	0	11	0	0	17	0	0	0	0	DNS	DNS	28
	Totals		2.4	3	1.0	105	328	3,140	299	364	378	1,012	1,703	1,786	413	DNS	DNS	9,527

Table 2. Number of readable herring scales collected by purse seine sampling, Kamishak Bay District, Lower Cook Inlet, 2000-2003.

Date	Sample ID	Sample Type	Sample Location	Sample Size	P Value	Vessel
			2000			
28-Apr	ET0001	Testfish	Amakdedori Beach	154	0.533	Gore Point
1-May	ET0002	Testfish	Amakdedulia Cove	321	0.891	Gore Point
1-May	ET0003	Testfish	Amakdedulia Cove	359	0.930	Gore Point
2-May	ET0004	Testfish	Fortification Bluff	386	0.938	Gore Point
4-May	ET0005a	Testfish	Iniskin Bay	66	0.139	Gore Point
5-May	ET0005b	Testfish	Iniskin Bay	288	0.858	Gore Point
5-May	ET0006	Testfish	Iniskin Bay	402	0.941	Gore Point
			2001			
26-Apr	ET0101	Testfish	Amakdedori	468	0.967	Gore Point
27-Apr	ET0102	Testfish	Chenik Head	467	0.961	Gore Point
28-Apr	ET0103	Testfish	Cottonwood	422	0.951	Gore Point
29-Apr	ET0104	Testfish	Iliamna	460	0.960	Gore Point
30-Apr	ET0105	Testfish	Rocky Cove	459	0.956	Gore Point
1-May	ET0106	Testfish	Iniskin	460	0.958	Gore Point
16-May	LT0101	Testfish	Iniskin	471	0.952	Silver Beach
16-May	LT0102	Testfish	Black Reef	436	0.934	Silver Beach
19-May	LT0103[1]	Testfish	Oil Bay	469	0.956	Silver Beach
			2002			
28-Apr	ET0201	Testfish	Chenik Head	473	0.965	Silver Beach
2-May	ET0202	Testfish	Kirschner	462	0.961	Silver Beach
2-May	ET0203	Testfish	Amakdedori	477	0.966	Silver Beach
2-May	ET0204	Testfish	Amakdedori	478	0.971	Silver Beach
4-May	ET0205	Testfish	Contact Point	478	0.956	Silver Beach
4-May	ET0206	Testfish	Iliamna Bay	476	0.971	Silver Beach
5-May	ET0207	Testfish	Iniskin Bay	476	0.970	Silver Beach
16-May	LT0201	Testfish	Iniskin	477	0.966	Inlet Sunrise
16-May	LT0202	Testfish	Fortification Bluff	476	0.960	Inlet Sunrise
19-May	LT0203[2]	Testfish	Ursus Cove	20	NA	Inlet Sunrise
19-May	LT0204	Testfish	Oil Bay	477	0.956	Inlet Sunrise
20-May	LT0205	Testfish	Iniskin	478	0.965	Inlet Sunrise
20-May	LT0206	Testfish	Dry Bay	477	0.965	Inlet Sunrise
			2003			
28-Apr	ET0301	Testfish	Amakdedulia	463	0.956	Silver Beach
3-May	ET0302	Testfish	Cottonwood Bay	413	0.940	Silver Beach
3-May	ET0303	Testfish	Iliamna Bay	340	0.929	Silver Beach
16-May	LT0301	Testfish	McNeil Cove	234	0.834	Inlet Sunrise
18-May	LT0302	Testfish	Iniskin Gut	469	0.950	Inlet Sunrise
18-May	LT0303	Testfish	Iniskin Head	471	0.952	Inlet Sunrise
18-May	LT0304	Testfish	Dry Bay	470	0.967	Inlet Sunrise
20-May	LT0305	Testfish	Oil Point	447	0.963	Inlet Sunrise

1. Sample LT0103 are samples LT0103a and LT0103b combined.
2. All age 1 fish; not included in the season summary.

Table 3. Age, sex, and size distribution of Pacific herring sampled (ET0001) by purse seine at Amakdedori Beach, Kamishak Bay District, Lower Cook Inlet, 28-April-00.

		Numbers of Fish						Percent	Weight			Length			Biomass		
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	5	0	1	0	0	6	3.9	99	30.4	6	196	19.1	6	4	0.4	0.4
	4	15	0	10	0	0	25	16.2	124	21.4	25	212	11.2	25	15	2.1	1.9
	5	11	0	8	0	0	19	12.3	163	24.6	18	233	9.7	19	11	2.0	1.8
	6	21	0	9	0	0	30	19.5	183	18.3	30	238	8.4	30	18	3.7	3.4
	7	25	0	14	0	0	39	25.3	221	28.1	39	250	11.0	39	24	5.8	5.3
28-April-00	8	4	0	4	0	0	8	5.2	224	34.2	8	251	9.4	8	5	1.2	1.1
	9	11	0	3	0	0	14	9.1	251	31.5	14	257	9.3	14	9	2.4	2.1
	10	3	0	6	0	0	9	5.8	265	41.4	9	262	11.9	9	6	1.6	1.5
	11	2	0	1	0	0	3	1.9	292	24.2	3	267	15.9	3	2	0.6	0.5
	12	0	0	1	0	0	1	0.6	312	0.0	1	277	0.0	1	1	0.2	0.2
	13																
	14																
	15																
	16																
Sample Total		97	0	57	0	0	154	100.0	194	55.4	153	239	20.6	154	94	20.0	18.1
Sex Composition (%)		63.0	.0	37.0	.0												
Not Aged		3	0	0	0	0	3	1.9	226	17.5	3	257	7.0	3			
Sex Composition (%)		100.0	.0	.0	.0												

Table 4. Age, sex, and size distribution of Pacific herring sampled (ET0002) by purse seine at Amakdedulia Cove, Kamishak Bay District, Lower Cook Inlet, 1-May-00.

		Numbers of Fish						Percent	Weight			Length			Biomass		
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	7	0	2	0	0	9	2.8	85	11.4	9	194	5.0	9	27	2.5	2.3
	4	38	0	26	0	0	64	19.9	120	16.6	64	212	9.1	64	193	25.5	23.2
	5	23	0	17	0	0	40	12.5	164	27.2	40	231	10.3	40	121	21.9	19.8
	6	53	0	37	0	0	90	28.0	197	24.9	90	242	9.2	90	271	59.0	53.6
	7	40	0	31	0	0	71	22.1	223	26.0	71	250	7.0	71	214	52.5	47.7
1-May-00	8	10	0	9	0	0	19	5.9	232	23.4	19	253	7.1	19	57	14.7	13.3
	9	9	0	3	0	0	12	3.7	248	26.5	12	258	7.3	12	36	9.9	9.0
	10	6	0	4	0	0	10	3.1	257	21.9	10	268	6.6	10	30	8.5	7.7
	11	3	0	1	0	0	4	1.2	254	6.0	4	263	10.7	4	12	3.4	3.1
	12	1	0	0	0	0	1	0.3	285	0.0	1	276	0.0	1	3	0.9	0.9
	13	1	0	0	0	0	1	0.3	324	0.0	1	286	0.0	1	3	1.1	1.0
	14																
	15																
	16																
Sample Total		191	0	130	0	0	321	100.0	187	51.6	321	238	19.5	321	968	200.0	181.4
Sex Composition (%)		59.5	.0	40.5	.0												
Not Aged		4	0	5	0	0	9	2.8	215	61.8	9	245	19.4	9			
Sex Composition (%)		44.4	.0	55.6	.0												

Table 5. Age, sex, and size distribution of Pacific herring sampled (ET0003) by purse seine at Amakdedulia Cove, Kamishak Bay District, Lower Cook Inlet, 1-May-00.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
1-May-00	1																
	2																
	3	29	0	18	0	0	47	13.1	76	10.4	47	190	6.4	47	425	35.5	32.2
	4	51	0	33	0	0	84	23.4	122	21.5	84	214	10.0	84	759	101.6	92.2
	5	23	0	16	0	0	39	10.9	160	21.4	39	233	8.2	39	352	62.0	56.3
	6	49	0	26	0	0	75	20.9	192	22.0	75	243	8.8	75	678	143.3	130.0
	7	43	0	28	0	0	71	19.8	214	26.4	71	251	8.1	71	642	151.6	137.5
	8	14	0	6	0	0	20	5.6	233	30.8	20	257	9.3	20	181	46.4	42.1
	9	7	0	2	0	0	9	2.5	244	32.6	9	263	7.1	9	81	21.9	19.8
	10	4	0	2	0	0	6	1.7	253	9.1	6	269	5.4	6	54	15.1	13.7
	11	0	0	5	0	0	5	1.4	280	32.0	5	276	4.2	5	45	13.9	12.6
	12	2	0	1	0	0	3	0.8	289	30.4	3	275	5.1	3	27	8.6	7.8
	13																
	14																
	15																
	16																
Sample Total		222	0	137	0	0	359	100.0	168	58.9	359	232	24.5	359	3244	600.0	544.3
Sex Composition (%)		61.8	.0	38.2	.0												
Not Aged		4	0	0	0	0	4	1.1	173	100.1	4	234	44.2	4			
Sex Composition (%)		100.0	.0	.0	.0												

Table 6. Age, sex, and size distribution of Pacific herring sampled (ET0004) by purse seine at Fortification Bluff, Kamishak Bay District, Lower Cook Inlet, 2-May-00.

		Numbers of Fish						Percent	Weight			Length			Biomass		
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	10	0	5	0	0	16	4.1	86	9.6	16	197	7.6	16	4	0.4	0.4
	4	45	0	34	0	0	79	20.5	115	21.4	79	213	9.5	79	20	2.6	2.3
	5	21	0	10	1	0	32	8.3	161	22.6	32	233	9.3	32	8	1.5	1.3
	6	44	0	35	0	0	79	20.5	191	26.8	79	246	8.7	79	20	4.3	3.9
	7	61	0	53	0	0	114	29.5	206	25.7	114	250	8.9	114	29	6.7	6.1
2-May-00	8	11	0	19	0	0	30	7.8	226	26.3	30	259	10.0	30	8	1.9	1.8
	9	7	0	5	0	0	12	3.1	251	25.2	12	265	5.4	12	3	0.9	0.8
	10	9	0	6	0	0	15	3.9	263	33.1	15	268	10.1	15	4	1.1	1.0
	11	5	0	2	0	0	7	1.8	244	20.1	7	265	6.4	7	2	0.5	0.4
	12	2	0	0	0	0	2	0.5	276	28.3	2	270	2.8	2	1	0.2	0.1
	13																
	14																
	15																
	16																
Sample Total		215	0	169	1	0	386	100.0	182	52.9	386	240	21.1	386	100	20.0	18.1
Sex Composition (%)		55.7	.0	43.8	.3												
Not Aged		1	0	1	0	0	2	.5	164	30.4	2	237	7.8	2			
Sex Composition (%)		50.0	.0	50.0	.0												

Table 7. Age, sex, and size distribution of Pacific herring sampled (ET0005a) by purse seine at Iniskin Bay (gut), Kamishak Bay District, Lower Cook Inlet, 4-May-00.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
4-May-00	1																
	2																
	3	23	0	4	0	1	38	57.6	64	8.8	37	186	8.7	38	331	23.2	21.1
	4	12	0	7	0	0	24	36.4	88	20.1	24	201	11.5	24	215	20.9	19.0
	5																
	6	1	0	1	0	0	3	4.5	155	29.5	3	240	6.7	3	27	4.6	4.2
	7	0	0	0	0	0	1	1.5	129	0.0	1	240	0.0	1	9	1.3	1.2
	8																
	9																
	10																
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		36	0	12	0	1	66	100.0	78	26.3	65	195	16.6	66	582	50.0	45.4
Sex Composition (%)		54.5	.0	18.2	.0												
Not Aged		0	0	0	0	0	0	.0	0	.0	0	0	.0	0			

Table 8. Age, sex, and size distribution of Pacific herring sampled (ET0005b) by purse seine at Iniskin Bay (gut), Kamishak Bay District, Lower Cook Inlet, 4-May-00.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
5-May-00	1																
	2	1	0	0	0	0	1	0.3	48	0.0	1	156	0.0	1	0	0.0	0.0
	3	40	0	19	2	2	66	22.9	68	10.1	64	186	9.3	66	18	1.4	1.2
	4	81	0	48	7	4	146	50.7	96	15.0	142	205	10.2	146	41	4.3	3.9
	5	6	0	4	0	0	12	4.2	136	19.8	12	226	9.2	12	3	0.5	0.5
	6	9	0	8	1	0	19	6.6	172	27.0	19	238	7.4	19	5	1.0	0.9
	7	21	0	10	1	0	32	11.1	195	25.9	32	247	10.0	32	9	2.0	1.8
	8	3	0	2	0	0	6	2.1	211	26.5	6	253	9.6	6	2	0.4	0.4
	9	1	0	1	0	0	2	0.7	255	6.4	2	256	4.2	2	1	0.2	0.1
	10	1	0	0	0	0	1	0.3	211	0.0	1	259	0.0	1	0	0.1	0.1
	11	2	0	1	0	0	3	1.0	212	27.6	3	258	3.2	3	1	0.2	0.2
	12																
	13																
	14																
	15																
	16																
Sample Total		165	0	93	11	6	288	100.0	113	49.2	282	210	23.3	288	80	10.0	9.1
Sex Composition (%)		57.3	.0	32.3	3.8												
Not Aged		2	0	0	0	0	2	.7	77	17.0	2	187	24.0	2			
Sex Composition (%)		100.0	.0	.0	.0												

Table 9. Age, sex and size composition of Pacific herring sampled (ET0006) by purse seine at Iniskin Bay (right side), Kamishak Bay District, Lower Cook Inlet, 5-May-00.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
5-May-00	1																
	2																
	3	14	0	14	0	0	28	7.0	76	15.6	28	186	9.6	28	487	40.8	37.0
	4	59	0	62	0	0	121	30.1	115	21.8	121	208	12.0	121	2106	265.8	241.1
	5	19	0	20	0	0	39	9.7	155	21.7	39	229	9.5	39	679	116.0	105.2
	6	40	0	29	0	0	69	17.2	180	23.5	69	237	11.3	69	1201	237.8	215.8
	7	43	0	59	0	0	102	25.4	204	26.0	102	244	9.4	102	1775	398.7	361.7
	8	13	0	16	0	0	29	7.2	216	34.5	29	250	12.1	29	505	120.4	109.2
	9	0	0	5	0	0	5	1.2	269	37.5	5	268	9.9	5	87	25.8	23.4
	10	3	0	2	0	0	5	1.2	255	37.3	5	266	7.5	5	87	24.4	22.2
	11	3	0	0	0	0	3	0.7	245	25.9	3	276	9.3	3	52	14.1	12.8
	12																
	13	0	0	1	0	0	1	0.2	321	0.0	1	272	0.0	1	17	6.2	5.6
	14																
	15																
	16																
Sample Total		194	0	208	0	0	402	100.0	162	53.5	402	228	23.0	402	6996	1250.0	1134.0
Sex Composition (%)		48.3	.0	51.7	.0												
Not Aged		1	0	2	0	0	3	.7	201	53.1	3	251	21.5	3			
Sex Composition (%)		33.3	.0	66.7	.0												

Table 10. Herring biomass estimates by area and date, Southern District, Lower Cook Inlet, 2000.

Flight No.	Date	Time	Survey Rating	Spawn Sightings No.	Spawn Sightings Length	Anchor Pt/ Bluff Pt.	West Spit	East Spit/ N. Shore	Bear Cove	Mallard Bay	Glacier Spit	Peterson/ China Poot	Tutka Bay	Daily Total	Peak Counts
						Estimated Biomass by Index Area									
					mi.	Biomass Estimates in Tons									
1	2-May	10:30	2	0	0	0	0	0	0	136	13	0	0	149	
2	6-May	10:50	2	0	0	0	0	0	0	0	130	0	31	161	
3	11-May	11:20	2	0	0	2	0	228	0	3	14	0	260	506	
4	16-May	10:15	2	0	0	0	0	3	0	561	145	2	75	786	
5	22-May	9:35	2	0	0	5	40	254	87	153	453	17	30	1,038	
6	26-May	9:00	2	0	0	0	8	201	203	603	635	26	46	1,723	1,723
7	1-Jun	9:30	2	0	0	31	0	38	0	454	637	34	254	1,447	
8	6-Jun	9:50	2	0	0	0	29	0	0	642	365	0	340	1,376	
	Totals		2.0	0	0.0	38	76	724	290	2,552	2,392	79	1,035	7,186	1,723
					km	Biomass Estimates in Tonnes									
1	2-May	10:30	2	0	0	0	0	0	0	124	12	0	0	135	
2	6-May	10:50	2	0	0	0	0	0	0	0	118	0	28	146	
3	11-May	11:20	2	0	0	1	0	207	0	3	12	0	236	459	
4	16-May	10:15	2	0	0	0	0	2	0	509	132	1	68	713	
5	22-May	9:35	2	0	0	5	36	231	79	138	411	15	27	942	
6	26-May	9:00	2	0	0	0	7	182	185	547	576	24	41	1,563	1,556
7	1-Jun	9:30	2	0	0	28	0	34	0	411	578	31	230	1,313	
8	6-Jun	9:50	2	0	0	0	26	0	0	583	331	0	308	1,248	
	Totals		2.0	0	0.0	34	69	657	263	2,315	2,170	71	939	6,519	1,556

Table 11. Number of readable herring scales collected by purse seine sampling, Southern District, Lower Cook Inlet, 2000-2003.

Date	Sample ID	Sample Type	Sample Location	Sample Size	P Value	Vessel
			2000			
6-May	ST0001	Testfish	Glacier Spit	353	0.904	Gore Point
			2001			
10-May	ST0101	Testfish	Glacier Spit	467	0.974	Silver Beach
10-May	ST0102	Testfish	Rusty's Lagoon	437	0.947	Silver Beach
			2002			
			No sample was collected from the Southern District in 2002.			
			2003			
9-May	ST0301	Testfish	Glacier Spit	468	0.99	Silver Beach

Table 12. Age, sex, and size distribution of Pacific herring sampled (ST0001) by purse seine at Glacier Spit, Southern District, Lower Cook Inlet, 6-May-00.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
6-May-00	1																
	2																
	3	5	0	1	0	0	6	1.7	71	12.7	6	183	9.5	6	40	3.1	2.8
	4	11	0	15	0	0	26	7.4	124	16.9	26	209	9.7	26	172	23.5	21.3
	5	14	0	15	0	0	29	8.2	166	19.3	29	225	10.8	29	191	34.9	31.7
	6	54	0	60	0	0	114	32.3	187	27.7	114	234	11.2	114	752	155.3	140.9
	7	63	0	60	0	0	123	34.8	209	30.0	123	243	10.6	123	812	186.6	169.3
	8	13	0	24	0	0	37	10.5	238	28.8	37	250	11.4	37	244	64.0	58.1
	9	6	0	6	0	0	12	3.4	241	29.3	12	258	11.0	12	79	21.1	19.1
	10	4	0	2	0	0	6	1.7	265	50.5	6	265	10.7	6	40	11.5	10.5
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		170	0	183	0	0	353	100.0	195	43.5	353	237	17.2	353	2329	500.0	453.6
Sex Composition (%)		48.2	.0	51.8	.0												
Not Aged		9	0	4	0	0	13	3.7	195	47.9	13	242	20.8	13			
Sex Composition (%)		69.2	.0	30.8	.0												

Table 13. Herring biomass estimates by area and date, Kamishak Bay District, Lower Cook Inlet, 2001. DNS indicates that an area within the district was not surveyed during a flight.

Flight No.	Date	Time	Survey Rating	Spawn Sightings No.	Spawn Sightings Length	Chinitna/ Dry Bays	Oil Bay	Iniskin Bay	Cottonwood/ Iliamna	Ursus Cove	Fortification Bluff	Bruin/ Amakdedori	Chenik/ Nordyke	Kamishak Bay	Douglas Reef	Augustine Island	Silver Beach	Daily Total	Peak Counts
						Estimated Biomass by Index Area													
					mi.	Biomass Estimates in Tons													
1	17-Apr	10:05	2	0	0	0	0	0	0	0	0	0	0	0	0	DNS	DNS	0	
2	19-Apr	10:15	2	0	0	0	0	0	0	0	0	0	0	0	0	DNS	DNS	0	
3	23-Apr	13:40	3	1	0.25	0	0	0	33	0	0	26	0	0	0	DNS	DNS	59	
4	27-Apr	10:00	3	0	0	0	0	0	299	96	222	659	13	0	0	DNS	DNS	1,289	1,289
5	30-Apr	9:55	4	1	0.28	0	0	68	120	44	0	0	11	0	0	DNS	DNS	243	
6	8-May	13:40	4	0	0	0	0	141	0	0	13	362	0	0	0	DNS	DNS	516	516
7	11-May	9:10	2	3	0.8	37	12	15	0	0	14	0	0	0	0	DNS	DNS	78	
8	15-May	9:45	3	0	0	0	0	30	0	54	26	32	9	0	0	DNS	DNS	151	151
9	19-May	10:40	3	0	0	3	0	0	0	0	3	13	2	0	0	DNS	DNS	20	
10	22-May	14:00	3	0	0	0	0	0	0	0	0	0	2	158	41	DNS	DNS	201	201
11	25-May	15:00	3	0	0	0	0	0	0	0	0	0	0	34	9	DNS	DNS	43	
12	29-May	9:50	3	0	0	0	0	61	0	0	0	0	0	0	0	DNS	220	280	280
13	1-Jun	9:50	3	0	0	0	57	0	0	10	0	0	6	0	0	DNS	50	122	
14	4-Jun	11:25	2	0	0	0	0	27	0	0	0	9	6	0	0	DNS	237	280	
15	8-Jun	9:45	2	0	0	0	14	74	0	19	0	0	0	0	6	DNS	36	148	
	Totals		2.8	5	1.3	40	82	417	453	223	277	1,101	47	192	56	DNS	542	3,430	2,437
					km	Biomass Estimates in Tonnes													
1	17-Apr	10:05	2	0	0	0	0	0	0	0	0	0	0	0	0	DNS	DNS	0	
2	19-Apr	10:15	2	0	0	0	0	0	0	0	0	0	0	0	0	DNS	DNS	0	
3	23-Apr	13:40	3	1	0.40	0	0	0	30	0	0	23	0	0	0	DNS	DNS	54	
4	27-Apr	10:00	3	0	0	0	0	0	272	87	201	598	12	0	0	DNS	DNS	1,169	1,169
5	30-Apr	9:55	4	1	0.45	0	0	62	109	40	0	0	10	0	0	DNS	DNS	220	
6	8-May	13:40	4	0	0	0	0	128	0	0	12	328	0	0	0	DNS	DNS	468	468
7	11-May	9:10	2	3	1.29	34	11	14	0	0	12	0	0	0	0	DNS	DNS	71	
8	15-May	9:45	3	0	0	0	0	28	0	49	23	29	8	0	0	DNS	DNS	137	137
9	19-May	10:40	3	0	0	2	0	0	0	0	2	12	1	0	0	DNS	DNS	18	
10	22-May	14:00	3	0	0	0	0	0	0	0	0	0	1	144	37	DNS	DNS	182	182
11	25-May	15:00	3	0	0	0	0	0	0	0	0	0	0	30	8	DNS	DNS	39	
12	29-May	9:50	3	0	0	0	0	55	0	0	0	0	0	0	0	DNS	199	254	254
13	1-Jun	9:50	3	0	0	0	51	0	0	9	0	0	5	0	0	DNS	45	111	
14	4-Jun	11:25	2	0	0	0	0	25	0	0	0	8	6	0	0	DNS	215	254	
15	8-Jun	9:45	2	0	0	0	12	67	0	17	0	0	0	0	5	DNS	33	134	
	Totals		2.8	5	2.1	36	75	378	411	202	251	999	43	174	51	DNS	492	3,111	2,211

Table 14. Age, sex, and size distribution of Pacific herring sampled (ET0101) by purse seine at Amakdedori Beach, Kamishak Bay District, Lower Cook Inlet, 26-April-01.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	2	0	2	0	0	4	0.9	85	16.5	4	191	8.3	4	0	0.0	0.0
	4	45	0	33	1	0	79	16.9	119	21.3	79	210	9.5	79	2	0.2	0.2
	5	67	0	36	0	0	103	22.0	151	23.6	103	226	11.9	103	2	0.4	0.3
	6	63	0	32	1	0	96	20.5	183	29.7	96	242	12.7	96	2	0.4	0.4
	7	68	0	47	0	1	116	24.8	202	27.3	115	247	10.9	116	3	0.6	0.5
26-April-01	8	35	0	16	0	0	51	10.9	218	28.1	51	253	10.2	51	1	0.3	0.2
	9	6	0	6	0	0	12	2.6	237	34.3	12	261	9.4	12	0	0.1	0.1
	10	2	0	2	0	0	4	0.9	259	51.6	4	272	12.4	4	0	0.0	0.0
	11	1	0	2	0	0	3	0.6	224	8.7	3	265	12.1	3	0	0.0	0.0
	12																
	13																
	14																
	15																
	16																
Sample Total		289	0	176	2	1	468	100.0	175	44.6	467	236	19.5	468	10	2.0	1.8
Sex Composition (%)		61.8	.0	37.6	.4												
Not Aged		4	0	2	0	0	6	1.3	214	63.4	6	250	17.0	6			
Sex Composition (%)		66.7	.0	33.3	.0												

Table 15. Age, sex, and size distribution of Pacific herring sampled (ET0102) by purse seine at Chenik Head, Kamishak Bay District, Lower Cook Inlet, 27-April 01.

Sample Period	Age	Numbers of Fish: Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	Percent of Total	Weight: Mean (g)	SD	Number Weighed	Length: Mean (mm)	SD	Number Measured	Biomass: No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	17	0	14	0	1	32	6.9	85	14.4	32	196	10.2	32	82	7.7	6.9
	4	92	1	66	4	0	163	34.9	118	18.4	163	215	9.8	163	417	54.2	49.2
	5	60	0	53	5	0	118	25.3	147	23.8	118	230	11.4	118	302	49.0	44.4
	6	41	0	26	0	0	67	14.3	189	25.6	67	249	10.2	67	171	35.6	32.3
	7	31	0	23	0	0	54	11.6	210	27.8	54	254	8.5	54	138	32.0	29.0
27-April-01	8	12	0	7	0	0	19	4.1	221	28.2	19	261	9.1	19	49	11.8	10.7
	9	6	0	5	0	0	11	2.4	236	46.6	11	266	18.5	11	28	7.3	6.6
	10	1	0	1	0	0	2	0.4	282	15.6	2	282	2.8	2	5	1.6	1.4
	11	1	0	0	0	0	1	0.2	297	0.0	1	289	0.0	1	3	0.8	0.8
	12																
	13																
	14																
	15																
	16																
Sample Total		261	1	195	9	1	467	100.0	152	48.1	467	230	21.6	467	1195	200.0	181.4
Sex Composition (%)		55.9	.2	41.8	1.9												
Not Aged		3	0	3	0	0	6	1.3	183	76.4	6	240	31.8	6			
Sex Composition (%)		50.0	.0	50.0	.0												

Table 16. Age, sex, and size distribution of Pacific herring sampled (ET0103) by purse seine at Cottonwood Bay, Kamishak Bay District, Lower Cook Inlet, 28-April-01.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	8	0	4	0	0	12	2.8	83	8.9	12	191	9.5	12	1	0.1	0.1
	4	51	0	31	0	0	82	19.4	118	15.3	82	213	10.4	82	10	1.3	1.2
	5	72	0	46	0	0	118	28.0	152	20.7	118	230	9.9	118	15	2.5	2.2
	6	32	0	37	0	0	69	16.4	196	30.0	69	246	13.3	69	9	1.9	1.7
	7	44	0	43	0	0	87	20.6	210	27.3	87	252	11.6	87	11	2.5	2.3
28 April-01	8	27	0	16	0	0	43	10.2	220	35.9	43	256	10.6	43	5	1.3	1.2
	9	3	0	1	0	0	4	0.9	242	40.0	4	271	12.6	4	0	0.1	0.1
	10	4	0	1	0	0	5	1.2	265	32.4	5	264	13.1	5	1	0.2	0.2
	11	0	0	2	0	0	2	0.5	214	63.6	2	253	22.6	2	0	0.1	0.1
	12																
	13																
	14																
	15																
	16																
Sample Total		241	0	181	0	0	422	100.0	172	48.0	422	236	20.6	422	53	10.0	9.1
Sex Composition (%)		57.1	.0	42.9	.0												
Not Aged		7	0	5	0	0	12	2.8	193	63.3	12	246	26.2	12			
Sex Composition (%)		58.3	.0	41.7	.0												

Table 17. Age, sex, and size distribution of Pacific herring sampled (ET0104) by purse seine at Turtle Reef, Illiamna Bay, Kamishak Bay District, Lower Cook Inlet, 29-April-01.

		Numbers of Fish						Percent	Weight			Length			Biomass		
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	3	0	1	0	0	4	0.9	90	9.1	4	198	7.9	4	2	0.2	0.2
	4	40	0	30	2	0	72	15.7	114	21.4	72	217	7.8	72	42	5.3	4.8
	5	96	0	61	0	0	158	34.3	148	29.7	158	231	8.9	158	93	15.2	13.8
	6	53	0	43	1	0	97	21.1	187	34.4	97	249	8.3	97	57	11.8	10.7
	7	40	0	39	0	0	79	17.2	200	33.7	79	255	8.9	79	47	10.2	9.3
29-April-01	8	18	0	15	0	0	33	7.2	213	23.9	33	256	8.6	33	19	4.6	4.1
	9	6	0	1	0	0	7	1.5	208	22.5	7	261	9.1	7	4	0.9	0.9
	10	7	0	0	0	0	7	1.5	265	39.1	7	278	9.2	7	4	1.2	1.1
	11	2	0	0	0	0	2	0.4	244	16.3	2	273	13.4	2	1	0.3	0.3
	12																
	13																
	14																
	15	0	0	1	0	0	1	0.2	307	0.0	1	279	0.0	1	1	0.2	0.2
	16																
Sample Total		265	0	191	3	0	460	100.0	168	46.4	460	240	17.5	460	271	50.0	45.4
Sex Composition (%)		57.6	.0	41.5	.7												
Not Aged		9	0	7	0	0	16	3.5	153	53.4	16	233	22.2	16			
Sex Composition (%)		56.3	.0	43.8	.0												

Table 18. Age, sex, and size distribution of Pacific herring sampled (ET0105) by purse seine at Rocky Cove, Kamishak Bay District, Lower Cook Inlet, 30-April-01.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
30-April-01	1																
	2																
	3	2	0	4	0	0	6	1.3	95	15.4	6	201	11.3	6	0	0.0	0.0
	4	44	0	44	0	0	88	19.2	119	17.0	88	213	8.2	88	0	0.0	0.0
	5	104	0	62	1	0	167	36.4	147	24.6	167	226	9.6	167	0	0.0	0.0
	6	55	0	33	1	0	89	19.4	182	27.8	89	244	9.7	89	0	0.0	0.0
	7	53	0	29	0	0	82	17.9	195	24.8	82	249	8.6	82	0	0.0	0.0
	8	13	0	10	0	0	23	5.0	219	31.5	23	256	9.3	23	0	0.0	0.0
	9	1	0	2	0	0	3	0.7	203	87.5	3	246	37.0	3	0	0.0	0.0
	10	0	0	1	0	0	1	0.2	251	0.0	1	265	0.0	1	0	0.0	0.0
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		272	0	185	2	0	459	100.0	160	39.7	459	233	17.2	459	0	0.0	0.0
Sex Composition (%)		59.3	.0	40.3	.4												
Not Aged		8	0	7	0	0	15	3.3	176	48.2	15	244	25.4	15			
Sex Composition (%)		53.3	.0	46.7	.0												

Table 19. Age, sex, and size distribution of Pacific herring sampled (ET0106) by purse seine at Iniskin Bay, Kamishak Bay District, Lower Cook Inlet, 01-May-01.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
1-May-01	1																
	2																
	3	4	0	5	0	0	9	2.0	85	12.8	9	193	9.7	9	4	0.4	0.4
	4	53	0	42	0	0	95	20.7	120	18.6	95	218	9.6	95	46	6.1	5.5
	5	90	1	69	0	0	160	34.8	151	21.8	160	231	12.3	160	77	12.9	11.7
	6	37	0	36	0	0	73	15.9	192	23.3	73	251	11.8	73	35	7.5	6.8
	7	53	0	34	1	0	88	19.1	195	29.9	88	252	14.0	88	43	9.1	8.3
	8	18	0	10	0	0	28	6.1	210	34.2	28	257	12.1	28	14	3.1	2.8
	9	1	0	0	0	0	1	0.2	229	0.0	1	253	0.0	1	0	0.1	0.1
	10	3	0	1	0	0	4	0.9	253	20.1	4	275	10.7	4	2	0.5	0.5
	11	1	0	0	0	0	1	0.2	275	0.0	1	283	0.0	1	0	0.1	0.1
	12	0	0	1	0	0	1	0.2	259	0.0	1	275	0.0	1	0	0.1	0.1
	13																
	14																
	15																
	16																
Sample Total		260	1	198	1	0	460	100.0	163	41.2	460	237	19.7	460	222	40.0	36.3
Sex Composition (%)		56.5	.2	43.0	.2												
Not Aged		12	0	8	0	0	20	4.3	176	48.5	20	238	18.4	20			
Sex Composition (%)		60.0	.0	40.0	.0												

Table 20. Age, sex, and size distribution of Pacific herring sampled (LT0101) by purse seine at Iniskin Bay, Kamishak Bay District, Lower Cook Inlet, 16-May-01.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
16-May-01	1																
	2	2	0	2	0	0	4	0.8	59	22.5	4	167	21.3	4	0	0.0	0.0
	3	51	0	37	2	0	90	19.1	70	13.7	90	180	10.4	90	0	0.0	0.0
	4	65	0	67	7	0	139	29.5	113	18.4	139	207	11.8	139	0	0.0	0.0
	5	89	0	68	12	0	169	35.9	139	20.9	169	223	10.2	169	0	0.0	0.0
	6	19	0	13	1	0	33	7.0	185	25.5	33	245	9.1	33	0	0.0	0.0
	7	14	0	12	2	0	28	5.9	198	31.2	28	249	11.4	28	0	0.0	0.0
	8	3	0	0	0	0	3	0.6	183	23.7	3	244	2.3	3	0	0.0	0.0
	9	2	0	0	0	0	2	0.4	269	7.8	2	277	11.3	2	0	0.0	0.0
	10	1	0	1	0	0	2	0.4	226	8.5	2	256	11.3	2	0	0.0	0.0
	11																
	12	0	0	1	0	0	1	0.2	216	0.0	1	256	0.0	1	0	0.0	0.0
	13																
	14																
	15																
	16																
Sample Total		246	0	201	24	0	471	100.0	126	43.2	471	213	23.7	471	0	0.0	0.0
Sex Composition (%)		52.2	.0	42.7	5.1												
Not Aged		6	0	3	0	0	9	1.9	132	30.1	9	219	14.8	9			
Sex Composition (%)		66.7	.0	33.3	.0												

Table 21. Age, sex, and size distribution of Pacific herring sampled (LT0102) by purse seine at Black Reef, Kamishak Bay District, Lower Cook Inlet, 16-May-01.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
16-May-01	1																
	2																
	3	44	4	32	1	0	81	18.6	74	15.4	81	179	10.5	81	0	0.0	0.0
	4	96	1	76	6	0	179	41.1	117	17.7	179	204	9.9	179	0	0.0	0.0
	5	64	0	72	2	0	138	31.7	146	18.0	138	220	9.3	138	0	0.0	0.0
	6	10	0	8	0	0	18	4.1	179	18.5	18	239	8.4	18	0	0.0	0.0
	7	10	0	5	0	0	15	3.4	192	30.6	15	241	11.6	15	0	0.0	0.0
	8	1	0	3	0	0	4	0.9	210	22.8	4	242	11.6	4	0	0.0	0.0
	9	1	0	0	0	0	1	0.2	206	0.0	1	240	0.0	1	0	0.0	0.0
	10																
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		226	5	196	9	0	436	100.0	124	36.5	436	208	19.7	436	0	0.0	0.0
Sex Composition (%)		51.8	1.1	45.0	2.1												
Not Aged		7	0	2	0	0	9	2.1	122	32.4	9	210	16.6	9			
Sex Composition (%)		77.8	.0	22.2	.0												

Table 22. Age, sex, and size distribution of Pacific herring sampled (LT0103) by purse seine at Oil Bay, Kamishak Bay District, Lower Cook Inlet, 19-May-01.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
19-May-01	1																
	2	1	0	0	0	0	1	0.2	45	0.0	1	171	0.0	1	0	0.0	0.0
	3	9	0	19	1	0	29	6.2	69	18.3	29	184	11.2	29	0	0.0	0.0
	4	44	0	71	9	0	124	26.4	127	16.8	124	217	8.3	124	0	0.0	0.0
	5	87	0	135	24	0	246	52.5	151	20.6	246	228	8.1	246	0	0.0	0.0
	6	12	1	18	3	0	34	7.2	172	20.5	34	240	7.0	34	0	0.0	0.0
	7	14	0	6	5	0	25	5.3	174	30.3	25	244	11.7	25	0	0.0	0.0
	8	4	0	5	1	0	10	2.1	211	23.6	10	256	8.5	10	0	0.0	0.0
	9																
	10																
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		171	1	254	43	0	469	100.0	143	32.9	469	225	16.1	469	0	0.0	0.0
Sex Composition (%)		36.5	.2	54.2	9.2												
Not Aged		7	0	0	1	0	8	1.7	143	37.0	8	226	19.9	8			
Sex Composition (%)		87.5	.0	.0	12.5												

Table 23. Herring biomass estimates by area and date, Southern District, Lower Cook Inlet, 2001.

Flight No.	Date	Time	Survey Rating	Spawn Sightings No.	Spawn Sightings Length	Anchor Pt/ Bluff Pt.	West Spit	East Spit/ N. Shore	Bear Cove	Mallard Bay	Glacier Spit	Peterson/ China Poot	Tutka Bay	Daily Total	Peak Counts
						Estimated Biomass by Index Area									
					mi.	Biomass Estimates in Tons									
1	24-Apr	13:40	2	0	0	0	0	0	0	0	0	0	0	0	
2	30-Apr	10:10	1	0	0	0	0	182	0	0	0	0	609	791	791
3	7-May	11:15	1	0	0	0	0	0	0	0	0	0	3	3	
4	10-May	13:20	2	0	0	0	0	138	0	0	150	0	107	395	
5	14-May	9:50	1	0	0	0	0	30	0	81	0	0	3	114	
6	18-May	9:25	2	0	0	0	33	0	4	0	31	0	0	69	
7	23-May	11:50	3	0	0	0	0	0	2	4	0	0	0	6	
	Totals		1.7	0	0.0	0	33	350	6	85	181	0	721	1,377	791
					km	Biomass Estimates in Tonnes									
1	24-Apr	13:40	2	0	0	0	0	0	0	0	0	0	0	0	
2	30-Apr	10:10	1	0	0	0	0	165	0	0	0	0	552	718	718
3	7-May	11:15	1	0	0	0	0	0	0	0	0	0	3	3	
4	10-May	13:20	2	0	0	0	0	125	0	0	136	0	97	358	
5	14-May	9:50	1	0	0	0	0	28	0	73	0	0	3	104	
6	18-May	9:25	2	0	0	0	30	0	4	0	28	0	0	63	
7	23-May	11:50	3	0	0	0	0	0	1	4	0	0	0	5	
	Totals		1.7	0	0.0	0	30	318	5	77	165	0	654	1,249	718

Table 24. Age, sex, and size distribution of all Pacific herring sampled (ST0101) by purse seine at Glacier Spit, Southern District, Lower Cook Inlet, 10-May-01.

Sample Period	Age	Numbers of Fish: Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	Percent of Total	Weight: Mean (g)	SD	Number Weighed	Length: Mean (mm)	SD	Number Measured	Biomass: No. Fish X 1000	Tons	Tonnes
	1																
	2	1	0	2	0	0	3	0.6	54	20.1	3	168	15.7	3	0	0.0	0.0
	3	43	0	51	1	0	95	20.3	81	27.2	95	189	15.9	95	0	0.0	0.0
	4	35	0	52	0	1	88	18.8	124	28.6	88	211	13.8	88	0	0.0	0.0
	5	28	1	58	1	0	88	18.8	156	24.9	88	226	12.7	88	0	0.0	0.0
	6	23	0	24	0	0	47	10.1	178	34.3	47	238	16.3	47	0	0.0	0.0
	7	28	0	63	0	0	91	19.5	197	28.5	91	243	12.7	91	0	0.0	0.0
10-May-01	8	14	0	21	0	0	35	7.5	205	39.6	35	244	18.0	35	0	0.0	0.0
	9	8	0	8	0	0	16	3.4	231	49.9	16	251	22.1	16	0	0.0	0.0
	10	3	0	1	0	0	4	0.9	244	20.7	4	256	4.0	4	0	0.0	0.0
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		183	1	280	2	1	467	100.0	151	55.8	467	222	25.9	467	0	0.0	0.0
Sex Composition (%)		39.2	.2	60.0	.4												
Not Aged		3	0	5	0	0	8	1.7	166	73.0	8	225	27.9	8			
Sex Composition (%)		37.5	.0	62.5	.0												

Table 25. Age, sex, and size distribution of Pacific herring sampled (ST0102) by purse seine at Rusty's Lagoon, Southern District, Lower Cook Inlet, 10-May-01.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
10-May-01	1																
	2	1	0	0	0	0	1	0.2	33	0.0	1	151	0.0	1	0	0.0	0.0
	3	86	0	85	0	0	171	39.1	80	17.8	171	190	10.5	171	0	0.0	0.0
	4	36	1	62	0	0	99	22.7	121	24.8	99	212	11.5	99	0	0.0	0.0
	5	39	0	44	0	0	83	19.0	160	26.8	83	229	11.7	83	0	0.0	0.0
	6	21	0	17	0	0	38	8.7	187	31.3	38	244	12.0	38	0	0.0	0.0
	7	13	0	17	0	0	30	6.9	208	27.8	30	249	7.1	30	0	0.0	0.0
	8	7	0	6	0	0	13	3.0	208	19.3	13	253	9.9	13	0	0.0	0.0
	9	1	0	1	0	0	2	0.5	306	74.2	2	277	14.8	2	0	0.0	0.0
	10																
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		204	1	232	0	0	437	100.0	127	52.5	437	213	24.9	437	0	0.0	0.0
Sex Composition (%)		46.7	.2	53.1	.0												
Not Aged		7	0	2	0	0	9	2.1	122	51.7	9	210	28.0	9			
Sex Composition (%)		77.8	.0	22.2													

Table 26. Herring biomass estimates by area and date, Kamishak Bay District, Lower Cook Inlet, 2002. DNS indicates that an area within the district was not surveyed during a flight.

Flight No.	Date	Time	Survey Rating	Spawn Sightings No.	Length	Estimated Biomass by Index Area: Chinitna/ Dry Bays	Oil Bay	Iniskin Bay	Cottonwood/ Iliamna	Ursus Cove	Fortification Bluff	Bruin/ Amakdedori	Chenik/ Nordyke	Kamishak Bay	Douglas Reef	Augustine Island	Silver Beach	Daily Total	Peak Counts
					mi.	Biomass Estimates in Tons													
1	19-Apr	11:45	5	0	0	0	0	DNS	DNS	0	0	DNS	DNS	DNS	DNS	DNS	DNS	0	
2	20-Apr	10:30	4	0	0	0	0	0	0	0	0	0	0	0	0	DNS	DNS	0	
3	23-Apr	10:55	2	0	0	0	0	0	0	0	0	0	0	0	0	DNS	0	0	
4	26-Apr	11:40	3	0	0	2	0	0	0	0	0	0	0	0	0	DNS	0	2	
5	29-Apr	12:45	2	0	0	DNS	DNS	DNS	DNS	DNS	0	0	40	0	DNS	DNS	DNS	40	
6	2-May	10:55	3	0	0	2	0	0	0	2	63	117	0	0	0	DNS	DNS	183	
7	4-May	11:45	2	0	0	0	0	6	83	14	0	140	11	9	0	DNS	0	263	263
8	9-May	10:18	2	0	0	3	0	0	40	290	9	270	11	5	6	DNS	0	634	
9	13-May	9:54	2	1	0.06	0	172	43	14	54	83	171	196	44	0	DNS	0	777	
10	17-May	9:48	3	2	0.12	0	0	0	2	27	0	0	0	49	0	DNS	0	78	
11	20-May	10:55	2	0	0	165	0	55	31	268	11	62	104	31	0	DNS	57	784	784
12	24-May	7:53	3	0	0	169	67	0	0	0	0	0	39	0	0	DNS	17	292	
13	28-May	14:10	3	0	0	0	0	62	0	0	0	0	0	0	0	DNS	0	62	
14	31-May	11:50	3	0	0	9	0	8	0	18	0	0	0	0	0	DNS	DNS	34	
15	4-Jun	9:40	3	0	0	16	36	174	42	41	0	0	0	0	0	DNS	0	309	309
16	7-Jun	10:09	3	0	0	0	0	0	0	2	0	0	289	0	0	DNS	0	291	291
	Totals		2.8	3	0.2	365	276	347	211	716	166	760	691	138	6	DNS	73	3,748	1,647
					km	Biomass Estimates in Tonnes													
1	19-Apr	11:45	2	0	0	0	0	DNS	DNS	0	0	DNS	DNS	DNS	DNS	DNS	DNS	0	
2	20-Apr	10:30	2	0	0	0	0	0	0	0	0	0	0	0	0	DNS	DNS	0	
3	23-Apr	10:55	3	1	0	0	0	0	0	0	0	0	0	0	0	DNS	0	0	
4	26-Apr	11:40	3	0	0	1	0	0	0	0	0	0	0	0	0	DNS	0	1	
5	29-Apr	12:45	4	1	0	DNS	DNS	DNS	DNS	DNS	0	0	37	0	DNS	DNS	DNS	37	
6	2-May	10:55	4	0	0	1	0	0	0	1	57	106	0	0	0	DNS	DNS	166	
7	4-May	11:45	2	3	0	0	0	6	75	13	0	127	10	8	0	DNS	0	239	239
8	9-May	10:18	3	0	0	3	0	0	36	263	8	245	10	4	5	DNS	0	575	
9	13-May	9:54	3	0	0.10	0	156	39	12	49	75	155	178	40	0	DNS	0	705	
10	17-May	9:48	3	0	0.19	0	0	0	1	25	0	0	0	44	0	DNS	0	70	
11	20-May	10:55	3	0	0	150	0	50	28	243	10	56	94	28	0	DNS	51	711	711
12	24-May	7:53	3	0	0	153	61	0	0	0	0	0	35	0	0	DNS	15	265	
13	28-May	14:10	3	0	0	0	0	56	0	0	0	0	0	0	0	DNS	0	56	
14	31-May	11:50	2	0	0	8	0	7	0	16	0	0	0	0	0	DNS	DNS	31	
15	4-Jun	9:40	2	0	0	15	33	157	38	37	0	0	0	0	0	DNS	0	280	280
16	7-Jun	10:09	3	0	0	0	0	0	0	2	0	0	263	0	0	DNS	0	264	264
	Totals		2.8	5	0.3	331	250	315	192	649	151	689	627	125	5	DNS	66	3,400	1,495

Table 27. Age, sex, and size distribution of Pacific herring sampled (ET0201) by purse seine near Chenik Head, Kamishak Bay District, Lower Cook Inlet, 8-May-02.

		Numbers of Fish						Percent	Weight			Length			Biomass		
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	28	0	6	0	0	34	7.2	93	9.7	34	200	8.0	34	4	0.4	0.4
	4	19	0	7	0	0	26	5.5	138	44.2	26	221	12.9	26	3	0.4	0.4
	5	100	0	60	0	0	160	33.8	164	26.7	160	235	10.6	160	18	3.3	3.0
	6	75	0	43	0	0	118	24.9	195	28.0	117	246	10.3	118	13	2.8	2.6
	7	37	0	27	0	0	64	13.5	228	33.2	64	257	10.7	64	7	1.8	1.6
28-April-02	8	31	0	15	0	0	46	9.7	248	27.8	46	262	9.4	46	5	1.4	1.3
	9	12	0	5	0	0	17	3.6	252	31.7	17	265	9.7	17	2	0.5	0.5
	10	3	0	1	0	0	4	0.8	232	59.3	4	263	20.0	4	0	0.1	0.1
	11	1	0	2	0	0	3	0.6	306	64.8	3	280	5.0	3	0	0.1	0.1
	12																
	13	1	0	0	0	0	1	0.2	318	0.0	1	285	0.0	1	0	0.0	0.0
	14																
	15																
	16																
Sample Total		307	0	166	0	0	473	100.0	187	51.9	472	242	19.7	473	53	11.0	10.0
Sex Composition (%)		64.9	.0	35.1	.0												
Not Aged		3	0	4	0	0	7	1.5	211	41.5	7	250	14.9	7			
Sex Composition (%)		42.9	.0	57.1	.0												

Table 28. Age, sex, and size distribution of Pacific herring sample (ET0202) by purse seine near Kirschner, Kamishak Bay District, Lower Cook Inlet, 8-April-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	18	0	9	0	0	27	5.8	89	13.0	27	195	5.7	27	16	1.6	1.5
	4	14	0	7	0	0	21	4.5	123	21.5	21	216	8.0	21	13	1.7	1.6
	5	77	0	44	1	0	122	26.4	166	23.0	122	232	9.0	122	74	13.6	12.3
	6	86	0	55	0	0	141	30.5	199	25.7	141	242	8.4	141	86	18.8	17.1
	7	55	0	23	0	0	78	16.9	230	24.8	78	254	7.9	78	47	12.0	10.9
2-May-02	8	36	0	17	0	0	53	11.5	243	28.1	53	258	7.3	53	32	8.6	7.8
	9	8	0	4	0	0	12	2.6	264	28.2	12	264	9.1	12	7	2.1	1.9
	10	2	0	2	0	0	4	0.9	278	23.2	4	269	9.0	4	2	0.7	0.7
	11	3	0	1	0	0	4	0.9	271	19.5	4	270	8.1	4	2	0.7	0.7
	12																
	13																
	14																
	15																
	16																
Sample Total		299	0	162	1	0	462	100.0	194	49.1	462	240	18.3	462	281	60.0	54.4
Sex Composition (%)		64.7	.0	35.1	.2												
Not Aged		4	0	0	0	0	4	.9	203	43.9	4	247	19.5	4			
Sex Composition (%)		100.0	.0	.0	.0												

Table 29. Age, sex, and size distribution of Pacific herring sampled (ET0203) by purse seine at Amakdedori Beach, Kamishak District, Lower Cook Inlet, 2-May-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
2-May-02	1																
	2																
	3	85	0	42	0	0	127	26.6	84	14.5	126	191	8.3	127	78	7.2	6.5
	4	26	0	17	0	0	43	9.0	126	17.5	43	215	8.7	43	27	3.7	3.3
	5	80	0	65	0	0	145	30.4	160	25.0	144	229	9.4	145	89	15.7	14.2
	6	46	0	28	1	0	75	15.7	190	24.9	75	240	7.9	75	46	9.7	8.8
	7	17	0	11	0	0	28	5.9	211	22.0	28	248	7.4	28	17	4.0	3.6
	8	23	0	16	0	0	39	8.2	238	29.2	39	255	9.4	39	24	6.3	5.7
	9	5	0	4	0	0	9	1.9	235	35.5	9	261	10.9	9	6	1.4	1.3
	10	2	0	4	0	0	6	1.3	269	39.7	6	267	7.8	6	4	1.1	1.0
	11	3	0	1	0	0	4	0.8	255	39.4	4	263	11.8	4	2	0.7	0.6
	12	1	0	0	0	0	1	0.2	268	0.0	1	272	0.0	1	1	0.2	0.2
	13																
	14																
	15																
	16																
Sample Total		288	0	188	1	0	477	100.0	155	57.3	475	224	24.4	477	293	50.0	45.4
Sex Composition (%)		60.4	.0	39.4	.2												
Not Aged		3	0	0	0	0	3	.6	175	86.0	3	236	38.4	3			
Sex Composition (%)		100.0	.0	.0	.0												

Table 30. Age, sex, and size distribution of Pacific herring sampled (ET0204) by purse seine at Amakdedori Beach, Kamishak Bay District, Lower Cook Inlet, 2-May-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
4-May-02	1																
	2																
	3	30	0	12	0	0	42	8.8	95	14.7	42	202	8.1	42	9	0.9	0.8
	4	20	0	20	0	0	40	8.4	138	17.5	40	226	8.1	40	8	1.2	1.1
	5	76	0	47	0	0	123	25.7	161	24.1	123	236	10.7	123	25	4.5	4.0
	6	74	0	59	0	0	133	27.8	194	25.0	133	247	8.5	133	27	5.8	5.3
	7	36	0	25	0	0	61	12.8	231	24.5	61	260	7.5	61	12	3.2	2.9
	8	34	0	17	0	0	51	10.7	244	27.2	51	266	8.6	51	10	2.8	2.5
	9	10	0	8	0	0	18	3.8	257	30.1	18	268	10.5	18	4	1.0	0.9
	10	6	0	0	0	0	6	1.3	246	26.2	6	273	5.3	6	1	0.3	0.3
	11	2	0	1	0	0	3	0.6	281	30.0	3	279	3.8	3	1	0.2	0.2
	12																
	13	0	0	1	0	0	1	0.2	312	0.0	1	289	0.0	1	0	0.1	0.1
	14																
	15																
	16																
Sample Total		288	0	190	0	0	478	100.0	186	51.0	478	244	20.4	478	98	20.0	18.1
Sex Composition (%)		60.3	.0	39.7	.0												
Not Aged		1	0	1	0	0	2	.4	253	64.3	2	275	19.8	2			
Sex Composition (%)		50.0	.0	50.0	.0												

Table 31. Age, sex, and size distribution of Pacific herring sampled (ET0205) by purse seine at Contact Point, Kamishak Bay District, Lower Cook Inlet, 4-May-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
4-May-02	1																
	2	1	0	0	0	0	1	0.2	78	0.0	1	192	0.0	1	0	0.0	0.0
	3	81	0	36	1	0	118	24.7	87	18.0	118	195	11.2	118	55	5.3	4.8
	4	27	0	14	1	0	42	8.8	130	22.1	42	221	10.4	42	20	2.8	2.6
	5	74	0	56	2	0	132	27.6	164	25.4	132	236	9.7	132	62	11.2	10.1
	6	56	0	30	1	0	87	18.2	195	26.6	87	248	9.4	87	41	8.8	7.9
	7	20	0	15	1	0	36	7.5	231	24.8	36	258	7.2	36	17	4.3	3.9
	8	24	0	15	0	0	39	8.2	233	35.6	39	260	12.1	39	18	4.7	4.2
	9	12	0	3	0	0	15	3.1	246	32.9	15	267	9.4	15	7	1.9	1.7
	10	4	0	3	0	0	7	1.5	255	9.7	7	277	5.7	7	3	0.9	0.8
	11	1	0	0	0	0	1	0.2	262	0.0	1	260	0.0	1	0	0.1	0.1
	12																
	13																
	14																
	15																
	16																
Sample Total		300	0	172	6	0	478	100.0	162	58.7	478	232	26.1	478	224	40.0	36.3
Sex Composition (%)		62.8	.0	36.0	1.3												
Not Aged		1	0	0	0	0	1	.2	267	.0	1	272	.0	1			
Sex Composition (%)		100.0	.0	.0	.0												

Table 32. Age, sex, and size distribution of Pacific herring sampled (ET0206) by purse seine at Illiamna Bay, Kamishak Bay District, Lower Cook Inlet, 4-May-02.

		Numbers of Fish						Percent	Weight			Length			Biomass		
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	50	0	23	1	0	74	15.5	83	14.9	74	193	11.2	74	239	21.8	19.7
	4	17	0	12	0	0	29	6.1	123	19.8	29	216	10.9	29	94	12.7	11.5
	5	56	0	42	0	0	98	20.6	161	23.8	98	234	9.5	98	317	56.2	51.0
	6	89	1	59	0	0	149	31.3	191	25.6	149	244	8.0	149	481	101.2	91.8
	7	34	0	17	0	0	51	10.7	225	27.8	51	256	9.9	51	165	40.9	37.1
4-May-02	8	29	0	12	0	0	41	8.6	244	29.2	41	264	9.9	41	132	35.6	32.3
	9	17	0	8	0	0	25	5.3	254	25.8	25	265	8.4	25	81	22.6	20.5
	10	3	0	2	0	0	5	1.1	288	30.6	5	275	7.7	5	16	5.1	4.7
	11	1	0	1	0	0	2	0.4	288	7.8	2	276	2.8	2	6	2.0	1.9
	12	2	0	0	0	0	2	0.4	270	12.7	2	285	0.0	2	6	1.9	1.7
	13																
	14																
	15																
	16																
Sample Total		298	1	176	1	0	476	100.0	177	58.5	476	237	24.6	476	1538	300.0	272.2
Sex Composition (%)		62.6	.2	37.0	.2												
Not Aged		3	0	1	0	0	4	.8	232	27.7	4	259	8.7	4			
Sex Composition (%)		75.0	.0	25.0	.0												

Table 33. Age, sex, and size distribution of Pacific herring sampled (ET0207) by purse seine at Iniskin Bay, Kamishak Bay District, Lower Cook Inlet, 5-May-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
5-May-02	1																
	2																
	3	30	0	13	0	0	43	9.0	85	11.5	42	190	8.6	43	20	1.9	1.7
	4	17	0	11	0	0	28	5.9	132	21.1	28	217	8.2	28	13	2.0	1.8
	5	64	0	38	1	0	103	21.6	157	25.6	103	227	9.5	103	50	8.6	7.8
	6	111	0	46	0	2	159	33.4	182	25.4	158	237	8.3	158	76	15.3	13.9
	7	34	0	16	0	0	50	10.5	218	27.6	50	250	9.3	50	24	5.8	5.3
	8	35	0	17	0	0	52	10.9	225	25.7	52	254	6.8	52	25	6.2	5.6
	9	19	0	9	0	0	28	5.9	236	32.0	28	258	7.5	28	13	3.5	3.2
	10	5	0	0	0	0	5	1.1	263	19.7	4	275	7.5	5	2	0.6	0.5
	11	1	0	3	0	0	4	0.8	308	19.0	4	270	6.8	4	2	0.7	0.6
	12	1	0	2	0	0	3	0.6	298	19.1	3	274	9.0	3	1	0.5	0.4
	13	1	0	0	0	0	1	0.2	317	0.0	1	281	0.0	1	0	0.2	0.2
	14																
	15																
	16																
Sample Total		318	0	155	1	2	476	100.0	179	50.6	473	235	20.5	475	228	45.0	40.8
Sex Composition (%)		66.8	.0	32.6	.2												
Not Aged		0	0	1	0	0	1	.2	362	.0	1	284	.0	1			
Sex Composition (%)		.0	.0	100.0	.0												

Table 34. Age, sex, and size distribution of Pacific herring sampled (LT0201) by purse seine at Iniskin Bay, Kamishak Bay District, Lower Cook Inlet, 16-May-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	137	0	7	112	0	256	53.7	75	65.2	256	189	9.2	256	0	0.0	0.0
	4	19	0	0	19	0	38	8.0	113	117.7	38	207	12.6	38	0	0.0	0.0
	5	33	0	2	29	1	65	13.6	136	26.6	65	230	11.5	65	0	0.0	0.0
	6	51	0	0	33	0	84	17.6	152	23.5	83	238	8.4	84	0	0.0	0.0
	7	8	0	0	4	0	12	2.5	176	12.0	12	249	9.6	12	0	0.0	0.0
16-May-02	8	4	0	0	9	0	13	2.7	179	31.1	13	252	15.3	13	0	0.0	0.0
	9	4	0	0	2	0	6	1.3	191	31.2	6	258	12.5	6	0	0.0	0.0
	10	1	0	0	2	0	3	0.6	224	16.2	3	274	6.7	3	0	0.0	0.0
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		257	0	9	210	1	477	100.0	107	71.1	476	209	25.8	477	0	0.0	0.0
Sex Composition (%)		53.9	.0	1.9	44.0												
Not Aged		1	0	0	1	0	2	.4	125	36.8	2	231	4.9	2			
Sex Composition (%)		50.0	.0	.0	50.0												

Table 35. Age, sex, and size distribution of Pacific herring sampled (LT0202) by purse seine at Fortification Bluff, Kamishak Bay District, Lower Cook Inlet, 16-May-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	85	0	44	0	0	129	27.1	97	96.9	129	193	11.6	129	0	0.0	0.0
	4	34	0	9	0	0	43	9.0	123	27.5	42	212	12.0	43	0	0.0	0.0
	5	65	0	51	0	0	116	24.4	153	22.3	116	227	9.6	116	0	0.0	0.0
	6	90	0	42	0	0	132	27.7	184	26.6	130	238	9.1	132	0	0.0	0.0
	7	21	0	7	0	0	28	5.9	216	31.6	28	249	10.3	28	0	0.0	0.0
16-May-02	8	10	0	9	0	0	19	4.0	237	28.9	19	255	9.6	19	0	0.0	0.0
	9	4	0	1	0	0	5	1.1	224	23.1	5	259	8.6	5	0	0.0	0.0
	10	1	0	0	0	1	2	0.4	230	27.6	2	256	0.7	2	0	0.0	0.0
	11																
	12	2	0	0	0	0	2	0.4	277	24.7	2	258	2.8	2	0	0.0	0.0
	13																
	14																
	15																
	16																
Sample Total		312	0	163	0	1	476	100.0	152	69.7	473	223	23.2	476	0	0.0	0.0
Sex Composition (%)		65.5	.0	34.2	.0												
Not Aged		1	0	3	0	0	4	.8	202	40.4	4	246	11.5	4			
Sex Composition (%)		25.0	.0	75.0	.0												

Table 36. Age, sex, and size distribution of Pacific herring sampled (LT0203) by purse seine at Ursus Cove, Kamishak Bay District, Lower Cook Inlet, 19-May-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
19-May-02	1	0	0	0	0	20	20	100.0	4	0.7	19	78	5.5	20	0	0.0	0.0
	2																
	3																
	4																
	5																
	6																
	7																
	8																
	9																
	10																
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		0	0	0	0	20	20	100.0	4	0.7	19	78	5.5	20	0	0.0	0.0
Sex Composition (%)		.0	.0	.0	.0												
Not Aged		0	0	0	0	0	0	.0	0	.0	0	0	.0	0			

Note: Sample was not used in statistical analysis.

Table 37. Age, sex, and size distribution of Pacific herring sampled (LT0204) by purse seine at Oil Bay, Kamishak Bay District, Lower Cook Inlet, 19-May-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
19-May-02	1																
	2																
	3	7	0	4	1	0	12	2.5	85	19.8	12	192	14.6	12	0	0.0	0.0
	4	25	0	13	1	0	39	8.2	138	37.5	39	218	17.1	39	0	0.0	0.0
	5	45	0	46	0	0	91	19.1	161	19.2	91	230	8.7	91	0	0.0	0.0
	6	111	0	93	1	0	205	43.0	190	24.2	205	242	9.2	205	0	0.0	0.0
	7	37	0	14	1	0	52	10.9	219	29.6	52	252	8.8	52	0	0.0	0.0
	8	32	0	17	0	0	49	10.3	232	27.9	49	256	8.1	49	0	0.0	0.0
	9	13	0	9	1	0	23	4.8	243	34.9	23	259	12.3	23	0	0.0	0.0
	10	3	0	2	0	0	5	1.0	262	41.9	5	259	9.5	5	0	0.0	0.0
	11	1	0	0	0	0	1	0.2	252	0.0	1	273	0.0	1	0	0.0	0.0
	12																
	13																
	14																
	15																
	16																
Sample Total		274	0	198	5	0	477	100.0	188	42.6	477	240	16.9	477	0	0.0	0.0
Sex Composition (%)		57.4	.0	41.5	1.0												
Not Aged		3	0	0	0	0	3	.6	232	35.1	3	256	4.0	3			
Sex Composition (%)		100.0	.0	.0	.0												

Table 38. Age, sex, and size distribution of Pacific herring sampled (LT0205) by purse seine at Iniskin Bay, Kamishak Bay District, Lower Cook Inlet, 20-May-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
	1																
	2																
	3	30	0	3	25	0	58	12.1	79	19.2	58	195	13.3	58	0	0.0	0.0
	4	10	0	3	8	0	21	4.4	108	24.2	21	215	13.8	21	0	0.0	0.0
	5	55	0	5	43	0	103	21.5	142	20.4	103	236	9.9	103	0	0.0	0.0
	6	115	0	9	68	0	192	40.2	159	21.0	192	244	9.1	192	0	0.0	0.0
	7	21	0	0	14	0	35	7.3	180	20.5	35	254	8.8	35	0	0.0	0.0
20-May-02	8	20	0	3	19	0	42	8.8	191	17.0	42	259	7.9	42	0	0.0	0.0
	9	13	0	2	8	0	23	4.8	203	20.4	23	263	8.3	23	0	0.0	0.0
	10	2	0	0	0	0	2	0.4	234	7.1	2	271	8.5	2	0	0.0	0.0
	11	1	0	0	0	0	1	0.2	232	0.0	1	276	0.0	1	0	0.0	0.0
	12	0	0	1	0	0	1	0.2	237	0.0	1	273	0.0	1	0	0.0	0.0
	13																
	14																
	15																
	16																
Sample Total		267	0	26	185	0	478	100.0	151	39.5	478	238	21.3	478	0	0.0	0.0
Sex Composition (%)		55.9	.0	5.4	38.7												
Not Aged		1	0	0	1	0	2	.4	144	67.2	2	233	30.4	2			
Sex Composition (%)		50.0	.0	.0	50.0												

Table 39. Age, sex, and size distribution of Pacific herring sampled (LT0206) by purse seine at Dry Bay, Kamishak Bay District, Lower Cook Inlet, 20-May-02.

Sample Period	Age	Numbers of Fish						Percent of Total	Weight			Length			Biomass		
		Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total		Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish X 1000	Tons	Tonnes
20-May-02	1																
	2																
	3	155	0	93	2	0	250	52.4	71	13.1	249	184	8.8	250	0	0.0	0.0
	4	31	0	18	0	0	49	10.3	107	27.4	49	206	14.9	49	0	0.0	0.0
	5	48	0	30	0	0	78	16.4	148	21.6	78	226	8.7	78	0	0.0	0.0
	6	42	0	33	0	0	75	15.7	176	28.0	75	235	11.0	75	0	0.0	0.0
	7	11	0	5	0	0	16	3.4	200	20.5	16	246	6.8	16	0	0.0	0.0
	8	5	0	0	0	0	5	1.0	210	18.6	5	245	9.2	5	0	0.0	0.0
	9	3	0	1	0	0	4	0.8	213	22.8	4	254	5.0	4	0	0.0	0.0
	10																
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		295	0	180	2	0	477	100.0	111	50.8	476	204	25.4	477	0	0.0	0.0
Sex Composition (%)		61.8	.0	37.7	.4												
Not Aged		1	0	2	0	0	3	.6	146	41.0	3	219	15.3	3			
Sex Composition (%)		33.3	.0	66.7	.0												

Table 40. Herring biomass estimates by area and date, Southern District, Lower Cook Inlet, 2002.

Flight No.	Date	Time	Survey Rating	Spawn Sightings No.	Spawn Sightings Length	Anchor Pt/ Bluff Pt.	West Spit	East Spit/ N. Shore	Bear Cove	Mallard Bay	Glacier Spit	Peterson/ China Poot	Tutka Bay	Daily Total	Peak Counts
						Estimated Biomass by Index Area									
					mi.	Biomass Estimates in Tons									
1	2-May	14:55	2	0	0	0	0	0	0	0	0	0	0	0	
2	7-May	9:50	2	0	0	0	0	0	0	4	25	0	0	30	
3	13-May	10:35	2	0	0	0	0	15	6	0	0	0	135	156	
4	17-May	9:55	2	0	0	0	3	16	0	126	8	0	85	238	
5	21-May	9:50	2	0	0	0	0	150	97	162	739	30	53	1,231	1,231
6	28-May	11:38	3	0	0	84	0	2	0	31	99	0	249	464	
7	31-May	9:25	2	0	0	178	22	125	8	37	5	0	141	516	
8	7-Jun	9:53	2	0	0	8	8	16	179	15	59	0	51	337	
	Totals		2.1	0	0.0	269	33	324	290	376	935	30	714	2,971	1,231
					km	Biomass Estimates in Tonnes									
1	2-May	14:55	2	0	0	0	0	0	0	0	0	0	0	0	
2	7-May	9:50	2	0	0	0	0	0	0	4	23	0	0	27	
3	13-May	10:35	2	0	0	0	0	14	5	0	0	0	122	141	
4	17-May	9:55	2	0	0	0	3	15	0	114	7	0	77	216	
5	21-May	9:50	2	0	0	0	0	136	88	147	670	28	48	1,117	1,117
6	28-May	11:38	3	0	0	76	0	1	0	28	90	0	226	421	
7	31-May	9:25	2	0	0	161	20	114	8	34	4	0	128	468	
8	7-Jun	9:53	2	0	0	7	7	15	162	14	54	0	47	305	
	Totals		2.1	0	0.0	244	30	294	263	341	848	28	648	2,696	1,117

Table 41. Herring biomass estimates by area and date, Kamishak Bay District, Lower Cook Inlet, 2003. DNS indicates that an area within the district was not surveyed during a flight.

Flight No.	Date	Time	Survey Rating	Spawn Sightings No.	Spawn Sightings Length	Chinitna/ Dry Bays	Oil Bay	Iniskin Bay	Cottonwood/ Iliamna	Ursus Cove	Fortification Bluff	Bruin/ Amakdedori	Chenik/ Nordyke	Kamishak Bay	Douglas Reef	Augustine Island	Silver Beach	Daily Total	Peak Counts
									Estimated Biomass by Index Area										
					mi.							Biomass Estimates in Tons							
1	17-Apr	9:37	3	0	0	0	0	0	0	0	0	0	0	0	0	DNS	0	0	
2	23-Apr	10:57	3	0	0	0	0	0	0	0	0	0	0	0	0	DNS	0	0	
3	25-Apr	9:44	4	0	0	0	0	0	0	0	0	30	0	0	0	DNS	0	30	
4	28-Apr	10:45	2	1	0.9	0	0	0	0	10	3	3	24	24	136	DNS	13	213	213
5	30-Apr	9:57	1	0	0	0	0	0	32	9	0	2	0	44	12	DNS	0	98	
6	2-May	9:45	3	0	0	0	0	0	8	9	16	0	0	2	0	DNS	0	34	
7	6-May	9:57	2	0	0	2	3	149	339	0	0	41	0	6	0	DNS	0	539	539
8	12-May	11:05	3	1	0.5	0	409	3	0	5	0	41	313	33	0	DNS	0	805	805
9	16-May	14:22	3	0	0	0	0	0	0	0	0	2	8	6	0	DNS	0	15	
10	19-May	10:55	4	0	0	0	0	0	0	0	0	0	0	0	0	DNS	0	0	
11	22-May	9:57	3	1	0.1	0	0	18	0	5	0	11	0	19	0	DNS	0	52	
12	28-May	9:30	3	0	0	0	0	36	0	0	116	0	0	0	0	DNS	0	153	153
13	2-Jun	10:20	3	0	0	0	0	0	0	0	0	0	0	0	0	DNS	0	0	
	Totals		2.8	3	1.5	2	412	207	378	38	135	128	345	133	148	DNS	DNS	1,938	1,709
					km							Biomass Estimates in Tonnes							
1	17-Apr	9:37	3	0	0	0	0	0	0	0	0	0	0	0	0	DNS	0	0	
2	23-Apr	10:57	3	0	0	0	0	0	0	0	0	0	0	0	0	DNS	0	0	
3	25-Apr	9:44	4	0	0	0	0	0	0	0	0	27	0	0	0	DNS	0	27	
4	28-Apr	10:45	2	1	1.4	0	0	0	0	9	3	2	22	22	124	DNS	12	193	193
5	30-Apr	9:57	1	0	0	0	0	0	29	8	0	1	0	40	11	DNS	0	89	
6	2-May	9:45	3	0	0	0	0	0	7	8	14	0	0	1	0	DNS	0	31	
7	6-May	9:57	2	0	0	1	3	135	307	0	0	37	0	6	0	DNS	0	489	489
8	12-May	11:05	3	1	0.8	0	371	3	0	5	0	37	284	30	0	DNS	0	730	730
9	16-May	14:22	3	0	0	0	0	0	0	0	0	1	7	6	0	DNS	0	14	
10	19-May	10:55	4	0	0	0	0	0	0	0	0	0	0	0	0	DNS	0	0	
11	22-May	9:57	3	1	0.2	0	0	17	0	4	0	10	0	17	0	DNS	0	47	
12	28-May	9:30	3	0	0	0	0	33	0	0	105	0	0	0	0	DNS	0	138	138
13	2-Jun	10:20	3	0	0	0	0	0	0	0	0	0	0	0	0	DNS	0	0	
	Totals		2.8	3	2.4	1	374	188	343	34	122	116	313	121	134	DNS	12	1,758	1,550

Table 42. Age, sex, and size distribution of herring sampled (ET0301) by purse seine at Amakdedulia Cove, Kamishak Bay District, Lower Cook Inlet, 28-Apr-03.

		Numbers of Fish						Percent	Weight			Length			Biomass		
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish x 1000	Tons	Tonnes
	1																
	2																
	3	9	0	7	1	0	17	3.7	88	15.9	17	201	8.6	17	1	0.2	0.2
	4	66	1	77	1	0	145	31.3	129	18.7	145	225	9.5	145	7	1.6	1.4
	5	14	0	12	0	0	26	5.6	163	22.0	26	241	11.4	26	1	0.3	0.3
	6	66	0	38	2	0	106	22.9	186	19.7	106	251	8.0	106	5	1.1	1.0
	7	63	0	51	1	0	115	24.8	208	24.8	115	259	9.0	115	5	1.2	1.1
28-Apr-03	8	18	0	11	0	0	29	6.3	233	25.4	29	266	8.8	29	1	0.3	0.3
	9	13	0	5	0	0	18	3.9	254	36.5	18	274	10.5	18	1	0.2	0.2
	10	5	0	2	0	0	7	1.5	255	21.0	7	273	8.9	7	0	0.1	0.1
	11																
	12																
	13																
	14																
	15																
	16																
Sample Total		254	1	203	5	0	463	100.0	176	48.2	463	245	20.4	463	21	5.0	4.5
Sex Composition		54.9%	0.2%	43.8%	1.1%	0.0%											
Not Aged		41	0	44	1	0	86	18.6	363	51.8	85	236	21.8	85	0	0.0	0.0
Sex Composition		47.7%	0.0%	51.2%	1.2%	0.0%											

Table 43. Age, sex, and size distribution of herring sampled (ET0302) by purse seine at White Gull Island, Kamishak Bay District, Lower Cook Inlet, 3-May-03.

		Numbers of Fish						Percent	Weight			Length			Biomass	
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish x 1000	Tons
	1															
	2	1	0	0	0	0	1	0.2	40	NA	1	156	NA	1	1	0.1
	3	12	0	7	0	0	19	4.6	95	19.7	19	196	12.9	19	9	1.8
	4	62	0	64	0	0	126	30.5	132	21.4	126	217	11.1	126	56	12.2
	5	9	0	14	0	0	23	5.6	176	17.1	23	234	7.9	23	10	2.2
	6	51	0	46	0	0	97	23.5	195	20.1	97	244	10.6	97	39	9.4
	7	54	0	42	0	0	96	23.2	213	22.4	96	247	9.0	96	38	9.3
3-May-03	8	14	0	11	0	0	25	6.1	232	25.7	25	254	9.4	25	10	2.4
	9	10	0	7	0	0	17	4.1	248	39.8	17	257	10.9	17	6	1.6
	10	4	0	2	0	0	6	1.5	274	53.1	6	260	10.7	6	2	0.6
	11	2	0	1	0	0	3	0.7	327	40.5	3	273	8.7	3	1	0.3
	12															
	13															
	14															
	15															
	16															
Sample Total		219	0	194	0	0	413	100.0	180	52.2	413	235	20.3	413	171	40.0
Sex Composition		53.0%	0.0%	47.0%	0.0%	0.0%										
Not Aged		6	0	8	1	0	15	3.6	426	79.1	15	256	24.9	15	0	0.0
Sex Composition		40.0%	0.0%	53.3%	6.7%	0.0%										

Table 44. Age, sex, and size distribution of herring sampled (ET0303) by purse seine at Illiamna Bay, Kamishak Bay District, Lower Cook Inlet, 03-May-03.

		Numbers of Fish						Percent	Weight			Length			Biomass	
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish x 1000	Tons
	1															
	2	1	0	0	0	0	1	0.3	47	NA	1	146	NA	1	0	0.1
	3	16	0	16	0	0	32	9.4	88	16.8	32	192	11.5	32	10	1.9
	4	80	1	80	0	0	161	47.4	127	18.2	162	212	9.2	162	45	9.5
	5	0	0	11	0	0	11	3.2	162	18.6	21	227	8.1	21	3	0.6
	6	0	0	49	1	0	50	14.7	186	23.1	101	236	9.8	101	12	2.9
	7	0	0	52	0	0	52	15.3	207	22.8	92	243	8.4	92	13	3.1
3-May-03	8	0	0	21	0	0	21	6.2	229	18.7	33	250	7.4	33	5	1.2
	9	0	0	9	0	0	9	2.6	231	24.4	11	254	8.5	11	2	0.5
	10	0	0	2	0	0	2	0.6	283	33.1	4	266	9.7	4	0	0.1
	11	0	0	1	0	0	1	0.3	351	NA	1	282	NA	1	0	0.1
	12															
	13															
	14															
	15															
	16															
Sample Total		97	1	241	1	0	340	100.0	156	50.2	458	223	20.5	458	91	20.0
Sex Composition		28.5%	0.3%	70.9%	0.3%	0.0%										
Not Aged		-3	0	32	1	0	30	8.8	348	68.5	86	216	58.2	86	0	0.0
Sex Composition		-10.0%	0.0%	106.7%	3.3%	0.0%										

Table 45. Age, sex, and size distribution of herring sampled (LT0301) by purse seine at McNeil Cove, Kamishak Bay District, Lower Cook Inlet, 16-May-03.

		Numbers of Fish						Percent	Weight			Length			Biomass	
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish x 1000	Tons
	1															
	2															
	3	3	0	1	0	0	4	1.7	110	4.6	4	203	1.7	4	0	0.1
	4	78	0	62	1	0	141	60.3	133	14.7	141	212	7.5	141	14	3.0
	5	12	0	13	1	0	26	11.1	163	20.3	26	227	9.5	26	2	0.6
	6	19	0	7	0	0	26	11.1	182	28.1	26	235	7.9	26	2	0.6
	7	15	0	13	0	0	28	12.0	201	30.0	28	241	9.6	28	2	0.6
16-May-03	8	4	0	2	0	0	6	2.6	227	32.2	6	247	10.8	6	1	0.1
	9	1	0	1	0	0	2	0.9	247	16.3	2	265	11.3	2	0	0.0
	10	1	0	0	0	0	1	0.4	319	NA	1	269	NA	1	0	0.0
	11															
	12															
	13															
	14															
	15															
	16															
Sample Total		133	0	99	2	0	234	100.0	154	40.7	234	221	16.5	234	23	5.0
Sex Composition		56.8%	0.0%	42.3%	0.9%	0.0%										
Not Aged		4	0	9	0	0	13	5.6	408	60.7	13	235	28.9	13	0	0.0
Sex Composition		30.8%	0.0%	69.2%	0.0%	0.0%										

Table 46. Age, sex, and size distribution of herring sampled (LT0302) by purse seine at Iniskin Bay (gut), Kamishak Bay District, Lower Cook Inlet, 18-May-03.

		Numbers of Fish						Percent	Weight			Length			Biomass	
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish x 1000	Tons
	1															
	2															
	3	78	0	44	29	0	151	32.2	75	15.5	151	184	10.5	151	9	1.6
	4	121	0	100	29	0	250	53.3	119	19.3	250	209	9.4	250	13	2.7
	5	9	0	5	1	0	15	3.2	157	27.6	15	227	8.7	15	1	0.2
	6	12	0	10	1	0	23	4.9	165	20.6	23	233	6.7	23	1	0.2
	7	16	0	4	4	0	24	5.1	192	34.1	24	242	9.4	24	1	0.3
18-May-03	8	3	0	2	1	0	6	1.3	226	30.2	6	258	11.0	6	0	0.1
	9															
	10															
	11															
	12															
	13															
	14															
	15															
	16															
Sample Total		239	0	165	65	0	469	100.0	114	39.9	469	205	20.3	469	25	5.0
Sex Composition		51.0%	0.0%	35.2%	13.9%	0.0%										
Not Aged		7	0	4	0	0	11	2.3	286	63.0	11	208	26.6	11	0	0.0
Sex Composition		63.6%	0.0%	36.4%	0.0%	0.0%										

Table 47. Age, sex, and size distribution of herring sampled (LT0303) by purse seine at Iniskin Bay (head), Kamishak Bay District, Lower Cook Inlet, 18-May-03.

		Numbers of Fish						Percent	Weight			Length			Biomass	
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish x 1000	Tons
	1															
	2	1	0	0	0	0	1	0.2	58	NA	1	165	NA	1	0	0.0
	3	75	0	60	8	0	143	30.4	81	16.6	143	184	9.3	143	17	3.0
	4	119	0	130	6	0	255	54.1	120	15.8	255	206	8.4	255	26	5.4
	5	7	0	12	0	0	19	4.0	148	20.1	19	222	11.8	19	2	0.4
	6	19	0	16	0	0	35	7.4	170	24.8	35	233	8.6	35	3	0.7
	7	9	0	6	0	0	15	3.2	185	25.6	15	235	7.5	15	1	0.3
18-May-03	8	2	0	0	0	0	2	0.4	188	31.1	2	238	8.5	2	0	0.0
	9	0	0	0	0	0	0	0.0	0	0.0	0	0	0.0	0	0	0.0
	10	0	0	1	0	0	1	0.2	251	NA	1	258	NA	1	0	0.0
	11															
	12															
	13															
	14															
	15															
	16															
Sample Total		232	0	225	14	0	471	100.0	116	34.2	471	203	18.1	471	50	10.0
Sex Composition		49.3%	0.0%	47.8%	3.0%	0.0%										
Not Aged		7	0	2	0	0	9	1.9	267	49.0	8	210	28.7	8	0	0.0
Sex Composition		77.8%	0.0%	22.2%	0.0%	0.0%										

Table 48. Age, sex, and size distribution of herring sampled (LT0304) by purse seine at Dry Bay, Kamishak Bay District, Lower Cook Inlet, 18-May-03.

		Numbers of Fish						Percent	Weight			Length			Biomass	
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish x 1000	Tons
	1															
	2															
	3	49	0	22	0	0	71	15.1	78	16.9	71	184	10.6	71	1233	226.6
	4	140	0	113	3	0	256	54.5	120	16.8	256	208	8.4	256	3927	817.0
	5	16	0	18	0	0	34	7.2	150	22.0	34	222	9.6	34	489	108.5
	6	26	0	29	0	0	55	11.7	169	20.9	55	231	10.0	55	759	175.5
	7	21	0	20	0	0	41	8.7	187	23.0	41	240	7.0	41	546	130.9
18-May-03	8	8	0	1	0	0	9	1.9	209	15.3	9	245	7.8	9	117	28.7
	9	1	0	2	0	0	3	0.6	221	22.4	3	247	6.0	3	39	9.6
	10	1	0	0	0	0	1	0.2	260	NA	1	261	NA	1	12	3.2
	11															
	12															
	13															
	14															
	15															
	16															
Sample Total		262	0	205	3	0	470	100.0	130	39.4	470	212	19.1	470	7123	1500.0
Sex Composition		55.7%	0.0%	43.6%	0.6%	0.0%										
Not Aged		4	0	6	0	0	10	2.1	340	58.0	10	224	25.9	10	0	0.0
Sex Composition		40.0%	0.0%	60.0%	0.0%	0.0%										

Table 49. Age, sex, and size distribution of herring sampled (LT0305) by purse seine at Oil Point, Kamishak Bay District, Lower Cook Inlet, 20-May-03.

		Numbers of Fish						Percent	Weight			Length			Biomass	
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish x 1000	Tons
	1															
	2	1	0	0	0	0	1	0.2	86	NA	1	187	NA	1	0	0.0
	3	28	0	24	5	0	57	12.8	81	18.6	57	184	12.5	57	14	2.6
	4	126	0	102	9	0	237	53.0	125	16.2	237	210	7.9	237	50	10.6
	5	20	0	22	1	0	43	9.6	152	25.3	43	222	12.6	43	9	1.9
	6	22	0	15	3	0	40	8.9	170	17.4	40	232	7.7	40	8	1.8
	7	39	0	13	0	0	52	11.6	188	22.1	52	239	8.8	52	10	2.3
20-May-03	8	8	0	2	1	0	11	2.5	217	25.9	11	254	5.2	11	2	0.5
	9	2	0	2	0	0	4	0.9	223	19.5	4	253	2.4	4	1	0.2
	10	1	0	1	0	0	2	0.4	267	54.4	2	261	4.9	2	0	0.1
	11															
	12															
	13															
	14															
	15															
	16															
Sample Total		247	0	181	19	0	447	100.0	137	39.9	447	215	19.6	447	94	20.0
Sex Composition		55.3%	0.0%	40.5%	4.3%	0.0%										
Not Aged		5	0	8	0	0	13	2.9	302	57.1	13	209	23.2	13	0	0.0
Sex Composition		38.5%	0.0%	61.5%	0.0%	0.0%										

Table 50. Herring biomass estimates by area and date, Southern District, Lower Cook Inlet, 2003.

Flight No.	Date	Time	Survey Rating	Spawn Sightings No.	Spawn Sightings Length	Estimated Biomass by Index Area: Anchor Pt/ Bluff Pt.	West Spit	East Spit/ N. Shore	Bear Cove	Mallard Bay	Glacier Spit	Peterson/ China Poot	Tutka Bay	Daily Total	Peak Counts
					mi.	Biomass Estimates in Tons									
1	6-May	10:03	2	0	0	0	0	67	0	0	20	0	0	87	
2	13-May	9:30	2	0	0	7	9	117	0	0	0	0	0	133	
3	20-May	9:30	1	0	0	69	36	3	0	46	2	0	0	155	
4	29-May	11:05	2	0	0	59	30	41	0	8	0	41	3	183	183
	Totals		1.8	0	0.0	135	76	228	0	54	21	41	3	558	183
					km	Biomass Estimates in Tonnes									
1	6-May	10:03	2	0	0	0	0	61	0	0	18	0	0	79	
2	13-May	9:30	2	0	0	6	8	106	0	0	0	0	0	121	
3	20-May	9:30	1	0	0	62	33	3	0	41	1	0	0	141	
4	29-May	11:05	2	0	0	54	28	37	0	8	0	37	3	166	166
	Totals		1.8	0	0.0	122	69	207	0	49	19	37	3	506	166

Table 51. Age, sex, and size distribution of herring sampled (ST0301) purse seine at Glacier Spit, Southern District, Lower Cook Inlet, 09-May-03.

		Numbers of Fish						Percent	Weight			Length			Biomass	
Sample Period	Age	Male	Imm. Female	Ripe Female	Spawned Female	Unknown	Total	of Total	Mean (g)	SD	Number Weighed	Mean (mm)	SD	Number Measured	No. Fish x 1000	Tons
	1															
	2	0	0	0	2	0	2	0.4	33	7.1	2	150	6.4	2	0	0.0
	3	11	0	10	6	0	27	5.8	75	13.0	27	186	10.2	27	3	0.6
	4	191	0	100	72	0	363	77.6	99	15.6	363	201	8.3	363	39	7.8
	5	31	0	9	14	0	54	11.5	114	16.4	54	210	10.0	54	5	1.2
	6	7	0	0	3	0	10	2.1	135	13.7	10	224	7.1	10	1	0.2
	7	4	0	1	1	0	6	1.3	145	38.6	6	226	17.2	6	1	0.1
9-May-03	8	2	0	3	0	0	5	1.1	204	18.3	5	243	9.6	5	0	0.1
	9	1	0	0	0	0	1	0.2	183	NA	1	255	NA	1	0	0.0
	10															
	11															
	12															
	13															
	14															
	15															
	16															
Sample Total		247	0	123	98	0	468	100.0	102	23.4	468	202	12.5	468	50	10.0
Sex Composition		52.8%	0.0%	26.3%	20.9%	0.0%										
Not Aged		2	0	9	1	0	12	2.6	272	12.7	11	220	3.8	11	0	0.0
Sex Composition		16.7%	0.0%	75.0%	8.3%	0.0%										

Table 52. Estimates of Pacific herring spawning activity and total run biomass by year using four different methods, Kamishak Bay District, Lower Cook Inlet, 1995-2003.

Year	[1]Preseason Forecast	[2]In Season Accumulative Aerial Survey Biomass Index	[3]In Season Aerial Survey Peaks Index	[4]Post Season ASA Hindcast Biomass Estimate	Final Total Run Biomass Estimate	[5]Aerial Survey Spawning Index (milted shoreline)	Method Used for Final Biomass Estimate
			Biomass in Tonnes, Spawn in km				
1995	19,948	6,239	5,194	22,784	NA	8.7	Poor surveys
1996	18,983	4,836	2,627	25,075	19,161	31.4	Accum. W Linear Int.
1997	22,954	2,826	2,463	14,607	NA	1.2	Poor surveys
1998	17,931	2,983	1,710	7,033	NA	2.9	Poor surveys
1999	8,616	11,300	9,818	5,229	5,785	6.0	Aerial Survey
2000	5,743	9,527	7,363	7,364	7,364	1.0	ASA Hindcast
2001	10,298	3,174	2,211	7,015	7,015	2.1	ASA Hindcast
2002	8,183	3,400	1,494	3,659	3,659	0.3	ASA Hindcast
2003	4,328	1,758	1,551	3,161	3,161	3.2	ASA Hindcast
			Biomass in Tons, Spawn in miles				
1995	21,989	6,878	5,726	25,115	NA	5.4	Poor surveys
1996	20,925	5,331	2,896	27,640	21,121	19.5	Accum./Linear Int.
1997	25,302	3,115	2,716	16,102	NA	0.8	Poor surveys
1998	19,766	3,288	1,885	7,753	NA	1.8	Poor surveys
1999	9,497	12,456	10,823	5,764	6,377	3.8	Aerial Survey
2000	6,331	10,502	8,117	8,117	8,117	0.6	ASA Hindcast
2001	11,352	3,499	2,437	7,733	7,733	1.3	ASA Hindcast
2002	9,020	3,748	1,647	4,033	4,033	0.2	ASA Hindcast
2003	4,771	1,758	1,709	3,484	3,484	2.0	ASA Hindcast

[1]Generated by an age-structured model, the preseason forecast is used to set the harvest guideline.

[2]This index is simply the sum of all herring biomass estimates made during individual survey flights. Survey conditions effect the value of this abundance index.

[3]Because the same herring schools may be observed more than once during consecutive surveys, this index counts only the peak daily observations considered "new" fish.

[4]The age-structured model used to forecast the next years biomass also hindcasts previous years biomasses based on the most current information available.

[5]Although they don't provide a reliable index of population size, aerial surveyors estimate the extent of milted shoreline as an index of spawning activity.

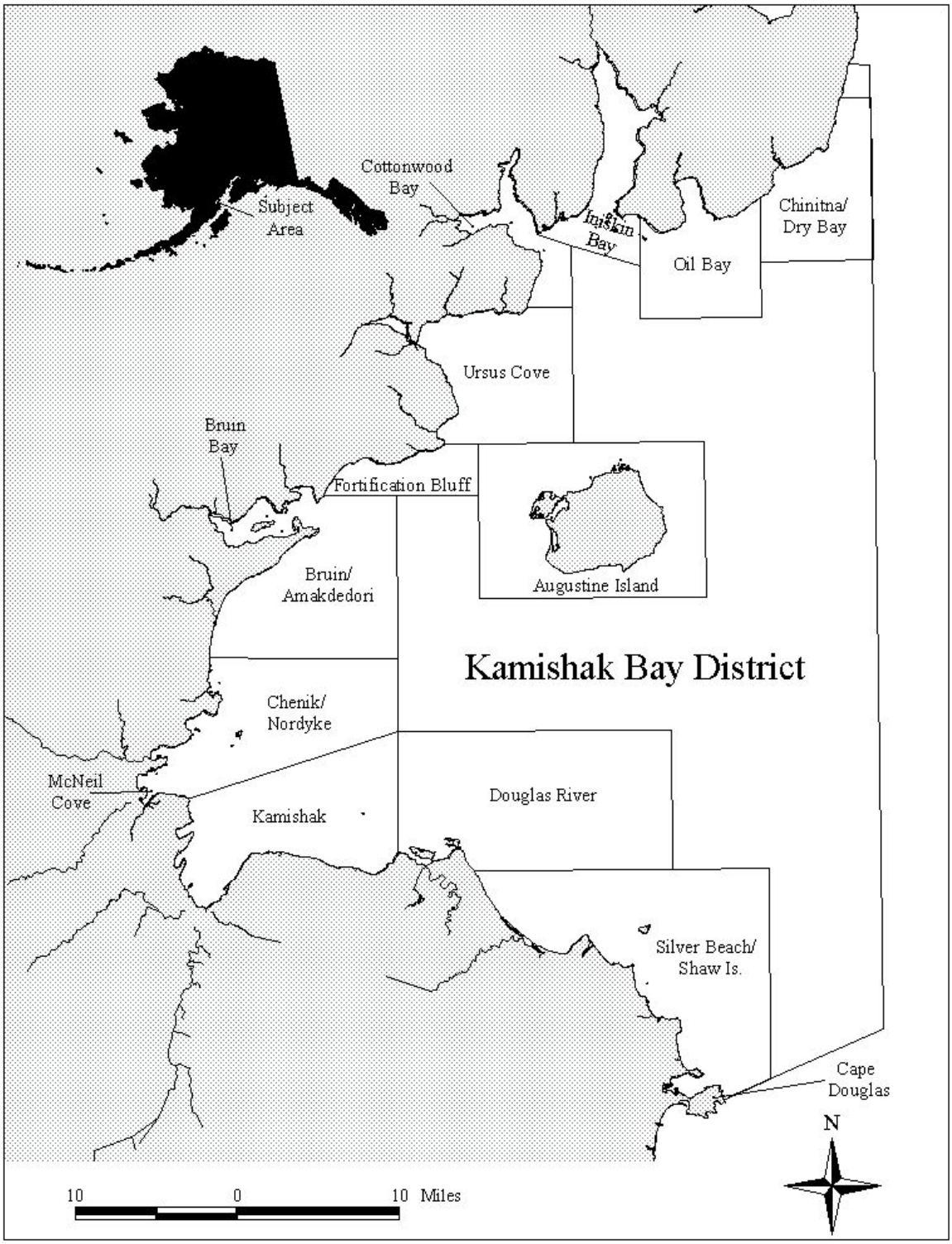


Figure 1. Map of the Kamishak Bay District and herring aerial survey index areas.

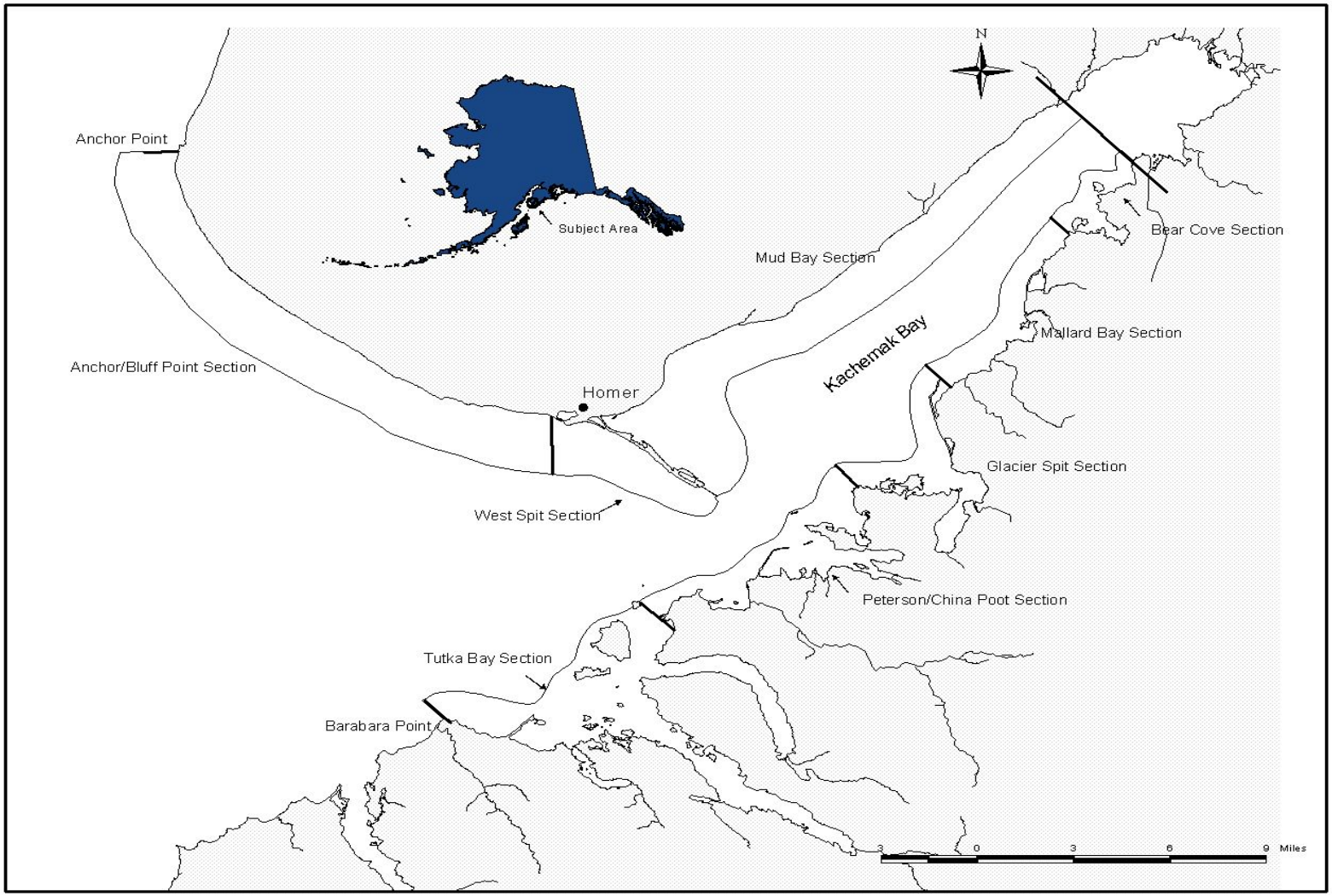


Figure 2. Map of the Southern District and principal herring aerial survey index areas.

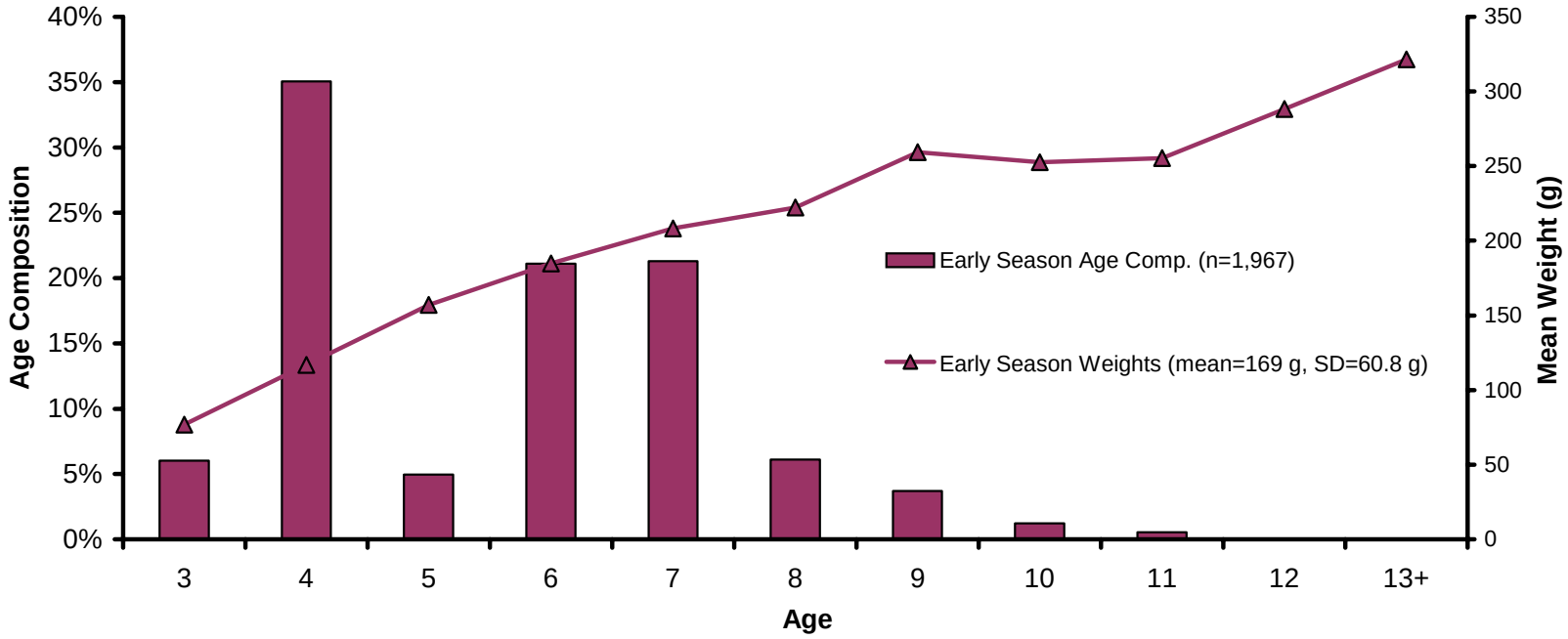


Figure 3. Age composition and mean weight-at-age of herring sampled in Kamishak Bay during 28 April-5 May, 2000.

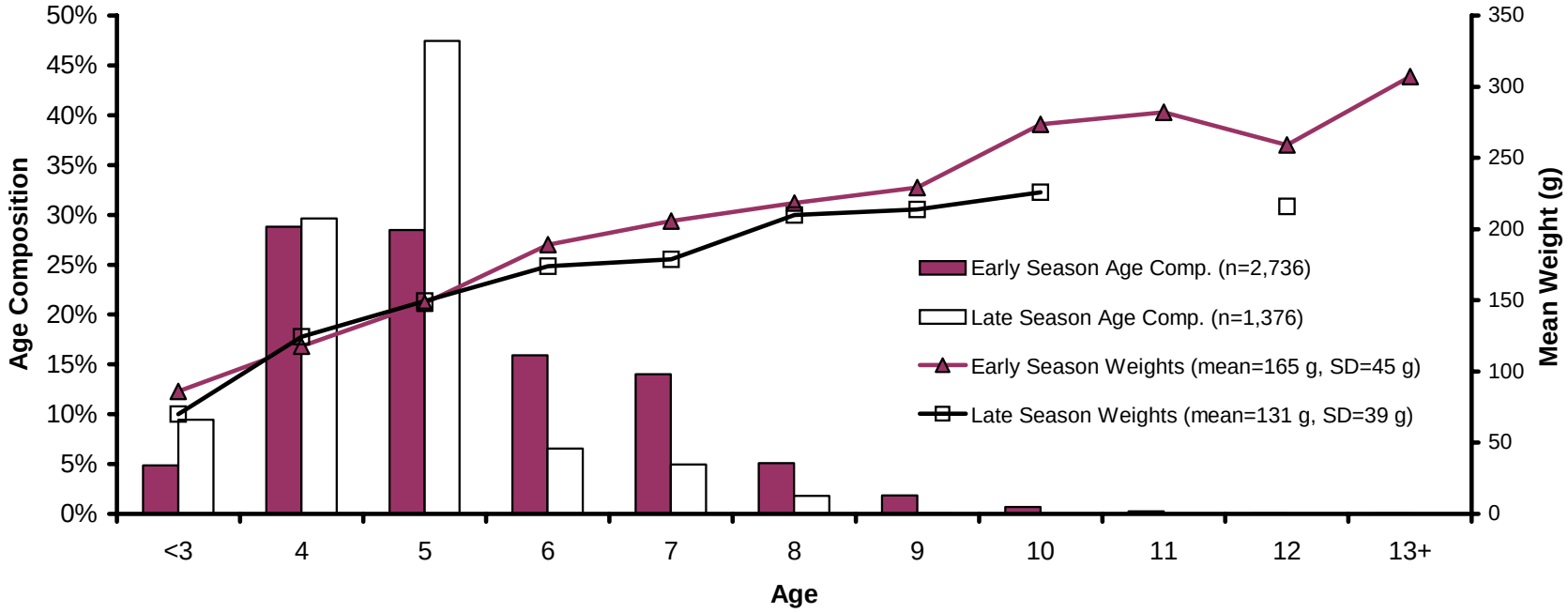


Figure 4. Age composition and mean weights-at-age of two temporally distinct spawning aggregations of herring sampled in Kamishak Bay, 2001.

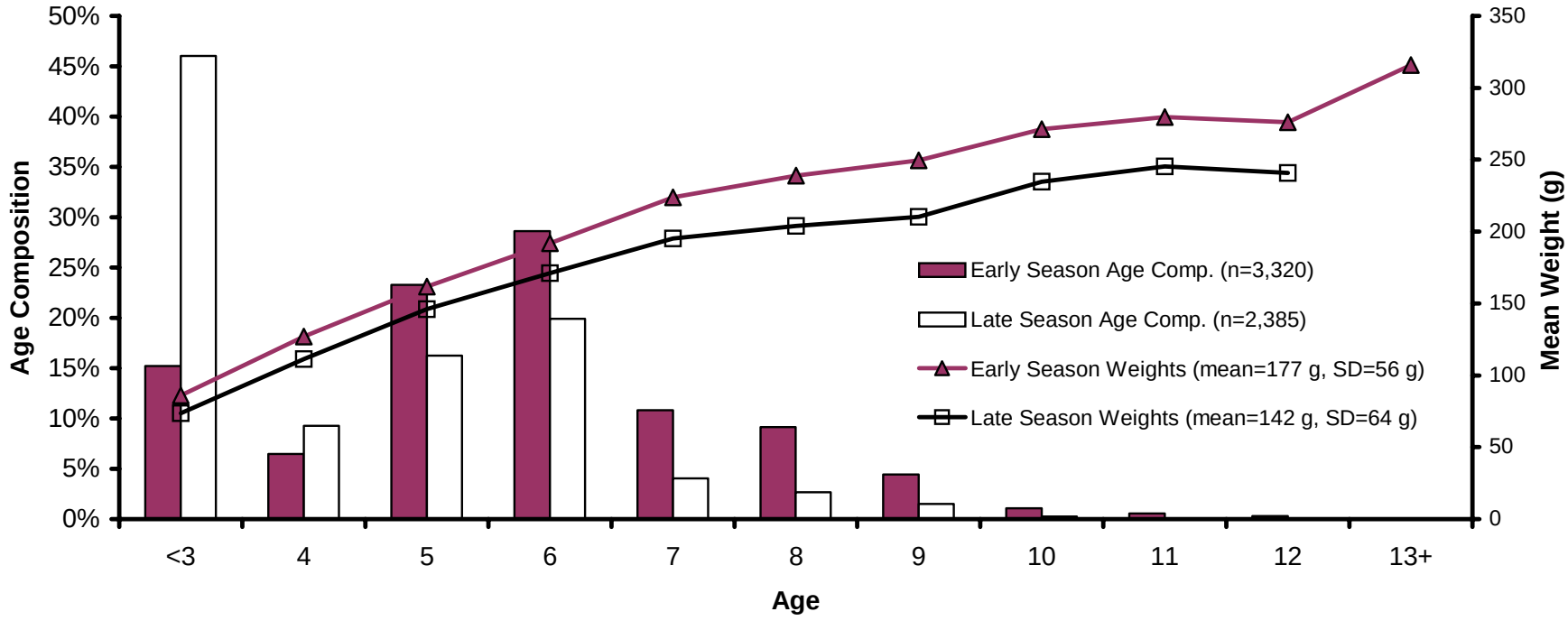


Figure 5. Age composition and mean weights-at-age of two temporally distinct spawning aggregations of herring sampled in Kamishak Bay, 2002.

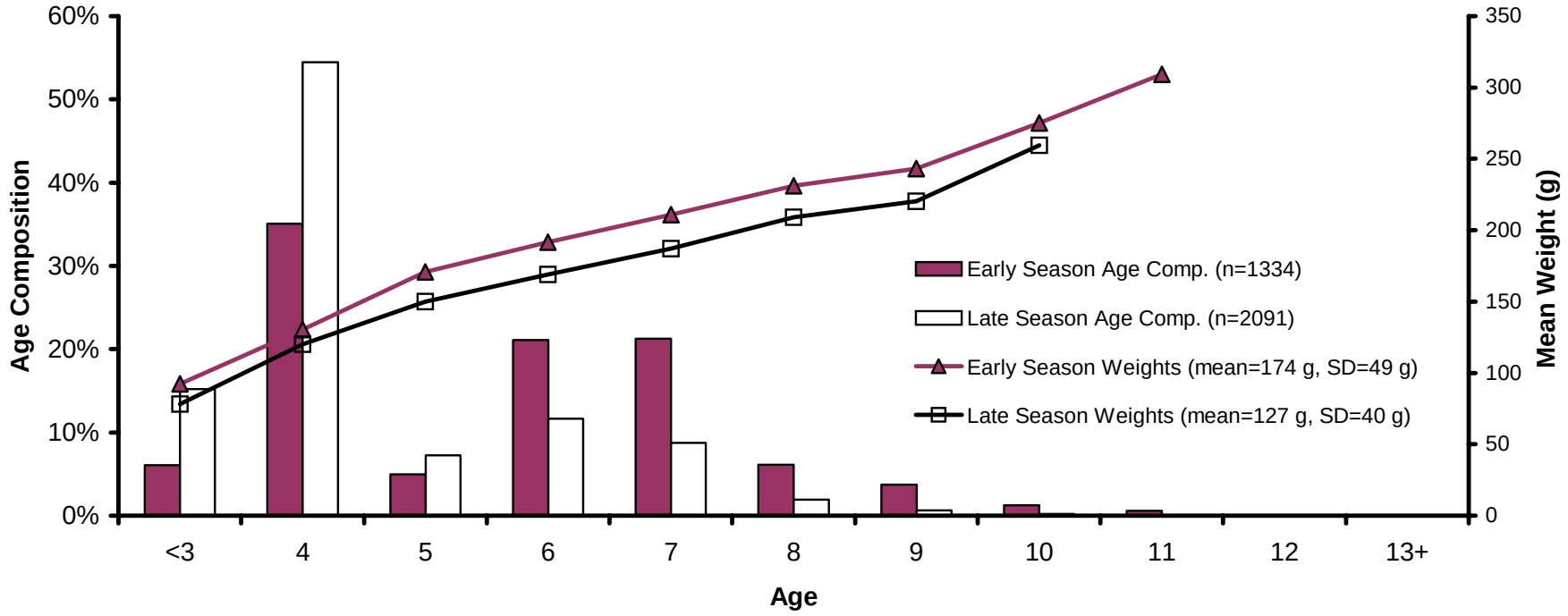
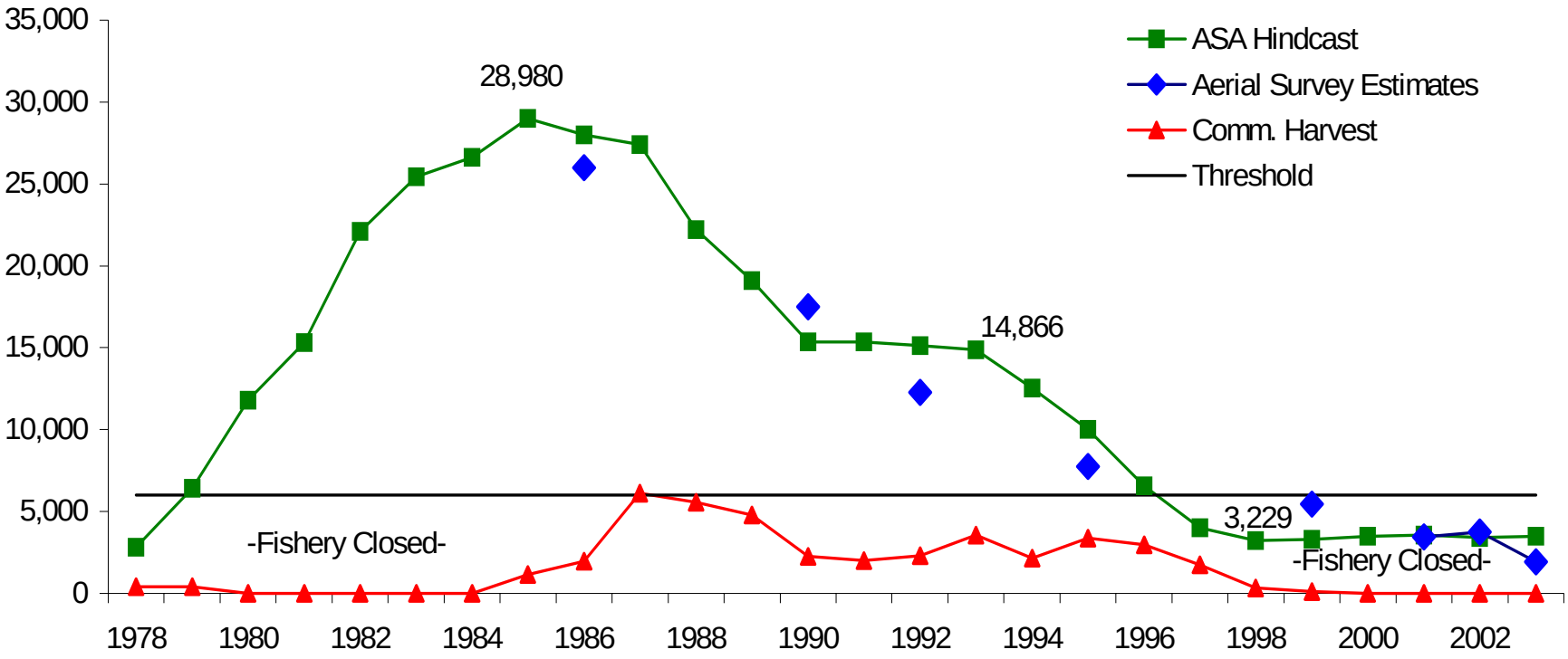


Figure 6. Age composition and mean weights-at-age of two temporally distinct spawning aggregations of herring sampled in Kamishak Bay, 2003.

APPENDIX

Appendix A. Commercial herring harvest abundance (x 1,000) by harvest year, Kamishak Bay District, Lower Cook Inlet, 1978-2003.

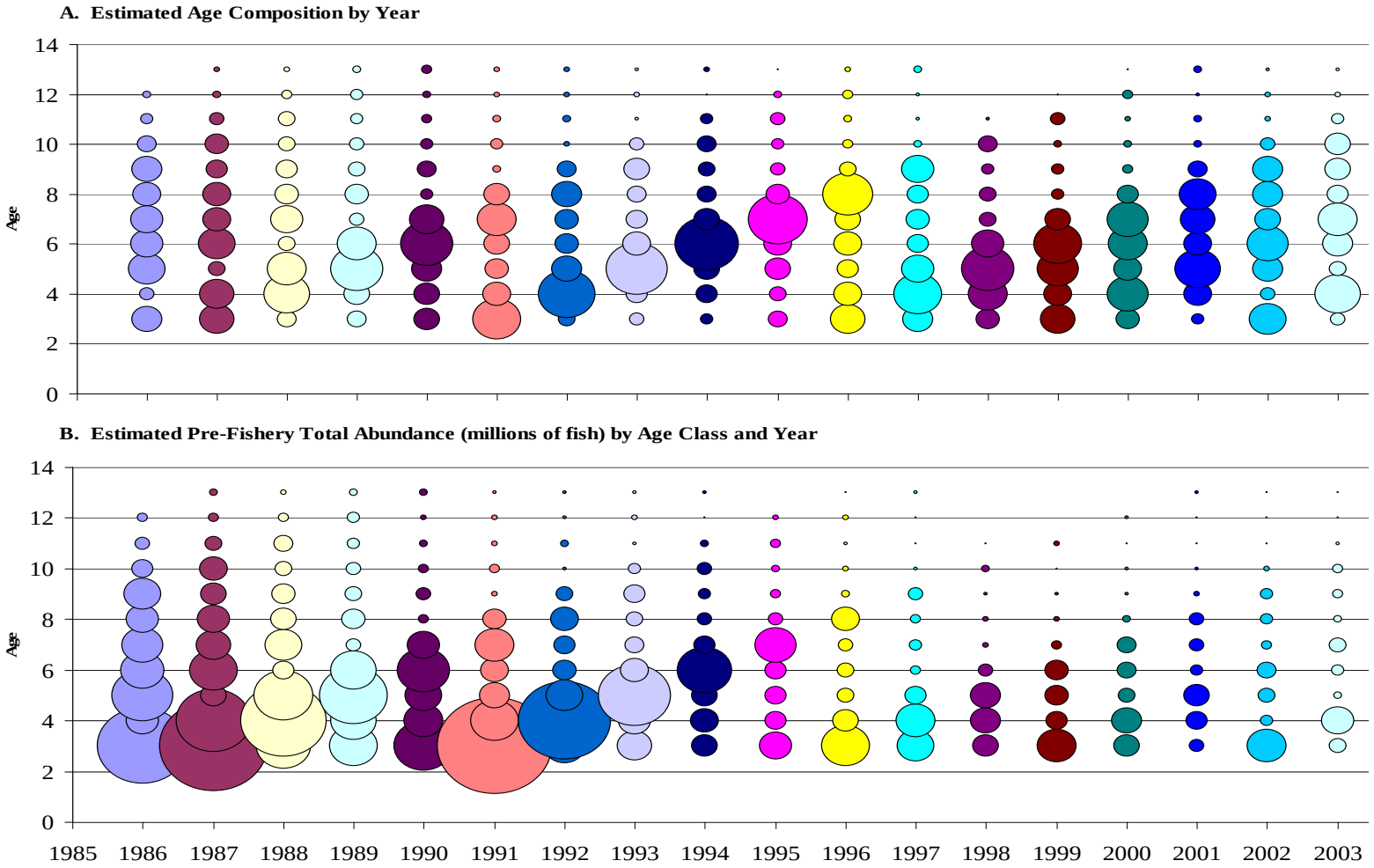
	Age																
Harvest Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total Harvest
1978	0	55	400	1,353	915	93	88	131	110	110	44	11	0	0	0	0	3,310
1979	0	0	0	618	533	1,012	725	53	32	43	21	21	21	0	0	0	3,079
1980	No Commercial Harvest																
1981	No Commercial Harvest																
1982	No Commercial Harvest																
1983	No Commercial Harvest																
1984	No Commercial Harvest																
1985	0	0	10	569	700	1,124	739	1,177	433	253	204	49	0	0	0	0	5,258
1986	0	0	1,093	227	1,028	889	1,586	1,190	1,609	647	25	196	58	8	0	0	8,556
1987	0	0	2,342	3,098	476	5,133	3,612	3,696	2,454	3,182	1,335	579	476	112	9	0	26,504
1988	90	6	120	5,593	5,338	592	5,160	2,687	2,743	1,231	1,485	481	92	103	14	0	25,735
1989	0	0	12	388	7,599	4,704	825	2,796	1,615	1,168	938	662	234	51	57	37	21,086
1990	0	0	154	364	603	4,327	2,333	647	789	444	211	94	34	26	2	15	10,043
1991	0	0	1,102	697	787	945	3,690	1,462	45	270	112	22	22	0	0	0	9,154
1992	0	0	87	8,344	1,848	520	491	1,415	491	115	173	29	29	58	0	0	13,600
1993	0	0	26	367	10,077	2,362	945	945	1,916	630	105	52	26	26	0	0	17,477
1994	0	0	0	187	343	4,589	949	654	488	971	507	77	53	53	22	20	8,913
1995	0	0	49	346	673	1,035	6,959	1,366	756	724	756	312	66	0	0	0	13,040
1996	0	0	49	687	1,079	1,006	1,227	5,691	1,006	393	245	196	148	0	0	0	11,727
1997	0	0	543	1,911	1,006	564	1,036	961	2,004	229	98	66	21	0	0	0	8,439
1998	0	0	71	220	694	283	92	129	89	94	9	7	5	0	0	0	1,693
1999	0	0	52	37	121	181	77	26	23	9	7	1	0	0	0	0	534
2000	No Commercial Harvest																
2001	No Commercial Harvest																
2002	No Commercial Harvest																
2003	No Commercial Harvest																



Appendix B. Age Structured Assessment model hindcast biomass trend, aerial survey biomass estimates, and commercial harvests for Kamishak Bay Pacific herring, 1978-2003.

Appendix C. Commercial herring harvest age composition (%) by year of harvest, Kamishak Bay District, Lower Cook Inlet, 1978-2003.

Harvest Year	Age ≤3	4	5	6	7	8	9	10	11	12	13+
1978	13.8	41.0	27.6	2.8	2.6	4.0	3.3	3.3	1.3	0.3	0.0
1979	20.1	17.3	32.9	23.5	1.7	1.0	1.4	0.7	0.7	0.7	0.0
1980	No Commercial Harvest										
1981	No Commercial Harvest										
1982	No Commercial Harvest										
1983	No Commercial Harvest										
1984	No Commercial Harvest										
1985	0.2	10.8	13.3	21.4	14.1	22.4	8.2	4.8	3.9	0.9	0.0
1986	12.4	2.6	11.7	10.1	18.1	13.6	18.3	7.4	2.8	2.2	0.8
1987	8.8	11.7	1.8	19.4	13.6	13.9	9.3	12.0	5.0	2.2	2.3
1988	0.5	21.8	20.8	2.3	20.1	10.5	10.7	4.8	5.8	1.9	0.8
1989	0.1	1.8	36.0	22.3	3.9	13.3	7.7	5.5	4.4	3.1	1.8
1990	1.5	3.6	6.0	43.1	23.2	6.4	7.9	4.4	2.1	0.9	0.8
1991	12.0	7.6	8.6	10.3	40.3	16.0	0.5	2.9	1.2	0.2	0.2
1992	0.6	61.4	13.6	3.8	3.6	10.4	3.6	0.8	1.3	0.2	0.6
1993	0.1	2.1	57.5	13.6	5.4	5.4	11.0	3.6	0.6	0.3	0.3
1994	0.0	2.1	3.9	51.4	10.7	7.3	5.6	10.9	5.7	0.9	1.6
1995	0.4	2.7	5.2	7.9	53.4	10.5	5.8	5.5	5.8	2.4	0.5
1996	0.4	5.9	9.2	8.6	10.5	48.5	8.6	3.4	2.1	1.7	1.3
1997	6.4	22.6	11.9	6.7	12.3	11.4	23.7	2.7	1.2	0.8	0.2
1998	4.2	13.0	41.0	16.7	5.4	7.6	5.3	5.6	0.5	0.4	0.3
1999	9.7	6.9	22.7	33.9	14.4	4.9	4.3	1.7	1.3	0.2	0.0
2000	No Commercial Harvest										
2001	No Commercial Harvest										
2002	No Commercial Harvest										
2003	No Commercial Harvest										



Appendix D. Bubble plots illustrating the relative abundance of each age class year (A) and the absolute abundance of Pacific herring by age class and year (B), Kamishak Bay, 1986-2003. Both data series were estimated by an Age Structured Assessment (ASA) model used to simultaneously forecast the next year's herring abundance and age composition while hindcasting the previous year's values for these parameters.

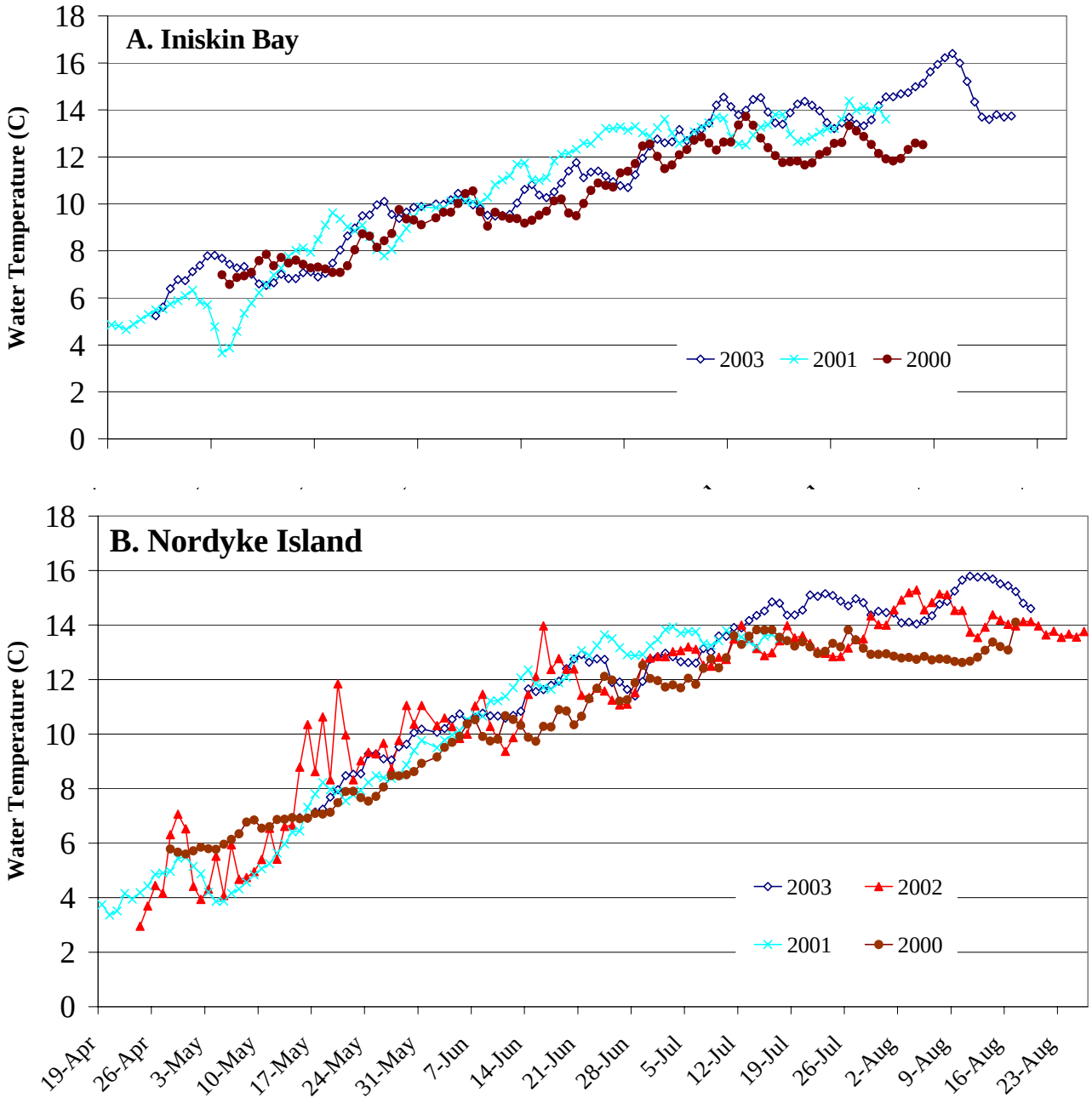
Appendix E. Herring weight-at-age (g) by sample year, Kamishak Bay District, Lower Cook Inlet, 1978-2003. Estimates represent the mean weight-at-age calculated from early- and late-season samples weighted by each period's aerial survey biomass estimates.

	Age											
Year	3	4	5	6	7	8	9	10	11	12	13+	unweighted Mean wt
1978	61	85	121	168	170	188	204	217	212	247	NA	167
1979	68	98	128	156	170	197	210	221	272	265	NA	179
1980[a]	***69***	***107***	***136***	***155***	***186***	***204***	***219***	***229***	***260***	***270***	***NA***	***184***
1981[a]	70	88	124	121	***186***	***204***	***219***	***229***	***260***	***270***	***NA***	***177***
1982[a]	***69***	***107***	***136***	***155***	***186***	***204***	***219***	***229***	***260***	***270***	***NA***	***184***
1983[a]	74	118	137	160	182	196	210	218	253	***270***	***NA***	***182***
1984[a]	***69***	***107***	***136***	***155***	***186***	***204***	***219***	***229***	***260***	***270***	***NA***	***184***
1985	64	125	155	182	205	220	238	248	255	275	NA	197
1986	88	104	155	189	215	233	249	261	272	281	292	213
1987	91	134	162	198	218	241	251	267	276	275	288	218
1988	84	123	163	196	218	236	248	261	266	280	298	216
1989	98	131	158	199	228	245	254	268	285	288	298	223
1990	90	135	162	182	220	245	256	273	289	303	310	224
1991	79	118	172	208	214	259	267	288	280	229	413	230
1992	99	116	156	210	229	234	266	304	303	279	333	230
1993	88	131	152	193	230	245	260	293	302	317	382	236
1994	***91***	147	174	190	223	256	261	283	300	315	325	233
1995	76	124	168	200	223	258	282	295	310	325	327	235
1996	81	119	162	199	224	241	264	299	298	311	326	229
1997	80	120	151	189	206	222	233	264	271	290	278	209
1998	79	126	156	179	204	222	237	249	261	283	291	208
1999	76	121	149	170	187	210	223	233	241	244	292	195
2000[b]	***76***	***121***	***149***	***170***	***187***	***210***	***223***	***233***	***241***	***244***	***292***	195
2001	78	121	149	181	191	214	221	248	282	259	307	205
2002	75	113	148	174	199	209	215	239	280	276	316	204
2003	85	125	160	180	198	220	231	267	309	***261***	***300***	212
Mean	80	119	153	182	206	227	241	260	275	278	316	213
Max	99	147	174	210	230	259	282	304	310	325	413	250
Min	61	85	121	121	170	188	204	217	212	229	278	171

Due to inadequate sample sizes, bold italicized weights were estimated from the mean weight-at-age from previous years.

[a] The fishery was closed during 1980-1984 and very few samples were collected to estimate mean weight-at-age.

[b] Because there were no late season samples collected in 2000, and therefore no way to calculate a weighted mean weight-at-age, we used the 1999 values in 2000.



Appendix F. Mean daily water temperatures* recorded by thermographs deployed 2-meters below the surface at Iniskin Bay and Nordyke Island, 2000-2003.

**Note that bogus values were periodically recorded by the Nordyke Island thermograph in 2002 because it became exposed during minus tides.*