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# Pacific Herring Stocks and Fisheries in the Arctic-Yukon-Kuskokwim Region of the Bering Sea, Alaska, 1995

A Report to the Alaska Board of Fisheries


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# INTRODUCTION

The objectives of this report are to summarize the results of the 1995 herring stock assessment programs of the Arctic-Yukon-Kuskokwim (AYK) Region, review 1995 harvests and management strategies of all AYK commercial herring fisheries and the Yukon-Kuskokwim River Delta subsistence fishery, and present general management strategies planned for the AYK herring fishing season in 1996. Commercial fishing districts included in this report consist of the Security Cove, Goodnews Bay, Cape Avinof, Nelson Island, Nunivak Island, Cape Romanzof, Norton Sound, and Port Clarence Districts (Figures 1 and 2).

The Alaska Board of Fisheries established threshold biomass levels, below which harvests are not allowed under the Bering Sea Herring Fishery Management Plan (5 AAC 27.060, ADF&G 1994), for all districts with the exception of the Port Clarence District. Exploitation rates are limited to a maximum of 20% in all areas. In some areas the Board of Fisheries has further restricted exploitation rates to protect subsistence harvests. Fishing effort has been limited by a moratorium which was placed on entry into the Nelson Island, Nunivak Island, Cape Romanzof, and Norton Sound herring fisheries in 1987. In addition, all AYK Region commercial herring districts, except Security Cove and Port Clarence, are designated as superexclusive use areas.

A total biomass of 69,660 tons of herring was estimated to have been present in the surveyed portion of the AYK Region herring districts in 1995. This is nearly the same as was estimated in 1994 but is less than the record biomass of 90,243 tons observed in 1992 (Tables 2 and 5). The 1995 return is slightly less than the 5-year average (1990-1994) of 71,043 tons. Ages 7 and 8 combined comprised 35% to 40% of the biomass for districts south of Norton Sound with the exception of Nunivak Island. Ages 5 and 7 dominated the Nunivak Island biomass and age 7 herring comprised approximately one-third of the Norton Sound biomass. Recruitment was strong in most of the Kuskokwim districts, where recruits, ages 2 through 5, comprised 39% to 46% of the return in numbers of fish, with the exception of Goodnews Bay where recruits represented 26% of the return. Relatively little recruitment was observed in either the Norton Sound or Cape Romanzof districts (10% and 13%, respectively).

The 1995 herring harvest for the AYK Region was approximately 11,299 tons with an estimated exvessel value of $7,433,000 (Tables 1 and 2). This dramatic increase in both harvest and value compared to 1994 levels of 3,636 tons and $1,181,000 is primarily due to record harvests in Norton Sound, Security Cove, Cape Avinof, Nelson Island, and a near-record harvest in Goodnews Bay. In addition, the price paid to fishermen for a ton of herring was twice that paid in 1994. The harvest is nearly twice the 5-year average (1990-1994) of 5,763 tons and the value is more than three times the 5-year average of $2,298,400 (Table 2). The price paid to fishermen in AYK fishing districts was approximately $600 per ton for herring with 10% roe content plus or minus $60 a percentage point and $50 per ton for bait-quality herring. Food and bait sales during the sac roe fishery totaled 123 tons, with the remaining harvest sold as sac roe product. Harvest identified as food and bait primarily occurs during the sac roe fisheries when fish are sold with a roe content that is below

buyer's acceptable minimums. In some years, wastage occurs when fishermen abandon gillnets or cannot sell their catch. This amount is added to the total harvest and is included in calculations of exploitation rates. In 1995, 13 tons of herring were discarded (Table 2).

A total of 703 fishermen participated in AYK sac roe herring fisheries during the 1995 season (Table 3). This is the highest effort since 1990. Effort had been declining in recent years as fishermen have been discouraged by both low prices and fewer buyers than in previous years. There was no herring fishery in the Port Clarence District during the sac roe season in 1995. There has not been a commercial sac roe fishery in the Port Clarence District since 1988 due to a lack of buyers. In most years there has been a small bait fishery in the Port Clarence District.

Surveyed subsistence fishermen from selected Yukon-Kuskokwim River Delta villages harvested approximately 104 tons of herring (Table 4).

Average roe recovery of the sac roe harvest ranged from 10.1% in the Cape Romanzof District to 13.5% in the Goodnews Bay District, with a regional average of 11.0%. Record roe recoveries were observed in all AYK districts. An awareness among processors, managers and fishermen of the poor market conditions and the need for a high-quality product helped produce high roe percentages again this year. Managers strived to limit period harvests to an amount that could be processed within three days. The 1995 total exploitation rate for the AYK Region was 16.2%. Exploitation rates ranged from 0.9% in the Nunivak Island District to 25.0% in the Goodnews Bay District (Table 2).

Biomass projections for each district using postseason escapement estimates, historic mean rates of survival, current mean weights for each age class and estimates of recruitment for each age class (Wespedstad 1982), suggest that the 1996 spawning biomass for the northeastern Bering Sea herring stocks (Security Cove to Norton Sound) will be approximately 53,323 tons with a projected harvest of 10,335 tons (Table 7). This is a slight decline from the 1995 biomass of 69,660 tons. Districts with projected declines are either those with poor aerial survey conditions in 1995, e.g. Security Cove and Goodnews Bay, or Norton Sound where a slight decline is expected as the predominant year class ages. These projections do not include age classes not yet seen in the fishery.

Variability in survival rates and in aerial survey assessments of biomass and deviations from the assumed survival or recruitment rates may result in the observed biomass being either above or below these projections. Harvest levels will be adjusted during the season according to observed herring spawning biomass. In addition, in accordance with the AYK Region harvest policy, newly recruited age classes will not be targeted by the commercial fishery. If it is not possible to determine herring abundance using aerial survey methods, stock abundance will be assessed using information from the projected biomass, test and commercial catches and spawn deposition observations.

## STOCK STATUS

*Assessment Methods*

The arrival of herring in the northeastern Bering Sea is greatly influenced by climate and oceanic conditions, particularly the extent and distribution of the Bering Sea ice pack. Most herring appear immediately after ice breakup, which generally occurs between late-April and mid-June. Spawning usually begins in the Security Cove District and generally progresses in a northerly direction. In some areas spawning may continue as late as July.

Aerial survey techniques have been used since 1978 in Bering Sea herring fisheries to estimate herring spawning biomass (Lebida and Whitmore 1985). However, it is often difficult to obtain biomass estimates from aerial surveys in the AYK Region because of poor survey conditions caused by unfavorable weather, ice conditions or turbid water. Herring school surface areas are recorded in 538 $ft^2$ relative abundance index (RAI) units. In the AYK Region, RAI units are converted to biomass based on water depth. Because purse seine gear is needed to estimate the conversion factors, and purse seine gear is not fished in the AYK Region, these conversion factors were estimated from sampling performed in the Togiak District. Ground surveys are conducted in some districts to obtain information on the distribution and density of kelp beds and herring spawn deposition.

During 1995, 83 aerial surveys totaling 96.1 hours of flight time were flown in the AYK Region: 11 (5.6 hours) in Security Cove, 10 (4.8 hours) in Goodnews Bay, 3 (1.5 hours) in Cape Avinof, 15 (8.1 hours) in Nelson Island, 8 (10.7 hours) in Nunivak Island, 8 (1.6 hours) in Jacksmith Bay, 6 (1.8 hours) in Cape Romanzof, and 22 (62.0 hours) in Norton Sound and Port Clarence combined. Only one-fifth of these were rated as acceptable surveys.

Gillnets are the only legal gear in the AYK Region with the exception of Norton Sound, where a portion of the harvest is taken by beach seine. An attempt was made to sample at least 420 herring from each commercial gear type and district or subdistrict. The sampling goal for test fish catches was to sample a minimum of 60 herring per day or 420 per week from each district or subdistrict. Herring from test fish and commercial catches were sampled in all but the Port Clarence District to estimate age, sex, size, and sexual maturity of herring and to note the occurrence of other schooling fishes. A total of 17,337 herring from commercial, subsistence and test catches were during the 1995 fishing season.

In most districts, fishermen, in cooperation with the department, provided catch samples for roe quality evaluation by industry representatives. Participation by fishermen in collecting samples, processor evaluation of samples, and the flexibility of fishermen to fish on short notice aided in obtaining optimum roe recoveries.

*Spawning Populations*

Security Cove District

Since 1981, the estimated biomass of herring in the Security Cove District has ranged from 2,300 tons in 1987 to 8,267 tons in 1981 (Table 5). During the 1995 season, eleven aerial surveys were flown in the district between May 7 and June 1 to estimate herring biomass and observe spawning activity. Only one of these surveys was flown under acceptable conditions. On May 11, 5,279 tons of herring were observed during an aerial survey. Since there were no other acceptable surveys, the preseason forecasted biomass of 6,702 tons was used as the total biomass estimate for 1995. This is the second year in a row that the preseason projection was used to estimate biomass due to poor survey conditions. A total of 18.2 miles of spawn was observed in the district with peak spawning activity (8.5 miles) on May 11.

The Security Cove test fish crew sampled 1,306 fish caught with variable mesh gillnets from May 9 to May 29. Ages 7 and 8 dominated the biomass (20.9% and 18.2% respectively; Figure 5) and ages 4 and 5 dominated the return in numbers of fish (21.3% and 19.2% respectively). Age 9 and older herring comprised 26% of the biomass. Recruit herring represented 41% of the return in numbers of fish (Figure 7).

Goodnews Bay District

Since 1981, the estimated biomass of herring in the Goodnews Bay District has ranged from 2,000 tons in 1987 to 6,211 tons in 1993 (Table 5). During the 1995 season, ten aerial surveys were flown in the district between May 7 and June 1. Due to turbidity caused by high winds no surveys were flown under acceptable conditions. On May 11, 3,302 tons were observed during an aerial survey flown under poor conditions. The Department's test fish crew documented spawning activity on May 8. Since conditions were unacceptable for estimating herring biomass from aerial surveys in 1995, the preseason projection of 4,219 tons was used as the estimate of herring biomass. This is the second consecutive year that weather conditions in Goodnews Bay precluded a herring biomass estimate from aerial surveys. One-half mile of spawn was observed during an aerial survey on May 10.

The Department's test fish crew sampled 1,540 herring caught with variable mesh gillnets from May 5 to May 29. Ages 7 and 8 dominated the return in both biomass (21.5% and 19.9%, respectively) and numbers of fish (22.1% and 18.2%, respectively). Age 9 and older herring comprised 38.8% of the biomass. Recruit herring represented 26.2% of the return in numbers of fish (Figure 7).

Cape Avinof District

Aerial surveys have been conducted by the department in the Cape Avinof area since 1985 and biomass estimates have ranged from 1,225 tons in 1987 to 4,108 tons in 1988 (Table 5). During 1995, three surveys were flown in the Cape Avinof District from May 23 to June 6. None of these were flown under acceptable aerial survey conditions. The total biomass present in the district was estimated to be 3,627 tons based on a comparison of the commercial fishery CPUE in 1994 and 1995.

The Cape Avinof test fish crew sampled 1,039 fish caught with variable mesh gillnets from May 24 to June 7. Age 7 dominated the biomass (24.6%) and age 5 dominated in numbers of fish (25.5%). Age 9 and older herring comprised 27.1% of the biomass. Recruit herring represented 45.9% of the returning population (Figure 7).

Nelson Island District

Since 1985, biomass estimates of herring in the Nelson Island District have ranged from 2,385 tons in 1991 to 9,500 tons in 1985 (Table 5). In 1995, fifteen aerial surveys were flown in the Nelson Island area between May 15 and June 6. Five of these surveys were made under acceptable conditions. During a survey flown on May 22, 3,715 tons of herring were observed in the district. On a second survey, flown May 31, 3,323 tons of herring were seen. Changes in age composition of test catches before and after May 28 indicate that some new fish had entered the district after May 28. The total biomass estimate of 7,754 tons was calculated by combining the May 22 and May 31 surveys and the commercial harvest before May 22. A total of 5.5 miles of spawn was observed during aerial surveys of the district. Peak spawning was observed on May 28 when 3.2 miles of spawn were sighted.

Test fishing with variable mesh gillnets occurred from May 17 through June 15. Of the fish caught, 2,089 herring were sampled for biological data. Age 7 dominated the returning biomass (24.5%, Figure 5) and age 5 dominated in numbers of fish (24.1%). Age 9 and older herring comprised 29.4% of the biomass. Recruit herring represented 39.1% of the spawning population (Figure 7).

Nunivak Island District

Since 1985, the estimated biomass in the Nunivak Island District has ranged from 422 tons in 1990 to 6,000 tons in 1986 (Table 5). In 1995, eight aerial surveys were flown in the Nunivak Island District between May 17 and June 6. During an aerial survey on May 31, 842 tons of herring were observed. Total biomass in the district was assumed to be 4,579 tons based on the projected return from the 1994 escapement. About 4.4 miles of spawn were observed during aerial surveys with peak spawning (2.1 miles) occurring on May 21. An industry spotter pilot reported seeing approximately 10 miles of spawn on May 20.

Test fishing with variable mesh gillnets occurred from May 13 through June 7. From this catch, 1,369 herring were sampled for biological data. Age 7 dominated the biomass (20.3%) and age 5 dominated the return in numbers of fish (26.5%; Figure 6). Age 9 and older herring comprised 34.7% of the biomass. Recruit herring represented 46.0% of the spawning population (Figure 7).

Cape Romanzof District

Due to excessive water turbidity in the Cape Romanzof area, it is generally not possible to estimate herring biomass using aerial survey techniques. Biomass has been estimated using information from aerial surveys, test and commercial catches, spawn deposition, and age composition. Six aerial surveys were flown during the 1995 season from May 18 through June 8. A total of 1.8 hours were surveying the district. None of the surveys were flown under acceptable survey conditions. The largest quantity of herring observed during an aerial survey was 400 tons on June 5. The projected biomass of 3,417 tons was used to manage the fishery. Based on other indicators of abundance, the 1995 biomass of herring in the Cape Romanzof District was estimated postseason to be about 5,000 tons.

Daily qualitative spawn deposition surveys were conducted from May 13 until June 7. A light deposition of herring spawn was first observed on May 15 in Kokechik Bay. Artificial spawning substrates used in a quantitative spawn deposition study were located in the same locations as in 1992 through 1994. Forty platforms, covered with an artificial spawning substrate, were placed just north of the department's field camp on May 16 and 17. Spawn deposited on the substrate was removed and weighed daily at low tide. Daily removal of spawn allowed measurements of new spawn deposition and decreased the problem of spawn loss due to wave action and desiccation observed in previous studies. The largest spawn depositions within the study area occurred on May 16, 18, 19, and 29. The spawn deposition index of 4,985 g obtained this year was the largest since the study was initiated in 1992. The spawn deposition index was 2,403 g in 1992, 3,746 g in 1993 and 4,068 g in 1994. Although the spawn deposition this year was the largest, it is unknown whether the study area results are indicative of the total spawning biomass within the entire district.

The Department's test fish crew at Cape Romanzof sampled 1,545 herring which were caught from May 15 through June 7 with variable mesh gillnets. Age 7 herring dominated the return in both biomass (22.3%) and numbers of fish (23.3%). Age 9 and older herring comprised 50.3 % of the biomass (Figure 6). Recruit herring represented 12.5 % of the spawning population (Figure 7).

Norton Sound District

Historically, the primary spawning areas within Norton Sound have been from Stuart Island to Tolstoi Point. Additional spawning areas have been documented along Cape Denbigh and several bedrock outcroppings along the northern shore of Norton Sound between Bald Head and Topkok, especially in years when sea ice has remained in the nearshore areas into June.

Since 1978, herring biomass estimates in the Norton Sound District have ranged from 5,291 tons in 1978 to 57,974 tons in 1992. During 1995, 22 surveys were flown between May 15 and June 14. Aerial survey conditions were generally rated from fair to poor during the 1995 herring season Only six surveys were flown under acceptable survey conditions. Herring were first sighted during an aerial survey on May 19 and a heavy spawn was first observed on May 22. The 1995 herring biomass for Norton Sound of 37,779 tons was calculated by combining the estimated season's harvest to-date with the peak survey of 34,255 tons.

Two Department field crews were operational during the 1995 season. One crew operated from Cape Denbigh and the second crew operated from Klikitarik. Test fishing was conducted in the Unalakleet area as time allowed. Test fish crews sampled 2,942 herring caught with variable mesh gillnets from May 19 through June 9 for biological data. Age 7 herring comprised 28.8% of the biomass and 32.8% of the return in numbers of fish. The biomass consisted of 52.5% age 9 and older herring (Figure 6). Recruit herring represented 10.1% of the return in numbers of fish (Figure 7).

Port Clarence District

Generally, it is not possible to survey this district due to ice, water stain, and poor weather. In addition, it is difficult to identify herring due to the large numbers of saffron cod, whitefish, and other pelagic species typically present in the area. A record biomass for this district of 1,652 tons was sighted during an aerial survey in 1992. In 1995, two aerial surveys were flown in the district, but no herring were spotted.

## SUBSISTENCE FISHERY

Pacific herring are an important component of the diet of residents of many Yukon-Kuskokwim Delta villages. Surveys of subsistence harvests have been conducted annually in Yukon Delta villages and sporadically in Kuskokwim Delta villages since 1975.

Extensive subsistence surveys have been conducted in most years since 1990 by Subsistence Division in the Nelson and Nunivak Island Districts in the Kuskokwim Area (Pete 1990, 1991, 1992, 1993). A total of 98.4 tons of herring was harvested for subsistence by 91 Nelson Island fishing families in 1995 (Table 4). No herring subsistence surveys were conducted on Nunivak Island in 1995.

During 1995, a subsistence harvest of 6 tons was estimated to have been taken by 42 fishing families from the Yukon Delta villages of Hooper Bay, Chevak, and Scammon Bay (Table 4). In addition, 706 pounds of spawn-on-kelp (*fucus*) were harvested for subsistence use by 26 families. A total of 222 herring survey questionnaires were mailed to subsistence fishing families and 52 (23%) were returned. Additionally, personal interviews were conducted in Hooper Bay and Scammon Bay in September to contact fishermen who did not return questionnaires. Thirty-five households were interviewed. A total of 87 households were contacted. The subsistence catch

figures represent only the harvest which was reported. Therefore, the reported catch is a minimum estimate since not all families were contacted and not all families who received questionnaires returned them.

## COMMERCIAL FISHERY

*Security Cove District*

The commercial herring fishery in the Security Cove District has opened and closed by emergency order since 1981 to provide for an orderly fishery and allow periodic assessment of herring biomass. In 1995, 106 fishermen harvested 1,257 tons of herring in two commercial periods for a total fishing time of 12 hours. The average roe recovery of the harvest was 12.3%. An additional 35 tons was harvested during an ADF&G aerial survey calibration study.

The fishery opened May 14 for four hours and resulted in a catch of 324 tons of herring with an average roe content of 13.1%. One hundred one permit holders participated in this first opening. A second opening was scheduled for the same day for eight hours and 933 tons of herring with a roe content of 12.2% were caught by 97 permit holders. On May 18, 35 tons of herring with an average roe content of 8.0% was taken by a chartered seine vessel as part of an aerial survey calibration program. During the 1995 herring season, 12 processors bought herring from 106 permit holders who made 257 deliveries. The harvest was worth $56,000 to fishermen.

A sample of 424 herring was taken from the commercial catch. Age 8 herring comprised the largest age group in the harvest biomass. Age 9 and older herring made up 53.1% of the catch by weight (Figure 5). Recruit herring comprised less than 1% of the harvest.

*Goodnews Bay District*

Since 1981, commercial herring fishing in Goodnews Bay has opened and closed by emergency order to provide for an orderly fishery and periodic assessments of herring biomass. In 1995 1,054 tons were harvested in nine commercial periods for a total fishing time of 56 hours (Tables 1, 2 and 6).

A meeting with fishermen and processors was held on May 18. Commercial fishermen brought catch samples to the meeting for evaluation by industry roe technicians. Roe content of commercial test fish samples averaged 12.6%. The fishery first opened on May 19 for 6 hours. Seventy-nine permit holders delivered 97 tons of sac roe herring with an average roe content of 12.6%. During a seven hour period on May 26, 141 tons of herring were caught. Approximately 200 tons remained on the harvest quota. The largest previous catch had been 164 tons during a six hour period on May 22. A seven hour period was justified given catch rates from previous openings. The harvest quota

was exceeded when catch rates increased dramatically during the final period and 395 tons were taken.

The catch consisted of 1,051 tons (Table 2) of sac roe quality herring with an average roe content of 13.5% and three tons of waste. Period catches ranged from 10 tons on May 20 to 395 tons on May 26. During the fishery roe contents ranged from 12.3% to 14.1%. Four processors bought herring from 127 permit holders who made 878 deliveries with an estimated exvessel value of $848,000 (Tables 2 and 3). The exploitation rate was 25.0% of the available biomass.

A sample of 420 herring was taken from the commercial catch. The largest age class in the harvest was age 8. Age 9 and older herring made up 55.5% of the catch (Figure 5). Recruit herring comprised less than 1% of the harvest.

*Cape Avinof District*

As in all AYK districts, commercial herring fishing is regulated by emergency order. In 1995, 485 tons of herring were harvested during eight commercial openings for a total fishing time of 48 hours (Tables 1, 2, and 6).

The district was first opened to commercial fishing for six hours on May 26. The harvest was 66 tons of sac roe herring with an average roe content of 11.9%. Forty-eight permit holders made deliveries. Between May 27 and May 30 the district was reopened seven times for 42 hours of fishing time. Catches ranged from 18 tons on May 28 to 158 tons on May 30. Roe contents ranged from 11.2% to 13.1%.

A total of 485 tons of sac roe-quality herring with an average roe content of 12.5% were caught. In the Cape Avinof District, 93 fishermen made 537 deliveries with an exvessel value of $363,000 to two processors (Tables 2 and 3). The exploitation rate was 13.4% of the available biomass.

Four hundred and forty-two herring were sampled from the commercial catch. Age 8 herring dominated the harvest. Age 9 and older herring made up 65.3% of the catch (Figure 5). Recruit herring comprised less than 1% of the harvest.

*Nelson Island District*

During the 1995 season, 1,113 tons of sac roe-quality herring with an average roe content of 10.6% were harvested. The fishery consisted of six commercial openings from May 21 to May 29 for a total fishing time of 28 hours (Tables 1, 2 and 6).

The first opening was for five hours on May 21. The harvest of 316 tons with an average roe content of 11.1% was taken by 83 permit holders. The second opening was for six hours on May 21. Eighty-six fishermen landed 288 tons of sac roe herring with an average roe content of 11.4%. The next commercial period was on May 22 for 2.5 hours. Catch from this period totaled 112 tons

of sac roe herring with a roe content of 9.8%. On May 27, 155 tons of sac roe herring with 9.3% roe recovery were harvested. On May 28, 66 permit holders harvested 126 tons of herring with an average roe recovery of 10.6% during a six hour period. The final period of the season lasted 2.5 hours on May 28. Fifty-five permit holders delivered 116 tons with an average roe content of 10.2% (Table 6).

Four processors paid approximately $710,000 to 100 permit holders (Tables 2 and 3). The exploitation rate was 14.3% of the available biomass.

A total of 724 herring were sampled from the commercial catch. Age 11 herring dominated the harvest. Age 9 and older herring made up 83.6% of the catch (Figure 5). Recruit herring comprised less than 1% of the harvest.

*Nunivak Island District*

Commercial fishing for herring in the Nunivak Island District began in 1985. To provide for an orderly fishery and to allow for periodic assessment of herring biomass, the fishery has opened and closed by emergency order. The Nunivak Island District had seven commercial herring periods in 1995 for a total fishing time of 423 hours. Fishermen harvested 33 tons of sac roe herring with an average roe content of 11.0% and 7 tons of bait (Table 2).

The district was open for six six-hour periods from May 19 to May 22. On May 22 the fishery remained opened continuously until June 7. The season ended after processors left the area on June 5. Two processors purchased $22,000 worth of herring from 13 permit holders. The exploitation rate was 0.9% of the projected biomass or 4.9% of the peak aerial survey biomass.

A total of 110 herring were sampled from the commercial catch. Recruit herring comprised less than 1% of the harvest. Age 7, 8 and 11 herring equally dominated the harvest biomass; however age 7 dominated the catch in numbers of fish. Herring aged 9 and older comprised 58.0% of the catch sample by weight (Figure 6).

*Cape Romanzof District*

A total of 541 tons of herring was harvested by 49 fishermen utilizing 49 fishing vessels in 1995 (Tables 1, 2 and 3). All 541 tons were purchased as sac roe with an average sac roe recovery of 10.1%. The commercial fishery consisted of six periods between May 21 and May 26. Fishing periods ranged from 1.5 hours to 4 hours duration for a total fishing time of 15 hours. Fishing was restricted to one 50-fathom gillnet per vessel throughout the commercial season.

The commercial harvest was allowed to exceed the preseason harvest projection of 513 tons. Buyers reported roe recovery and sex ratio information early during each fishing period to determine if periods could be extended. This information was used during the second, fifth and sixth periods to extend fishing time.

Fishing effort in 1995 was the second lowest on record. Local Alaskan residents (defined as residents of Chevak, Hooper Bay, and Scammon Bay) accounted for 98% (48 permits) of the effort and 99% (534 tons) of the harvest. The estimated value of the total harvest to fishermen was $328,500 (Table 2). Two companies purchased herring. These companies were represented by two processing vessels and five tenders during the fishery (Table 3).

A total of 502 herring were sampled from the commercial harvest. Age 11 herring dominated the harvest. Age 9 and older herring made up 66.7 % of the catch (Figure 6). Recruit herring comprised less than 1% of the harvest.

*Norton Sound District*

The 1995 Norton Sound herring fishery opened by emergency order on May 23. During the sac roe season, there were six gillnet openings for a total fishing time of 87.5 hours and four beach seine openings for a total of 18.5 hours of fishing (Table 6). An additional opening was scheduled May 26 and 27 in the St Michael's area for an educational permit fishery. The total harvest during the sac roe fishery was approximately 6,773 tons of herring, a record for the Norton Sound herring fishery. The catch consisted of 6,647 tons of sac roe herring, 116 tons of bait-quality herring and 10 tons of wasted herring. Since 1981, catches, including waste, have averaged 4,222 tons.

There were 215 fishermen who made at least one delivery during the season (Table 3). This is the same number of participants as in 1994 and is the lowest effort since 1984, excluding 1992 when there was no fishery. Fishing effort has been declining since limited entry was put into effect. This season's low effort was due in part to a declining market and the poor harvests in recent years. During the 1995 season, 209 fishermen used gillnets to harvest a total of 6,142 tons (Tables 3 and 6). The gillnet harvest consisted of 6,033 tons of sac roe-quality herring with an average sac roe recovery of 10.6%, and 110 tons of bait. Seven fishermen participated in the beach seine fishery, but only six made deliveries, landing 621 tons of herring. The beach seine harvest consisted of 615 tons of herring with an average sac roe recovery of 8.9%, and six tons of bait. Table 8 compares historic beach seine and gillnet commercial catches in the Norton Sound District.

The commercial fishery was initially managed using the preseason projected harvest of 6,051 tons since the peak aerial survey did not occur until May 25. The harvest guideline was adjusted during the fishery to 7,556 tons based on inseason biomass estimates. The Norton Sound biomass was exploited at 17.9%. The fishery was conducted on two runs of herring that had two modes of abundance. The older age classes came to nearshore waters first, and roughly five days later the younger herring ripened and were available for harvest. Both runs were first apparent at Cape Denbigh, but the earlier run migrated south to spawn while the second run moved north. The first opening occurred on May 22 in Subdistricts 1, 2 and 3 after heavy spawning was observed. However many fishermen and several buyers were not prepared for this first opening. The first opening was extended until processing capacity was reached. Subsequent fishing periods were closed when processing capacity was reached. During the last two gillnet openings, gear was restricted to one shackle to encourage fishermen to closely tend their nets. Beach seine and gillnet

openings were staggered to minimize gear conflict. The fishery was closed when younger age classes moved in and roe recoveries declined.

The average sac roe recovery for all gear types was 10.4% (Table 2). The total value of the herring harvest to Norton Sound fishermen was approximately $4,205,848. Six companies registered 11 processors and 45 tenders to operate in Norton Sound (Table 3).

A total of 2,665 herring were sampled from the commercial harvest. Age 9 and older herring, comprised (79.9%) of the gillnet harvest and were dominated by age 11 herring. Age 7 herring comprised 37.6% of beach seine catches. There was less than 1% recruit-aged herring in the gillnet sample; recruits comprised only 6% of the beach seine sample.

*Port Clarence District*

There has not been a commercial sac roe fishery in the Port Clarence District since 1988 because buyers have not been present in the district.

## ENFORCEMENT

The Division of Fish and Wildlife Protection (FWP) was present in most AYK herring districts this year. At least ten people from FWP using the P/V Walstad, two supercub aircraft, a Cessna 185 and a FWP skiff were involved with the Kuskokwim area fisheries. A few citations were issued in the Kuskokwim area however no fish were confiscated. Two FWP officers using the Department's skiff were present at Cape Romanzof during the fourth and fifth fishing periods. A few citations involving unlicensed crewmembers and no photo ID in possession were issued. In addition, 1.4 tons of herring were confiscated from one permit holder for fishing after a period closure. Enforcement in Norton Sound consisted of four single engine aircraft (three supercubs on wheels and a C-185 on wheels) and a small boat. Personnel consisted of four permanent full-time FWP officers. FWP officers patrolled the fishery during each opening and closure. Three citations were issued for no crew license and two were issued for hiring a crew member without a license. No herring were confiscated in Norton Sound by the State of Alaska during the 1995 season.

## OUTLOOK AND MANAGEMENT STRATEGY FOR 1996

Projections from post-season escapement estimates, using historic mean rates of survival and current mean weights for each age class, and estimates of recruitment for each age class (Wespedstad 1982), suggest that the 1996 spawning biomass for the northeastern Bering Sea herring stocks (Security Cove to Norton Sound) will be approximately 53,258 tons with a projected harvest of 10,322 tons (Table 7). If the return is as expected, a moderate reduction in biomass will be observed in all districts. However, variability in the quality of aerial survey assessments of

biomass and deviations from the assumed survival or recruitment rates may result in the observed biomass being either above or below these projections. Therefore, harvest levels will be adjusted during the season according to observed herring spawning biomass. In addition, in accordance with the AYK Region harvest policy, newly recruited age classes (age 2 through 5 year-old-herring) will not be targeted by the commercial fishery. If it is not possible to determine herring abundance using aerial survey methods, stock abundance will be assessed using information from the projected biomass, test and commercial catches and spawn deposition observations.

*Security Cove District*

The 1996 projected return to the Security Cove District is 5,623 tons. A 20% exploitation rate would result in a harvest of about 1,125 tons (Table 7). A larger catch may occur if the 1996 biomass assessment is greater than the projection. Commercial fishing will not be allowed until the observed biomass reaches 1,200 tons or significant spawning activity is observed. The occurrence and length of fishing periods will depend on stock strength, fishing effort, and spawning activity.

Ages 5, 6 and 8 herring are expected to dominate the return. Age 9 and older herring are expected to comprise approximately one-fourth of the biomass.

*Goodnews Bay District*

The management strategy for this district will be similar to that planned for Security Cove. The season will open and close by emergency order when a biomass of 1,200 tons is observed or spawning activity occurs. The 1996 projected return of herring to the Goodnews Bay District is 2,847 tons. A 20% exploitation rate would result in a harvest of 569 tons (Table 7). A larger catch may occur if the 1996 biomass assessment is greater than the projection.

Age 8 and 9 herring are expected to comprise nearly one-half of the biomass. Age 9 and older herring are expected to comprise nearly one-third of the biomass.

*Cape Avinof District*

Either significant spawning activity or a biomass of 500 tons must be observed before the commercial herring season can be opened. The season will open and close by emergency order. the projected 1996 biomass for the Cape Avinof District is 3,230 tons (Table 7). The exploitation rate will be no greater than 15% because of the limited data base for this area and the priority of subsistence fishing. Assuming a 15% commercial exploitation rate, the projected harvest would be 484 tons of herring.

Age 5, 6 and 8 herring are expected to dominate the returning population. Age 9 and older herring are expected to comprise nearly one-fourth of the biomass.

*Nelson Island District*

In the Bering Sea Herring Fishery Management Plan, the Alaska Board of Fisheries set a minimum biomass threshold of 3,000 tons necessary for a commercial herring fishery in the Nelson Island District. The inseason estimate of herring biomass must exceed the threshold level before a commercial fishery can be allowed. The spawning biomass projected to return to the Nelson Island District in 1996 is 6,638 tons (Table 7). At an exploitation rate of 15%, the harvest will be 996 tons of herring. A larger catch may occur if the 1996 biomass assessment is greater than the projection.

Age 8 is expected to be the dominant age group in the biomass; age 6 herring are expected to dominate in numbers of fish. Age 9 and older herring are expected to comprise almost one-third of the biomass in 1996.

To provide additional protection for the subsistence harvest of herring, the following guidelines will be followed:

1. The commercial fishery will not be allowed to take more than 15% of the herring biomass, compared to up to 20% for most other fisheries having stocks of similar size and condition.

2. Periodic closures of the commercial fishery will be scheduled, during which time only subsistence fishing will be allowed.

3. Several important subsistence use areas occur throughout the district, including the waters around Cape Vancouver. Specific areas may be closed to commercial fishing to insure the adequacy of subsistence harvests.

4. The department will by all available means, including input from local residents, insure the adequacy of subsistence herring harvests during the commercial fishing season.

*Nunivak Island District*

The commercial season will open when the biomass reaches 1,500 tons or when significant spawning is observed. The projected biomass of herring returning to the Nunivak Island District in 1996 is 4,197 tons. A 20% exploitation rate would result in a 839 ton harvest (Table 7). A larger catch may occur if the 1996 biomass assessment is greater than the projection.

Age 6 is expected to be the dominant age group. Age 9 and older herring are expected to comprise nearly one-third of the return.

*Cape Romanzof District*

The projected return for 1996, based upon limited data, is 3,416 tons, which would result in a 683 ton harvest at a 20% exploitation rate (Table 7). Emergency order authority will be used to regulate the occurrence and length of fishing periods. It is likely that fishing gear will be restricted to no more than 50 fathoms and one gillnet per vessel by emergency order. Aerial biomass assessment cannot be used to determine the opening of commercial fishing due to typically poor survey conditions caused by turbid water. Therefore, spawn deposition observations and test and commercial catch rates will be used to determine timing and duration of commercial fishing periods. If stock abundance is judged to be lower or higher than the projection, the projected harvest of 683 tons will be modified accordingly. Age 8 herring are expected to dominate the biomass. Age 9 and older herring are expected to comprise approximately half of the return.

*Norton Sound District*

The Norton Sound projected biomass return is 27,307 tons. A 20% exploitation rate would result in a harvest of 5,461 tons (Table 7). Age 8 herring are expected to comprise 36% of the returning biomass. Age 9 and older herring are expected to comprise about one-half of the biomass.

Inseason assessment of herring biomass will supersede projected biomass for management of the Norton Sound herring fishery, except where weather prevents obtaining an inseason estimate. The beach seine harvest is, by regulation, 10% of the projected harvest, or 546 tons.

The 1996 herring fishery will be opened by emergency order. The fishery will close by emergency order when up to 20% of the available herring biomass has been harvested. Varied harvest rates may be applied to individual subdistricts based on biomass distribution, roe quality, weather, and sea ice conditions.

*Port Clarence District*

The department does not generally project an outlook for the Port Clarence fishery due to the lack of data on Port Clarence herring and the very limited scope of the fishery. The guideline harvest of 165 tons established by the Board of Fisheries in 1981 will determine the allowable harvest in 1995. This harvest guideline is based on two years research by the department in both the Port Clarence and Kotzebue Districts. Even though this guideline has not appeared in the regulation book since 1984, it still represents the best estimate of harvestable biomass at this time.

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Table 1. Pacific herring harvests by domestic commercial fishermen during the sac-roe fisheries in the northeastern Bering Sea, Alaska, 1909-1995.

| | Herring (st)[a] | | | | | | | | | Spawn on Kelp (st) |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Security Cove | Goodnews Bay | Cape Avinof | Nelson Island | Nunivak Island | Cape Romanzof | Norton Sound | Port Clarence | Total Harvest | Norton Sound |
| 1909-1916 | - | - | - | - | - | - | 1-[b] | - | - | - |
| 1916-1928 | - | - | - | - | - | - | 1,881 | - | 1,881 | - |
| 1929 | - | - | - | - | - | - | 166 | - | 166 | - |
| 1930 | - | - | - | - | - | - | 441 | - | 441 | - |
| 1931 | - | - | - | - | - | - | 86 | - | 86 | - |
| 1932 | - | - | - | - | - | - | 529 | - | 529 | - |
| 1933 | - | - | - | - | - | - | 31 | - | 31 | - |
| 1934 | - | - | - | - | - | - | 4 | - | 4 | - |
| 1935 | - | - | - | - | - | - | 15 | - | 15 | - |
| 1936 | - | - | - | - | - | - | - | - | - | - |
| 1937 | - | - | - | - | - | - | 6 | - | 6 | - |
| 1938 | - | - | - | - | - | - | 10 | - | 10 | - |
| 1939 | - | - | - | - | - | - | 6 | - | 6 | - |
| 1940 | - | - | - | - | - | - | 14 | - | 14 | - |
| 1941 | - | - | - | - | - | - | 3 | - | 3 | - |
| 1942-1944 | - | - | - | - | - | - | - | - | - | - |
| 1945 | - | - | - | - | - | - | - | - | - | - |
| 1946 | - | - | - | - | - | - | - | - | - | - |
| 1947-1963 | - | - | - | - | - | - | - | - | - | - |
| 1964 | - | - | - | - | - | - | 20 | - | 20 | - |
| 1965 | - | - | - | - | - | - | - | - | - | - |
| 1966 | - | - | - | - | - | - | 12 | - | 12 | - |
| 1967 | - | - | - | - | - | - | - | - | - | - |
| 1968 | - | - | - | - | - | - | - | - | - | - |
| 1969 | - | - | - | - | - | - | 2 | - | 2 | - |
| 1970 | - | - | - | - | - | - | 8 | - | 8 | - |
| 1971 | - | - | - | - | - | - | 20 | - | 20 | - |
| 1972 | - | - | - | - | - | - | 17 | - | 17 | - |
| 1973 | - | - | - | - | - | - | 35 | - | 35 | - |
| 1974 | - | - | - | - | - | - | 2 | - | 2 | - |
| 1975 | - | - | - | - | - | - | - | - | - | - |
| 1976 | - | - | - | - | - | - | 9 | - | 9 | - |
| 1977 | - | - | - | - | - | - | 11 | - | 11 | <1 |
| 1978 | 286 | - | - | - | - | - | 15 | - | 301 | 4 |
| 1979 | 424 | 90 | - | - | - | - | 1,292 | - | 1,806 | 13 |
| 1980 | 697 | 448 | - | - | - | 611 | 2,452 | - | 4,208 | 24 |
| 1981 | 1,173 | 657 | - | - | - | 720 | 4,371 | - | 6,921 | 47 |
| 1982 | 813 | 486 | - | - | - | 657 | 3,933 | - | 5,889 | 38 |
| 1983 | 1,073 | 435 | - | - | - | 816 | 4,582 | - | 6,906 | 29 |
| 1984 | 335 | 717 | - | - | - | 1,185 | 3,662 | - | 5,899 | 19[c] |
| 1985 | 733 | 724 | - | 977 | 358 | 1,299 | 3,548 | - | 7,639 | - |
| 1986 | 751 | 557 | - | 886 | 511 | 1,865 | 5,194 | - | 9,764 | - |
| 1987 | 313 | 321 | - | 923 | 414 | 1,342 | 4,082 | 146 | 7,541 | - |
| 1988 | 324 | 483 | 348 | 775 | - | 1,119 | 4,672 | 80 | 7,801 | - |
| 1989 | 554 | 616 | 129 | 233 | 116 | 926 | 4,771 | - | 7,345 | - |
| 1990 | 234 | 455 | 50 | - | - | 329 | 6,439 | - | 7,507 | - |
| 1991 | 570 | 263 | 267 | - | 59 | 526 | 5,672 | - | 7,357 | - |
| 1992 | 834 | 740 | 451 | 246 | 27 | 530 | - | - | 2,828 | - |
| 1993 | 5 | 954 | 215 | 739 | - | 371 | 5,079 | - | 7,363 | - |
| 1994 | - | 1,062 | 427 | 717 | 14 | 456 | 960 | - | 3,636 | - |
| 1995 | 1,292 | 1,054 | 485 | 1,113 | 41 | 541 | 6,763 | - | 11,289 | |

[a] Pre-1964 harvest primarily in summer and fall for food; post 1964 harvest primarily in spring for sac roe. Wastage included.
[b] Fishery occurred some years but harvest data unavailable.
[c] Additional 3 st harvested from imported kelp (*Macrocystis* sp) not included.

Table 2. Estimated biomass and commercial harvest of Pacific herring in northeastern Bering Sea fishing districts, Alaska, 1989-1995

| Year | District | Estimated Biomass (st) | Harvest (st) Sac roe | Bait | Waste | Total | Roe % | Estimated Value ($ x 1,000) | Exploitation Rate (%) |
|---|---|---|---|---|---|---|---|---|---|
| 1995 | Security Cove | 6,702[b] | 1,292 | 0 | 0 | 1,292 | 12.3 | 956 | 19.3 |
| | Goodnews Bay | 4,219[b] | 1,051 | 0 | 3 | 1,054 | 13.5 | 848 | 25.0 |
| | Cape Avinof | 3,627[b] | 485 | 0 | 0 | 485 | 12.5 | 363 | 13.4 |
| | Nelson Island | 7,754 | 1,113 | 0 | 0 | 1,113 | 10.6 | 710 | 14.3 |
| | Nunivak Island | 4,579[b] | 33 | 7 | 0 | 41 | 11.0 | 22 | 0.9 |
| | Cape Romanzof | 5,000 | 541 | 0 | 0 | 541 | 10.1 | 328 | 10.8 |
| | Norton Sound | 37,779 | 6,647 | 116 | 10 | 6,773 | 10.4 | 4,206 | 17.9 |
| Total | | 69,660 | 11,162 | 123 | 13 | 11,299 | 11.0 | 7,433 | 16.2 |
| 1994 | Security Cove[c] | 7,638[b] | - | - | - | - | - | - | - |
| | Goodnews Bay | 5,679[b] | 1,061 | 0 | 1 | 1,062 | 12.3 | 391 | 18.7 |
| | Cape Avinof | 2,827[b] | 427 | 0 | 0 | 427 | 12.2 | 156 | 15.1 |
| | Nelson Island | 5,564 | 713 | 4 | 0 | 717 | 11.0 | 235 | 12.9 |
| | Nunivak Island | 4,921 | 14 | 0 | 0 | 14 | 8.6 | 4 | 0.3 |
| | Cape Romanzof | 5,000 | 456 | 0 | 0 | 456 | 9.2 | 124 | 9.1 |
| | Norton Sound | 37,829 | 958 | 2 | 0 | 960 | 10.3 | 271 | 2.5 |
| Total | | 69,458 | 3,629 | 6 | 1 | 3,636 | 11.1 | 1,181 | 5.2 |
| 1993 | Security Cove | 6,995 | 5 | 0 | 0 | 5 | 12.8 | 2 | 0.1 |
| | Goodnews Bay | 6,211 | 945 | 9 | 0 | 954 | 10.3 | 293 | 15.4 |
| | Cape Avinof | 2,837[b] | 206 | 9 | 0 | 215 | 12.0 | 75 | 7.6 |
| | Nelson Island | 4,944 | 613 | 52 | 74 | 739 | 10.6 | 198 | 14.9 |
| | Nunivak Island[c] | 5,176 | - | - | - | - | - | - | - |
| | Cape Romanzof | 4,000 | 371 | 0 | 0 | 372 | 9.6 | 110 | 9.3 |
| | Norton Sound | 46,549 | 4,713 | 321 | 45 | 5,079 | 9.9 | 1,411 | 10.9 |
| Total | | 76,712 | 6,853 | 391 | 119 | 7,363 | 10.1 | 2,089 | 9.6 |
| 1992 | Security Cove | 7,773 | 697 | 127 | 10 | 834 | 9.2 | 285 | 10.7 |
| | Goodnews Bay | 5,572 | 711 | 29 | 0 | 740 | 9.5 | 286 | 13.3 |
| | Cape Avinof | 3,446 | 442 | 9 | 0 | 451 | 9.9 | 178 | 13.1 |
| | Nelson Island | 5,275 | 188 | 52 | 6 | 246 | 8.3 | 78 | 4.7 |
| | Nunivak Island | 5,703 | 7 | 20 | 0 | 27 | 8.5 | 4 | 0.5 |
| | Cape Romanzof | 4,500 | 516 | 14 | 0 | 530 | 8.0 | 159 | 11.8 |
| | Norton Sound | 57,974 | - | - | - | - | - | - | - |
| Total | | 90,243 | 2,561 | 251 | 16 | 2,828 | 9.1 | 990 | 3.1[a] |
| 1991 | Security Cove | 4,434 | 561 | 9 | 0 | 570 | 9.3 | 208 | 12.9 |
| | Goodnews Bay | 4,387 | 259 | 4 | 0 | 263 | 8.9 | 93 | 6.0 |
| | Cape Avinof | 2,083 | 240 | 27 | 0 | 267 | 9.5 | 94 | 12.8 |
| | Nelson Island[c] | 2,385 | - | - | - | - | - | - | - |
| | Nunivak Island | 3,903 | 17 | 42 | 0 | 59 | 7.4 | 9 | 1.5 |
| | Cape Romanzof | 4,500 | 451 | 75 | 0 | 526 | 8.8 | 210 | 11.7 |
| | Norton Sound | 42,854 | 5,465 | 207 | 125 | 5,797 | 9.3 | 2,414 | 13.5 |
| Total | | 64,546 | 6,993 | 364 | 125 | 7,482 | 9.2 | 3,028 | 11.4 |
| 1990 | Security Cove | 2,650 | 174 | 60 | 0 | 234 | 8.7 | 94 | 8.8 |
| | Goodnews Bay | 2,577 | 427 | 28 | 0 | 455 | 12.2 | 314 | 17.7 |
| | Cape Avinof | 2,020[b] | 49 | 1 | 0 | 50 | 12.0 | 35 | 2.5 |
| | Nelson Island[c] | 2,705 | - | - | - | - | - | - | - |
| | Nunivak Island[c] | 422 | - | - | - | - | - | - | - |
| | Cape Romanzof | 4,500 | 318 | 11 | 0 | 329 | 8.4 | 155 | 7.3 |
| | Norton Sound | 39,384 | 5,353 | 1,026 | 60 | 6,439 | 8.8 | 3,606 | 16.0 |
| Total | | 54,258 | 6,321 | 1,126 | 60 | 7,507 | 9.0 | 4,204 | 13.8 |
| 1989 | Security Cove | 2,830 | 544 | 10 | 0 | 554 | 9.4 | 265 | 19.6 |
| | Goodnews Bay | 4,040 | 453 | 162 | 0 | 616 | 8.4 | 335 | 15.2 |
| | Cape Avinof | 2,780[b] | 90 | 39 | 0 | 129 | 8.0 | 54 | 18.7 |
| | Nelson Island | 3,320 | 122 | 100 | 11 | 233 | 8.5 | 57 | 7.0 |
| | Nunivak Island | 620 | 79 | 37 | 0 | 116 | 9.4 | 42 | 18.8 |
| | Cape Romanzof | 4,400 | 925 | 1 | 0 | 926 | 9.3 | 486 | 21.0 |
| | Norton Sound | 25,980 | 4,494 | 247 | 30 | 4,771 | 9.2 | 2,322 | 18.3 |
| Total | | 43,970 | 6,708 | 596 | 41 | 7,345 | 9.0 | 3,561 | 16.7 |

[a] Total exploitation rate for fishing districts which had a commercial fishery in 1992 is 8.8%.
[b] Inseason biomass estimate from poor aerial survey, therefore projected biomass used.
[c] No commercial fishery.

Table 3. Number of buyers and fishermen participating in northeastern Bering Sea Pacific herring fisheries, Alaska, 1989-1995.

| Year | District | Number of Buyers | Number of Fishermen | | |
|---|---|---|---|---|---|
| | | | Gillnet | Beach Seine[a] | Total |
| 1995 | Security Cove | 12 | 106 | - | - |
| | Goodnews Bay | 4 | 127 | - | - |
| | Cape Avinof | 2 | 93 | - | - |
| | Nelson Island | 4 | 100 | - | - |
| | Nunivak Island | 2 | 13 | - | - |
| | Cape Romanzof | 2 | 49 | - | - |
| | Norton Sound | 6 | 209 | 6 | 215 |
| 1994 | Security Cove | - | - | - | - |
| | Goodnews Bay | 2 | 103 | - | - |
| | Cape Avinof | 1 | 85 | - | - |
| | Nelson Island | 3 | 104 | - | - |
| | Nunivak Island | 1 | 12 | - | - |
| | Cape Romanzof | 2 | 55 | - | - |
| | Norton Sound | 7 | 212 | 3 | 215 |
| 1993 | Security Cove | 1 | 9 | - | - |
| | Goodnews Bay | 3 | 63 | - | - |
| | Cape Avinof | 1 | 97 | - | - |
| | Nelson Island | 1 | 73 | - | - |
| | Nunivak Island | - | - | - | - |
| | Cape Romanzof | 2 | 41 | - | - |
| | Norton Sound | 6 | 256 | 7 | 263 |
| 1992 | Security Cove | 6 | 58 | - | - |
| | Goodnews Bay | 3 | 78 | - | - |
| | Cape Avinof | 2 | 121 | - | - |
| | Nelson Island | 3 | 85 | - | - |
| | Nunivak Island | 1 | 14 | - | - |
| | Cape Romanzof | 2 | 73 | - | - |
| | Norton Sound | 0 | - | - | - |
| 1991 | Security Cove | 6 | 52 | - | - |
| | Goodnews Bay | 2 | 103 | - | - |
| | Cape Avinof | 1 | 137 | - | - |
| | Nelson Island | - | - | - | - |
| | Nunivak Island | 2 | 17 | - | - |
| | Cape Romanzof | 2 | 80 | - | - |
| | Norton Sound | 8 | 272 | 7 | 279 |
| 1990 | Security Cove | 9 | 52 | - | - |
| | Goodnews Bay | 3 | 126 | - | - |
| | Cape Avinof | 1 | 101 | - | - |
| | Nelson Island | - | - | - | - |
| | Nunivak Island | - | - | - | - |
| | Cape Romanzof | 4 | 95 | - | - |
| | Norton Sound | 8 | 357 | 8 | 365 |
| 1989 | Security Cove | 8 | 110 | - | - |
| | Goodnews Bay | 6 | 138 | - | - |
| | Cape Avinof | 3 | 147 | - | - |
| | Nelson Island | 4 | 162 | - | - |
| | Nunivak Island | 3 | 45 | - | - |
| | Cape Romanzof | 6 | 115 | - | - |
| | Norton Sound | 9 | 351 | 6 | 357 |

[a]Gear prohibited in all districts except Norton Sound and Port Clarence

Table 4. Pacific herring subsistence harvest (st) and effort data from selected northeastern Bering Sea areas, Alaska, 1977-1995.[a]

| Village | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Nelson Island | | | | | | | | | | |
| Tununak | 57 | 38 | 34 | 65 | 40 | 48 | 94 | - | 43 | 63 | 48 | 49 | 47 | 54 | 21 | 32 | 45 | 42 | 30 |
| Umkumiut | 3 | 11 | 8 | 3 | 10 | 0 | - | - | - | - | -[c] | -[c] | -[c] | -[c] | -[c] | -[c] | - | - | - |
| Toksook Bay | 21 | 37 | 51 | 29 | 14 | 35 | - | - | 46 | 70 | 51 | 58 | 52 | 46 | 40 | 43 | 23 | 53 | 46 |
| Nightmute | - | - | - | - | - | - | - | - | 3[b] | 21 | 15 | 16 | 15 | 18 | 8 | 10 | 9 | 13 | 13 |
| Newtok | - | - | - | - | - | - | - | - | 7[b] | 13 | 10 | 12 | 10 | 8 | 1 | 7 | 6 | 9 | 9 |
| Total | 81 | 86 | 93 | 97 | 64 | 83 | 94 | - | 99 | 167 | 124 | 136 | 124 | 126 | 70 | 92 | 82 | 117 | 98 |
| No. Fishing Families | 90 | 83 | 54 | 70 | 93 | 65 | 43 | - | 65[b] | 72[b] | 96 | 104 | -[b] | 100 | 85 | 97 | 89 | - | 91 |
| | | | | | | | | | Nunivak Island | | | | | | | | | | |
| Mekoryuk | - | - | - | - | - | - | - | - | <1 | <1 | - | - | - | 5 | 4 | 4 | 2 | - | |
| No. Fishing Families | - | - | - | - | - | - | - | - | 11 | 6[b] | - | - | - | 19 | 20 | 17 | 16 | - | - |
| | | | | | | | | | Other Kuskokwim Delta | | | | | | | | | | |
| Chefornak | - | - | - | - | - | - | - | - | 13[b] | - | 14 | - | - | - | - | - | - | - | - |
| Kipnuk | - | - | - | - | - | - | - | - | 9 | - | 14 | - | - | - | - | - | - | - | - |
| Kongiganak | - | - | - | - | - | - | - | - | 3 | 2[b] | - | - | - | - | - | - | - | - | - |
| Kwigillingok | 1 | - | 8 | 13 | - | 13 | - | - | 5 | - | - | - | - | - | - | - | - | - | - |
| Total | 1 | - | 8 | 13 | - | 13 | - | - | 30 | 2 | 28 | - | - | - | - | - | - | - | - |
| No. Fishing Families | 9 | - | 22 | 19 | - | 21 | - | - | 55[b] | 12[b] | 49 | - | - | - | - | - | - | - | - |
| | | | | | | | | | Yukon Delta | | | | | | | | | | |
| Scammon Bay | - | 1 | 6 | 3 | 8 | 4 | 3 | 4 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |
| Chevak | <1 | - | 2 | 4 | 2 | 2 | 1 | 3 | 2 | 1 | 1 | 2 | <1 | 1 | <1 | <1 | <1 | 2 | 1 |
| Hooper Bay | 2 | 4 | 3 | 4 | 4 | 5 | 5 | 4 | 4 | 4 | 1 | 4 | 2 | 6 | 2 | 2 | 2 | 3 | 4 |
| Total | <3 | 5 | 11 | 11 | 14 | 11 | 9 | 11 | 8 | 7 | 3 | 7 | 3 | 8 | 3 | 4 | 5 | 6 | 6 |
| No. Fishing Families | 30 | 29 | 84 | 61 | 46 | 43 | 37 | 47 | 44 | 41 | 39 | 32 | 24 | 32 | 18 | 30 | 42 | 48 | 42 |

[a] Subsistence survey results are believed to accurately reflect harvest trends, however, reported catches reflect minimum figures since all fishermen cannot be contacted.
[b] Fishing families were not interviewed or only a portion of fishing families were interviewed as catch was enumerated while on drying racks.
[c] Umkumiut effort included with Tununak.

Table 5. Pacific herring estimated biomass in the northeastern Bering Sea, Alaska, 1978-1995

| | Herring (st) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Security Cove | Goodnews Bay | Cape Avinof | Nelson Island | Nunivak Island | Cape Romanzof[a] | Norton Sound | Port Clarence | Total Biomass |
| 1978 | 1,323 | 441 | - | 5,952 | 805 | 2,976 | 5,291 | - | 16,788 |
| 1979 | 21,495 | 7,385 | - | 5,952 | - | 2,976 | 7,716 | - | 45,524 |
| 1980 | 1.213 | 1,213 | - | 5,952 | - | 2,976 | 8,377 | - | 19,731 |
| 1981 | 8,267 | 4,299 | - | 3,968 | 19 | 4,850 | 22,360 | - | 44,331 |
| 1982 | 5,071 | 2,646 | - | 3,968 | - | 4,850 | 19,403 | - | 33,951 |
| 1983 | 6,393 | 3,197 | - | 7,275 | 7,606 | 5,512 | 6,841 | - | 58,092 |
| 1984 | 5,071 | 4,079 | - | 11,023 | 6,695 | 6,063 | 21,475 | - | 56,079 |
| 1985 | 4,900 | 4,300 | 2,000 | 9,500[b] | 5,700[b] | 7,000 | 20,000 | - | 51,400 |
| 1986 | 3,700[b] | 3,000[b] | - | 7,300[b] | 6,000 | 7,500 | 28,100 | - | 55,600 |
| 1987 | 2,300[b] | 2,000[b] | 1,225 | 8,100 | 4,400[b] | 7,200 | 32,370 | 932 | 57,332 |
| 1988 | 4,906 | 4,479 | 4,108 | 7,152 | 2,800[b] | 6,600 | 33,924 | 788 | 64,757 |
| 1989 | 2,830 | 4,040 | 2,780[b] | 3,320 | 620 | 4,400 | 25,981 | - | 43,970 |
| 1990 | 2,650 | 2,577 | 2,020[b] | 2,705 | 422 | 4,500 | 39,384 | - | 54,258 |
| 1991 | 4,434 | 4,387 | 2,083 | 2,385 | 3,903 | 4,500 | 42,854 | - | 64,546 |
| 1992 | 7,773 | 5,572 | 3,446 | 5,275 | 5,703 | 4,500 | 57,974 | 1,652 | 91,895 |
| 1993 | 6,995 | 6,211 | 2,837[b] | 4,944 | 5,176 | 4,000 | 46,549 | 822 | 77,534 |
| 1994 | 7,638[b] | 5,679[b] | 2,827[b] | 5,564 | 4,921 | 5,000 | 37,829 | 92 | 69,550 |
| 1995 | 6,702[b] | 4,219[b] | 3,627[b] | 7,754 | 4,579[b] | 5,000 | 37,779 | - | 69,660 |

[a]Biomass estimate based on aerial surveys, spawn deposition, age composition, and the CPUE from commercial and test fisheries.

[b]Unacceptable aerial survey conditions for estimating herring biomass, therefore projected biomass or some other method of estimating biomass was used.

Table 6. Summary of Pacific herring commercial harvest by fishing period for northeastern Bering Sea fishing districts, Alaska, 1995.

| District | Subdistrict Sec/Area | Gear | Period | Date | Time | Total Hours | Harvest (st) |
|---|---|---|---|---|---|---|---|
| Security Cove | | Gillnet | 1 | 5/14 | 0900-1300 | 4.0 | 324.4 |
| | | | 2 | 5/14-15 | 1700-0100 | 8.0 | 932.7 |
| | | | 3[a] | 5/18 | ----- | --- | 35.0 |
| | | | | | Total | 12.0 | 1,292.1 |
| Goodnews Bay | | Gillnet | 1 | 5/19 | 0800-1400 | 6.0 | 97.4 |
| | | | 2 | 5/20 | 0900-1500 | 6.0 | 10.1 |
| | | | 3 | 5/21 | 1000-1600 | 6.0 | 55.1 |
| | | | 4 | 5/22 | 1030-1630 | 6.0 | 163.5 |
| | | | 5 | 5/23 | 1130-1730 | 6.0 | 22.8 |
| | | | 6 | 5/24 | 1200-1800 | 6.0 | 25.6 |
| | | | 7 | 5/25 | 1400-2000 | 6.0 | 142.5 |
| | | | 8 | 5/26 | 0200-0900 | 7.0 | 141.4 |
| | | | 9 | 5/26 | 1430-2130 | 7.0 | 395.1 |
| | | | | | Total | 56.0 | 1,053.5 |
| Cape Avinof | | Gillnet | 1 | 5/26 | 1700-2300 | 6.0 | 66.3 |
| | | | 2 | 5/27 | 0600-1200 | 6.0 | 43.0 |
| | | | 3 | 5/27 | 1800-2400 | 6.0 | 46.5 |
| | | | 4 | 5/28 | 0700-1300 | 6.0 | 17.5 |
| | | | 5 | 5/28-29 | 2000-0200 | 6.0 | 103.9 |
| | | | 6 | 5/29 | 0830-1430 | 6.0 | 24.1 |
| | | | 7 | 5/29-30 | 2100-0300 | 6.0 | 157.7 |
| | | | 8 | 5/30 | 0930-1530 | 6.0 | 26.4 |
| | | | | | Total | 48.0 | 485.4 |
| Nelson Island | | Gillnet | 1 | 5/21 | 0300-0800 | 5.0 | 316.3 |
| | | | 2 | 5/21 | 1400-2000 | 6.0 | 287.6 |
| | | | 3 | 5/22 | 0530-0800 | 2.5 | 111.8 |
| | | | 4 | 5/27-28 | 1900-0100 | 6.0 | 155.4 |
| | | | 5 | 5/28 | 0700-1300 | 6.0 | 125.5 |
| | | | 6 | 5/28-29 | 2230-0100 | 2.5 | 115.9 |
| | | | | Total | Total | 28.0 | 1,112.5 |
| Nunivak Island | | Gillnet | 1 | 5/19 | 1100-1700 | 6.0 | 0.0 |
| | | | 2 | 5/19-20 | 2300-0500 | 6.0 | 12.3 |
| | | | 3 | 5/20 | 1200-1800 | 6.0 | 8.6 |
| | | | 4 | 5/21 | 0000-0600 | 6.0 | 0.0 |
| | | | 5 | 5/21 | 0700-1300 | 6.0 | 0.2 |
| | | | 6 | 5/22 | 1600-2200 | 6.0 | 0.0 |
| | | | 7 | 5/22-6/7 | 1000-1300 | 387.0 | 19.7 |
| | | | | | Total | 423.0 | 40.8 |
| Cape Romanzof | | Gillnet | 1 | 5/21 | 0830-1000 | 1.5 | 24.6 |
| | | | 2 | 5/21 | 2000-2230 | 2.5 | 110.1 |
| | | | 3 | 5/22 | 0730-1000 | 2.5 | 160.4 |
| | | | 4 | 5/22 | 2130-2300 | 1.5 | 111.4 |
| | | | 5 | 5/23 | 2100-2400 | 3.0 | 48.9 |
| | | | 6 | 5/25-26 | 2200-0200 | 4.0 | 85.8 |
| | | | | | | 15.0 | 541.2 |
| Norton Sound | SD 1, 2, 3 | Gillnet | 1 | 5/23-24 | 1100-0100 | 23 | 2,398.9 |
| | SD 1, 2, 3 | | 2 | 5/25 | 0300-1200 | 9 | 993.9 |
| | SD1 | | 3[b] | 5/26-27 | | | 9.9 |
| | SD5 | | 4 | 5/28-29 | 0700-1000 | 13 | 1,170.9 |
| | SD6 | | 5 | 5/28-29 | 2000-1000 | 14 | 167.3 |
| | SD 1, 2, 3 | | 6 | 5/28-29 | 2200-1400 | 16 | 798.4 |
| | SD 5 | | 7 | 5/31 | 1030-2300 | 12.5 | 602.9 |
| | | | | | Total | 87.5 | 6,142.2 |
| | SD2, 3 | Beach | 1 | 5/24 | 1400-1700 | 3 | 121.0 |
| | SD 2 | Seine | 2 | 5/25 | 1400-2000 | 6 | 107.6 |
| | SD 2, 3 | | 3 | 5/26 | 1300-1900 | 6 | 58.4 |
| | SD 5 | | 4 | 5/28 | 1230-1600 | 3.5 | 333.6 |
| | | | | | Total | 18.5 | 620.6 |

[a] ADF&G aerial survey calibration study.

[b] Educational permit.

Table 7. Projections of Pacific herring spawning biomass and harvest for commercial fishing districts in the northeastern Bering Sea, Alaska, 1996.

| | | | 1996 Projection[a] | |
|---|---|---|---|---|
| District | Biomass (st) | Threshold | Harvest (st) | Exploitation Rate (%) |
| Security Cove | 5,623 | 1,200 | 1,125 | 20 |
| Goodnews Bay | 2,847 | 1,200 | 569 | 20 |
| Cape Avinof | 3,230 | 500 | 484 | 15 |
| Nelson Island | 6,638 | 3,000 | 996 | 15 |
| Nunivak Island | 4,197 | 1,500 | 839 | 20 |
| Cape Romanzof | 3,416[b] | 1,500 | 683 | 20 |
| Norton Sound | 27,307 | 7,000 | 5,461 | 20 |
| Port Clarence | - | - | 165[c] | - |
| Totals | 53,258 | | 10,322 | |

[a] Preseason projection. Biomass and harvest may be adjusted based on inseason estimates.
[b] Projection from estimated 1995 relative biomass which was based on 1995 aerial surveys, spawn deposition, age composition, and the CPUE from commercial and test fisheries.
[c] Harvest guideline of 165 st (150 mt).

Table 8. Herring harvest by gear type and subdistrict, Norton Sound District, 1981-1995.

NORTON SOUND HERRING CATCHES

| | | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GILLNET HARVEST (tons) | | | | | | | | | | | | | | | | |
| St. Michael | | 3,067 | 2,062 | 434 | — | 1,538 | 2,560 | 2,214 | 3,215 | 2,927 | 4,491 | — | — | 2,288 | 249 | 2,359 |
| Unalakleet | | 831 | 946 | 1,264 | — | 95 | — | — | 42 | 10 | 618 | 731 | — | 120 | 12 | 374 |
| Cape Denbigh | | 472 | 925 | 2,692 | 3,244 | 1,599 | 2,420 | 1,545 | 1,211 | 1,414 | 923 | 4,419 | — | 1,659 | 619 | 1,467 |
| Elim | | — | — | 65 | — | 147 | — | — | 6 | — | — | — | — | 225 | 41 | 1,774 |
| Golovin | | — | — | 85 | — | — | — | — | — | — | — | — | — | — | — | 191 |
| total | a/ | 4,370 | 3,933 | 4,540 | 3,244 | 3,379 | 4,980 | 3,759 | 4,474 | 4,351 | 6,032 | 5,150 | b/ | 4,291 | 921 | 6,166 |
| SEINE HARVEST (tons) | | | | | | | | | | | | | | | | |
| St. Michael (beach) | | — | — | — | — | — | — | 4 | 45 | 329 | 6 | — | — | — | 1 | — |
| Unalakleet (beach) | | — | — | — | — | 93 | — | — | 58 | 50 | 332 | 149 | — | 467 | 24 | 230 |
| Cape Denbigh (beach) | | — | — | 41 | 327 | 76 | 30 | 293 | 96 | 11 | 9 | 373 | — | 222 | 15 | 57 |
| Elim (beach) | | — | — | — | — | — | 185 | — | — | — | — | — | — | 54 | — | 334 |
| Cape Denbigh (purse) | | — | — | — | — | — | | 26 | — | — | — | — | — | — | — | — |
| total | a/ | 0 | 0 | 41 | 327 | 169 | 215 | 323 | 198 | 390 | 347 | 522 | b/ | 743 | 40 | 621 |
| TOTAL HARVEST (tons) | a/ | 4,370 | 3,933 | 4,581 | 3,571 | 3,548 | 5,195 | 4,082 | 4,672 | 4,741 | 6,380 | 5,672 | 0 | 5,034 | 961 | 6,787 |
| Percent of total harvest | | | | | | | | | | | | | | | | |
| Gillnet Harvest | | 100.0 | 100.0 | 99.1 | 90.8 | 95.2 | 95.9 | 92.1 | 95.8 | 91.8 | 94.6 | 90.8 | | 85.2 | 95.9 | 90.9 |
| Seine Harvest | | 0.0 | 0.0 | 0.9 | 9.2 | 4.8 | 4.1 | 7.9 | 4.2 | 8.2 | 5.4 | 9.2 | | 14.8 | 4.1 | 9.1 |

a/ Totals do not include waste.

b/ No commercial fishery.

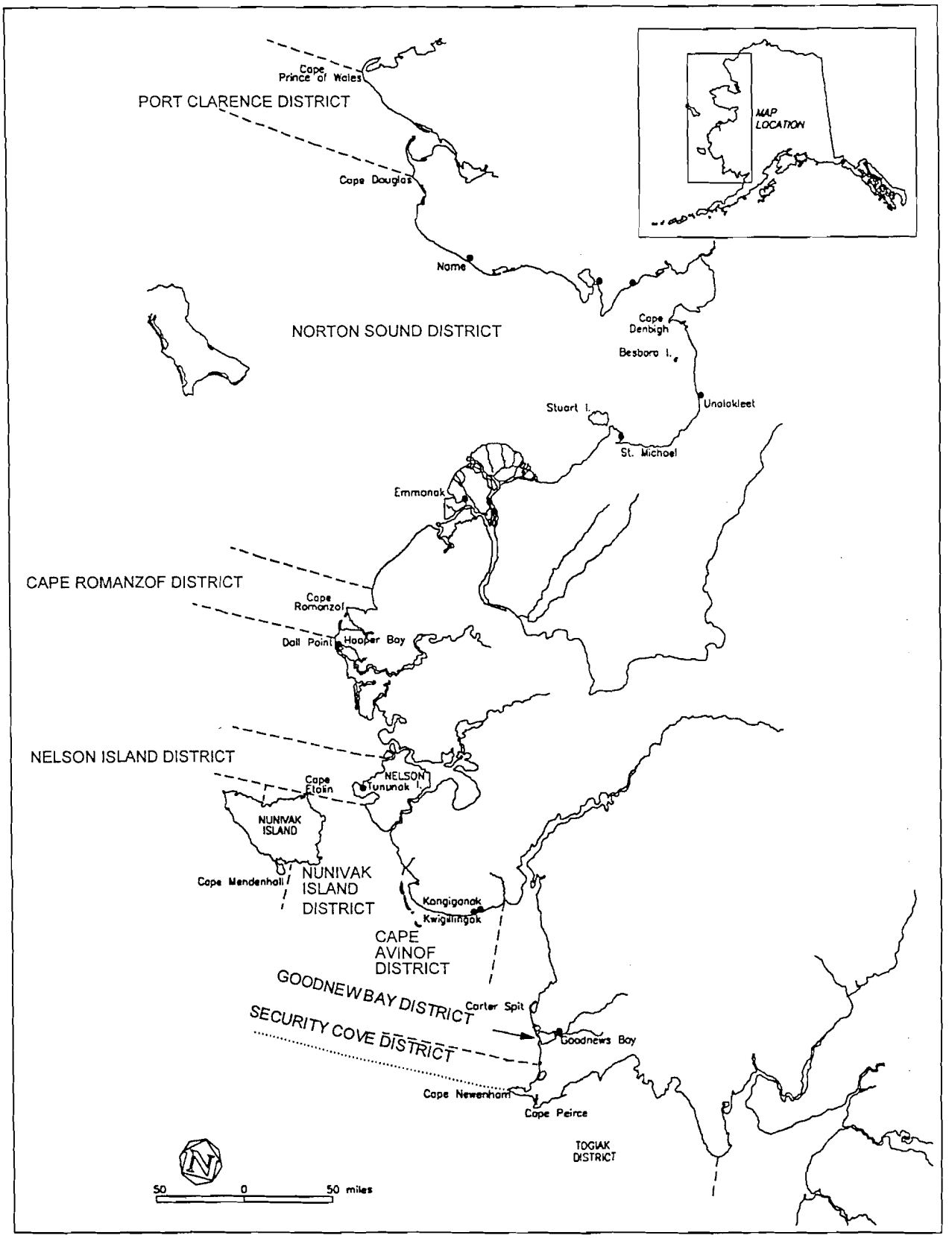


Figure 1. Commercial herring districts in the Arctic-Yukon-Kuskokwim Region of the northeastern Bering Sea, Alaska.

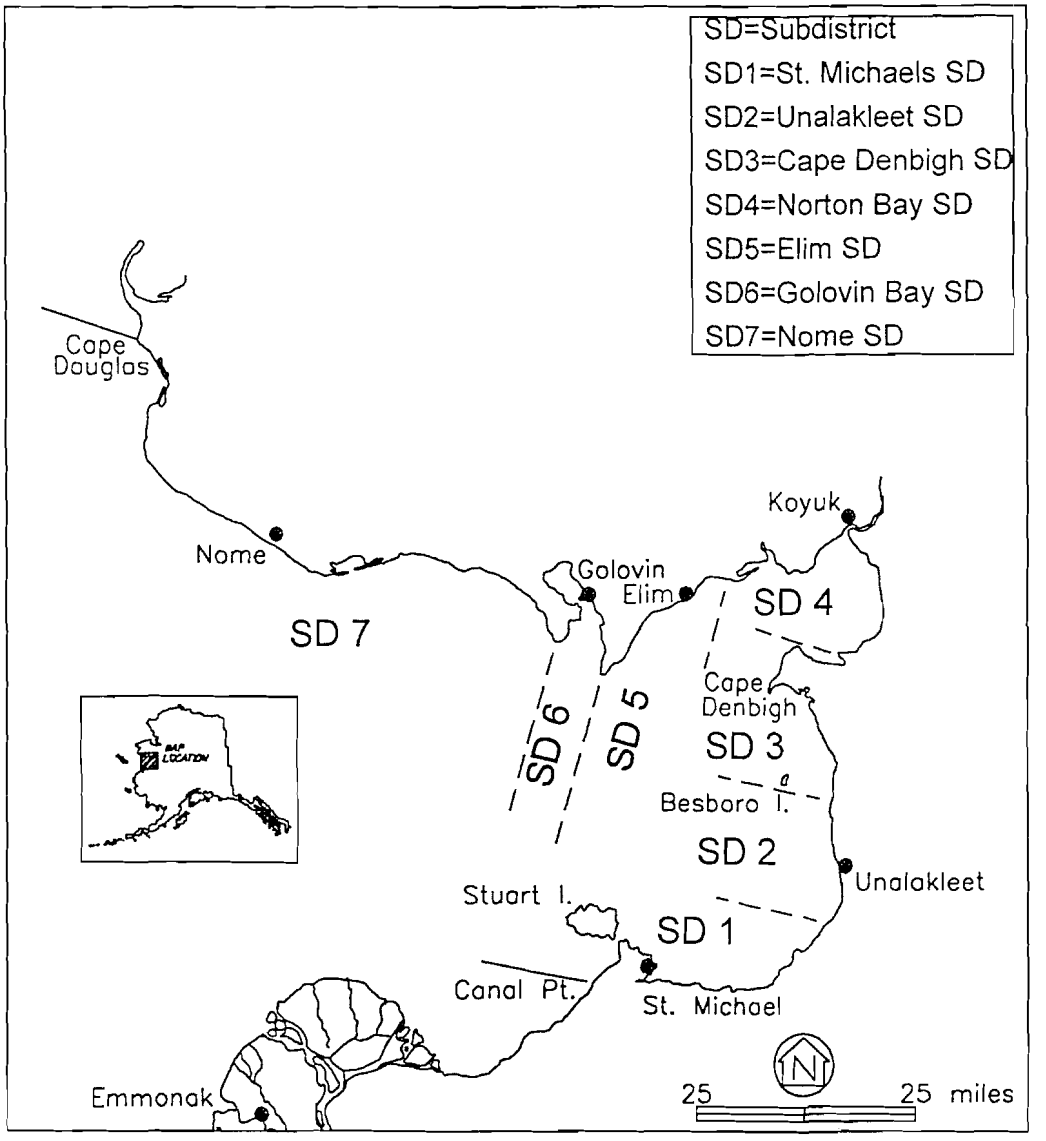


Figure 2. Norton Sound commerical herring subdistricts.

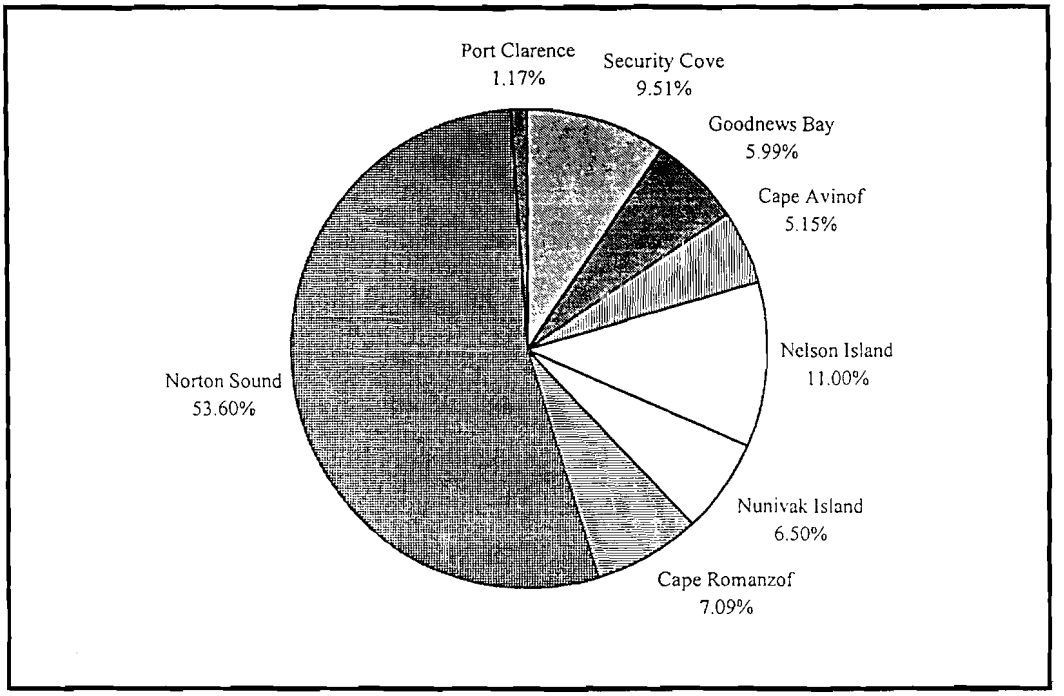


Figure 3. Pacific herring run biomass distribution by fishing distirct, Arctic-Yukon-Kuskokwim Region, Alaska, 1995.

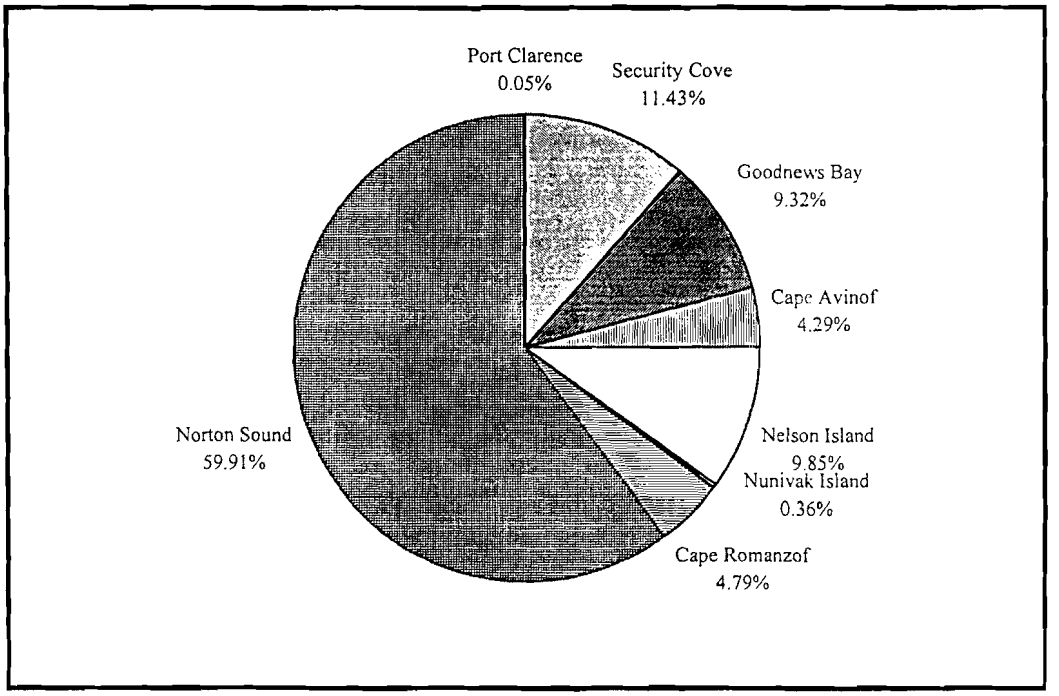


Figure 4. Pacific herring commercial harvest distribution by fishing district, Arctic-Yukon-Kuskokwim Region, Alaska, 1995.

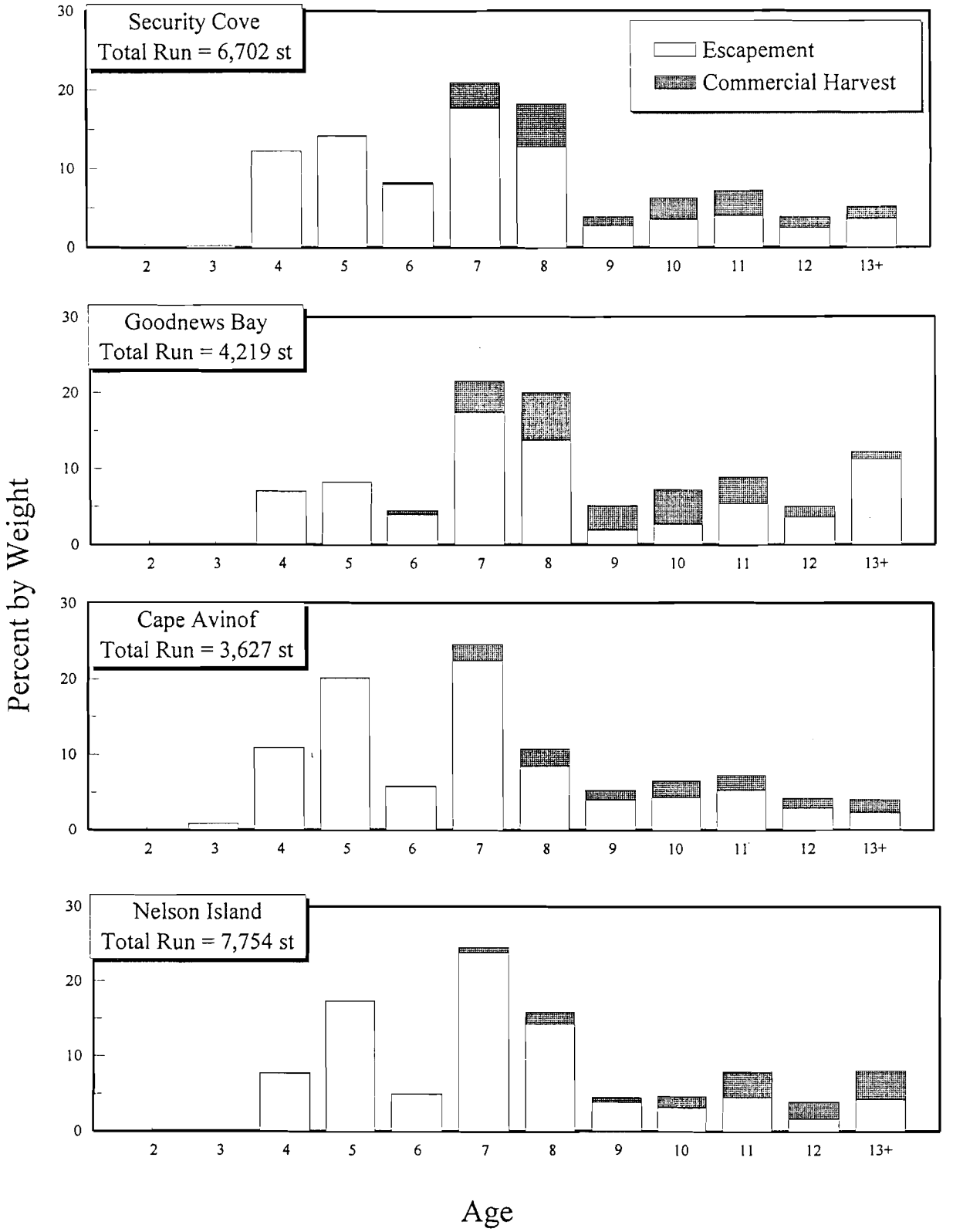


Figure 5. Age composition of the total biomass, escapement and commercial harvest for the Security Cove, Goodnews Bay, Cape Avinof, and Nelson Island commercial herring fishing districts within the Arctic-Yukon-Kuskokwim Region, Alaska, 1995.

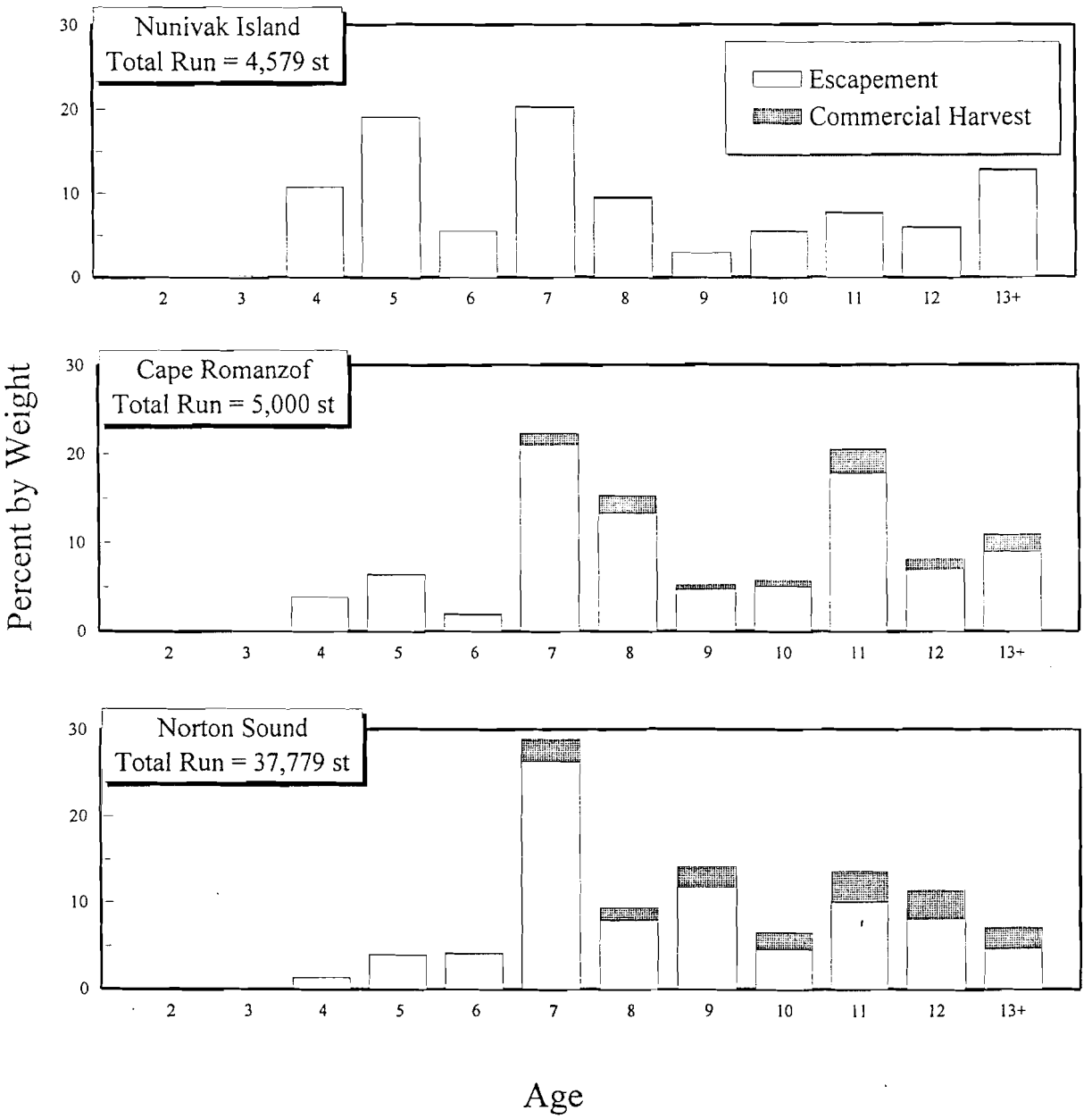


Figure 6. Age composition of the total biomass, escapement and commercial harvest for the Nunivak Island, Cape Romanzof, Norton Sound commercial herring fishing districts within the Arctic-Yukon-Kuskokwim Region, Alaska, 1995.

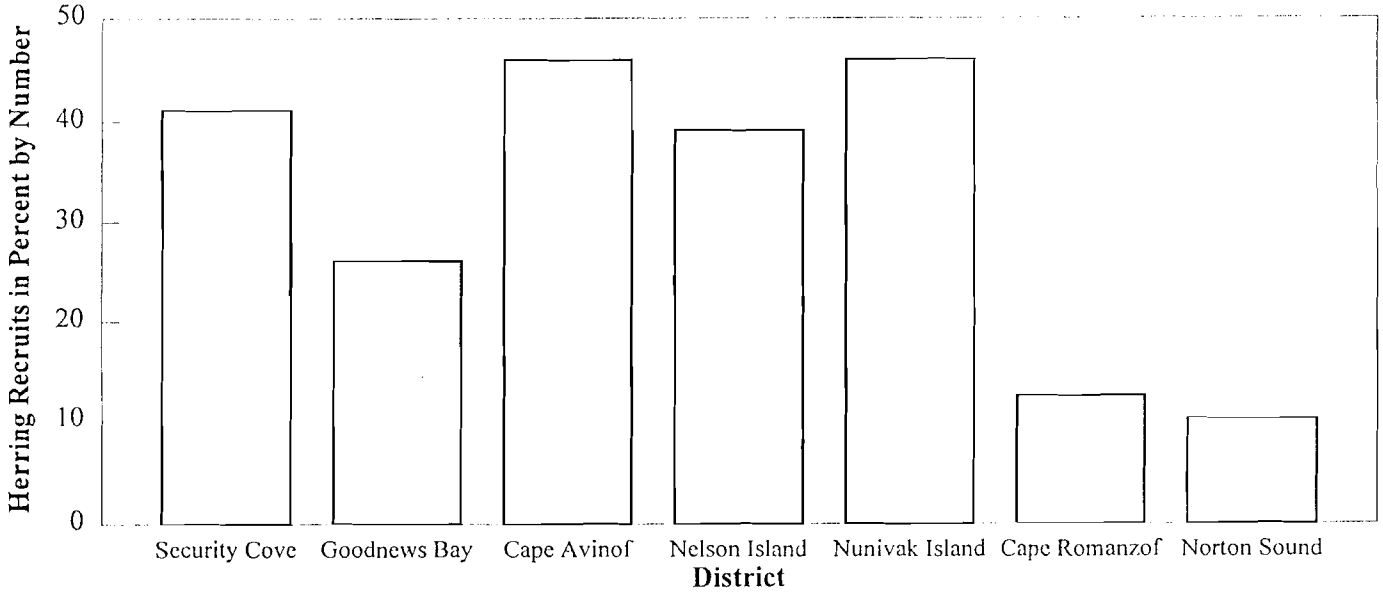


Figure 7. Pacific herring recruits (ages 2, 3, 4, and 5) for commercial fishing districts within the Arctic-Yukon-Kuskokwim Region, Alaska, 1995.