3A94-01

Pacific Herring Stocks and Fisheries in the Arctic-Yukon-Kuskokwim Region of the Bering Sea, Alaska, 1993

A Report to the Alaska Board of Fisheries

Compiled by

Helen H. Hamner
and
Carol Kerkvliet

Regional Information Report[1] No. 3A94-01

Alaska Department of Fish and Game
Division of Commercial Fisheries, AYK Region
333 Raspberry Road
Anchorage, Alaska 99518

January 1994

---

[1]The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse and ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries.

ACKNOWLEDGEMENTS

Data collection and reporting for the subsistence and commercial fisheries for Pacific herring in the northeastern Bering Sea were provided by the following AYK Region staff:

Security Cove, Goodnews Bay, Cape Avinof, Nelson Island, and Nunivak Island Districts
Kim Francisco, Area Manager, and Charles Burkey and Cindy Anderson, Asst. Area Managers. Commercial Fisheries Division, P.O. Box 90, Bethel, Alaska. 99559-9990. 543-2433.

Cape Romanzof District
Dan Bergstrom, Area Manager, and Chuck Blaney, Asst. Area Manager. Commercial Fisheries Division, 333 Raspberry Rd., Anchorage, Alaska. 99518-1599. 344-0541.

Norton Sound and Port Clarence Districts
Charles Lean, Area Manager, and Fred Bue, Asst. Area Manager. Commercial Fisheries Division, P.O. Box 1148, Nome, Alaska. 99762-1148. 443-5167.

AYK Region
Rich Cannon, Regional Management Biologist, Commercial Fisheries Division, 333 Raspberry Rd., Anchorage, Alaska. 99518-1599. 344-0541.

TABLE OF CONTENTS

Page

LIST OF TABLES i

LIST OF FIGURES ii

INTRODUCTION 1

STOCK STATUS 3

Assessment Methods 3

Spawning Populations 4
Security Cove District 4
Goodnews Bay District 4
Cape Avinof District 4
Nelson Island District 5
Nunivak Island District 5
Cape Romanzof District 6
Norton Sound District 6
Port Clarence District 7

SUBSISTENCE FISHERY 7

COMMERCIAL FISHERY 8
Security Cove District 8
Goodnews Bay District 9
Cape Avinof District 9
Nelson Island District 10
Nunivak Island District 10
Cape Romanzof District 11
Norton Sound District 11
Port Clarence District 13

ENFORCEMENT 13

OUTLOOK AND MANAGEMENT STRATEGY FOR 1994 13
Security Cove District 14
Goodnews Bay District 14
Cape Avinof District 14
Nelson Island District 15
Nunivak Island District 15
Cape Romanzof District 16

Norton Sound District 16
Port Clarence District 16

LITERATURE CITED 17

LIST OF TABLES

Table		Page
1.	Pacific herring harvests by domestic commercial fishermen in the northeastern Bering Sea, Alaska, 1909-1993	18
2.	Estimated biomass and commercial harvest of Pacific herring in northeastern Bering Sea fishing districts, Alaska, 1988-1993	19
3.	Number of buyers and fishermen participating in northeastern Bering Sea Pacific herring fisheries, Alaska, 1987-1993	20
4.	Pacific herring subsistence harvest (st) and effort data from selected northeastern Bering Sea areas, Alaska, 1977-1993	21
5.	Pacific herring estimated biomass in the northeastern Bering Sea, Alaska, 1978-1993	22
6.	Summary of Pacific herring commercial harvest by fishing period for fishing districts in the northeastern Bering Sea, Alaska, 1993	23
7.	Projections of Pacific herring spawning biomass and harvest for commercial fishing districts in the northeastern Bering Sea, Alaska, 1994	25
8.	Herring harvest by gear type and subdistrict, Norton Sound District, 1981-1993.	26

LIST OF FIGURES

Page

1. Security Cove, Goodnews Bay, Cape Avinof, Nelson Island, and Nunivak Island Pacific herring commercial fishing districts in the northeastern Bering Sea, Alaska .. 27

2. Cape Romanzof, Norton Sound, and Port Clarence Pacific herring commercial fishing districts in the northeastern Bering Sea, Alaska 28

3. Pacific herring spawning biomass distribution by commercial fishing district, Arctic-Yukon-Kuskokwim Region, Alaska, 1993 29

4. Age composition of the total biomass 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, 1993 30

5. Age composition of the total biomass and commercial harvest for the Nunivak Island, Cape Romanzof, and Norton Sound commercial herring fishing districts within the Arctic-Yukon-Kuskokwim Region, Alaska, 1993 31

6. Pacific herring recruits (ages 2, 3, 4 and 5) in commercial fishing districts within the Arctic-Yukon-Kuskokwim Region, Alaska, 1993 32

INTRODUCTION

The objectives of this report are to summarize the results of the 1993 herring stock assessment programs of the Arctic-Yukon-Kuskokwim (AYK) Region, review and evaluate 1993 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 1994. 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), 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. A moratorium was placed on entry into the Nelson Island, Nunivak Island, Cape Romanzof, and Norton Sound herring fisheries in 1987. The Commercial Fisheries Entry Commission has been issuing limited entry permits for these fisheries. All AYK Region commercial herring districts, except Security Cove and Port Clarence, are designated as superexclusive use areas.

A total biomass of 76,712 tons of herring was estimated to have been present in the surveyed portion of the AYK Region herring districts. This estimate is lower than the record biomass of 90,243 tons observed in 1992, but is the second highest on record (Tables 2 and 5). Ages 5, 6 and 9 dominated herring biomass in most districts south of Cape Romanzof. The biomass in Cape Romanzof was dominated by older fish and ages 5 and 11 comprised the major age groups in the Norton Sound biomass. The number of recruits, ages 2 through 5, was over 35% of the spawning population in all AYK districts with the exception of Cape Romanzof where recruits comprised 18% of the population.

The 1993 herring harvest for the AYK Region was approximately 7,363 tons with an estimated exvessel value of $2,089,000 (Tables 1 and 2). The 1993 harvest greatly exceeded the 1992 harvest of 2,828 tons when the Norton Sound fishery did not open. However, the 1993 harvest was near average when compared to the previous five years. Excluding 1992, the value of the fishery was the lowest since 1984. Fishermen received approximately $150 less per ton for sac roe herring than they received in 1992. The price paid to fishermen in AYK fishing districts was approximately $300 per ton for herring with 10% roe content plus or minus $30 a percentage point and $50 per ton for bait-quality herring. Food and bait sales during the sac roe fishery totaled 391 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.

A total of 546 fishermen participated in AYK sac roe herring fisheries during the 1993 season. Effort was low in all districts as fishermen were discouraged by both low prices and fewer buyers. In addition, an exceptionally early return to the Togiak fishery surprised managers, fishermen and buyers and resulted in an extended season in that district which kept the fleet from arriving in Security Cove District until the end of the spawning migration. Only 9 fishermen participated in the Security Cove fishery compared to a five year average of 61.

There were no herring fisheries in the Port Clarence and Nunivak Island Districts during the sac roe season in 1993. There has not been a commercial fishery in the Port Clarence District since 1988 due to a lack of buyers. One ton of bait-quality herring has been harvested in Port Clarence since the end of the sac roe season. In the Nunivak Island District, fishermen were unable to locate herring of marketable-quality during the three days that a tender was present in the area.

Surveyed subsistence fishermen from selected Yukon-Kuskokwim River Delta villages harvested approximately 89 tons of herring (Table 4).

Average roe recovery of the sac roe harvest ranged from 9.6% in the Cape Romanzof District to 12.8% in the Security Cove District, with a regional average of 10.1%. A preseason meeting between processors, managers and fishermen was held to discuss poor market conditions and the need for a high-quality product. Managers were asked to limit period harvests to an amount that could be processed within three days. This resulted in an extended commercial season for most districts and helped produce a record roe recovery for the region. Exploitation rates were generally low in AYK Region herring districts. The 1993 total exploitation rate for the AYK Region was 9.6 %. Exploitation rates ranged from less than 1% in the Security Cove District to 15.4% in the Goodnews Bay District (Table 2).

Biomass projections for each district using postseason escapement estimates, historic mean rates of survival and current mean weights for each age class (Bromaghin and Hamner 1993, Alaska Department of Fish and Game, Anchorage, personal communication), and estimates of recruitment for each age class (Wespedstad 1982), indicate that the 1994 spawning biomass for the northeastern Bering Sea herring stocks (Security Cove to Norton Sound) will be approximately 67,760 tons. These projections do not include newly recruiting herring.

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. 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 mid-May 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 technique has 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 using conversions of 1.52 tons per RAI unit for water depths of 16 ft or less, 2.58 tons per RAI unit for water depths between 16 and 26 ft and 2.83 tons per RAI unit for water depths greater than 26 ft per RAI unit. 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 1993, 106 aerial surveys totalling 118.4 hours of flight time were flown in the AYK Region: 12 (6.1 hours) in Security Cove, 12 (5.9 hours) in Goodnews Bay, 10 (2.7 hours) in Jacksmith Bay, 6 (4.4 hours) in Cape Avinof, 15 (6.2 hours) in Nelson Island, 11 (16.9 hours) in Nunivak Island, 7 (1.9 hours) in Cape Romanzof, 32 (71.3 hours) in Norton Sound, and 1 (3 hours) in Port Clarence.

Gillnets are the only legal gear in the AYK Region with the exception of Norton Sound, where a small 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. Approximately 15,981 herring from commercial and test catches were sampled from seven of the eight AYK herring districts during the 1993 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 1993 season, twelve aerial surveys were flown in the district between April 28 and May 17 to estimate herring biomass and spawning activity. Only four of these were flown under acceptable survey conditions. On April 29, 2,774 tons of herring were observed during an aerial survey. Another 4,216 tons were seen during a May 16 survey. Total biomass present in the district was estimated to be 6,995 tons by combining these two surveys with the harvest. A total of 12.7 miles of spawn was observed in the district with peak spawning activity occurring on May 4 when 2.7 miles of milt were documented.

The Security Cove test fish crew fished from May 4 to May 26 with variable mesh gillnets. From this catch, 1,294 herring were sampled for biological data. Ages 5 and 6 dominated the return in both biomass (33.0% and 23.2%, respectively) and numbers of fish (38.3% and 21.4% respectively) (Figure 4). Age 9 and older herring comprised 24.9% of the biomass. Recruit herring represented 61.9% of the return in numbers of fish (Figure 6).

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 1993 season, twelve aerial surveys were flown between April 28 and May 27 in the district. Only one of these surveys was flown under satisfactory aerial survey conditions. The Department's test fish crew documented spawning activity on May 4. On May 14 5,970 tons were observed during an aerial survey. The total biomass of 6,211 tons was calculated by adding a harvest of 241 tons, which occurred prior to the peak aerial survey, to the peak survey. No spawn was observed during aerial surveys of the district.

Department test fishing was conducted from May 18 to May 29. A total of 1,497 herring were sampled for biological data. Age 5 herring dominated both the biomass (30.9%) and the return in numbers of fish (38.6%) (Figure 4). Age 9 and older herring represented 25.9% of the biomass. Recruit herring were 49.5% of the spawning population (Figure 6).

Cape Avinof District

Aerial surveys have been conducted by the department in the Cape Avinof area since 1985 and have ranged from 1,225 tons in 1987 to 4,108 tons in 1988 (Table 5). Weather and ice conditions in 1986, 1989, 1990 and 1993 precluded biomass estimates by aerial survey.

During 1993, 6 aerial surveys were flown in the Cape Avinof District between May 20 and June 1. Only two of these surveys were flown under satisfactory conditions. During an aerial survey on May 31, 203 tons of herring were observed. Due to poor aerial survey conditions the total biomass present in the district was estimated to be 2,358 tons based on the projected return from the 1992 escapement. The biomass was revised postseason to 2,837 tons based on updated survival rates. No spawn was observed during aerial surveys.

The department's test fisheries near Kipnuk and Kwigillingok captured 1,575 herring between May 18 and June 9 to sample for biological data. Age 5 herring dominated the return in both biomass (26.2%) and numbers of fish (33.9%) (Figure 4). Age 9 and older herring comprised 35.1% of the biomass. Recruit herring represented 50.9% of the return in numbers of fish (Figure 6).

Nelson Island District

Since 1985, biomass observations of herring in the Nelson Island District have ranged from 2,385 tons in 1991 to 9,500 tons in 1985 (Table 5).

In 1993, fifteen aerial surveys were flown in the Nelson Island area between May 8 and June 1. Four of these surveys were made under acceptable aerial survey conditions. During an aerial survey on May 17, 4,944 tons of herring were observed in the district. A total of 13.0 miles of spawn was observed during aerial surveys of the district. Peak spawning was observed on May 25 when 5.5 miles of spawn were sighted.

Test fishing with variable mesh gillnets occurred from May 22 to June 12. A total of 1,400 herring were sampled for biological data. Age 5 fish dominated the return in both biomass (33.3%) and numbers of fish (41.8%) (Figure 4). Age 9 and older herring comprised 35.2% of the biomass. Recruit herring represented 62.5% of the spawning population in numbers (Figure 6).

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 1985 (Table 5).

In 1993, 11 aerial surveys were flown in the Nunivak Island District between May 8 and June 1. During an aerial survey flown on May 8, 2,694 tons of herring were observed. Another survey was conducted on May 31 during which 2,482 tons of herring were sighted. The total biomass in the Nunivak Island District was estimated to be 5,176 tons by combining the two surveys. Only 2.6 miles of spawn were observed during aerial surveys with a peak spawn of 2.0 miles documented on May 8.

Test fishing with variable mesh gillnets occurred from May 16 to June 2. From this catch, 263 herring were sampled for biological data. Age 5 fish dominated the return in both biomass (25.7%) and numbers of fish (37.9%) (Figure 5). Age 9 and older herring comprised 48.4% of the biomass. Recruit herring represented 47.4% of the spawning population in numbers (Figure 6).

Cape Romanzof District

Since 1980, the estimated biomass of herring in the Cape Romanzof District has ranged from 2,976 tons in 1980 to 7,500 tons in 1986 (Table 5). 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 test and commercial catches, spawn deposition, and age composition. Seven aerial surveys were flown during the 1993 season from May 10 through June 3. A total of 1.9 hours was spent surveying the district. All surveys were unacceptable due to poor weather and/or turbid water conditions. No peak biomass estimate based upon aerial surveys was possible. Since it was not possible to estimate the biomass inseason, the projected biomass of 2,449 tons was used to manage the fishery.

Daily qualitative spawn deposition surveys were conducted from May 12 until June 2. The first observations were recorded on May 14 in Kokechik Bay. A gradual increase in spawn deposition followed, both in layers of eggs and distribution. Spawn deposition peaked approximately May 27, with an average of 3.4 layers on *Fucus* substrate and an average of 2.2 egg layers on rock substrate, depending on location.

A new quantitative study of spawn deposition started in 1992 was continued in 1993. Artificial substrates of astroturf were located in the same general spawning locations as in 1992. Spawn deposited on the astroturf was removed and weighted daily at low tide. The results indicated that the largest spawn deposition within the study area occurred on May 18 and 25. This data will be analyzed more rigorously at a later date, however subjectively it appeared that the overall deposition of spawn within the study area was greater in 1993 than in 1992.

Test fishing with variable mesh gillnets was conducted by the Department from May 13 to June 4. A total of 4,077 herring were caught, of which 1,349 were sampled for biological data. Age 9 and older herring comprised 74.0% of the run by weight (Figure 5). Recruit herring represented 18.4% of the spawning population in numbers (Figure 6).

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 fluctuated from 5,291 tons in 1978 to 57,974 tons in 1992. During 1993, 32 surveys were flown on 29 different days between April 19 and June 15. Twelve of these surveys were flown under acceptable survey conditions. The peak aerial survey of 41,298 tons on June 2 was the second largest biomass observed in Norton Sound. A regular schedule of surveying the entire district was continued through June 9, when the aerial survey fund was exhausted. Pilots and fishermen reported significant herring biomass present in Norton Sound for at least another week. A late run of small ripe fish was reported in the vicinity of Cape Denbigh on June 12. Forty-four miles of spawn were observed during surveys with a peak spawn of 8.4 miles seen on May 27. The 1993 biomass, which includes the harvest, is estimated to be 46,549 tons (Table 2).

Two Department field crews were operational during the 1993 season. One crew operated from Cape Denbigh and the second crew operated from Klikitarik. The Klikitarik camp closed June 1 due to a limited budget. Test fish crews sampled 2,597 herring caught with variable mesh gillnets for biological data. Age 11 herring comprised 22.1% of the biomass. Age 5 dominated (28.0%) the return in numbers of fish. The biomass consisted of 58.4% age 9 and older herring (Figure 5). Recruit herring represented 36.2% of the return in numbers of fish (Figure 6).

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. One aerial survey was flown in 1993. Under fair aerial survey conditions on June 15, 822 tons of herring were observed. No herring spawn was sighted.

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. The total catch reported from surveys or mailed questionnaires should be considered minimum levels of effort and harvest since not all fishing families are contacted and not all families contacted by mail return completed questionnaires.

Extensive subsistence surveys have been conducted by Subsistence Division in the Nelson and Nunivak Island Districts in the Kuskokwim Area since 1990 (Pete 1990, 1991, 1992). This effort was prompted by concern over expected low returns of herring to these districts. A total of 82 tons of herring was harvested for subsistence by 89 Nelson Island fishing families in 1993 (Mary Pete, 1993, ADF&G Alaska Department of Fish and Game, Bethel, personal communication) (Table 4). Sixteen fishing families in the village of Mekoryuk on Nunivak Island harvested 1.5

tons of herring.

During 1993, 190 subsistence herring survey questionnaires were mailed to subsistence fishing families in the Yukon Delta villages of Hooper Bay, Chevak and Scammon Bay. Additionally, personal interviews were conducted in Hooper Bay and Scammon Bay in September to contact fishermen who did not return questionnaires. Seventy-eight (41%) of the 190 identified subsistence fishing households were contacted. Approximately 5 tons of herring were reported as having been harvested by 42 fishing families (Table 4). In addition, 513 pounds of roe-on-kelp (*Fucus)* were taken by 19 kelpers for subsistence use.

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 periodic assessment of herring biomass. Only 5 tons of herring were harvested during four openings for a total fishing time of 24.5 hours in the Security Cove District in 1993 (Tables 1, 2 and 6).

The low harvest in the Security Cove District was probably due to the relatively late arrival of fishermen and processors. The district was placed on two hour advanced notice for commercial fishing on May 5; however fishermen did not arrive in the district until May 12. The average time between the first commercial periods in the Togiak and Security Cove Districts is four days (range 2 to 9 days). This year there were 15 days between the first opening at Togiak and Security Cove. There was a total of 11.7 miles of spawn observed in the district before May 12.

The district was opened to commercial harvest for three hours starting at 12:00 noon on May 12 (Table 6). One processor purchased 5.2 tons of sac roe herring with an average roe percentage of 12.8% from nine fishermen (Tables 2 and 3). There were three more openings: 6 hours on May 12-13, 6.5 hours on May 13 and 9 hours on May 14. No herring were delivered during these openings. The processor and all fishermen left the district after the May 14 opening. The total exvessel value of the catch to nine fishermen was approximately $2,000 (compared to $285,000 in 1992) (Table 2). The exploitation rate is estimated to be 0.1% of the observed biomass.

A sample of 98 herring was taken from the commercial catch. Age 9 and older herring represented 76.2% of the harvest (Figure 4). Recruits were only 1.4% of the catch.

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 reassessments of herring biomass. In 1993, 954.2 tons were harvested in a record 20 commercial periods for a total fishing time of 123 hours (Tables 1, 2 and 6).

A meeting with fishermen and processors was held on May 11. Commercial fishermen brought catch samples to the meetings for evaluation by industry roe technicians. Roe content of commercial test fish samples averaged 13.8%. The fishery first opened on May 12 for 6 hours with 33 fishermen delivering 65.5 tons of sac roe herring with an average roe content of 10.5% and 0.7 tons of bait. The total catch was 944.9 tons of sac roe quality herring with an average roe content of 10.3% and 9.3 tons of bait. Catches ranged from 130 tons on May 18 to 0.0 tons on May 27 and May 28-29. During the fishery, roe contents ranged from 9.6% to 12.1%. Three processors bought herring from 63 permit holders who made 705 deliveries with an estimated ex-vessel value of $293,000 (Tables 2 and 3). The exploitation rate was 15.4% of the available biomass.

A sample of 745 herring was taken from the commercial catch. Age 9 and older herring made up 61.4% of the catch by weight (Figure 4). Recruit herring comprised only 4.5% of the harvest.

Cape Avinof District

This was the sixth year of commercial herring fishing in the Cape Avinof District. As in all other Kuskokwim Bay districts, commercial herring fishing is regulated by emergency order. In November 1989, the Alaska Board of Fisheries moved the eastern boundary of the Cape Avinof District from Tsintulik Slough to the Ishkowik River. This area was previously closed to commercial fishing at the request of local residents to prevent interference with the subsistence harvest. In 1993, fishermen caught 215.2 tons of herring in sixteen commercial openings for a total of 106 hours of fishing time (Tables 1, 2 and 6).

Samples brought to Kipnuk by commercial fishermen on May 22 had an average roe content of 11.7%. The district was first opened to commercial fishing for 2 hours starting at 1:30 pm on May 23. The harvest was 28.3 tons of sac roe herring with an average roe content of 10.8%. Fifty-three fishers made deliveries. Between May 24 and June 1 the district was reopened fifteen times for 104 hours of fishing time. Catches ranged from 59.6 tons on May 24 to 0.1 tons on June 1. Roe contents ranged from 15.0% to 10.4%. A total of 205.9 tons of sac roe quality herring with an average roe content of 12.0% and 9.3 tons of bait were caught. In the Cape Avinof District, 97 fishermen made 478 deliveries to one processor worth approximately $75,000 (Tables 2 and 3). The exploitation rate was 7.6% of the available biomass. During the first five openings approximately twelve permit holders made 41 deliveries for 18 tons of sac roe herring with a 12.1% roe content in the Kwigillingok area.

A sample of 980 herring was taken from the commercial catch. Age 9 and older herring made up 82.3% of the catch by weight (Figure 4). Young herring (ages 3, 4, and 5) comprised only 3.0% of the harvest.

Nelson Island District

The commercial harvest of herring began in the Nelson Island District in 1985. The commercial fishery has opened and closed by emergency order to provide for an adequate subsistence harvest, an orderly commercial fishery, and to allow for periodic assessment of the herring biomass. Commercial fishing for herring occurred during the 1993 season for the second time since 1989 in the Nelson Island District. In 1993, 738.5 tons of herring were harvesting in sixteen commercial openings from May 17 to June 3 for a total fishing time of 63.5 hours (Table 6).

The first opening was for 1.5 hours starting at 8:00 pm on May 17. Sixteen fishermen landed 28.6 tons of sac roe herring with an average roe content of 9.3% and 1.4 tons of bait. An estimated three tons of herring was discarded. The next commercial period was on May 18 for 4 hours starting at 6:00 pm. Catch from this period was 32.8 tons of sac roe herring with a roe content of 9.5%, 5.7 tons of bait and 3.6 tons of waste. Thirty permit holders made 31 deliveries. On May 19, after being informed that two tenders would be available in the district, two periods were announced. Later, when told that one of the tenders would not be available, the second period was canceled. Even though fishermen were notified by the Department and processor after approximately two hours of fishing time that the available tender capacity was going to be exceeded, most continued to fish. The catch from the May 19 period totalled 151.8 tons and consisted of 69.4 tons of sac roe quality herring at 10.0% average roe content, 25.4 tons of bait and 57.0 tons of waste.

Between May 26 and June 3, there were an additional thirteen commercial periods for a total of 52 hours of fishing time. Catches ranged from 117.6 tons on May 30 to 0.0 tons on May 27. Average roe content ranged from 9.8% to 12.7%. The total catch of 738.5 tons consisted of 612.9 tons of sac roe herring with an average roe content of 10.6%, 51.6 tons of bait-quality herring and 74.0 tons of waste. One processor paid approximately $198,000 to 73 fishermen (Tables 2 and 3). The exploitation rate was 14.9% of the available biomass.

A total of 547 herring was sampled from the commercial catch. Age 9 and older herring were 85.3% of the catch (Figure 4). Only 0.6% of the harvest was recruit-aged herring.

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 no commercial herring periods in 1993. Between May 13 and May 16 approximately six fishermen attempted to locate herring between Cape Manning and Cape Corwin. A total of 13 samples averaged 4.9% roe content. A large percentage of males, combined with immature and spent fish, made location of market quality herring difficult. The

tender left the Nunivak Island District for the season on May 17.

Cape Romanzof District

A total of 371 tons of herring was harvested by 41 fishermen utilizing 41 fishing vessels in 1993 (Tables 1, 2 and 3). All 371 tons were purchased as sac roe. The average sac roe recovery of 9.6% was the second highest on record. Approximately 2 tons of herring were discarded in an abandoned gillnet. The commercial fishery consisted of 6 periods between May 17 and May 23. Fishing periods ranged from 1 hour to 4 hours duration for a total fishing time of 12.5 hours.

The commercial harvest was managed to achieve the preseason harvest projection of 367 tons, since no inseason biomass estimate was obtained. Fishing gear was restricted to one 50-fathom gillnet per vessel throughout the commercial season. Low effort, stormy weather and a relatively small tendering capacity resulted in low period catches. Fishing effort in 1993 was the lowest on record, and was 44% below the 1992 effort level. Local Alaskan residents (defined as residents of Chevak, Hooper Bay, and Scammon Bay) accounted for 95% (39 permits) of the effort and 91% (338 tons) of the harvest. The estimated value of the total harvest to fishermen was $106,403. Two companies purchased herring (Table 3). These companies were represented by two processing vessels and four tenders during the fishery.

A total of 886 herring were sampled from the commercial harvest. Age 9 and older herring made up 93.3% of the catch by weight (Figure 5). Herring recruits comprised only 0.5% of the harvest.

Norton Sound District

The 1993 Norton Sound herring fishery opened by emergency order on May 24. During the sac roe season, there were seven gillnet openings for a total fishing time of 41.5 hours; four beach seine openings for a total fishing time of 11 hours; and two cooperative beach seine openings for a total fishing time of 36.5 hours (Table 6). Two educational openings were also allowed for a total fishing time of 10 hours. Subdistricts 1 through 5 were closed on June 9. An additional 0.2 tons of bait-quality herring were taken after the sac roe season during 96 hours of fishing in subdistrict 7. The total harvest based on fish ticket data for the sac roe fishery was approximately 5,034 tons of herring. In addition, approximately 45 tons estimated to have been lost in abandoned beach seine sets were added to the commercial catch for a total commercial removal of 5,079 tons of herring (Tables 1 and 2). Since 1981, catches have averaged 4,667 tons. Table 8 compares historic beach seine and gillnet commercial catches in the Norton Sound District.

There were 264 fishermen who made at least one delivery during the season (Table 3). This is the lowest effort since 1985, 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 in part due to the

poor price projected prior to the season, the lack of a commercial herring fishery in 1992, and an extended commercial season in 1993.

During the 1993 season, 256 fishermen used gillnets, landing a total of 4,291.5 tons (Tables 3 and 6). The average sac roe recovery for the gillnet fishery was 10.0%. Seven fishermen participated in the beach seine fishery, landing 742.4 tons of herring. The average sac roe recovery for the beach seine fishery herring was 8.9%. One educational gillnet permit was issued by CFEC, and fished by the Bering Straits School District Commercial Fisheries Vocational class on May 30 and 31. A total of 8.7 tons was landed on this permit, and is included in the total gillnet harvest.

The average sac roe recovery for all gear types was 9.9% (Table 2). The average price paid to the fishermen for a short ton of herring with 9.9% roe recovery was approximately $294. Of the 5,034 tons harvested, 320.7 tons were purchased as bait-herring (with roe content less than 7.0%). The total value of the herring harvest to Norton Sound fishermen was approximately $1,411,142. Six companies registered 10 processors and 48 tenders to operate in Norton Sound (Table 3).

The commercial fishery was managed using the preseason biomass projection. The preseason guideline harvest was 9,054 tons, with 8,149 tons allocated to the gillnet fishery and 905 tons allocated to the beach seine fishery. During the fishery, it was assumed the projected biomass was present and that the preseason guideline harvest could be harvested.

The first beach seine opening was held on the morning of May 24. Because roe quality was good at some locations, a beach seine opening was scheduled for mid-day and a gillnet opening was scheduled for the evening of May 25. In order to minimize the harvest rate and to require the fishermen to more closely tend their nets, the gillnet fishery was restricted to one 50 fathom net. A second gillnet opening was announced the following day to allow approximately 1.5 days for processing the harvest. The catch rate for the second opening was less than expected so an extension of two hours was allowed. A third gillnet opening held on May 27 resulted in less than 500 tons harvested. On May 28, a beach seine opening produced a catch of less than 9.0% roe-recovery. The decision to curtail fishing for several days was made in order for the spawned-out older age classes to move out of nearshore waters and allow time for the younger age classes to migrate in. Over the next four days the educational permit fishery and test fishing occurred. Many fishermen made the decision to leave the area for the season.

On June 2, a large biomass of the younger age classes arrived in nearshore waters. Test fishing in the vicinity of St. Michael Island resulted in good roe quality and the gillnet fishery resumed that afternoon. The fishing fleet was reduced to one-half its size compared to the week before. During this time, the beach seine fishermen agreed to cooperatively harvest the remainder of their harvest allocation. The beach seine fleet fished the evening of June 1 at Besboro Island and on June 3 and 4 near Portage Roadhouse. The gillnet fleet completed their season in the vicinity of Cape Darby on June 5. Test fishing continued the next day, but no concentrations of marketable fish were found. During late June, three fishermen continued to fish in the vicinity of Nome and Port Clarence for small quantities of bait. The final harvest of 5,034 tons combined

with an estimated waste of 45 tons gives a total harvest of 5,079 tons with an exploitation rate of 10.9%.

A total of 2,630 herring were sampled from the commercial harvest. Age 9 and older dominated (94.5%) the gillnet harvest. Ages 5 and 11 herring comprised 23.5% and 18.1% of beach seine catches, respectively.

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. During 1993, 1 ton of bait-quality herring was harvested between April 15 and November 15 in the Port Clarence District.

ENFORCEMENT

At least 8 people from the Division of Fish and Wildlife Protection (FWP) were present in all but the Security Cove, Cape Avinof and Cape Romanzof Districts in 1993. The P/V Wolstad, a C-185 aircraft and a helicopter spent time in the Goodnews Bay, Nelson Island and Nunivak Island Districts during the season.

Protection efforts in Norton Sound consisted of three single engine aircraft (a super cub on wheels, a helicopter and a C-185 on wheels) and several small boats as well as the P/V Wolstad. Personnel consisted of 8 permanent, full-time Fish and Wildlife Protection officers and four civilian Public Safety employees. Fish and Wildlife Protection officers patrolled the grounds during each opening and closure. Twenty five citations were issued for the following sorts of violations: fishing after a closure, abandoned nets, vessel registration, over gear limit, improperly marked vessels, fishing without a permit, no photo ID and fishing without a crew member license. In addition, investigations are pending on abandoned gillnet gear and superexclusive use violations. A total of 10.9 st at 10.2% of herring was confiscated by the State of Alaska during the 1993 season in the Norton Sound District.

OUTLOOK AND MANAGEMENT STRATEGY FOR 1994

Projections from post-season escapement estimates, using historic mean rates of survival and current mean weights for each age class (Bromaghin and Hamner 1993, Alaska Department of Fish and Game, Anchorage, personal communication), and estimates of recruitment for each age class (Wespedstad 1982), indicate that the 1994 spawning biomass for the northeastern Bering Sea herring stocks (Security Cove to Norton Sound) will be approximately 67,760 tons (Table 7). 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 1994 projected return to the Security Cove District is 7,638 tons. A 20% exploitation rate would result in a harvest of about 1,528 tons (Table 7). This harvest would be a historic record for this district. A larger catch may occur if the 1994 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 7 herring are expected to dominate the return. Age 9 and older herring are expected to comprise approximately 16.1% of the biomass.

Goodnews Bay District

Management strategy for this district will be similar to that used 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 1994 projected return of herring to the Goodnews Bay District is 5,679 tons. A 20% exploitation rate would result in a harvest of 1,136 tons which if taken would be a historic record for this district (Table 7). A larger catch may occur if the 1994 biomass assessment is greater than the projection.

Ages 6 and 7 herring are expected to be the dominant year classes in the return. Age 9 and older herring are expected to comprise approximately 20% 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 1994 biomass for the Cape Avinof area stock is 2,827 tons (Table 7). The exploitation rate will be set at 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 424 tons of herring.

Age 6 herring are expected to be the largest year class in the returning population. Age 9 and older herring are expected to comprise approximately 29.4% of the returning population.

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 1994 is 4,888 tons (Table 7). At an exploitation rate of 15%, the harvest will be 733 tons of herring. A larger catch may occur if the 1994 biomass assessment is greater than the projection.

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 north of 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.

Age 6 herring are expected to be the dominant age group. Herring age 9 and older are expected to comprise approximately 16.7% of the biomass in 1993.

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 1994 is 4,909 tons. A 15% exploitation rate would result in a 736 ton harvest (Table 7). A larger catch may occur if the 1994 biomass assessment is greater than the projection.

Age 6 herring are expected to be the dominant age group. Age 9 and older herring are expected

to comprise 39.5% of the return.

Cape Romanzof District

The projected return for 1994, based upon limited data, is 2,758 tons which would result in a 414 ton harvest at a 15% exploitation rate (Table 7). Ages 10 and 12 herring are expected to dominate the biomass. Age 9 and older herring are expected to comprise 62.7% of the biomass.

Emergency order authority will be used to regulate the occurrence and length of fishing periods. 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 414 tons will be modified accordingly.

Norton Sound District

The Norton Sound projected return is 39,061 tons. A 20% exploitation rate would result in a harvest of 7,812 tons (Table 7). The 1994 biomass is expected to be dominated by 6 and 12 year old herring. Age 9 and older herring are expected to comprise 47.2% 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 781 tons.

The 1994 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 1994. 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.

LITERATURE CITED

Alaska Department of Fish and Game. February 1993. 1993 Herring Fisheries Management Plan. Regional Information Report No. 3A93-06. 7pp. Anchorage, Alaska.

Lebida, R. C. and D. C. Whitmore. 1985. Bering Sea Herring Aerial Survey Manual. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 85-2, Anchorage.

Pete, Mary C. 1990. Subsistence-Herring Fishing in the Nelson Island and Nunivak Island Districts, 1990. Alaska Department of Fish and Game, Division of Subsistence, Juneau. Technical Paper No. 196.

Pete, Mary C. 1991. Subsistence-Herring Fishing in the Nelson Island and Nunivak Island Districts, 1991. A Report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Division of Subsistence, Juneau.

Pete, Mary C. 1992. Subsistence-Herring Fishing in the Nelson Island and Nunivak Island Districts, 1992. Alaska Department of Fish and Game, Division of Subsistence, Juneau. Technical Paper No. 221.

Pete, Mary C. 1993. Subsistence-Herring Fishing in the Nelson Island and Nunivak Island Districts, 1992. Alaska Department of Fish and Game, Division of Subsistence, Juneau. Technical Paper No. 192.

Wespestad, V.G. 1982. Cohort analysis of catch data on Pacific herring in the eastern Bering Sea, 1959-81. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Technical Memorandum NMFS F/NWC-24, Seattle.

Table 1. Pacific herring harvests by domestic commercial fishermen during the sac-roe fisheries in the northeastern Bering Sea, Alaska, 1909-1993.

Year	Herring (st)[a]									Spawn on Kelp (st)
	Security Cove	Goodnews Bay	Cape Avinof	Nelson Island	Nunivak Island	Cape Romanzof	Norton Sound	Port Clarence	Total Harvest	Norton Sound
1909-1916	-	-	-	-	-	-	-[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	-

[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, 1988-1993.

Year	District	Estimated Biomass (st)	Harvest (st)				Roe %	Estimated Value ($ x 1,000)	Exploitation Rate (%)
			Sac-roe	Bait	Waste	Total			
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	5,176	-	-	-	-	-	-	-
	Cape Romanzof	4,000	371	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	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	2,705	-	-	-	-	-	-	-
	Nunivak Island	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
1988	Security Cove	4,906	324	0	0	324	9.3	362	6.6
	Goodnews Bay	4,479	473	10	0	483	8.0	463	10.7
	Cape Avinof	4,108	348	0	0	348	8.6	264	8.5
	Nelson Island	7,152	760	15	0	775	9.2	713	10.8
	Nunivak Island	2,800[b]	-	-	-	-	-	-	-
	Cape Romanzof	6,600	1,108	11	0	1,119	9.1	1,018	17.0
	Norton Sound	33,924	4,256	416	0	4,672	9.0	3,864	13.8
	Port Clarence	788	80	0	0	80	8.2	43	10.2
Total		64,757	7,349	452	0	7,801	9.0	6,727	12.0

[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.

Table 3. Number of buyers and fishermen participating in northeastern Bering Sea Pacific herring fisheries, Alaska, 1988-1993.

Year	District	Number of Buyers	Number of Fishermen		
				Seine[a]	
			Gill Net	Purse	Beach
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
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
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
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
1988	Security Cove	4	31	-	-
	Goodnews Bay	6	60	-	-
	Cape Avinof	1	98	-	-
	Nelson Island	7	174	-	-
	Nunivak Island	-	-	-	-
	Cape Romanzof	6	113	-	-
	Norton Sound	11	343	-	6
	Port Clarence	1	6	1	-

[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, 1977-1993.[a]

Village	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
									Nelson Island								
Tununak	57	38	34	65	40	48	94	-	43	63	48	49	47	54	21	32	45
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
Nightmute	-	-	-	-	-	-	-	-	3[b]	21	15	16	15	18	8	10	9
Newtok	-	-	-	-	-	-	-	-	7[b]	13	10	12	10	8	1	7	6
Total	81	86	93	97	64	83	94	-	99	167	124	136	124	126	70	92	82
No. Fishing Families	90	83	54	70	93	65	43	-	65[b]	72[b]	96	104	-[b]	100	85	97	89
									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
Chevak	<1	-	2	4	2	2	1	3	2	1	1	2	<1	1	<1	<1	<1
Hooper Bay	2	4	3	4	4	5	5	4	4	4	1	4	2	6	2	2	2
Total	<3	5	11	11	14	11	9	11	8	7	3	7	3	8	3	4	5
No. Fishing Families	30	29	84	61	46	43	37	47	44	41	39	32	24	32	18	30	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, 1978-1993.

Year	Herring (st)								
	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[c]
1993	6,995	6,211	2,837[b]	4,944	5,176	4,000	46,549	822	77,534[d]

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

[b] Inseason biomass estimated from poor aerial survey, therefore projected biomass was used.

[c] Biomass is 90,243 tons if Port Clarence is excluded from total.

[d] Biomass is 76,712 tons if Port Clarence is excluded from total.

Table 6. Summary of Pacific herring commercial harvest by fishing period for northeastern Bering Sea fishing districts, Alaska, 1993.

District	Subdistrict Section\Area	Gear	Period	Date	Time	Total Hours	Harvest (st)
Security Cove	Entire	GN	1	5\12	1200-1500	3.0	5.2
			2	5\12-13	2200-0400	6.0	0.0
			3	5\13	1000-1630	6.5	0.0
			4	5\14	0900-1800	9.0	0.0
					Total	24.5	5.2
Goodnews Bay	Entire	GN	1	5\12	0900-1500	6.0	66.3
			2	5\13	1000-1800	8.0	119.8
			3	5\14	1100-1700	6.0	55.3
			4	5\15	1200-1800	6.0	100.3
			5	5\16	1300-1900	6.0	68.0
			6	5\17	1400-2100	7.0	99.5
			7	5\18	1500-2200	7.0	130.0
			8	5\19	1500-2200	7.0	124.4
			9	5\20	0400-1000	6.0	59.3
			10	5\21	0400-1000	6.0	21.6
			11	5\21	1730-2300	6.0	41.4
			12	5\22	0530-1130	6.0	26.2
			13	5\22	1800-2400	6.0	17.4
			14	5\23-24	1900-0100	6.0	2.2
			15	5\24	0800-1200	4.0	11.5
			16	5\27	0830-1430	6.0	8.9
			17	5\27-28	2030-0230	6.0	0.0
			18	5\28	0930-1530	6.0	1.9
			19	5\28-29	2130-0330	6.0	0.2
			20	5\29	1030-1630	6.0	0.0
					Total	123.0	954.2
Cape Avinof	Entire	GN	1	5\23	1330-1530	2.0	28.3
			2	5\24	1000-1600	6.0	59.6
			3	5\25	1000-1700	7.0	22.2
			4	5\26	1100-1800	7.0	21.9
			5	5\26-27	2300-0630	7.0	19.7
			6	5\27	1200-1900	7.0	0.3
			7	5\28	0030-0730	7.0	13.7
			8	5\28	1300-2000	7.0	27.6
			9	5\29	0130-0830	7.0	8.5
			10	5\29	1400-2100	7.0	2.7
			11	5\30	0230-0930	7.0	5.3
			12	5\30	1500-2200	7.0	0.2
			13	5\31	0330-1030	7.0	1.7
			14	5\31	1530-2230	7.0	1.5
			15	6\01	0400-1100	7.0	0.1
			16	6\01	1630-2330	7.0	1.9
					Total	106.0	215.2
Nelson Island	Entire	GN	1	5\17	2000-2130	1.5	33.0
			2	5\18	1800-2200	4.0	42.1
			3	5\19	1700-2300	6.0	152.0
			4	5\26	0230-0430	2.0	23.0
			5	5\27	1400-1700	3.0	0.0
			6	5\29	0230-0630	4.0	35.4
			7	5\29	1300-1900	6.0	60.3
			8	5\30	0200-0700	5.0	4.9
			9	5\30	1400-2000	6.0	117.6
			10	5\31	0700-0900	2.0	30.2
			11	5\31	1700-2100	4.0	20.1
			12	6\01	0700-1000	3.0	26.8
			13	6\01	1830-2230	4.0	56.6
			14	6\02	0800-1100	3.0	24.3
			15	6\02	1730-2330	6.0	86.3
			16	6\03	0800-1200	4.0	25.9
					Total	63.5	738.5

Table 6. (page 2 of 2).

District	Subdistrict Section\Area	Gear	Period	Date	Time	Total Hours	Harvest (st)
Nunivak Island	Entire	GN			No Commercial Fishery		
Cape Romanzof	Entire	GN	1	5\17	2230-2400	1.5	98.8
			2	5\18	1400-1500	1.0	44.7
			3	5\20	1400-1500	1.0	22.1
			4	5\22	0000-0400	4.0	104.3
			5	5\22	1400-1700	3.0	59.2
			6	5\23	1530-1730	2.0	41.9
					Total	12.5	371.0
Norton Sound	S.D. 1,2,3	GN	1	5\25	1700-2000	3.0	1,038.9
	S.D. 1,2,3		2	5\26	1100-1800	7.0	1,126.3
	S.D. 1,3		3	5\27	1130-1630	5.0	441.9
	S.D. 1		4	6\02	1700-2300	6.0	630.2
	S.D. 1		5	6\03	1430-2200	7.5	720.5
	S.D. 1		6	6\04	0900-1500	6.0	100.3
	S.D. 5		7	6\05	1200-1900	7.0	224.5
	S.D. 7		8	6\10-12	1800-1800	48.0	0.0
	S.D. 7		9	6\16-18	1800-1800	48.0	0.2
					Total	137.5	4,282.8[1]
	S.D. 1 Educational		1	5\30-31	1200-open	10.0	8.7
					Total	147.5	4,291.5[2]
	S.D. 2,3	BS	1	5\24	1130-1430	3.0	166.2
	S.D. 2,3		2	5\25	1100-1400	3.0	162.7
	S.D. 2		3	5\28	1200-1500	3.0	257.3
	S.D. 2		4	5\31	1300-1500	2.0	78.0
	S.D. 2	Coop	5	6\1-2	1830-0400	9.5	24.4
	S.D. 5	Coop	6	6\3-4	1300-1600	27.0	53.8
					Total	47.5	742.4
Port Clarence	Open		1	4\15-8\15			0.5
				8\16-11\15			0.5
					Total		1.0

[1] Includes 6.9 st confiscated by Alaska Department of Public Safety.
[2] Does not include 45 st of waste.

Table 7. Projections of Pacific herring spawning biomass and harvest for commercial fishing districts in the northeastern Bering Sea, Alaska, 1994.

			1994 Projection[a]	
District	Biomass(st)	Threshold	Harvest(st)	Exploitation Rate (%)
Security Cove	7,638	1,200	1,528	20
Goodnews Bay	5,679	1,200	1,136	20
Cape Avinof	2,827	500	424	15
Nelson Island	4,888	3,000	733	15
Nunivak Island	4,909	1,500	736	15
Cape Romanzof	2,758[b]	1,500	414	15
Norton Sound	39,061	7,000	7,812	20
Port Clarence		-	165[c]	-

[a] Preseason projection. Biomass and harvest may be adjusted based on inseason estimates.
[b] Projection from estimated 1993 relative biomass which was based on 1993 aerial surveys, spawn deposition, age composition, and the CPUE from commercial and test fisheries.
[c] Harvest guideline of 165st (150mt).

Table 8. Herring harvest by gear type and subdistrict, Norton Sound District, 1981-1993.

NORTON SOUND HERRING CATCHES

		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
GILLNET HARVEST (tons)														
St. Michael		3,067	2,062	434	—	1,538	2,560	2,214	3,215	2,927	4,491	—	—	2,288
Unalakleet		831	946	1,264	—	95	—	—	42	10	618	731	—	120
Cape Denbigh		472	925	2,692	3,244	1,599	2,420	1,545	1,211	1,414	923	4,419	—	1,659
Elim		—	—	65	—	147	—	—	6	—	—	—	—	225
Golovin		—	—	85	—	—	—	—	—	—	—	—	—	—
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
SEINE HARVEST (tons)														
St. Michael (beach)		—	—	—	—	—	—	4	45	329	6	—	—	—
Unalakleet (beach)		—	—	—	—	93	—	—	58	50	332	149	—	467
Cape Denbigh (beach)		—	—	41	327	76	30	293	96	11	9	373	—	222
Elim (beach)		—	—	—	—	—	185	—	—	—	—	—	—	54
Cape Denbigh (purse)		—	—	—	—	—	—	26	—	—	—	—	—	—
total	a/	0	0	41	327	169	215	323	198	390	347	522	b/	743
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
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
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

a/ Totals do not include waste.
b/ No commercial fishery.

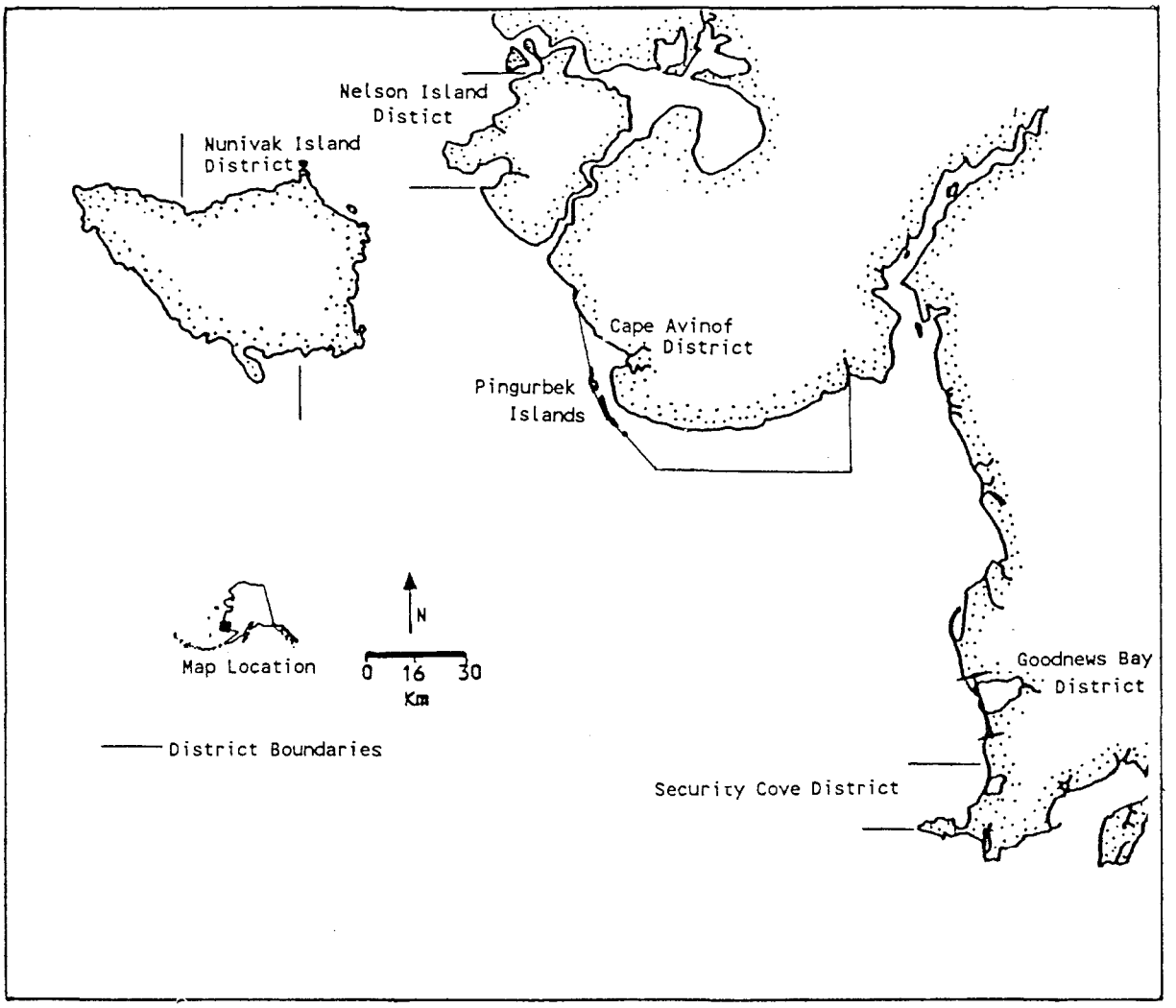

Figure 1. Security Cove, Goodnews Bay, Nelson Island, Nunivak Island, and Cape Avinof Pacific herring commercial fishing districts in the northeastern Bering Sea, Alaska

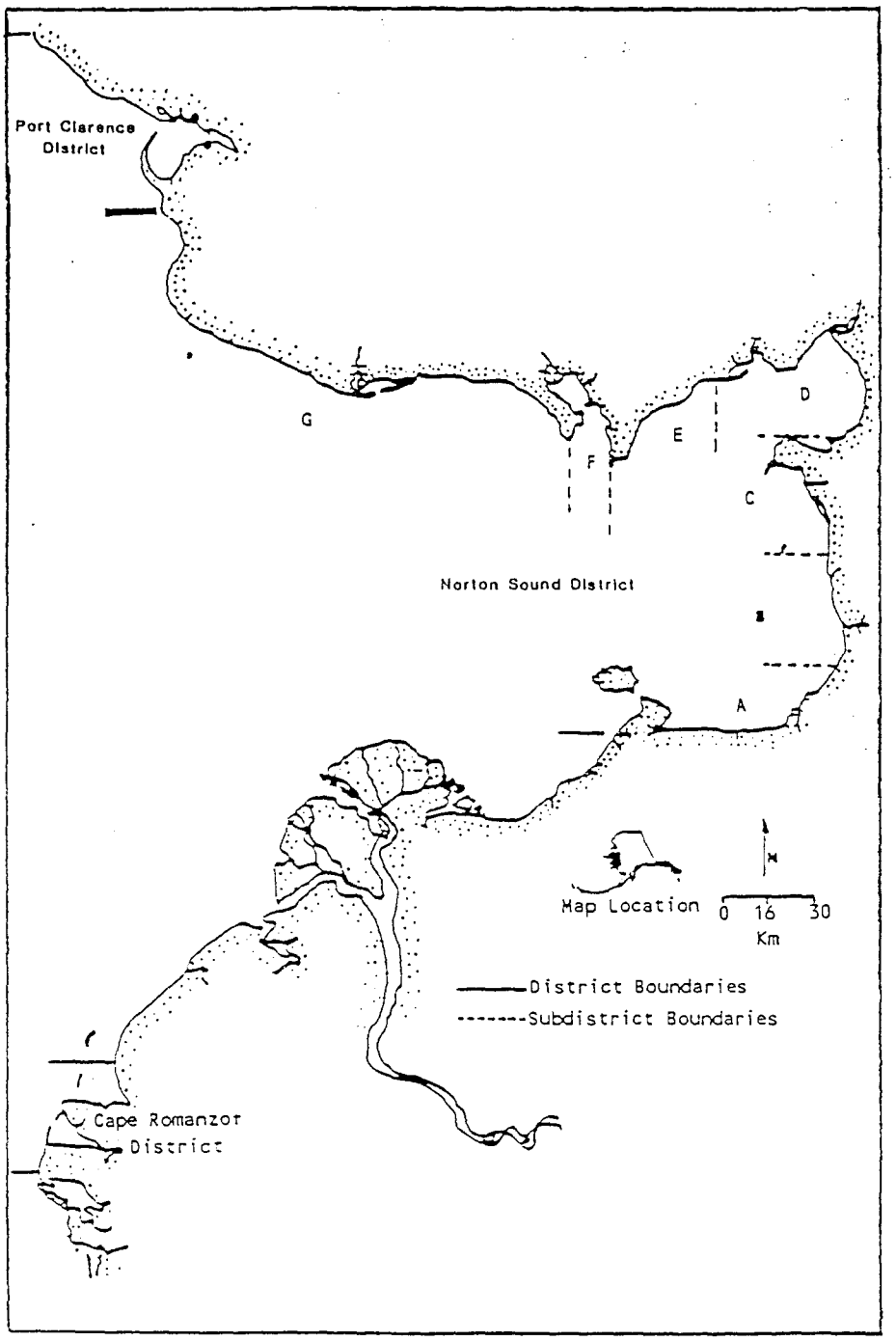

Figure 2. Cape Romanzof, Norton Sound, and Port Clarence Pacific herring commercial fishing districts in the northeastern Bering Sea, Alaska

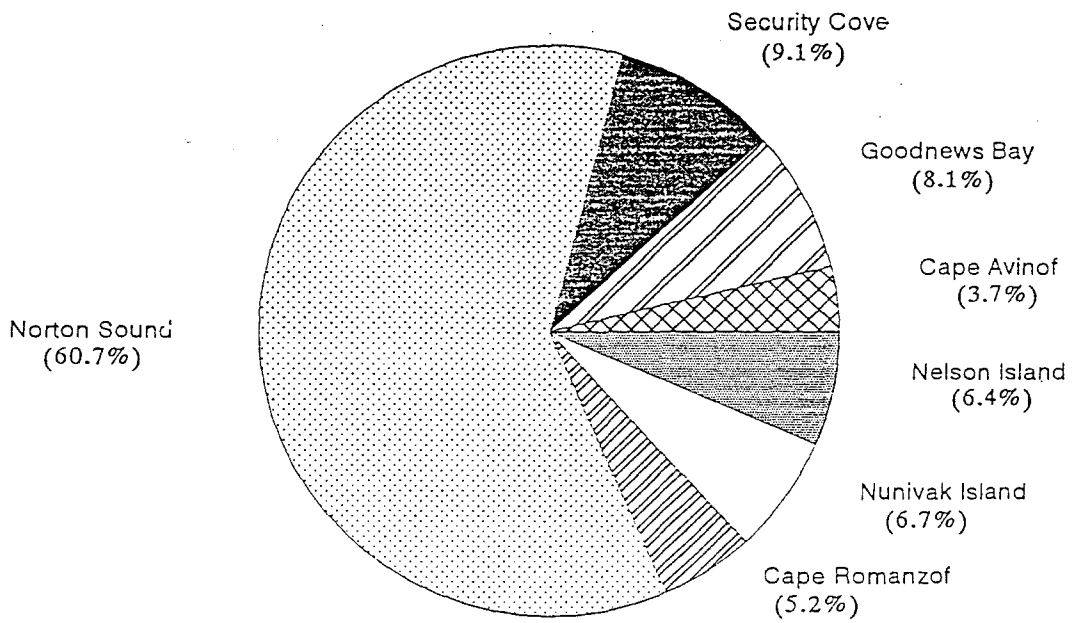

Figure 3. Pacific herring spawning biomass distribution by commercial fishing district, Arctic–Yukon–Kuskokwim Region, Alaska, 1993.

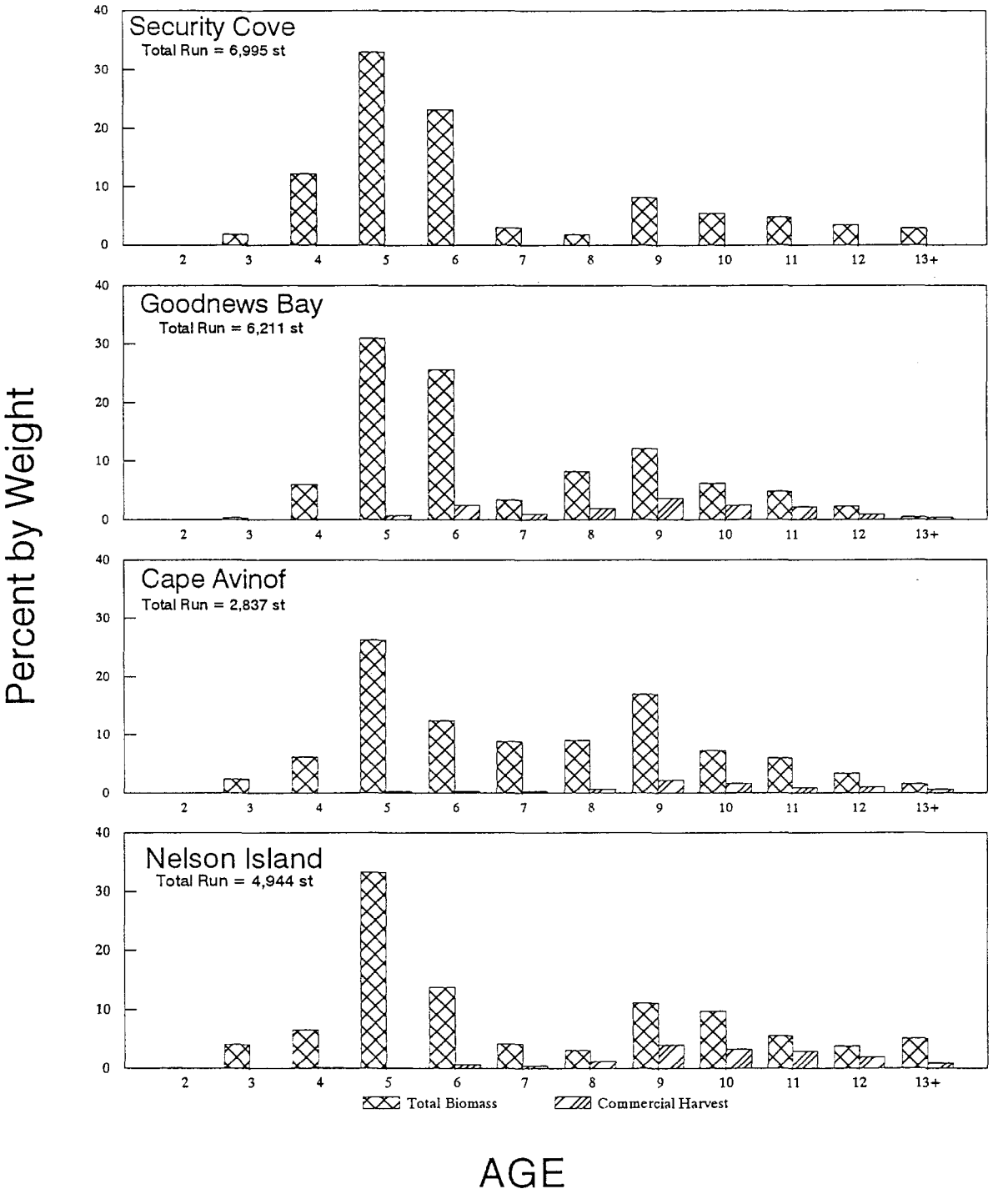

Figure 4. Age composition of the total biomass and commercial harvest for the Security Cove, Goodnews Bay, Cape Avinof, and Nelson Island commercial fishing districts within the Arctic–Yukon–Kuskokwim Region, Alaska, 1993.

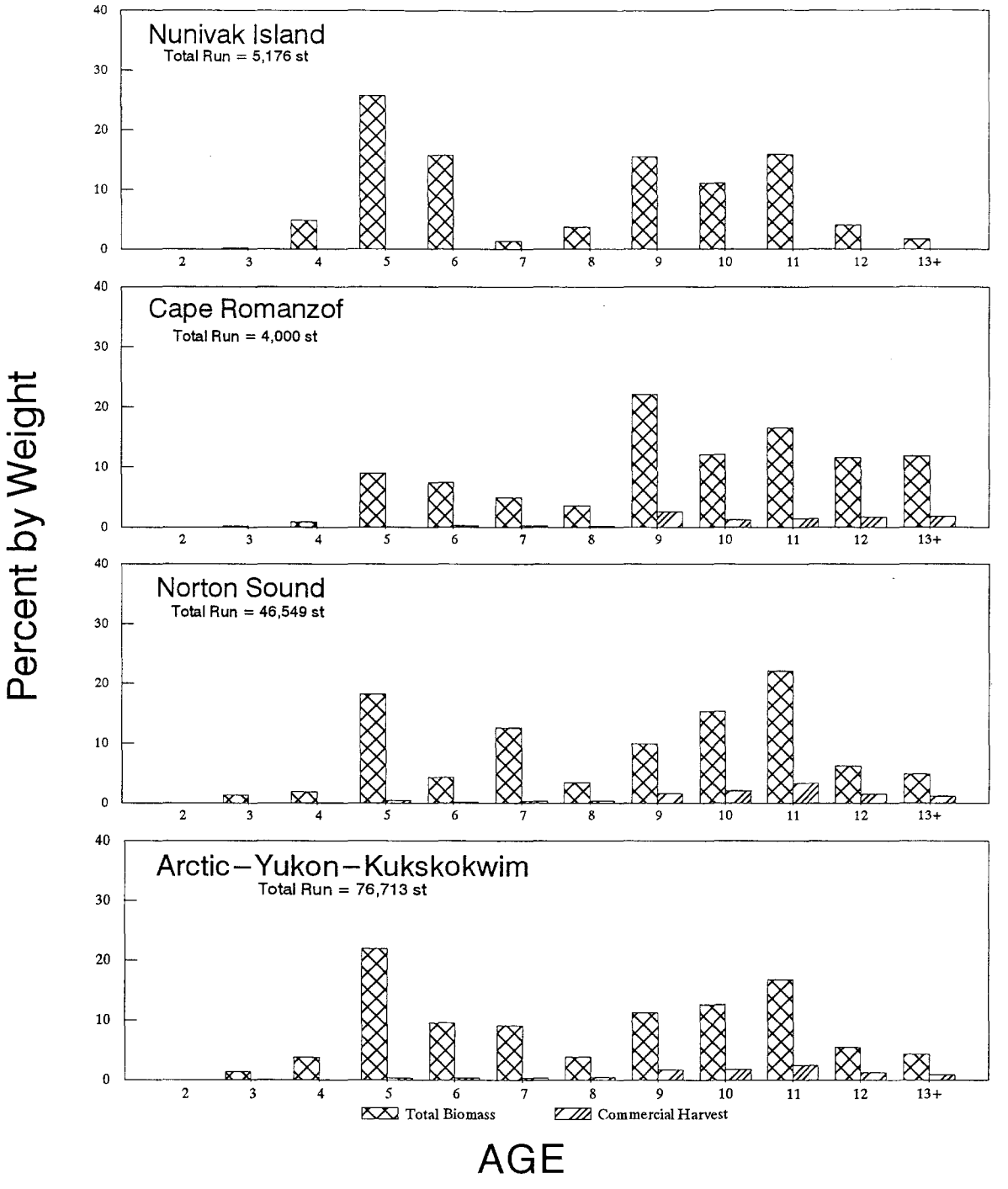

Figure 5. Age composition of the total biomass and commercial harvest for the Nunivak Island, Cape Romanzof, Norton Sound commercial fishing districts, and the Arctic–Yukon–Kuskokwim Region, Alaska, 1993.

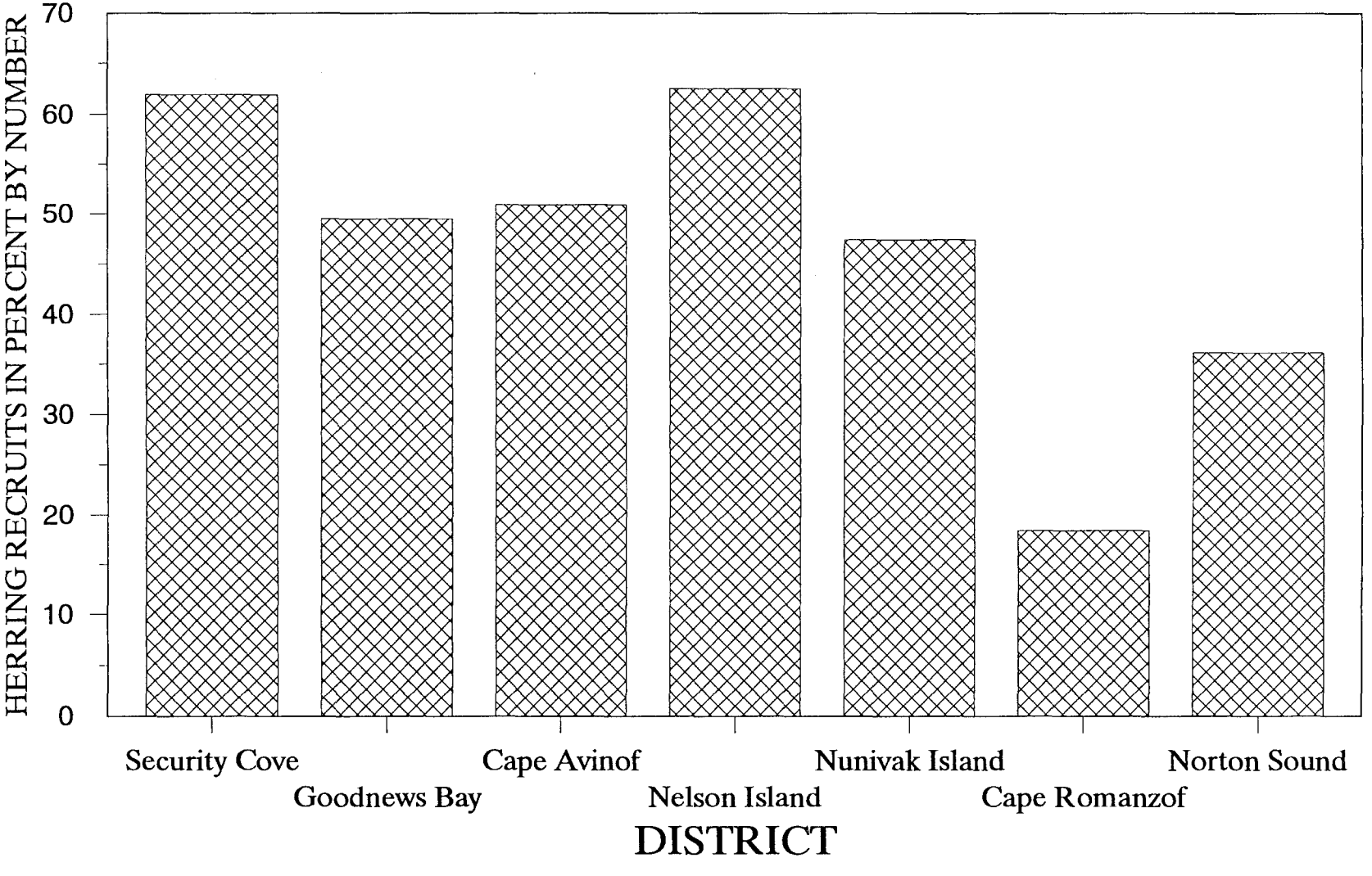

Figure 6. Pacific herring recruits (ages 2, 3, 4, and 5) for commercial fishing districts within the Arctic-Yukon-Kuskokwim Region, Alaska 1993.