

Pacific Herring Stocks and Fisheries in the
Arctic-Yukon-Kuskokwim Region
of the Bering Sea,
Alaska, 1998

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 1998 Pacific herring stock assessment programs of the Arctic-Yukon-Kuskokwim (AYK) Region, review 1998 management strategies and harvests in all AYK commercial and subsistence herring fisheries, and present harvest projections and general management strategies for the 1999 fishing season. 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 commercial harvests are not allowed under the Bering Sea Herring Fishery Management Plan (5 AAC 27.060, ADF&G 1998), 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. All AYK herring districts open and close by emergency order authority to provide for an orderly fishery and allow periodic assessment of herring biomass. The Nelson Island, Nunivak Island, Cape Romanzof, and Norton Sound herring fisheries have been limited entry since 1987. A moratorium to new entry was placed on the Goodnews Bay herring fishery for the 1998 season. In addition, all AYK Region commercial herring districts, except Security Cove and Port Clarence, are designated as superexclusive use areas.

The Alaska Board of Fisheries allowed an experimental open pound fishery, using imported *Macrocystis* substrate, to harvest herring spawn on kelp during the 1998 season in Norton Sound. An emergency order from the Commissioner allowed for a wild spawn on *Fucus* kelp fishery. These actions were made in response to an anticipated poor market for sac roe herring in this district. A commercial fishery for wild spawn on kelp had existed previously in Norton Sound, with the last harvest taken in 1984. However the fishery was closed over concern that the kelp harvest in combination with the sac roe fishery would exceed the maximum exploitation rate of 20%. The Board will decide whether to continue the open pound fishery at its January 1999 meeting in Kodiak.

A total biomass of 79,815 tons of herring was estimated to have been present in the surveyed portion of the AYK Region herring districts in 1998 (Tables 2 and 5). The 1998 return is 11.8% above the 5-year average (1993-1997) of 71,410 tons. Young (ages 4 and 5) herring comprised less than one-third of the biomass in all herring districts. Middle-aged (ages 6-8) and older (ages 9 and older) herring each comprised one-third or more of the biomass in the Kuskokwim herring districts (Security Cove, Goodnews Bay, Cape Avinof, Nelson Island and Nunivak Island). Ages 5 and 10 were the dominant age groups in these districts. Age ten dominated the herring biomass in the Cape Romanzof and Norton Sound Districts.

In recent years, some processors in western Alaska herring fisheries have adjusted delivery weights and roe percentages of the landed catch to reflect water weight. There is considerable

variation throughout the fleet in equipment and technique used to handle fish delivered to tenders. Newly implemented dewatering equipment used by some tenders has resulted in lower harvest weights on fish tickets compared to recent years. Two management areas in the Region chose to convert the 'dry' weights recorded on fish tickets in 1998 to a 'wet' weight to maintain consistency in harvest reporting and estimated exploitation rate. Processors were interviewed post-season to determine which tenders or processors used dewatering equipment and which weight-type was recorded on fish tickets. The converted wet weight is used in the text with the fish ticket weight in parenthesis for the Kuskokwim Area and Norton Sound District. Only the fish ticket weight is reported for the Cape Romanzof District. At Cape Romanzof, dry pumps were used by tenders to offload herring through the early 1990s. As wet pumps replaced dry pumps on tenders at Cape Romanzof, dewatering systems were used shortly thereafter to more accurately reflect landed weights. For the 1999 season, the Alaska Department of Fish and Game, Commercial Fisheries Division will issue a newly designed fish ticket that includes a check box where tender boat operators can record the type of weight used.

The 1998 herring harvest for the AYK Region was approximately 7,310 tons, a decrease from the 1997 harvest of 8,017 tons (Table 1). The 1998 harvest is 86% of the 5-year average (1993-1997) of 8,460 tons. Food and bait sales during the sac roe fishery totaled 110 tons, all taken in the Cape Romanzof District, 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. An additional eight tons of bait were harvested in the directed-bait fishery in the Norton Sound District. 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. No wastage occurred in 1998 (Table 2). The 1998 total exploitation rate for the AYK Region was 9.2%. Exploitation rates ranged from 5.1% in the Norton Sound District to 25.2% in the Security Cove District (Table 2).

An awareness among processors, managers and fishermen of poor market conditions and the need for a high-quality product has helped produce high roe percentages in recent years. Roe recoveries in the sac roe harvest ranged from 9.2% in the Norton Sound District to 11.8% in the Nelson Island District, with a combined regional roe recovery of 10.2% (Table 2).

The 1998 estimated ex-vessel value for the AYK Region of \$1,158,000 is a decrease compared to the 1997 value of \$1,602,000 (Table 2). The 1998 value is 28% of the 5-year average (1993-1997) of \$4,207,000. The primary reason for this dramatic decline is the poor market for herring in 1998. The price paid to fishermen in the Kuskokwim Area and the Cape Romanzof District for herring with 10% roe content was approximately \$200 per ton plus or minus \$20 a percentage point, and \$65 per ton for bait-quality herring. This is similar to prices paid in 1997. The largest fishery in AYK is the Norton Sound District, which has the last sac roe herring fishery to occur along the west coast each year. In 1998, only a very limited market for sac roe herring was available when the Norton Sound fishery opened. Both the average price paid per ton and fishing effort were at record lows. The price paid to fishermen in the Norton Sound District averaged \$72 per ton. This record low price was one-half of the price they received in 1997. After the sac roe fishery concluded in the Norton Sound District a directed-bait herring fishery was allowed. The price paid to fishermen during the directed-bait fishery was \$1,860 per ton (\$0.93 per pound).

A total of 440 permit holders participated in AYK sac roe herring fisheries during the 1998 season (Table 3). This is less than one-half of the number of permit holders fishing in 1997. Decreased participation in all districts resulted in one of the lowest efforts on record. In Norton Sound, only 35 gillnet permit holders fished compared to a 1993-1997 average of 234 fishermen. None of the beach seine fleet participated due to the lack of a market. Typically six permit holders participate in this fishery. Twenty five fishermen participated in the Norton Sound kelp fisheries and one permit holder harvested herring in a directed-bait herring fishery.

Surveyed subsistence fishermen from selected Yukon River coastal villages harvested approximately 2 tons of herring (Table 4). No surveys were conducted in the Nelson Island and Nunivak Island villages in 1998. These villages have historically harvested approximately 110 tons of herring annually (Pete 1992).

Biomass projections are made for each district using postseason escapement estimates, historical mean rates of survival, current mean weights for each age class and assumed recruitment rates for each age class (Wespestad 1982). The projected 1999 spawning biomass of the northeastern Bering Sea herring stocks (Security Cove to Norton Sound) is 63,198 tons, with an allowable commercial harvest of 12,425 tons (Table 7). This is a decline from the 1998 biomass of 79,815 tons. Districts with projected declines are either those with poor aerial survey conditions in 1998 or those in which a slight decline is expected due to natural mortality as the predominant year class ages. These projections do not include age classes, generally age 3, 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 may be adjusted inseason according to observed herring spawning biomass. In addition, in accordance with the AYK Region harvest strategy, the commercial fishery will not target newly recruited age classes. 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 timing of the spawning migration 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 soon after ice breakup, which generally occurs between late-April and mid-June. Spawning usually begins in the Security Cove District and 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 ft² 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 usually fished in the AYK Region, 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.

An aerial survey calibration study was conducted on May 20 on the east side of Nunivak Island in 1998. The objective of this study was to determine the accuracy of aerial survey biomass estimates by using purse seine gear to capture schools of herring after estimation of their surface area. The goal was to observe ten successful sets. Due to low ceilings, only two successful sets were observed. In one set, the actual weight of herring was 10 tons, whereas the aerial survey estimate was 12.9 tons. In the other set, the actual weight was 12 tons and the survey estimate was 13.7 tons. Because of the poor weather conditions, it was not possible to obtain a wide range of point estimates necessary for evaluating biomass conversion factors.

During 1998, 51 aerial surveys totaling 69.0 hours of flight time were flown in the AYK Region: 6 (3.3 hours) in Security Cove, 6 (2.8 hours) in Goodnews Bay, 1 (0.8 hours) in Cape Avinof, 8 (3.4 hours) in Nelson Island, 4 (6.1 hours) in Nunivak Island, 3 (0.7 hours) in Jacksmith Bay, 3 (1.5 hours) in Cape Romanzof, and 20 (50.4 hours) in Norton Sound and Port Clarence combined. Survey conditions were rated as fair or better in only one-fourth of these surveys.

Gillnets are the only legal gear in the AYK Region, with the exception of Norton Sound where a portion of the harvest is generally taken using beach seine gear. However, no beach seine fishery took place during the 1998 season. An attempt was made to sample at least 420 herring from each commercial gear type, district or subdistrict per week. 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 to estimate age, sex, size, and sexual maturity of herring, and to note the occurrence of other schooling fishes, in all but the Nunivak Island and Port Clarence Districts. Nunivak Island age composition summaries were compiled using samples from the purse seine calibration study and samples from the Nelson Island test fishery. A total of 12,624 herring from commercial gillnet, purse seine, subsistence and test catches were sampled during the 1998 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 helped to increase roe recoveries.

Spawning Populations

Security Cove District

Since 1981, biomass estimates in the Security Cove District have ranged from 2,300 tons in 1987 to 8,267 tons in 1981 (Table 5). The herring biomass projected to return to this district in 1998 was 4,017 tons. Between May 5 and May 29, 1998, six aerial surveys were flown in the district to estimate herring biomass and observe spawning activity. None of these surveys were flown under acceptable conditions. The largest biomass, 1,629 tons, was observed on May 8. The projected biomass estimate was used as the biomass estimate for 1998. A total of 6.5 miles of spawn was observed in the district, with the highest amount, 3.5 miles, observed on May 6.

The Security Cove test fish crew sampled 834 fish caught with variable-mesh gillnets from May 10 to May 24 for biological data. Age 5 herring dominated both the biomass (27.0%; Figure 5) and the return in numbers of fish (37.4%). Age 9 and older herring comprised 38.0% of the biomass. Recruit herring, ages 2-5, represented 42.0% of the returning population (Figure 7).

Goodnews Bay District

Since 1981, biomass estimates in the Goodnews Bay District have ranged from 2,000 tons in 1987 to 6,315 tons in 1996 (Table 5). The herring biomass projected to return to this district in 1998 was 4,064 tons. During the 1998 season, six aerial surveys were flown in the district between May 5 and May 29 to estimate herring biomass and observe spawning activity. None of these surveys were flown under acceptable conditions. The largest biomass, 226 tons, was observed on May 29. The projected biomass estimate was used as the 1998 biomass estimate. No spawn was observed during aerial surveys of the district.

The Department's test fish crew sampled 1,346 herring caught with variable-mesh gillnets from May 5 to May 26 for biological data. Age 10 was the largest component of the return in biomass (18.4%; Figure 5) and age 5 herring dominated in numbers of fish (24.7%). Age 9 and older herring comprised 46.7% of the biomass (Figure 5). Recruit herring represented 30.4% of the returning population (Figure 7).

Cape Avinof District

Since 1985, biomass estimates in the Cape Avinof District have ranged from 1,225 tons in 1987 to 4,600 tons in 1997 (Table 5). The herring biomass projected to return to this district in 1998 was 4,287 tons. During the 1998 season, one aerial survey was flown in the district on June 3 to estimate herring biomass and observe spawning activity. Under poor survey conditions, 289 tons of

herring and 0.5 miles of spawn were observed. Aerial survey estimates of herring biomass in the Cape Avinof District have been obtained in only three of the past ten years. The area consists of shallow mud flats where turbidity, caused by wind and wave action, often limits visibility. The last year in which the herring biomass was estimated by survey was in 1992, when 3,446 tons were observed. In other years, the preseason projection or commercial catch rates have been used to estimate herring biomass. Due to poor aerial survey conditions in 1998, the total biomass present in the district was assessed to be the projected biomass of 4,287 tons primarily based on a qualitative comparison of historical commercial catch rates. Other indicators of herring abundance such as spawn deposition, test fish catch rates, comments from local residents, age composition, and the limited information from aerial surveys were also used in assessing the size of the herring population at Cape Avinof.

The Cape Avinof test fish crew sampled 763 herring caught with variable-mesh gillnets from May 27 to June 4 for biological data. Age 5 herring dominated both the biomass (24.1%; Figure 5) and the return in numbers of fish (33.2%). Age 9 and older herring comprised 34.1% of the biomass. Recruit herring represented 40.3% of the returning population (Figure 7).

Nelson Island District

Since 1985, biomass estimates in the Nelson Island District have ranged from 2,385 tons in 1991 to 9,500 tons in 1985 (Table 5). The herring biomass projected to return to this district in 1998 was 7,136 tons. During the 1998 season, eight aerial surveys were flown between May 10 and June 3 to estimate herring biomass and observe spawning activity. None of these surveys was flown under acceptable conditions. The largest biomass, 1,672 tons, was observed on May 25. A total of 5.4 miles of spawn was observed in the district, with the highest amount, 4.0 miles, observed on May 25. Because there were no acceptable surveys, the total biomass present in the district was assessed to be the projected biomass of 7,136 tons primarily based on a qualitative comparison of historical commercial fishery CPUE. Other indicators of herring abundance such as spawn deposition, test fish and subsistence catch rates, comments from local residents, age composition, and the limited information from aerial surveys were also used in assessing the size of the herring population.

Test fishing with variable-mesh gillnets occurred from May 18 through June 11. The crew sampled 1,635 herring caught in variable-mesh gillnets for biological data. Age 5 herring dominated the return in both biomass (24.0%; Figure 5) and in numbers of fish (32.4%). Age 9 and older herring comprised 34.7% of the biomass. Recruit herring represented 38.0% of the spawning population (Figure 7).

Nunivak Island District

Since 1985, biomass estimates in the Nunivak Island District have ranged from 422 tons in 1990 to 6,000 tons in 1986 (Table 5). The herring biomass projected to return to this district in 1998 was

3,778 tons. During the 1998 season, four aerial surveys were flown between May 10 and June 3 to estimate herring biomass and observe spawning activity. Two of these surveys were flown under acceptable conditions. The largest biomass, 968 tons, was observed on May 20 under fair conditions. The preseason biomass projection was used as the biomass estimate for 1998. A total of 3.0 miles of spawn was observed in the district, with the highest amount, 2.0 miles, observed on May 20.

No herring were sampled using variable-mesh gillnets in the district. Age composition of the Nunivak Island herring biomass was estimated using 420 herring sampled from the purse seine catch and using variable-mesh gillnet samples from the Nelson Island District. Age 5 herring dominated the return in both biomass (24.0%; Figure 6) and in numbers of fish (32.4%). Age 9 and older herring comprised 34.7% of the biomass. Recruit herring represented 38.0% of the spawning population.

Central Kuskokwim Bay

The Central Kuskokwim Bay area extends from Jacksmith Bay, south of Quinhagak, to the Ishkowiik River. No commercial herring fishing districts are located in this area. Three aerial surveys were flown in this area from May 5 to May 29. All of these surveys were flown under unsatisfactory conditions. No herring were observed during these surveys.

Cape Romanzof District

Due to excessive water turbidity in the Cape Romanzof area, it is not generally possible to estimate herring biomass using aerial survey techniques. Based on information from limited aerial surveys, test and commercial catches, and spawn deposition, the estimated herring biomass in the Cape Romanzof District has ranged from approximately 5,000 to 7,500 tons since 1981 (Table 5). Three aerial surveys were flown during the 1998 season from May 20 through May 29. None of these surveys were flown under acceptable conditions. The only biomass observed was 416 tons on May 20. Based on spawn deposition study results, commercial and test fishery catch rates, herring age composition and the preseason projection, the 1998 biomass of herring in the Cape Romanzof District was estimated to be between 4,000 and 5,000 tons. This is a decrease from the 1997 biomass estimate of between 4,500 and 5,500 tons.

Artificial spawning substrates were located in the same general spawning locations as in 1992 through 1997. Forty platforms were placed just north of the Department's field camp on May 14. 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. The largest spawn deposition within the study area occurred on May 19. The spawn deposition season total index of 3,386 g documented this year was the second lowest since the project began in 1992 and was 28% below the 1993-1996 average of 4,113 g. The

project had indicated a trend of increasing spawn deposition within the study area from 1992 through 1996. However, it is uncertain whether the study area results are indicative of the total spawning biomass within the entire district.

The Department's test fish crew sampled 1,319 herring caught with variable-mesh gillnets from May 18 to June 4 for biological data. Age 10 herring dominated the return in both biomass (27.4%; Figure 6) and numbers of fish (23.0%). Age 9 and older herring comprised 52.2% of the biomass. Recruit herring represented 19.1% 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 (Table 5). During 1998, 20 surveys were flown between May 12 and June 12. Survey conditions were generally fair to poor. Herring and spawn were first sighted during an aerial survey on May 19. The peak aerial survey estimate was made on June 8, when a record 49,464 tons was observed. The 1998 herring biomass for Norton Sound of 52,033 tons was calculated by combining the peak aerial survey estimate from June 8 with that portion of the commercial harvest (2,569 tons) occurring prior to June 8. The preseason biomass projection was 40,688 tons.

Two Department test fish projects were operational during the 1998 season. One crew operated in the northern portion of Norton Sound at Cape Denbigh, and the second crew was stationed in the southern end of the district at Klikitarik. Test fishing was conducted in the Unalakleet area as time allowed. Test fish crews sampled 2,756 herring caught with variable-mesh gillnets from May 18 through June 9 for biological data. Age 10 herring dominated the return in both biomass (40.3%; Figure 6) and in numbers of fish (33.4%). The biomass consisted of 63.0% age 9 and older herring. Recruit herring, represented 24.9% of the return in numbers of fish (Figure 7).

Port Clarence District

Generally, it is not possible to survey this district due to the presence of ice, water stain, or 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. During the 1998 season, a single survey was flown on June 11, when 9.1 tons were observed.

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. In the Nelson and Nunivak Island Districts subsistence surveys have been conducted in most years since 1990 by Subsistence Division (Pete 1990, 1991, 1992, 1993). However, no herring subsistence surveys have been conducted in those districts since 1996 (Table 4). Nelson Island villages harvest approximately 110 tons of herring annually (Pete 1992).

A total of 210 herring were sampled from the 1998 subsistence catches from Nelson Island for biological data. Age 5 herring dominated the subsistence harvest (32.4%). The catch consisted of 18.2% age 9 and older herring and 34.1% recruit-aged herring.

A combination of mail-out questionnaires and personal interviews were used to collect subsistence harvest information in 1998. A total of 26 households responded out of a total of 215 identified households that were mailed questionnaires. A subsistence harvest of approximately 2 tons was reported to have been taken by 15 fishing families from the Yukon Delta villages of Hooper Bay, Chevak, and Scammon Bay (Table 4). In addition, six families harvested 565 pounds of spawn on *Fucus* kelp for subsistence use. The reported harvest is a minimum estimate since not all fishing families were contacted and not all households who received questionnaires returned them.

COMMERCIAL FISHERY

Security Cove District

The total harvest of 1,012 tons (fish ticket weight 1,004 tons) had an average roe content of 11.5% (Tables 1 and 2). Nine processors bought herring from 78 permit holders who made 255 deliveries in seven periods with 28.5 hours total fishing time (Tables 3 and 6). The estimated ex-vessel value was \$232,000. The exploitation rate was 25.2% based on the preseason biomass projection of 4,017 tons.

On May 9, the first period opened for 7.5 hours starting at 3:30 pm. Four permit holders delivered 37 tons of sac roe-quality herring with an average roe content of 12.4%. Between May 10 and May 12 the district was reopened 5 times for a total of 18 hours of fishing time. Harvest ranged from 18 tons on May 10 to 477 tons on May 11. The guideline harvest level was exceeded when catch rates increased substantially during the final period on May 13 when 274 tons were landed. Average roe contents ranged from 10.9% to 12.1% for an overall average roe content of 11.5%.

A sample of 420 herring was taken from the commercial catch. Age 10 herring comprised the largest age group (22.9%) in the harvest biomass. Age 9 and older herring made up 71.5% of the catch (Figure 5). Recruit-age herring made up less than 1% of the commercial sample.

Goodnews Bay District

The total harvest was 831 tons (fish ticket weight 798 tons) of sac roe herring with an average roe content of 11.3% (Tables 1 and 2). Two processors bought herring from 84 permit holders who made 580 deliveries in 12 periods with 79 hours total fishing time (Tables 3 and 6). The estimated ex-vessel value was \$188,000. The exploitation rate was 20.5% based on the preseason biomass projection of 4,064 tons.

On May 16, the first period opened for 6 hours at 8:00 am. Seven permit holders delivered 1 ton of sac roe herring with a 13.1% average roe content. Between May 17 and May 24, the district was opened 11 times for a total of 73 hours. Catches ranged from 5 tons on May 17 to 176 tons on May 20. Average roe contents ranged from 10.8% to 13.6% for an overall average roe content of 11.3%.

A sample of 420 herring was taken from the commercial catch. The largest age class in the harvest biomass was age 10 (31.9%; Figure 5). Age 9 and older herring made up 68.9% of the catch (Figure 5). Recruit-age herring comprised 1.2% of the harvest.

Cape Avinof District

The total harvest was 656 tons (fish ticket weight 620 tons) of sac roe herring with an average roe content of 11.6% (Tables 1 and 2). Two processors bought herring from 109 permit holders who made 561 deliveries in eight periods with a total fishing time of 44 hours (Tables 3 and 6). The estimated ex-vessel value was \$152,000. The exploitation rate was 15.3% based on the preseason biomass projection of 4,287 tons.

On May 29 the first period opened for 4 hours starting at 12:00 noon. Twenty permit holders delivered 24 tons of herring with an 11.8% average roe content. Between May 30 and June 3 the district was opened seven times for a total of 40 hours. Catches ranged from 15 tons on May 31 to 209 tons on June 3. Average roe contents ranged from 11.2% to 12.0% for an overall average roe content of 11.6%.

A total of 349 herring were sampled from the commercial catch. Age 10 herring dominated the harvest (29.6%). Age 9 and older herring made up 61.0% of the catch (Figure 5). Recruit-age herring comprised less than 1% of the harvest.

Nelson Island District

The total harvest was 1,250 tons (fish ticket weight 1,180 tons) of sac roe herring with an average roe content of 11.8% (Tables 1 and 2). Two processors bought herring from 86 permit holders who made 829 deliveries in 13 periods with a total fishing time of 64 hours (Tables 3 and 6). The estimated ex-vessel value was \$296,000. The exploitation rate was 17.5% based on a preseason biomass projection of 7,136 tons.

On May 23, the first period opened for 2 hours starting at 8:00 am. Nine permit holders delivered 4 tons of sac roe-quality herring with an 11.8% average roe content. There were 12 additional periods between May 23 and May 30 for a total of 62 hours of fishing time. Catches ranged from 11 tons on May 26 to 227 tons on May 27. Average roe contents ranged from 11.3% to 12.8% with an overall average roe content of 11.8%.

A total of 426 herring were sampled from the commercial catch. Age 10 was the largest age class, comprising 29.0% of the harvest. Age 9 and older herring made up 67.4% of the catch (Figure 5). Recruit-age herring made up less than 1% of the commercial sample.

Nunivak Island District

The total harvest by commercial gillnet was 2 tons of sac roe herring with an average roe content of 9.8%. One processor paid approximately \$450 to seven permit holders. The total harvest by purse seine associated with an aerial survey calibration study was 200 tons. The exploitation rate for both gear-types combined was 5.4% of the estimated available biomass.

The district was first opened to herring fishing for 6 hours on May 21 (Table 6). Seven permit holders delivered 2 tons of sac roe herring with an average roe content of 9.8%. Between May 22 and May 23 the district was reopened for commercial gillnet fishing four times for 21 hours of fishing time. Gillnet fishermen were unable to locate marketable quantities of herring, and no deliveries were made. The single purse seine permit holder fished from May 20 until May 24, when the purse seine harvest allocation was reached. The Nunivak Island Herring Fisherman's Association plans on approaching various state agencies with a proposal to co-op the Nunivak Island Commercial Herring fishery and use a chartered purse seine vessel to harvest the quota.

No herring were sampled from the commercial gillnet catch. Four hundred twenty herring were sampled from the purse seine harvest. Age 5 herring dominated the purse seine catch by weight (42.2%). Herring aged 9 and older comprised 14.5% of the catch (Figure 6). Recruit-age herring comprised 44.8% of the purse seine harvest.

Cape Romanzof District

A total of 727 tons of herring were harvested by 41 fishermen in 1998 (Tables 1, 2 and 3). The commercial harvest was 21% above the recent five-year-average (1993-1997) of 600 tons. Sac roe comprised 85%, or 617 tons of the harvest. The average sac roe recovery was 10.0%. A total of 110 tons of herring were purchased as bait. Bait herring consisted of deliveries with roe content below 8%. The commercial harvest was allowed to reach near the midpoint of the preseason harvest projection of 650 to 850 tons. The commercial fishery consisted of 11 fishing periods, between May 20 and May 29 (Table 6). Fishing periods ranged from 1.5 hours to 5 hours in duration for a total fishing time of 35 hours. Fishing gear was restricted to one 50-fathom gillnet per vessel throughout the commercial season.

The estimated value of the harvest to fishermen was \$131,000. One company purchased herring, represented by one processing vessel and five tenders during the fishery (Table 3).

Fishing effort was equal to the lowest on record in 1993. Lower prices because of market conditions resulted in a decline in fishing effort. Local Alaskan residents (defined as residents of Chevak, Hooper Bay, and Scammon Bay) accounted for 98% (40 permits) of the effort and 98% (714 tons) of the harvest (Table 2). Fishermen harvested an estimated 16.2% of the available biomass (Table 2).

A total of 583 herring were sampled from the commercial harvest. Age 10 herring dominated the harvest biomass (35.8%). Age 9 and older herring made up 71.1% of the catch (Figure 6). Recruit-age herring comprised less than 1% of the harvest.

Norton Sound District

Because of an anticipated poor market for herring, two herring spawn on kelp fisheries operated during the 1998 season besides the annual sac roe fishery: a herring spawn on imported *Macrocystis* kelp fishery and a herring spawn on wild *Fucus* kelp fishery. In addition, a directed-bait herring fishery was allowed.

Sac Roe Fishery

The 1998 Norton Sound herring sac roe fishery opened by emergency order on May 22. In response to a limited market and low effort, the season was opened by the Department and two buyers participating in the fishery were given permission to announce times when herring could be sold. The total harvest during the sac roe fishery was approximately 2,624 tons (fish ticket weight 2,463 tons) of herring with an average roe recovery of 9.2% (Tables 3 and 6). Since 1981, catches, including waste, have averaged 4,508 tons. There was no bait-quality herring harvested, nor wasted herring noted, during the 1998 sac roe herring season. Fishermen harvested an estimated 5.1% of the available biomass. Only 35 gillnet fishermen out of a possible 320 permit holders participated in the fishery. There was no market for beach seine-caught herring. Typically six fishermen participate in the beach seine fishery. Table 8 compares the historical beach seine and gillnet commercial catches in the Norton Sound District. A small quantity of herring was harvested with an educational permit. However, they were unable to sell their catch and chose to distribute it to subsistence users in Unalakleet.

The gillnet fishery was first opened in Subdistricts 1, 2, 3 and 4 on May 22. Only Subdistrict 5 was closed to sac roe fishing in keeping with the Management plans published prior to the season. An effort was made to separate the spawn on kelp fishery from the gillnet fleet to prevent gear conflicts and enable the Department to better monitor both fisheries.

Two companies were present on the grounds during the season to purchase herring. One company ceased operations on June 4 and the other on June 9. These two companies registered two processors and six tenders to operate in Norton Sound (Table 3). The total value of the herring harvest to Norton Sound fishermen was approximately \$203,470, less than one-tenth of the five-year (1993-1997) average of \$2,213,800.

A total of 1,143 herring were sampled from the commercial harvest. Age 10 herring dominated the harvest, comprising 40.3% of the catch by weight. Age 9 and older herring represented 63.0% of the catch. Recruit-age herring comprised less than 1% of the harvest.

Spawn on Kelp Fisheries

The Alaska Board of Fisheries approved an experimental herring spawn on imported *Macrocystis* kelp fishery to operate in Norton Sound during the 1998 season, with harvest limits of 2,000 blades per permittee and a fishery cap of 75,000 blades. The Commissioner approved emergency regulations to allow a herring spawn wild *Fucus* kelp fishery shortly before the normal start of the sac roe fishery. Only fishermen holding Norton Sound gillnet or beach seine permits were allowed to participate in the kelp fisheries. The intent of these decisions was to allow as much opportunity as possible to sac roe permit holders, since there would be an opportunity for only a small minority to participate in the sac roe fishery.

Twenty-two permit holders registered to participate in the herring spawn on *Macrocystis* kelp fishery. Eleven fishermen deployed their kelp in Subdistrict 5 and the other eleven fishermen expressed their intent to deploy in Subdistricts 1 and 2. Seven permittees reported harvests from Subdistrict 1. In addition to the *Macrocystis* harvest, three individuals reported harvests of wild kelp.

The Board of Fisheries purposely chose to leave the gear specifications fairly broad to allow participants to experiment and test a full range of ideas on how best to deploy *Macrocystis* kelp to facilitate the accumulation of herring spawn. The deployment methods fell into two general categories: floating frames and long lines. The frame deployment technique appeared to be the most successful method of kelp deployment. The most successful longline arrangement the staff observed was a spiral arrangement that resulted in a clumped deployment of kelp, similar to the frame deployment. Participants reported poor success with kelp deployed closer than 18 inches to the surface or with kelp that dragged the bottom. It was important to be in close proximity to wild plants with an on-going spawn to initiate spawn on the imported kelp.

Logistic problems encountered in the fishery included: poor timing of arrival of the kelp, both early and late, inadequate shelter after deployment, damage to stored kelp by ice movement and storms, and the inability to follow the spawning migration. The kelp arrived in good condition, but the loads differed as to blade size and quality. The kelp arrived at Elim on May 24. During the next several days the ice in Norton Bay broke-up and moved past Elim. Some kelp was stored and maintained on shore using frequent saltwater baths and the remainder was kept in sunken net bags a few hundred yards offshore. The sunken bags were caught and dragged three days later during a heavy ice movement. Kelp stored in the holds of the boats for approximately one week had significant losses despite the efforts to circulate water over the vegetation. Kelp suspended from frames kept viable for about 10 days. The viability of the kelp was limited by grazing sea life such as sea urchins and snails.

The portion of Subdistrict 1 west of Five Mile Point was closed to spawn on kelp harvest to minimize gear conflicts. The imported kelp was deployed as it arrived beginning May 22. Two wild kelp openings were allowed on May 29 and June 1 for 10 and 7 hours each. The 11 permittees participating in the spawn on kelp fishery harvested a total of 18,183 pounds of kelp. Of this harvest, 2,100 pounds were from wild kelp and 16,083 pounds from imported *Macrocystis* kelp. Fishermen received approximately \$8 per pound of herring spawn on *Macrocystis* kelp and \$5 per pound for spawn on wild kelp. A very small amount of herring spawn on *Macrocystis* kelp has been sold to date.

Directed-Bait Fishery

A permit holder from Nome requested that a directed-bait herring fishery be allowed after the sac roe fishery concluded. Approximately 8.3 tons of herring were harvested. The majority of the bait was harvested by a single permittee for use in the local halibut and crab fisheries, but a small

amount was harvested by crab permittees for their own use. Approximately 16,550 pounds of herring bait were sold at \$0.93 per pound. The value of the harvest was \$15,435.

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. A small bait fishery with a harvest less than 10 tons occurs in most years. However, there was no bait fishery in Port Clarence in 1998.

ENFORCEMENT

The Division of Fish and Wildlife Protection (FWP) was present in Goodnews Bay, Security Cove, Nelson Island, and Norton Sound Districts this year. Because of the timing of the Norton Sound fishery, officers were not present in the Cape Avinof, Nunivak Island and Cape Romanzof Districts. However, fishermen followed fishery period opening and closing times very well and buyers were timely and accurate with verbal reporting of purchases. At least ten people from FWP using the P/V Walstad, two Supercub aircraft, a Cessna 185, a R-22 helicopter and two FWP skiffs were involved with the Security Cove and Goodnews Bay fisheries.

Protection efforts in Norton Sound consisted of three single engine aircraft (two Supercubs on wheels and one Cessna 185), the P/V Wolstad and two small boats. Personnel consisted of seven permanent full-time FWP officers, two seasonal assistants and a US Fish and Wildlife agent. No citations were issued. Fish and Wildlife Protection officers patrolled the grounds early in the fishery.

OUTLOOK AND MANAGEMENT STRATEGY FOR 1999

Projections from postseason escapement estimates, using historic mean rates of survival, current mean weights for each age class, and estimates of recruitment for each age class (Wespestad 1982), suggest that the 1999 spawning biomass for northeastern Bering Sea herring stocks (Security Cove to Norton Sound) will be 63,198 tons, with an anticipated allowable harvest of 12,425 tons (Table 7). If the return is as expected, a small to moderate reduction in biomass will be observed in all districts.

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 may be adjusted during the season according to observed herring spawning biomass. In addition, in accordance with the AYK Region harvest strategy, newly recruited age classes (age 2 through age 5 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. In all districts, the Department will work together with fishermen and buyers during the 1999 season to optimize roe recovery.

Security Cove District

The 1999 projected return to the Security Cove District is 3,060 tons. A 20% exploitation rate would result in a harvest of 612 tons (Table 7). A larger catch may occur if the 1999 biomass is assessed to be greater than projected. 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 6 and 8 are expected to comprise over one-half of the biomass (39.7% and 15.0%, respectively). Age 9 and older herring are expected to comprise almost one-third 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 significant spawning activity is observed. The 1999 projected return of herring to the Goodnews Bay District is 3,009 tons. A 20% exploitation rate would result in a harvest of 602 tons (Table 7). A larger catch may occur if the 1999 biomass is assessed to be greater than projected.

Similar to Security Cove, ages 6 and 8 are expected to be the dominant age classes, and comprise 26.0% and 17.0%, respectively, of the returning biomass. Age 9 and older herring are expected to comprise 43.9% 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 projected 1999 biomass for the Cape Avinof District is 3,555 tons (Table 7). The exploitation rate will be no greater than 15% because of the limited database for this area and the priority of subsistence fishing. Assuming a 15% commercial exploitation rate, the projected harvest will be 533 tons of herring.

Ages 6, 8 and 9 herring are expected to comprise well over one-half of the returning population (32.4%, 15.3% and 15.2%, respectively). Age 9 and older herring are expected to comprise over one-third 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 for 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 1999 is 5,826 tons (Table 7). At an exploitation rate of 20% minus 200 tons for subsistence harvest, the commercial harvest will be 965 tons of herring. A larger catch may occur if the 1999 biomass is assessed to be greater than projected.

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

1. Two hundred tons of the exploitable biomass will be set aside for subsistence.
2. Periodic closures of the commercial fishery will be scheduled, during which 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 acting on input from local residents, insure the adequacy of subsistence herring harvests during the commercial fishing season.

Similar to Cape Avinof ages 6, 8, and 9 herring are expected to dominate the returning population (32.4%, 17.3% and 16.3%, respectively). Age 9 and older herring are expected to comprise over one-third of the biomass.

Nunivak Island District

The biomass of herring projected to return to the Nunivak Island District in 1999 is 3,319 tons. A 20% exploitation rate would result in a 664-ton harvest (Table 7). A larger catch may occur if the 1999 biomass is assessed to be greater than projected. The commercial season will open when the biomass reaches 1,500 tons, or when significant spawning is observed.

Due to insufficient data having been collected from the Nunivak Island District in 1998, the estimated 1999 herring age composition was calculated using data from the Nelson Island District. Ages 6, 8 and 9 herring are expected to dominate the returning population (27.1%, 17.0% and 17.1%, respectively). Age 9 and older herring are expected to comprise 45.3% of the biomass.

Cape Romanzof District

The projected return for 1999, based on limited data, is expected to be between 2,800 and 3,700 tons based on an assessed biomass of between 4,000 and 5,000 tons in 1998. The midpoint of this range for 1998 was 4,500 tons, which results in a projected biomass of 3,260 tons. At a 20% exploitation rate, the harvest based on this projection would be 650 tons (Table 7). The allowable harvest is expected to range from approximately 560 to 740 tons and will be based on inseason indicators of abundance. It is likely that fishing gear will be restricted to no more than 50 fathoms and one gillnet per vessel by emergency order. Since water turbidity in the Cape Romanzof area generally prevents aerial observations of herring, spawn deposition and test and commercial catch rates will be used to determine the timing and duration of commercial fishing periods.

Ages 11, 9, and 8 herring are expected to dominate the biomass, contributing 22.8%, 20.9%, and 19.9%, respectively. Age 9 and older herring are expected to comprise 59.4 % of the return.

Norton Sound District

The biomass projected to return to Norton Sound in 1999 is 41,169 tons. A 20% exploitation rate would result in a harvest of 8,234 tons (Table 7). 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 824 tons.

The 1999 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.

Ages 6 and 11 are expected to comprise over one-half the returning biomass (19.1% and 35.5%, respectively). Age 9 and older herring are expected to contribute almost two-thirds of the return.

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 1999. 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 commercial fishermen during the sac roe fisheries in the northeastern Bering Sea, Alaska, 1909-1998.

Year	Herring (st) ^a									Spawn on Kelp (st)
	Security Cove	Goodnews Bay	Cape Avinof	Nelson Island	Nunivak Island	Cape Romanzof	Norton Sound ^b	Port Clarence	Total Harvest	Norton Sound
1909-1916	-	-	-	-	-	-	-	-	-	-
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	6,773	-	11,289	-
1996	1,859	1,204	820	1,030	101	752	6,220	-	11,986	-
1997	892	805	687	778	0	879	3,976	-	8,017	-
1998	1,012	831	656	1,250	202 ^d	727	2,632 ^e	-	7,310	10 ^f

a Pre-1964 harvest primarily in summer and fall for food; post 1964 harvest primarily in spring for sac roe. Wastage is included.

b Fishery occurred some years but harvest data unavailable.

c Additional 3 st harvested from imported kelp (*Macrocystis* sp) not included.

d Includes 200 st harvested with purse seine during aerial survey calibration study.

e Includes 8.3 tons harvested during a directed bait fishery.

f Includes 2,100 lbs of wild kelp and 16,083 lbs of *Macrocystis* kelp (preliminary numbers).

Table 2. Estimated biomass and commercial harvest of Pacific herring in northeastern Bering Sea fishing districts, Alaska, 1991-1998.

Year	District	Harvest (st)					Roe %	Estimated Value (\$ x 1,000)	Exploitation Rate (%)
		Estimated Biomass(st)	Sac roe	Bait	Waste	Total			
1998	Security Cove	4,017 ^a	1,012			1,012	11.5	232	25.2
	Goodnews Bay	4,064 ^a	831			831	11.3	118	20.5
	Cape Avinof	4,287 ^a	856			856	11.6	152	15.3
	Nelson Island	7,136 ^a	1,250			1,250	11.8	296	17.5
	Nunivak Island	3,778 ^a	202 ^b			202	9.8	26 ^c	5.4
	Cape Romanzof	4,500 ^a	617	110		727	10.0	131	16.2
	Norton Sound	52,033	2,624	8		2,632	9.2	203 ^d	5.1
Total		79,815	7,192	118	0	7,310	10.2	1,158	9.2
1997	Security Cove	4,640 ^a	884	3	5	892	12.5	221	19.2
	Goodnews Bay	4,752 ^a	805	0	0	805	14.2	228	16.9
	Cape Avinof	4,600 ^a	687	0	0	687	11.5	157	14.9
	Nelson Island	7,900 ^a	778	0	0	778	12.7	198	9.8
	Nunivak Island	3,801 ^a	0	0	0	0	-	-	0
	Cape Romanzof	5,000 ^a	879	0	0	879	10.2	186	17.6
	Norton Sound	47,791	3,709	283	5	3,976	8.9	612	6.3
Total		78,484	7,742	266	10	8,017	11.1	1,602	10.2
1996	Security Cove	8,887	1,795	59	5	1,859	11.6	1,251	27.1
	Goodnews Bay	8,315	1,191	13	0	1,204	12.5	895	19.1
	Cape Avinof	4,500 ^a	820	0	0	820	13.4	659	18.2
	Nelson Island	6,638 ^a	986	44	0	1,030	11.4	679	15.5
	Nunivak Island	4,195 ^a	61	40	0	101	9.9	39	2.4
	Cape Romanzof	6,000 ^a	750	1	0	752	10.6	638	12.5
	Norton Sound	27,307 ^a	6,061	109	50	6,220	10.6	4,568	22.8
Total		61,822	11,664	266	55	11,986	11.2	8,730	19.4
1995	Security Cove	6,702 ^a	1,292	0	0	1,292	12.3	956	19.3
	Goodnews Bay	4,219 ^a	1,051	0	3	1,054	13.5	848	25.0
	Cape Avinof	3,627 ^a	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 ^a	33	7	0	41	11.0	22	0.9
	Cape Romanzof	5,000 ^a	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	7,638 ^a	-	-	-	-	-	-	-
	Goodnews Bay	5,879 ^a	1,061	0	1	1,062	12.3	391	18.7
	Cape Avinof	2,827 ^a	427	0	0	427	12.2	116	15.1
	Nelson Island	5,564	713	4	0	717	11.0	295	12.9
	Nunivak Island	4,921	14	0	0	14	8.6	4	0.3
	Cape Romanzof	5,000 ^a	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 ^a	206	9	0	215	12.0	75	7.8
	Nelson Island	4,944	613	52	74	739	10.6	198	14.9
	Nunivak Island	5,176	-	-	-	-	-	-	-
	Cape Romanzof	4,000 ^a	371	0	0	372	9.8	110	9.3
	Norton Sound	46,549	4,713	321	45	5,079	9.9	1,411	10.9
Total		78,712	6,853	391	119	7,363	10.1	2,088	9.6
1992	Security Cove	7,773	897	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 ^a	516	14	0	530	8.0	159	11.8
	Norton Sound	57,974	-	-	-	-	-	-	-
Total		90,243	1,561	251	16	2,828	9.1	990	3.9
1991	Security Cove	4,434	581	8	0	570	9.3	208	12.3
	Goodnews Bay	4,387	259	4	0	263	8.9	33	8.0
	Cape Avinof	2,083	240	27	0	267	9.5	94	12.8
	Nelson Island	2,385	-	-	-	-	-	-	-
	Nunivak Island	3,903	17	42	0	59	7.4	9	1.5
	Cape Romanzof	4,500 ^a	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

a Inseason biomass estimate from poor aerial survey, therefore projected biomass or some other method of estimating biomass was used.

b Includes 200 tons from the purse seine catch associated with an aerial survey calibration study.

c Includes estimated value of \$25,000 for the purse seine catch associated with an aerial survey calibration study.

d Includes values from sac-roe fishery only, does not include directed bait, or kelp fisheries values.

e No commercial fishery.

f Total exploitation rate for fishing districts which had a commercial fishery in 1992 is 8.8%.

Table 3. Number of buyers and fishermen participating in northeastern Bering Sea Pacific herring fisheries, Alaska, 1991-1998.

Year	District	Number of Buyers	Number of Fishermen		Totals
			Gillnet	Beach Seine ^a	
1998	Security Cove	9	78	-	-
	Goodnews Bay	2	84	-	-
	Cape Avinof	2	109	-	-
	Nelson Island	2	86	-	-
	Nunivak Island	1	7	-	8 ^b
	Cape Romanzof	1	41	-	-
	Norton Sound	2	35	0	61 ^c
1997	Security Cove	14	222	-	-
	Goodnews Bay	3	139	-	-
	Cape Avinof	2	145	-	-
	Nelson Island	3	105	-	-
	Nunivak Island	1	12	-	-
	Cape Romanzof	3	65	-	-
	Norton Sound	9	214	6	220
1996	Security Cove	14	326	-	-
	Goodnews Bay	5	182	-	-
	Cape Avinof	2	161	-	-
	Nelson Island	3	109	-	-
	Nunivak Island	2	24	-	-
	Cape Romanzof	3	63	-	-
	Norton Sound	10	281	6	287
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	0	0	-	-
	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	0	0	-	-
	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	0	-	-
1991	Security Cove	6	52	-	-
	Goodnews Bay	2	103	-	-
	Cape Avinof	1	137	-	-
	Nelson Island	0	0	-	-
	Nunivak Island	2	17	-	-
	Cape Romanzof	2	80	-	-
	Norton Sound	8	272	7	279

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

b Includes 7 gillnet fishermen and 1 seine fisherman.

c Includes 35 gillnet fishermen, 1 bait fisherman and 25 kelp fishermen.

Table 4. Pacific herring subsistence harvest (st) and effort data from selected northeastern Bering Sea areas, Alaska, 1978-1998.^a

Village	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Nelson Island																					
Tununak	38	34	65	40	48	94	-	43	63	48	49	47	54	21	32	45	42	30	25.8	-	-
Umkumiut	11	8	3	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toksook Bay	37	51	29	14	35	-	-	46	70	51	58	52	46	40	43	23	53	46	41.5	-	-
Nightmute	-	-	-	-	-	-	-	3 ^b	21	15	16	15	18	8	10	9	13	13	16.2	-	-
Newtok	-	-	-	-	-	-	-	7 ^b	13	10	12	10	8	1	7	6	9	9	11.5	-	-
Total	86	93	97	64	83	94	-	99	167	124	136	124	126	70	92	82	117	98	95	-	-
No. Fishing Families	83	54	70	93	65	43	-	65 ^b	72 ^b	96	104	^b	100	85	97	89	-	91	96	-	-
Nunivak Island																					
Mekoryuk	-	-	-	-	-	-	-	<1	<1	-	-	-	5	4	4	2	-	-	-	-	-
No. Fishing Families	-	-	-	-	-	-	-	11	6 ^b	-	-	-	19	20	17	16	-	-	-	-	-
Other Kuskokwim Delta																					
Cheformak	-	-	-	-	-	-	-	13 ^b	-	14	-	-	-	-	-	-	-	-	-	-	-
Kipnuk	-	-	-	-	-	-	-	9	-	14	-	-	-	-	-	-	-	-	-	-	-
Kongiganak	-	-	-	-	-	-	-	3	2 ^b	-	-	-	-	-	-	-	-	-	-	-	-
Kwigillingok	-	8	13	-	13	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	8	13	-	13	-	-	30	2	28	-	-	-	-	-	-	-	-	-	-	-
No. Fishing Families	-	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	1	1	<1
Chevak	-	2	4	2	2	1	3	2	1	1	2	<1	1	<1	<1	<1	2	1	<1	<1	<1
Hooper Bay	4	3	4	4	5	5	4	4	4	1	4	2	6	2	2	2	3	4	2	2	1
Total	5	11	11	14	11	9	11	8	6	3	7	3	8	3	4	5	6	6	3	3	2
No. Fishing Families	30	84	61	45	43	37	47	44	40	23	32	24	32	18	30	42	48	42	29	34	15

^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, 1978-1998.

Year	Herring (st)								Total Biomass
	Security Cove	Goodnews Bay	Cape Avinof	Nelson Island	Nunivak Island	Cape Romanzof ^a	Norton Sound	Port Clarence	
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
1996	6,867	6,315	4,500 ^b	6,638 ^b	4,195 ^b	6,000	27,307 ^b	-	61,822
1997	4,640 ^b	4,752 ^b	4,600 ^b	7,900 ^b	3,801 ^b	5,000 ^c	47,791	-	78,484
1998	4,017 ^b	4,064 ^b	4,287 ^b	7,136 ^b	3,778 ^b	4,500 ^d	52,033	-	79,815

a Biomass estimate based on limited aerial survey information, spawn deposition, age composition, and 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.

c Biomass listed for Cape Romanzof is midpoint for estimated range of 4,500 to 5,500 tons.

d Biomass listed for Cape Romanzof is midpoint for estimated range of 4,000 to 5,000 tons.

Table 6. Summary of Pacific herring commercial harvest by fishing period for northeastern Bering Sea fishing districts, Alaska, 1998.

District	Subdistrict Sec/Area	Gear	Period	Date	Time	Total Hours	Harvest (st)
Security Cove		Gillnet	1	5/09	1530-2300	7.5	36.5
			2	5/10	1700-2300	6.0	17.8
			3	5/11	0600-1000	4.0	60.4
			4	5/11	1930-2330	4.0	477.0
			5	5/12	0800-1000	2.0	73.9
			6	5/12	2000-2200	2.0	71.7
			7	5/13	0930-1230	3.0	274.4
			Total			28.5	1,011.7
Goodnews Bay		Gillnet	1	5/16	0800-1400	6.0	1.0
			2	5/17	0900-1500	6.0	5.0
			3	5/18	0930-1730	8.0	13.7
			4	5/19	0900-1700	8.0	88.6
			5	5/20	0000-0530	5.5	133.1
			6	5/20	1000-1800	8.0	176.3
			7	5/21	0100-0530	4.5	14.9
			8	5/21	1200-1900	7.0	157.7
			9	5/22	1300-2000	7.0	119.9
			10	5/23	1330-2000	6.5	47.0
			11	5/24	0200-0830	6.5	31.8
			12	5/24	1500-2100	6.0	42.1
			Total			79.0	831.1
Cape Avinof		Gillnet	1	5/29	1200-1600	4.0	23.6
			2	5/30	1030-1630	6.0	75.8
			3	5/31	0100-0400	3.0	14.8
			4	5/31	1200-1700	5.0	22.7
			5	6/01	1200-1800	6.0	113.5
			6	6/02	0100-0700	6.0	69.8
			7	6/02	1330-2030	7.0	126.9
			8	6/03	1400-2100	7.0	208.5
			Total			44.0	655.6
Nelson Island		Gillnet	1	5/23	0800-1000	2.0	3.8
			2	5/23	1900-2300	4.0	22.8
			3	5/24	1800-2400	6.0	75.4
			4	5/25	0800-1200	4.0	72.1
			5	5/25-26	1830-0030	6.0	156.0
			6	5/26	0900-1300	4.0	10.6
			7	5/26-27	1900-0100	6.0	89.8
			8	5/27	1000-1430	4.5	38.2
			9	5/27-28	1930-0130	6.0	226.9
			10	5/28	1100-1630	5.5	26.0
			11	5/28-29	2300-0500	6.0	164.7
			12	5/29	1300-1800	5.0	145.7
			13	5/30	0000-0500	5.0	218.0
			Total			64.0	1,250.1
Nunivak Island		Gillnet	1	5/21	1300-1900	6.0	2.2
			2	5/22	0200-0800	6.0	0.0
			3	5/22	1400-2100	7.0	0.0
			4	5/23	0300-0900	6.0	0.0
			5	5/23	1500-2300	8.0	0.0
		Purse Seine		5/20-24	continuous		200.0
			Total			33.0	202.2

-continued-

Table 6 (page 2 of 2).

District	Subdistrict Sec/Area	Gear	Period	Date	Time	Total Hours	Harvest (st)
Cape Romanzof		Gillnet	1	5/20	2200-2330	1.5	18.9
			2	5/21	2230-0030	2.0	22.4
			3	5/22	2230-0130	3.0	47.0
			4	5/23	1100-1300	2.0	9.5
			5	5/23	2230-0130	3.0	55.0
			6	5/24	2130-0230	5.0	108.5
			7	5/25	1230-1430	2.0	58.7
			8	5/25	2330-0400	4.5	138.3
			9	5/26	2300-0400	5.0	177.3
			10	5/28	0100-0400	3.0	64.8
			11	5/29	0100-0500	4.0	26.4
Total						35.0	726.8
Norton Sound	1,2,3,4,6,7	Gillnet	5/22-6/09		continuous		2,623.6
			6/09-7/22		continuous		8.3
	7	Bait	5/18-6/13		continuous		8.0 ^a
	1,2,3,4,5	Open Pound	1	5/29-30	1800-0400	10.0	0.8 ^a
1	Wild Kelp	2	6/01-02	2100-0400	7.0	0.2 ^a	
Total						17.0	2,631.9 ^b

^a Product weight

^b Does not include spawn on kelp product weight.

Table 7. Projections of Pacific herring spawning biomass and harvest guideline for commercial fishing districts in the northeastern Bering Sea, Alaska, 1999.

District	Threshold	Projected ^a Biomass (st)	Exploitation Rate (%)	Harvest (st) ^a Guideline
Security Cove	1,200	3,060	20	612
Goodnews Bay	1,200	3,009	20	602
Cape Avinof	500	3,555	15	533
Nelson Island	3,000	5,826	17	965 ^b
Nunivak Island	1,500	3,319	20	664
Cape Romanzof	1,500	3,260 ^c	20	650 ^c
Norton Sound	7,000	41,169	20	8,234
Port Clarence	-	-	-	165 ^d
Totals		63,198		12,425

a Preseason projection. Biomass and harvest may be adjusted based on inseason estimates.

b Nelson Island commercial harvest is 20% of projected biomass minus 200 st for subsistence harvest.

c Projection from midpoint of 1998 biomass estimate of 4,000 to 5,000 tons which was based on spawn deposition, age composition, and CPUE from commercial and test fisheries. Allowable harvest will range from 560 to 740 tons based on inseason indicators of abundance.

d Harvest guideline of 165 st (150 mt).

Table 8. Herring harvest by gear type and subdistrict, Norton Sound District, 1982-1998.

NORTON SOUND HERRING CATCHES																	
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
GILLNET HARVEST (tons)																	
St. Michael	2,062	434	-	1,538	2,560	2,214	3,215	2,927	4,491	-	-	2,288	249	2,359	3,074	1,575	1,543
Unalakleet	946	1,264	-	95	-	-	42	10	618	731	-	120	12	374	-	20	-
Cape Denbigh	925	2,692	3,244	1,599	2,420	1,545	1,211	1,414	923	4,419	-	1,659	619	1,467	2,507	1,864	1,081
Elim	-	65	-	147	-	-	6	-	-	-	-	225	41	1,774	-	-	-
Golovin	-	85	-	-	-	-	-	-	-	-	-	-	-	191	-	-	-
Total^a	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	5,581	3,459	2,632
SEINE HARVEST (tons)																	
St. Michael (beach)	-	-	-	-	-	4	45	329	6	-	-	-	1	-	-	472	-
Unalakleet (beach)	-	-	-	93	-	-	58	50	332	149	-	467	24	230	111	41	-
Cape Denbigh (beach)	-	41	327	76	30	293	96	11	9	373	-	222	15	57	325	-	-
Elim (beach)	-	-	-	-	185	-	-	-	-	-	-	54	-	334	153	-	-
Cape Denbigh (purse)	-	-	-	-	-	26	-	-	-	-	-	-	-	-	-	-	-
Total^a	0	41	327	169	215	323	198	390	347	522	^b	743	40	621	589	513	0
TOTAL HARVEST (tons)^a	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	6,170	3,972	2,632
Percent of total harvest																	
Gillnet Harvest	100	99.1	90.8	95.2	95.9	92.1	95.8	91.8	94.6	90.8	-	85.2	95.9	90.9	90.5	87.1	100
Seine Harvest	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	9.5	12.9	0

a Totals do not include waste.

b No commercial fishery.

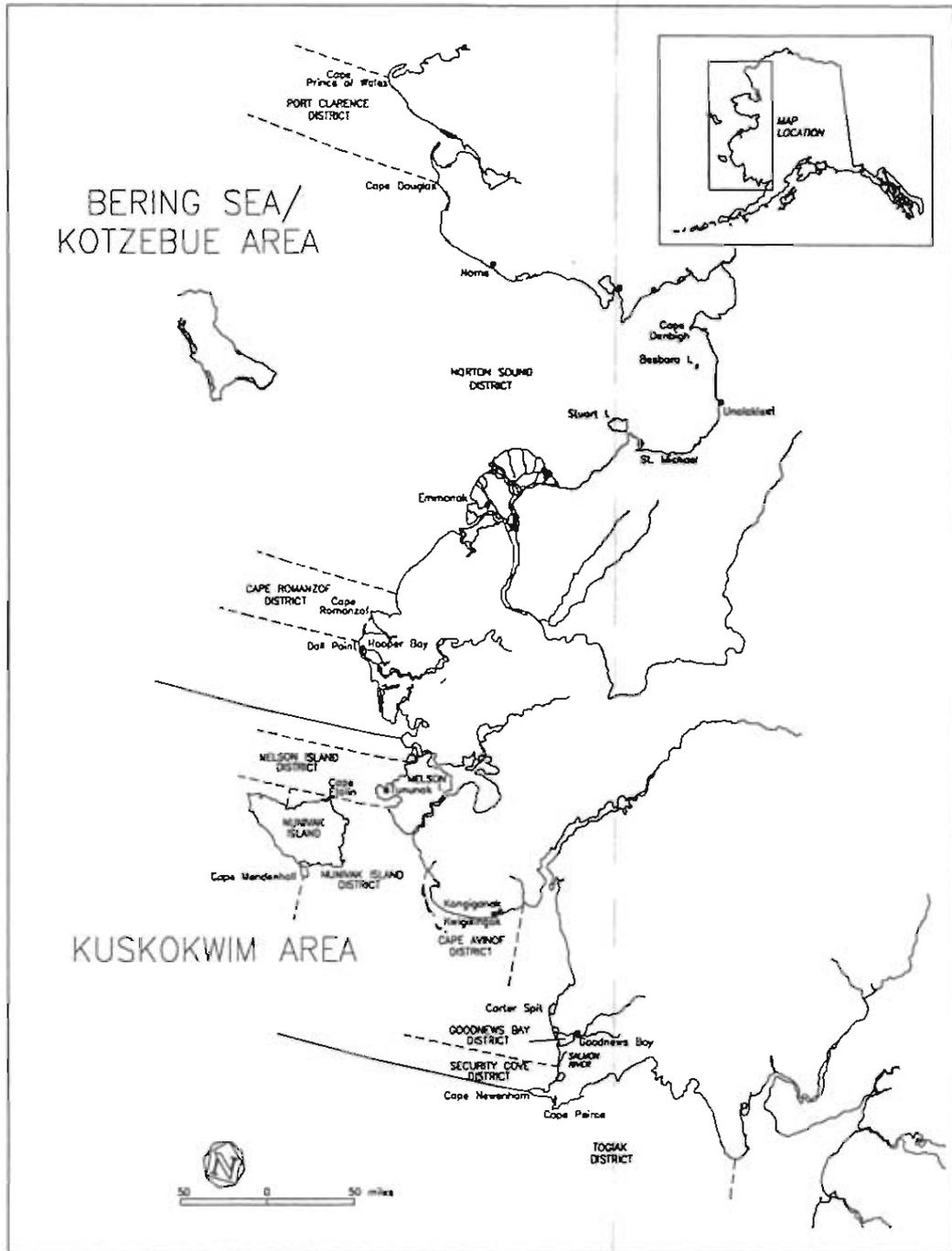


Figure 1. Commercial herring fishing districts within the Arctic-Yukon -Kuskokwim Region of the northeastern Bering Sea, Alaska.

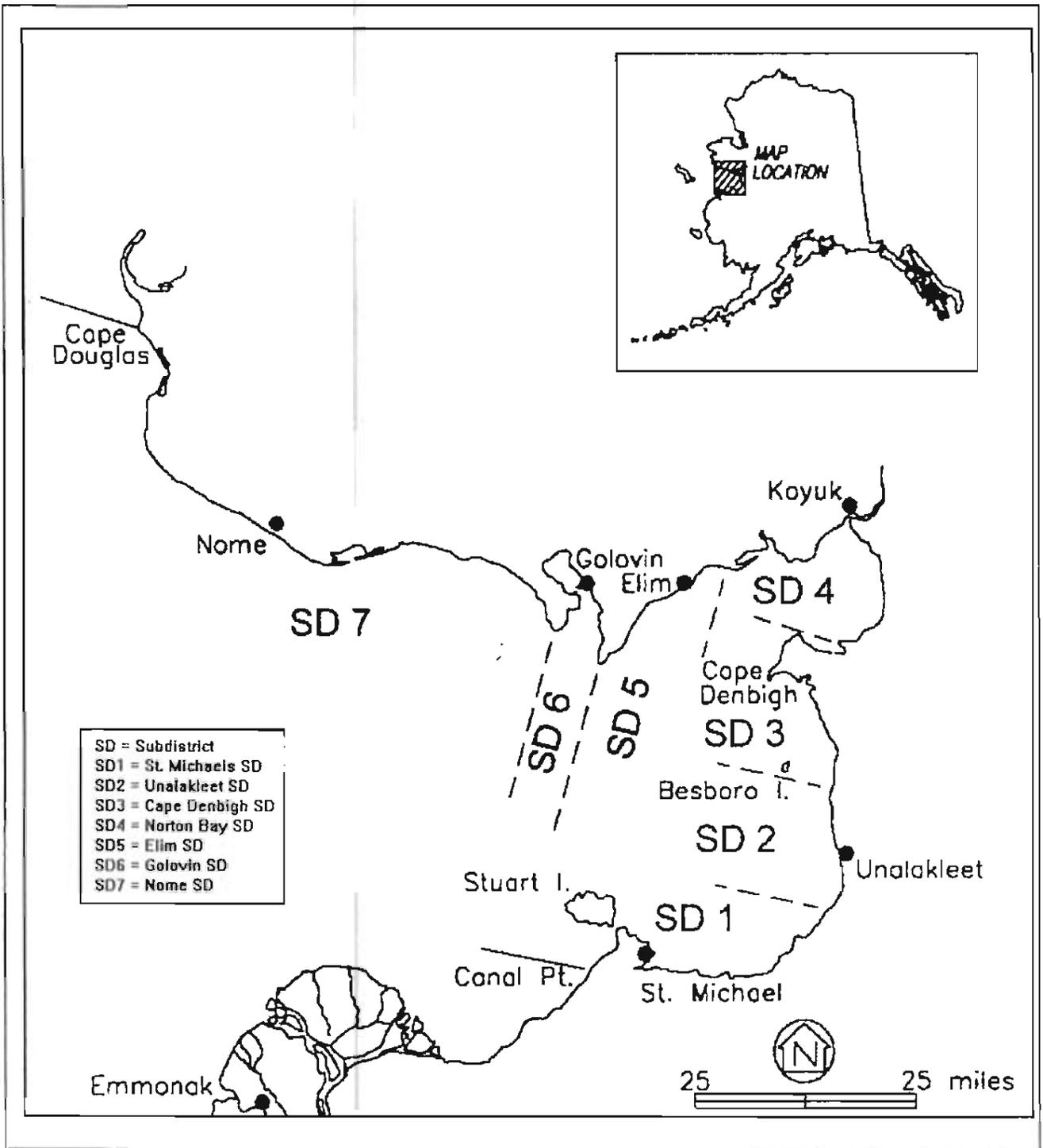


Figure 2. Norton Sound commercial herring subdistricts.

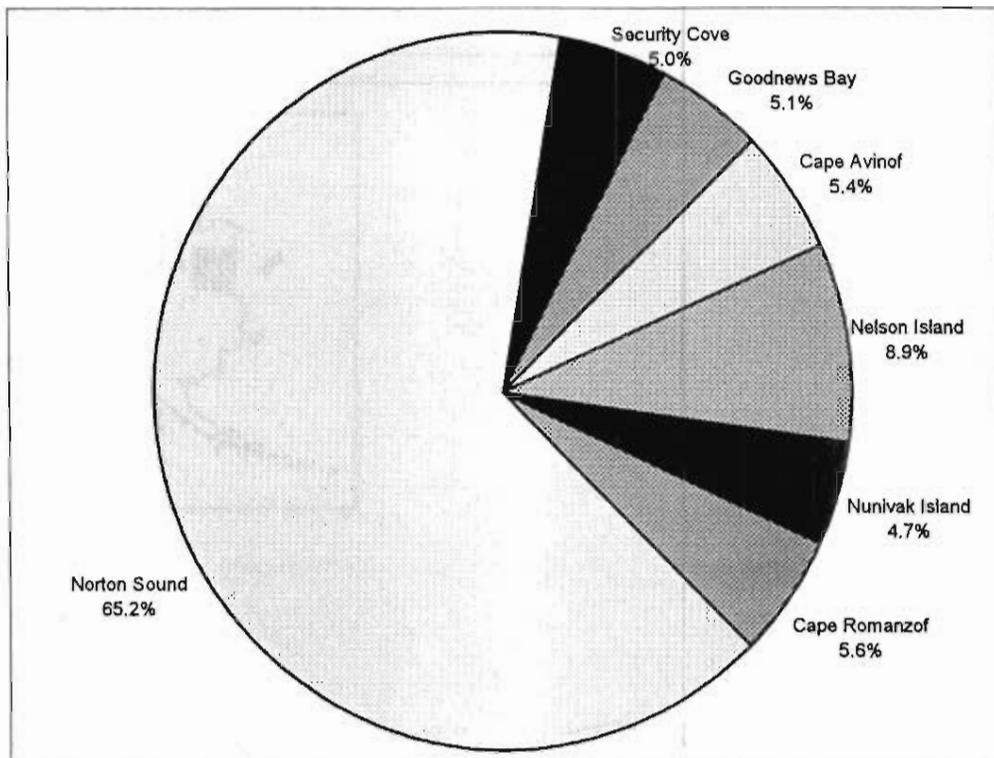


Figure 3. Pacific herring run biomass distribution by commercial fishing district, Arctic-Yukon-Kuskokwim Region, Alaska, 1998.

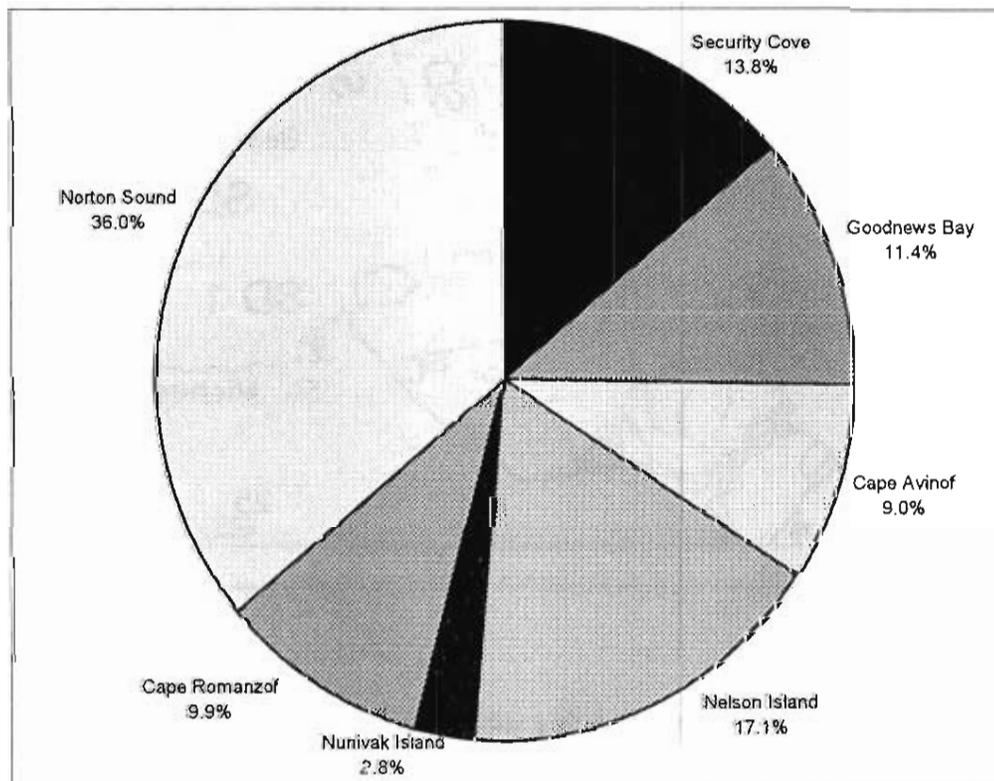


Figure 4. Pacific herring commercial harvest distribution by fishing district, Arctic-Yukon-Kuskokwim Region, Alaska, 1998.

Total Run Biomass (tons)

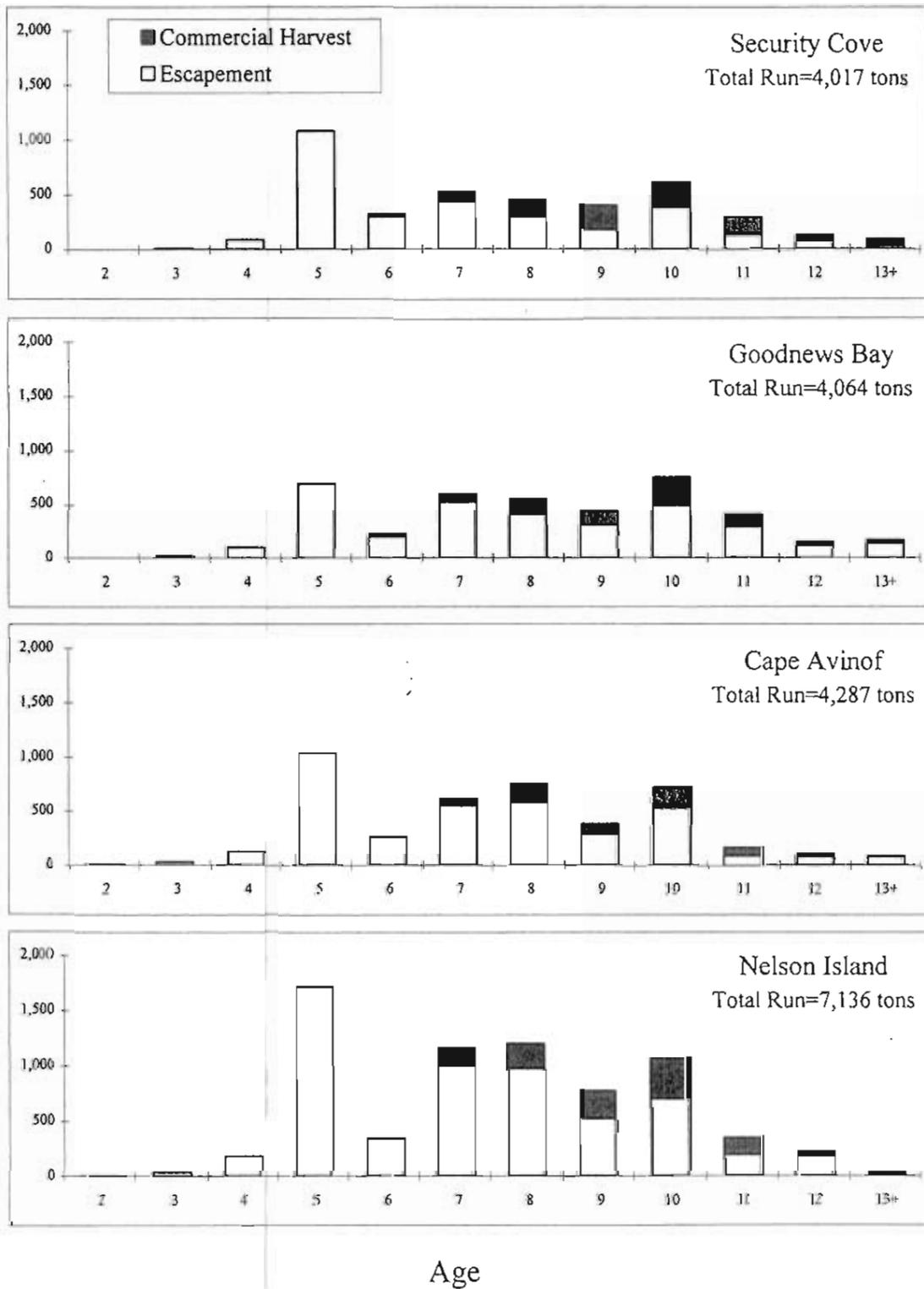


Figure 5. Age composition of Pacific herring for the total run, escapement and harvest biomass for the Security Cove, Goodnews Bay, Cape Avinof, and Nelson Island Districts within the Arctic-Yukon-Kuskokwim Region, Alaska, 1998.

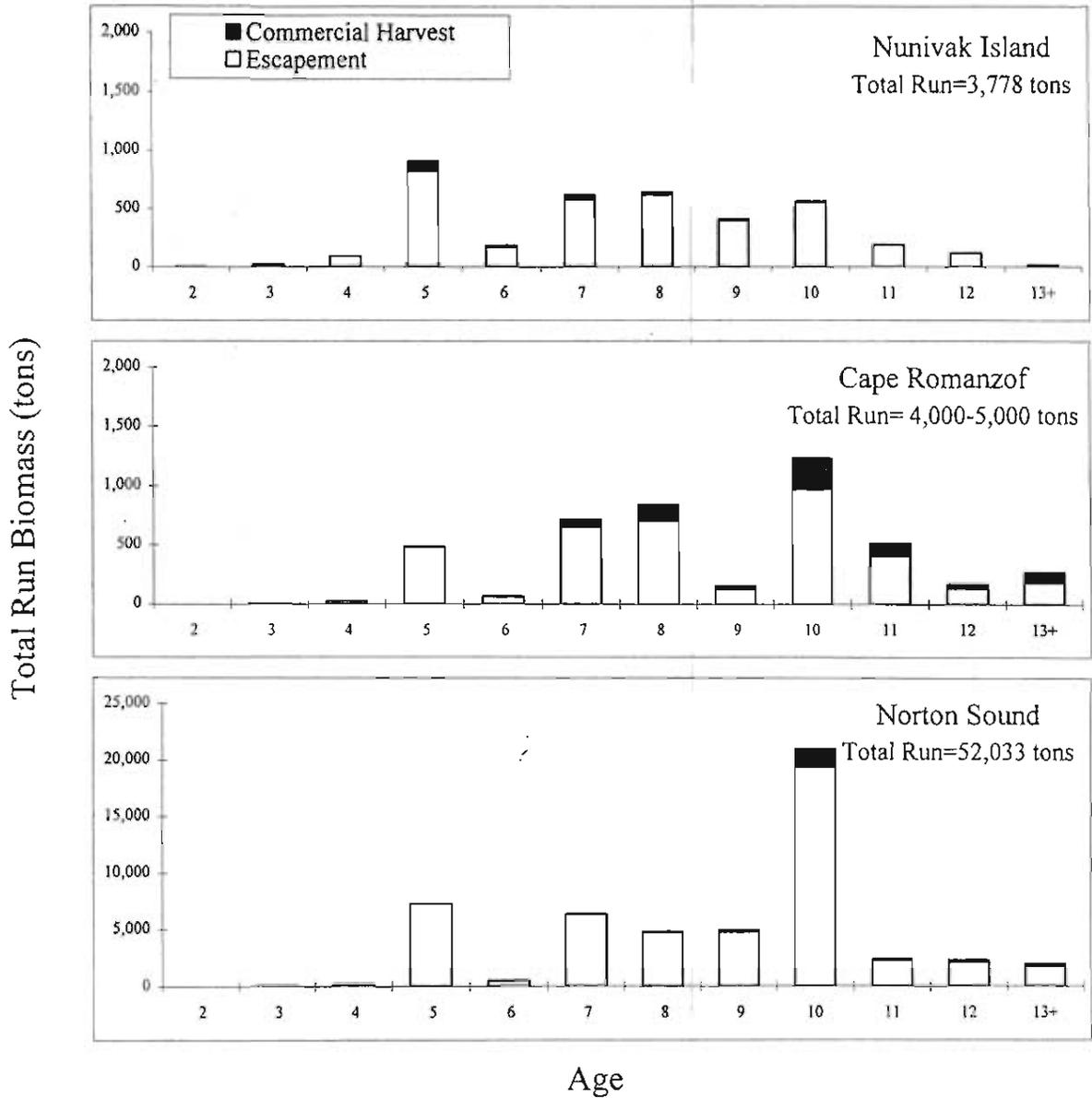


Figure 6. Age composition of Pacific herring for the total run, escapement and harvest biomass for the Nunivak Island, Cape Romanzof, and Norton Sound Districts, within the Arctic-Yukon-Kuskokwim Region, Alaska, 1998.

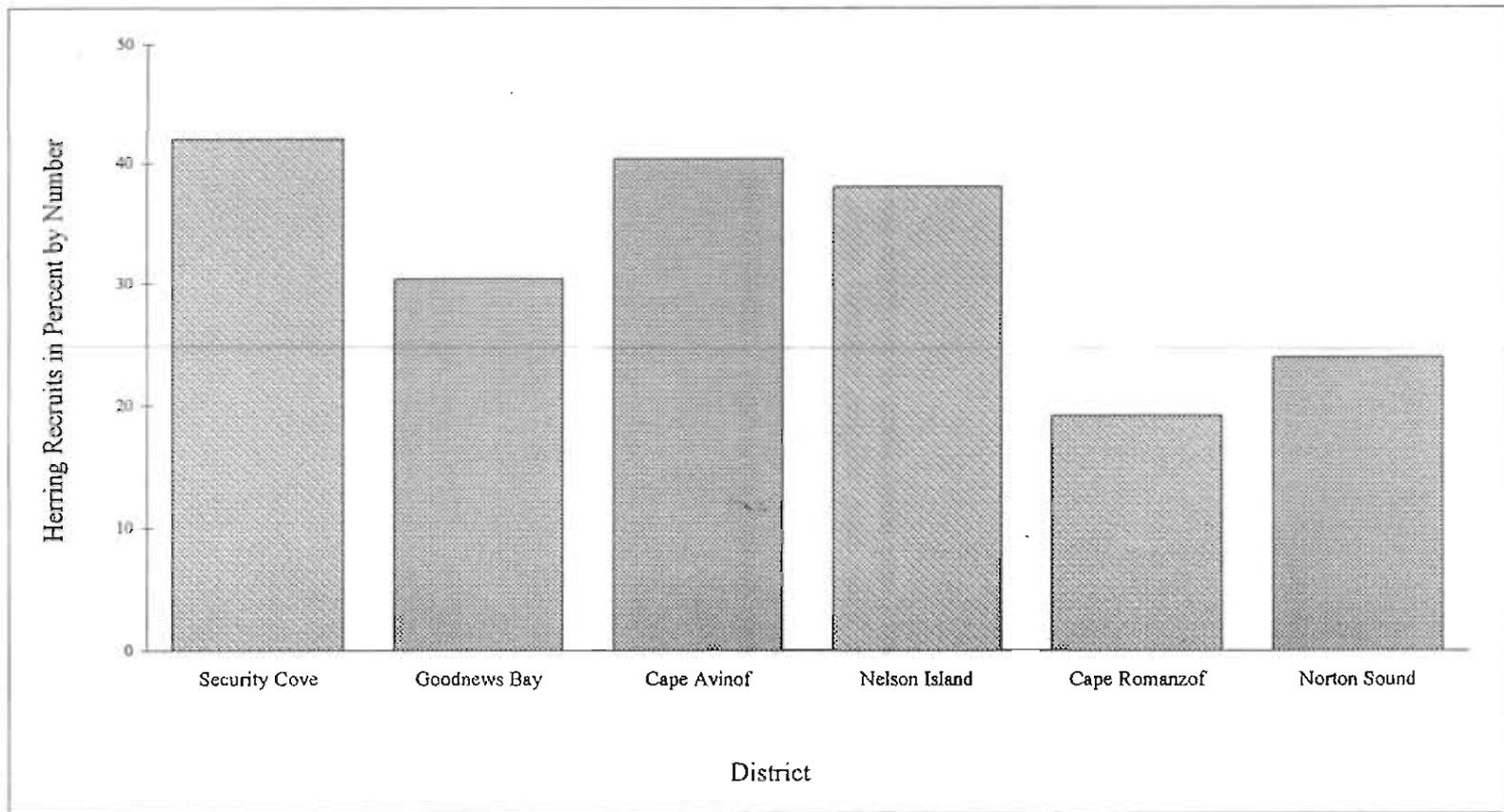


Figure 7. Pacific herring recruits (ages 2 through 5) for commercial fishing districts within the Arctic-Yukon Kuskokwim Region, Alaska, 1998.

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