

Pacific Herring Stocks and Fisheries in the  
Eastern Bering Sea, Alaska, 1983

A Report to the Alaska Board of Fisheries  
February 1984

Submitted by:

Stephen M. Fried  
Craig Whitmore  
Daniel Bergstrom  
Bering Sea Herring Program

Alaska Department of Fish and Game  
Division of Commercial Fisheries  
Anchorage, Alaska

# TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES.....	ii
LIST OF FIGURES.....	ii
ABSTRACT.....	iii
INTRODUCTION.....	1
SEASON SUMMARY.....	1
Stock Status.....	1
Assessment Methods.....	1
Spawning Populations.....	2
Togiak District.....	2
Security Cove District.....	2
Goodnews Bay District.....	3
Nelson & Nunivak Island Area.....	3
Cape Romanzof District.....	3
Norton Sound District.....	4
SUBSISTENCE FISHERY.....	4
COMMERCIAL FISHERY.....	4
Togiak District.....	4
Security Cove District.....	6
Goodnews Bay District.....	6
Cape Romanzof District.....	7
Norton Sound District.....	7
OUTLOOK AND MANAGEMENT STRATEGY FOR 1984.....	8
Togiak District.....	9
Security Cove District.....	9
Goodnews Bay District.....	9
Cape Romanzof District.....	9
Norton Sound District.....	10

LIST OF TABLES

	<u>Page</u>
1. Herring and herring spawn on kelp harvest in metric tons by U.S. commercial fishermen in the eastern Bering Sea, Alaska, 1909-1983.....	11
2. Estimated biomass and commercial harvest of Pacific herring in eastern Bering Sea fishing districts, Alaska, 1978-1983.....	12
3. Commercial harvest of Pacific herring spawn on rockweed kelp in eastern Bering Sea Fishing Districts, Alaska, 1978-1983.....	13
4. Numbers of buyers and fishermen participation in eastern Bering Sea Pacific herring fisheries, Alaska, 1978-1983.....	14
5. Subsistence herring catch (in metric tons) and effort data by selected areas, eastern Bering Sea, Alaska, 1978-1983.....	15
6. Relative abundance index (RAI) and estimated biomass of eastern Bering Sea herring, Alaska, 1978-1983.....	16
7. Conversion estimates (metric tons of Pacific herring per 50 m <sup>2</sup> school surface area) obtained from test purse seine fishing, Togiak district, Alaska, 1978-1983.....	17

LIST OF FIGURES

	<u>Page</u>
1. Togiak (A=Kulukak, B=Nunavachak, C=Togiak and D=Hagemeister Section), Security Cove and Goodnews Bay Commercial Herring Fishing Districts and Nelson Island (restricted to subsistence fishing), Alaska.....	18
2. Cape Romanzof and Norton Sound (A=St. Michael, B=Unalakleet, C=Cape Denbigh, D=Norton Bay, E=Elim and F=Golovin Bay Subdistricts), Commercial Herring Fishing Districts, Alaska.....	19
3. Age composition of Pacific herring in spawning populations and commercial harvests in Togiak, Security Cove and Goodnews Bay Commercial Herring Fishing Districts, Alaska, 1983.....	20
4. Age composition of Pacific herring in spawning populations and commercial harvests in Cape Romanzof and Norton Sound Commercial Herring Fishing Districts and the Nelson-Nunivak Island area, Alaska, 1983.....	21

## ABSTRACT

A total of 30,750 m.t. of Pacific herring and 147.8 m.t. of spawn-on-kelp was harvested in eastern Bering Sea Commercial Fishing Districts during 1983. This was the highest Pacific herring harvest recorded since these fisheries began in the 1960's. Estimated total value of harvests to fishermen was \$13.2 million. Subsistence fishermen representing at least 80 families from Yukon-Kuskokwim Delta villages harvested an estimated 93 m.t. of herring. Average roe recovery from commercially harvested herring was 8.8%, yielding about 2,706 m.t. of roe. Approximately 18% of the total estimated herring biomass of 167,800 m.t. within the Commercial Herring Fishing Districts was harvested. Age 5 and 6 herring (1978 and 1977 year classes) comprised 29 and 49%, respectively, of the total run and 24 and 53%, respectively, of the total catch. Season openings in Togiak, Security Cove, Goodnews Bay and Cape Romanzof Districts were regulated through Emergency Orders during 1983. This allowed a more controlled fishery, enhanced roe yield, minimal wastage and allowed the Department to make periodic reassessments of the resource. It also lessened disruption of herring schools, resulting in extensive spawn deposition. Due to the continued large returns of age 5 and 6 herring in 1983, harvestable surpluses of herring will be available in all Districts in 1984. Management strategies for 1984 will be similar to those followed in 1983.

## INTRODUCTION

The purpose of this report is to provide results from 1983 stock assessment programs, review and evaluate 1984 harvests and management strategies for all Commercial Fishing Districts and the Yukon-Kuskokwim Delta subsistence fishery, and present management strategies for the 1984 herring fishing season.

A total of 30,750 m.t. of Pacific herring and 147.8 m.t. of spawn-on-kelp were harvested in eastern Bering Sea Commercial Fishing Districts during 1983 (Table 1, Figures 1 and 2). This was the highest Pacific herring harvest recorded since these fisheries began in the 1960's. The spawn-on-kelp harvest was about average for the period 1976-1982 (mean 153.0 m.t., range 108.2-209.1 m.t.). Estimated value of total harvests to fishermen was \$13.2 million (Table 2 and 3). Wastage of herring was estimated to be about 700 m.t. Most wastage was due to storms and vessel mishaps rather than to dumping of unwanted herring. Spawn-on-kelp wastage appeared to have been minimal. In the sac roe fishery, numbers of fishermen increased in Togiak and Norton Sound, but decreased or remained at 1982 levels in all other Districts (Table 4). Numbers of buyers decreased in Togiak, but increased in all other Districts. In the spawn-on-kelp fishery, numbers of pickers decreased in Togiak and Norton Sound Districts (Table 3). Numbers of kelp buyers decreased in Togiak, but remained the same in Norton Sound District. Average percent roe recovery from harvested herring ranged from 8.6 in Norton Sound to 9.4 in Security Cove and Goodnews Bay (Table 2). Percent harvest of estimated herring biomass ranged from 13.6 in Goodnews Bay to 19.1 (19.5 if waste is included) in Togiak District. Subsistence fishermen representing at least 80 families from Yukon-Kuskokwim delta villages harvested an estimated 93 m.t. of herring (Table 5). An overall increase in herring abundance occurred in all Districts surveyed (181,300 m.t. total biomass) (Table 6). Recruitment of age 4 herring (1979 year class) in 1983 was below that documented for age 4 herring in 1982 (1978 year class).

## SEASON SUMMARY

### Stock Status

#### Assessment Methods

Aerial surveys were flown throughout the herring spawning season in all Fishing Districts to determine relative abundance, distribution and biomass of herring schools. Occurrence and extent of milt, numbers of fishing vessels, and visibility factors affecting survey quality were also recorded. Data collection methods were similar to those used since 1978. A total of 209 hrs. was spent in aerial surveys: 91 hr. in Togiak, 24 hr. in Security Cove/Goodnews Bay, 5 hr. in Nelson/Nunivak Island area, 1 hr. in Cape Romanzof and 88 hr. in Norton Sound. Weather and sea conditions were generally fair to good in Togiak and Norton Sound Districts. Storms and turbid water hampered survey coverage much of the season in all other Districts.

Contracted purse seine vessels provided data on tonnage per unit surface area for six herring schools within Togiak District during 1983 (Table 7). Factors of 1.2 (water depth 5 m or less), 2.5 (water depth greater than 5 m) and 3.0 m.t./50 m<sup>2</sup> (water depth greater than 8m) were used to convert estimated school

surface areas to biomass within Togiak District. Conversion factors of 2.4 or 3.0 m.t./50 m<sup>2</sup> were used for all other Districts.

Test fishing with variable mesh gillnets and sampling of commercial landings were conducted in all fishing districts to determine age, size and sexual maturity of herring and to estimate occurrence and abundance of other schooling fishes. Additionally, chartered purse seine and gillnet vessels collected herring samples within Togiak District. This information was used during post-season analyses to interpret and modify aerial survey data.

Ground surveys were conducted in most Districts to obtain information on the extent and density of herring spawn-on-kelp. Studies of growth, mortality and revegetation rates of Fucus sp. (rockweed) within Togiak District were completed by investigators from University of Alaska, Juneau, under a contract with ADF&G. Results of this three year study will be available in a separate report later this year.

### Spawning Populations

#### Togiak District

A total of 30 aerial surveys was flown on 27 days during the 1983 season, from 26 April to 3 June. About half of these surveys were made under fair to excellent conditions.

Test fishing with variable mesh gillnets was conducted from 26 April to 26 May. A total of 2,053 herring was sampled from these catches. Herring comprised 98% of the total catch of pelagic schooling fishes. Test fishing with purse seine gear from contracted vessels was conducted from 28 April to 18 May. A total of 1,130 herring was sampled from 31 different sets. Test fishing aboard contracted gillnet vessels was conducted on 1 and 7 May. A total of 174 herring was sampled.

During the season herring biomass was estimated to be 124,000 m.t. Analysis of data from test fishing and contracted commercial vessels resulted in a post-season herring biomass of 128,600 m.t. Approximately 80% of the total biomass was composed of age 5 and 6 herring (1978 and 1977 year classes) (Figure 3). Age 4 herring (1979 year class) accounted for only 4% of the biomass. Although the relative proportion of young, newly recruited, herring (age 4 and less) increased as the season progressed, it was not possible to identify separate abundance peaks for young and old (age 5 and greater) herring as had been documented during 1979-1981.

Spawn deposition appeared to be extensive. A total of 96 linear km. of milt was observed during aerial surveys. Most spawning occurred 2-19 May. Extensive subtidal spawning was observed in Metervik and Ungalikthluk Bays and along the west shore of Hagemeister Island.

#### Security Cove District

A total of 20 aerial surveys was flown on 15 days during the 1983 season, from 25 April to 19 May. All surveys were made under fair to unsatisfactory conditions.

Test fishing was conducted during 1-25 May. A total of 823 herring was sampled from these catches. Herring comprised 66% of the total catch of

schooling fishes.

During the season herring biomass was estimated to be 5,100 m.t. A post-season estimate of 5,800 m.t. was adopted based upon past stock mixing proportions for Security Cove and Goodnews Bay Districts (see below). Age 5 and 6 herring represented 73% of the sampled population (Figure 3). Age 4 herring comprised about 9% of the population. Based upon test and commercial catch rates, peak abundance of herring occurred during the period 8-14 May. A total of 23 linear km. of milt was observed during aerial and ground surveys, about three times the total extent of spawn documented in 1982.

#### Goodnews Bay District

A total of 20 aerial surveys were flown on 15 days during the 1982 season, from 25 April to 19 June. All surveys were made under poor to unsatisfactory conditions.

Test fishing was conducted from 5 May to 2 June. A total of 1,143 herring was sampled from these catches. Herring comprised 78% of the total catch of schooling fishes.

Due to turbid water conditions during the season herring biomass was assumed to be approximately equal to that estimated for 1982 (2,400 m.t.). Many herring schools were sighted at the entrance to Goodnews Bay. Although this area is within Security Cove District, many of these schools probably spawned within Goodnews Bay. Therefore, based upon past contributions of Goodnews Bay to the total biomass of both Districts, 34% of the biomass observed within Security Cove was apportioned to Goodnews Bay. This resulted in a revised estimate of 2,900 m.t. for Goodnews Bay. Age 5 and 6 herring represented 74% of the sampled population (Figure 3). Age 4 herring comprised about 14% of the population. Based upon test and commercial catch rates, peak abundance of herring occurred during the period 8-14 May. No milt patches were observed during aerial surveys.

#### Nelson and Nunivak Island Area

Two aerial surveys were flown during the 1983 season: on 15 and 18 May. Survey conditions were fair to good on the 18 May survey.

No test fishing was conducted in the Nelson Island area. However, a total of 288 herring was sampled from subsistence catches.

Herring biomass was estimated to be 6,600 m.t. for Nelson Island and 6,900 for Nunivak Island. Totals of 1 and 12 linear km. of milt were sighted during aerial surveys of Nelson and Nunivak Islands, respectively.

Age 6 herring comprised 77% of the subsistence catch (Figure 4).

#### Cape Romanzof District

One aerial survey was flown in this District on 15 May. Only 15 m.t. of fish were sighted under unsatisfactory survey conditions.

Test fishing was conducted during 13-31 May. A total of 829 herring was sampled from these catches. Herring comprised 96% of the total catch of schooling fishes.

Although aerial survey results could not be used to estimate biomass, test fishing study results indicated that herring were probably slightly more abundant than in 1982. Therefore, a post-season biomass estimate of 5,000 m.t. was adopted, an amount 600 m.t. greater than the 1982 estimate. Age 5 and 6 herring comprised 66% of the sampled population (Figure 4). Age 4 herring comprised 14% of the population. In general, spawn deposition extent and intensity appeared comparable to that documented in 1982.

#### Norton Sound District

A total of 36 aerial surveys was flown on 31 days during the season, from 9 May to 23 June. Survey conditions were generally fair throughout the District. However, sea ice hindered surveys in Subdistrict 1 until 27 May.

Test fishing was conducted from 14 May to 19 June. A total of 2,586 herring was sampled from these catches. Herring comprised 94% of the total catch of schooling fishes.

During the commercial fishing season herring biomass was estimated to be 23,500 m.t. Continued aerial surveys and analysis of data from test fishing resulted in a post-season estimate of 25,500 m.t. Age 5 and 6 herring comprised 71% of the total biomass (Figure 4). Peak abundance of herring occurred 1 June in Subdistrict 1 (St. Michael area) and 22-23 May in Subdistricts 2 (Unalakleet area) and 3 (Cape Denbigh area). A total of 31 linear km. of milt was observed during aerial surveys, slightly less than the amount observed in 1982. Spawning within Subdistrict 1 was delayed until sea ice dispersed by 27 May. Prior to this time herring that eventually spawned within Subdistrict 1 remained within Subdistricts 2 and 3. Peak spawning throughout the District occurred 27-31 May.

### SUBSISTENCE FISHERY

Subsistence fishing for herring is generally most important in villages on the Yukon-Kuskokwim River delta. Mean annual subsistence harvests in the eastern Bering Sea have been approximately 100 m.t. since 1975 (Table 5). About 75% of the total annual harvest is taken in the Nelson Island area at the villages of Tununak, Toksook Bay and Umkumiut (Nightmute). In 1983, an estimated 85 m.t. of herring were harvested by 43 families in Tununak. Subsistence surveys were not conducted in Toksook, Umkumuit or Kwigillingok. Three other villages on the Yukon-Kuskokwim delta, Scammon Bay, Hooper Bay and Chevak were surveyed in 1983. Total harvest was 8.3 m.t. by 37 families. Although subsistence survey results are believed to accurately reflect harvest trends, reported catches represent minimum figures since all fishermen cannot be contacted.

### COMMERCIAL FISHERY

#### Togiak District

Commercial herring fishing has been regulated by Emergency Orders since 1981 to eliminate wastage problems and achieve exploitation rate objectives. Four commercial openings were allowed during 3 to 11 May resulting in a total harvest of 24,486 m.t. (Table 2). This was the second year in which fishing time was regulated by gear type under Board of Fisheries directives. When commercial purse seine openings were less than 24 hours, gill net openings were three times as long. Total fishing times during the 1983 season were 14 hours for purse seine gear and 42 hours for gill net gear. Most of the

harvest (97%) was sold for sac roe; 814 m.t. were sold for food or bait. Purse seine vessels accounted for 81% of the total harvest; gillnet vessels accounted for 19%. Average roe recovery for the season was 8.8%. Average roe recovery from purse seine catches was 9.3%; average recovery from gillnet catches was 6.9%. The 1983 herring harvest was the largest in the history of Togiak District and the highest reported in the State for 1983. Wastage of herring was estimated at 544 m.t., far below that which occurred in 1980 (5,200 m.t.). Most wastage was due to storms and vessel mishaps. Value of harvested herring to fishermen is estimated to have been \$10.5 million. Average price was \$464 per s.t. for 10% roe recovery, with an increase or decrease of \$53 per s.t. for each percentage point above or below 10%. Average price for food and bait herring was \$75 per s.t. Numbers of processors decreased 30% from 1982 with 23 companies purchasing herring (Table 4). Numbers of fishing vessels increased 19% with 150 purse seine and 250 gillnet vessels participating in 1983.

Spawn-on-kelp harvests were also regulated by Emergency Orders, in accordance with a plan adopted by the Board of Fisheries in 1979. Three commercial openings were allowed, during 5-7 May, (52 hours total fishing time) resulting in a total harvest of 123 m.t. Since several K-areas did not contain marketable quantities of spawn-on-kelp, most of the harvest (64%) came from only two areas (K-3 and K-8). Therefore total harvest was 8% instead of 10% of estimated standing stock of rockweed. Four commercial processors purchased spawn-on-kelp from 125 fishermen (Table 3). Value of the total harvest to fishermen was estimated to be \$0.3 million. Average price was \$1.05 per lb. The 1983 spawn-on-kelp harvest was about 10% less than the mean harvest for 1976-1982 (mean harvest 137 m.t.).

Overall herring exploitation rate was 19.1% of estimated available biomass (Table 2). Age 5 and 6 herring comprised 78% of the harvest (Figure 3). Age 4 herring represented about 1% of the harvest. Separate harvest strategies could not be used on young, newly recruited, herring (age 4 and less) and old herring (age 5 and greater). Although the relative proportion of young herring did increase as the season progressed, separate abundance peaks for young and old herring were not evident. This was probably due to poor recruitment of young herring into the spawning population. Good visibility conditions generally persisted during the season which allowed reliable aerial assessments to be made of herring biomass. Three commercial openings (11 hours purse seine, 33 hours gillnet) were allowed 3-5 May when biomass was approaching 100,000 m.t. and herring were ripening. Test fishing was done with contracted vessels from 28 April to 18 May to monitor sexual maturity and age composition of the herring spawning population. During this time period meetings were held with industry representatives to discuss the quality and roe content of herring samples. The proportion of spawned out herring was high during the 11 May opening, and many purse seine vessels released their catches. By early June it became evident that most herring had spawned and left the District and no further openings were allowed.

In general, management of the commercial herring fishery has greatly benefited by adoption of Emergency Order procedures and Board of Fisheries harvest directives since 1981. Wastage has been reduced, catch reporting has been timely and accurate, and stock assessment capabilities have been improved. The restriction of fishing effort to discrete periods has lessened disruption of herring schools resulting in more extensive spawning. Increased mobility

provided by a chartered helicopter has also aided in efforts to monitor and manage the fishery. Availability of the Fish and Wildlife Protection vessels R/V WOLSTAD, COMPLIANCE, VIGILENT and PUBLIC SAFETY I enhanced efforts to enforce regulations. The most common violations were gillnets fishing after closures and purse seine vessels making sets prior to and after openings. Numerous oil slicks, due to bilge pumping by vessels and various accidents within the large fleet, were again documented. Staff from the Alaska Department of Environmental Conservation and U.S. Coast Guard were present on the grounds to monitor these problems and help reduce occurrences. Effects of exposure of herring spawn to oil and fuel in areas such as Nunavachak Bay, where a large portion of the fishing fleet anchors, is not known.

#### Security Cove District

Commercial herring fishing has been regulated by Emergency Order since 1981 to provide for a more orderly fishery and allow for periodic reassessment of herring biomass. Four commercial openings and three extensions of fishing time were allowed during 6-13 May for a total fishing time of 144 hours. Total harvest was 973 m.t. (Table 2). Seventy-four percent of the harvest was taken during 11-13 May by 57 fishermen in 52 boats. Prior to and after this time period the number of fishermen making deliveries ranged from 15-54 each day. Most (90%) of the harvest was sold for sac roe; 98 m.t. were sold for food or bait. Average roe recovery for the season was 9.4%. Wastage of herring was estimated to be less than 100 m.t. tons. About half the wastage was due to fishermen dumping entire loads of unwanted herring, the other half due to fishermen culling male and spent female herring from catches to increase roe recovery. Value of harvested herring to fishermen was estimated to be \$0.4 million. Average price was \$464 per s.t. for 10% roe recovery, with an increase or decrease of \$53 per s.t. for each percentage point above or below 10%. Average price for food and bait herring was \$50 per s.t. Six processors, twice the number in 1982, purchased herring (Table 4). Most processors established 8% roe recovery as a minimum required for herring to be purchased for sac roe. Lack of processors on the grounds early in the season almost delayed fishing during the first opening. A total of 94 fishermen in 74 gillnet vessels participated in 1983, a 12% decrease in fishermen and a 25% decrease in vessels from 1982. Area residents (i.e. fishermen living in Platinum, Goodnews Bay, Quinhagak and Bethel) accounted for 2% of the effort and less than 1% of the harvest.

Overall exploitation rate of herring was 17% of estimated available biomass (Table 2). Age 5 and 6 herring comprised 74% of the total harvest (Figure 3). Age 4 herring accounted for less than 1% of the harvest.

Although weather conditions limited assessment capabilities, management of the 1983 commercial herring fishery was without major problems. No Fish and Wildlife vessel or personnel were present in Security Cove during the season. However, fewer fishing violations were observed by ADF&G staff than in previous years.

#### Goodnews Bay District

Commercial herring fishing has been regulated by Emergency Order since 1981. Four commercial openings and three extensions of fishing time were allowed 6-18 May for a total fishing time of 192 hours. Total herring harvest for the season was 395 m.t. (Table 2). No processors were present to purchase fish within this District until 11 May, about 100 hours after the fishery had

opened. However, three fishermen delivered about 5 m.t. of herring to processors based in Security Cove during 8-9 May. Most of the harvest (98%) was sold for sac roe; 8 m.t. were sold for food or bait. Average roe recovery was 9.4%. Wastage of herring was not a problem. Value of harvested herring to fishermen is estimated to have been \$0.2 million. Average price was \$464 per s.t. for 10% roe recovery, with an increase or decrease of \$53 per s.t. for every percentage point above or below 10%. Four processors purchased herring, one more than in 1982 (Table 4). Most processors established 8% as the minimum roe recovery required for herring to be purchased for sac roe. A total of 84 fishermen in 64 gillnet vessels participated in 1983, the same number of fishermen that participated in 1982, but a 26% increase in vessels. Local fishermen (i.e. residents of Platinum, Goodnews Bay, Quinhagak and Bethel) accounted for 66% of the effort and about 50% of the harvest.

Overall exploitation rate of herring was 14% of estimated available biomass (Table 2). Age 5 and 6 herring comprised 77% of the total harvest, (Figure 3). Age 4 herring accounted for about 11% of the harvest.

Although hampered by severe weather conditions, management of the 1983 commercial herring fishery was without major problems. No Fish and Wildlife Protection vessel or personnel were present in Goodnews Bay District during the season. However, fewer fishing violations were observed by ADF&G staff than in previous years.

#### Cape Romanzof District

Commercial herring fishing has been regulated by Emergency Orders since 1982. Seven fishing periods were allowed during 16-26 May for a total fishing time of 144 hours. Total harvest was 740 m.t. All of the harvest was sold for sac roe. Average roe recovery was 9.0%. Wastage of herring was not a problem in this District. Value of harvested herring to fishermen is estimated to have been \$0.4 million. Average price was \$450 per s.t. for 10% roe recovery with an increase or decrease of \$45 per s.t. for each percentage point above or below 10%. Three processors purchased herring, one more than in 1982 (Table 4). A total of 63 fishermen in 57 gillnet vessels participated, a 16% decrease in fishermen and a 12% increase in vessels from 1982. Fishermen from the local area (primarily Hooper Bay, Chevak and Scammon Bay) accounted for about 92% of the effort and 88% of the total harvest, a higher percentage than in previous years. Increased success of local fishermen can be attributed to implementation of exclusive area registration, development of improved catch transfer techniques and use of more suitable commercial gear.

Overall exploitation rate of herring was estimated to be 15% of available biomass (Table 2). Age 5 and 6 herring comprised about 76% of the total harvest (Figure 4). Age 4 herring represented about 11% of the harvest.

Management of the 1983 commercial herring fishery was without major problems. No Fish and Wildlife Protection vessel or personnel were present in Cape Romanzof District during the season. However, fewer fishing violations were observed by ADF&G staff than during previous years.

#### Norton Sound

In contrast to other Bering Sea Districts, commercial herring fishing within Norton Sound continues to be opened on a specified date by regulation. During 1983 fishing did not begin until 18 May, although the fishery opened on 15

April. Fishing was terminated under Emergency Order on 22 May in Subdistricts 1 (St. Michael area) and 2 (Unalakleet area) and on 24 May in Subdistrict 3 (Cape Denbigh area). Remaining Subdistricts were allowed to remain open for exploratory fishing until closed by regulation 31 July. Total harvest for the District was 4,156 m.t., the highest ever taken (Table 2). About 87% of the harvest was taken in Subdistricts 2 and 3 (3,626 m.t.); the remainder was taken from Subdistricts 1, 5 and 6. Most of the herring harvest (96%) was sold for sac roe; 182 m.t. were sold for food or bait. Average sac roe recovery for the season was 8.6%. Value of harvested herring to the fishermen is estimated to have been \$1.5 million. Average price was \$400 per s.t. for 10% roe recovery, with an increase or decrease of \$40 per s.t. for each percentage point above or below 10%. Average price for food and bait herring was about \$60 per s.t. A total of 9 companies purchased herring from 273 fishermen, an increase of 22 and 13%, respectively, from 1982 (Table 4). Local fishermen (i.e. residents of Nome, Golovin, Koyuk, Shaktoolik, Unalakleet, St. Michael, Stebbins and other area villages) accounted for 49% of the effort and 41% of the harvest. This is the highest percentage of harvest ever taken by local fishermen and can be attributed to implementation of exclusive area registration and use of more suitable gear.

The commercial spawn-on-kelp harvest was regulated by Emergency Orders for the first time in 1983. This provided for a more controlled fishery and allowed harvests to be maintained within the 30 m.t. guideline level. Subdistricts 1-5 were opened 3 and 4 June for three and six hours each day, respectively. However, the entire harvest came from Subdistrict 1 (St. Michael). Inclement weather kept most Unalakleet fishermen from traveling to Subdistrict 1 for the 3 June opening. Subdistrict 6 (Golovin Bay) was not opened, since ADF&G surveys indicated that commercial quantities of spawn-on-kelp were not available in that area. A total of 25 m.t. of spawn-on-kelp was harvested (Table 3). An additional 1.5 m.t. was picked, but could not be sold because it was of unmarketable quality (e.g. silty, poor spawn coverage, etc.). A single company bought spawn-on-kelp from 35 fishermen. Value of the total harvest to fishermen was estimated to be \$38,000. Average price was \$0.70 per lb. The 1983 spawn-on-kelp harvest was about 14% greater than the mean harvest for 1976-1982 (mean harvest 22 m.t.).

Overall exploitation of herring was 16% of estimated available biomass (Table 2). Exploitation of herring within Subdistricts 1-3 was 18%; poor catch rates and low fishing effort within Subdistricts 4-7 kept exploitation rates at 4% even though these Subdistricts remained open until 31 July. Age 5 and 6 herring comprised 73% of the total harvest (Figure 4). Age 4 herring represented about 3% of the harvest.

Management of the 1983 commercial herring fishery was without major problems. Catch reporting was timely and accurate. Availability of five Fish and Wildlife Protection officers using two skiffs and a single engine aircraft enhanced efforts to enforce regulations. Approximately 40 citations were issued. Violations included fishing after closures, failure to possess valid licenses and violation of the exclusive area registration regulation.

#### OUTLOOK AND MANAGEMENT STRATEGY FOR 1984

Based upon continued large returns of the 1977 and 1978 year classes in 1983 (age 5 and 6 herring), the Department anticipates a harvestable surplus of

herring to be available in all Districts in 1984. However, since methods to reliably forecast actual returns are still being developed and estimates of recruitment are not available, harvest levels will be adjusted during the season according to observed herring biomass. If it is not possible to determine herring abundance using aerial survey methods, stock abundance will be assessed using information from test and commercial catches along with spawn deposition observations. Projections from post-season escapement estimates, using mean rates of natural mortality and growth for each age class, indicate that 1984 spawning biomass should be 128,700 m.t. (23% lower than 1983 biomass). However, increased recruitment of ages 3 through 5 year old herring could raise this figure.

#### Togiak District

As in 1981, different management strategies will be applied to early run, old herring (age 5 and above) and late run, young herring (age 4 and below) if these two population components arrive on the grounds at sufficiently different times. Magnitude and age composition of the run will be monitored during the spawning season by aerial surveys, test fishing, and commercial catch sampling. Emergency Order authority will be used to adjust the occurrence and length of fishing periods in relation to stock strength and spawning. No fishing will be allowed until older age herring reach a total daily observed biomass of 5,000 m.t. and spawning has started. This will allow a normal onshore migration, assure commencement of spawning, increase roe quality and content, and minimize waste. Harvest of old herring will be 10 to 20% of estimated biomass. Projected return, based upon 1983 escapement, is 96,700 m.t. Spawn-on-kelp harvests will also be allowed in areas judged to have sufficient spawn deposition and adequate kelp standing crop. A more conservative approach will be taken in managing harvests of young herring since these herring are newly recruited to the spawning population and will contribute to future harvests and provide future spawning stock. A minimum observed biomass of 20,000 m.t. of younger age herring must be present before fishing is allowed. A graduated harvest rate of up to 20% of the biomass of these younger age herring will be allowed at that time. Additional spawn-on-kelp openings may also be permitted during this period, if additional spawn deposition and remaining kelp standing stock are at levels which allow further harvest.

#### Security Cove District

Emergency Order authority will be used to adjust the occurrence and length of fishing periods to stock strength and spawning. No fishing will be allowed until total biomass reaches 800-1,000 m.t. and spawning has started. Attempts will be made to maintain an overall harvest of 10-20% of the available biomass. Projected return is 4,600 m.t. No major change in management strategy from 1983 is anticipated.

#### Goodnews Bay District

Management strategy for this District will be similar to that used for Security Cove: 1) Emergency Order regulation of season and periods, 2) Minimum total biomass of 800-1000 m.t. prior to the first opening, and 3) 10-20% harvest of available biomass. Projected return is 2,400 m.t.

#### Cape Romanzof District

Emergency Order authority will be used to adjust the occurrence and length of fishing periods so that greater management control, better stock assessment

and adequate spawning are assured. A threshold level of biomass cannot be used to determine the first opening, since turbid water conditions usually preclude aerial assessments. Test and commercial catch rates and spawn deposition will be the primary information on which fishery openings and fishing time will be based. Mean harvest for the period 1980-1983 was 636 m.t. Projected return, based upon limited data from 1983, is 4,100 m.t.

#### Norton Sound District

Major changes in management strategy are not anticipated. The season will open on 15 April and Subdistricts will close when 10-20% of the available herring biomass has been harvested. Projected return is 20,900 m.t. Frequent season closures may be used: 1) to monitor sac-roe recovery so that it can be maximized and 2) to maintain harvest levels within the guideline of 10-20% of available biomass. To allow the Department to adequately evaluate harvest data, all processors, buyers and tenders will be required to report landings twice each day. The spawn-on-kelp harvest will be managed to minimize wastage problems and spread effort levels more evenly. Spawn-on-kelp harvest openings may be of short duration to maintain the guideline harvest level if effort and efficiency continue to increase. Attempts will be made to survey more areas to determine if commercial quantities of kelp are available.



Table 1. Herring and herring spawn-on-kelp harvests in metric tons by U.S. commercial fishermen in the eastern Bering Sea, Alaska 1909-1983.

Year	Herring 1/					Total	Herring Spawn-on-Kelp		
	Unalaska Island	Bristol Bay	Security Cove/ Goodnews Bay	Cape Romanzof	Norton Sound		Bristol Bay	Norton Sound	Total
1909-1916	-	-	-	-	2/	2/	-	-	-
1916-1928	-	-	-	-	1,705.6	1,705.6 3/	-	-	-
1929	1,141.9	-	-	-	151.3	1,293.2	-	-	-
1930	1,738.2	-	-	-	399.7	2,137.9	-	-	-
1931	957.9	-	-	-	78.2	1,036.1	-	-	-
1932	2,726.9	-	-	-	480.0	3,206.9	-	-	-
1933	1,438.2	-	-	-	27.8	1,466.0	-	-	-
1934	1,390.9	-	-	-	3.5	1,394.4	-	-	-
1935	2,188.0	-	-	-	14.1	2,202.1	-	-	-
1936	1,251.1	-	-	-	-	1,251.1	-	-	-
1937	525.4	-	-	-	5.0	530.4	-	-	-
1938	465.5	-	-	-	9.0	474.5	-	-	-
1939	-	-	-	-	5.0	5.0	-	-	-
1940	-	-	-	-	12.7	12.7	-	-	-
1941	-	-	-	-	3.4	3.4	-	-	-
1942-1944	-	-	-	-	-	-	-	-	-
1945	68.0	-	-	-	-	68.0	-	-	-
1946	-	-	-	-	-	-	-	-	-
1947-1963	-	No Commercial Operations Reported				-	-	-	-
1964	-	-	-	-	18.1	18.1	-	-	-
1965	-	No Commercial Operations Reported				-	-	-	-
1966	-	-	-	-	10.8	10.8	-	-	-
1967	-	122.0	-	-	-	122.0	-	-	-
1968	-	82.4	-	-	-	82.4	24.8	-	24.8
1969	-	42.8	-	-	2.0	44.8	4.6	-	4.6
1970	-	25.0	-	-	7.3	32.3	17.6	-	17.6
1971	-	-	-	-	17.7	17.7	23.5	-	23.5
1972	-	73.7	-	-	15.3	89.0	29.1	-	29.1
1973	-	46.3	-	-	32.3	78.6	5.3	-	5.3
1974	-	111.7	-	-	2.4	114.1	57.0	-	57.0
1975	-	50.4	-	-	-	50.4	50.4	-	50.4
1976	-	-	-	-	7.7	7.7	134.1	-	134.1
1977	-	2,534.9	-	-	9.5	2,544.4	125.1	Trace	125.1
1978	-	7,030.4	259.0	-	13.6	7,303.0	149.6	3.4	153.0
1979	-	10,115.3	466.0	-	-	10,581.3	188.0	11.8	199.8
1980	-	17,774.0 4/	1,039.0	554.0	2,215.4	21,582.4	86.0	22.2	108.2
1981	639.0	11,374.3	1,660.2	653.2	3,964.5	18,291.2	171.9	37.2 5/	209.1
1982 5/	3,233.6	19,556.0	1,178.0	596.0	3,567.0	28,130.6	106.5	34.9	141.4
1983 5/	3,238.2 6/	24,486.0 7/	1,368.1	739.6	4,156.0	33,987.9	122.8	25.0 8/	147.8

1/ Prior to 1964 majority of herring catch was taken in summer and fall for food market; since 1964 majority of herring catch was taken in spring primarily for marketing of roe.

2/ Fishery occurred some years, but harvests unavailable.

3/ Total catch for all years.

4/ There was an additional estimated 5,200 m.t. of wastage.

5/ Preliminary data.

6/ Does not include 5 m.t. dumped (unmarketable or no market when harvested).

7/ Does not include 544 m.t. of wastage.

8/ Does not include 1.5 m.t. of wastage.

Table 2. Estimated biomass and commercial harvest of Pacific herring in eastern Bering Sea fishing Districts, Alaska, 1978-1983.

District	Biomass (m.t.)	Harvest (m.t.)	Roe %	Estimated Value (dollars)	% Biomass Harvested
<u>1983</u>					
Togiak	128,600	24,486 2/	8.8	10,517,300	19.1
Security Cove	5,800	973	9.4	422,300	16.8
Goodnews Bay	2,900	395	9.4	184,800	13.6
Cape Romanzof	5,000	740	9.0	367,100	14.8
Norton Sound	25,500	4,156	8.6	1,519,200	16.3
Total	167,800	30,750	8.8	13,010,700	18.3
<u>1982</u>					
Togiak	88,800	19,556	8.8	6,174,300	22.0
Security Cove	4,600	737	9.3	271,000	16.0
Goodnews Bay	2,400	441	9.5	187,900	18.4
Cape Romanzof	4,400	596	9.3	221,700	13.6
Norton Sound	15,800	3,567	8.8	1,046,200	22.6
Total	116,000	24,897	8.9	7,630,100	21.5
<u>1981</u>					
Togiak	143,900	11,374	9.1	3,988,000	7.9
Security Cove	7,500	1,064	8.1	347,070	14.2
Goodnews Bay	3,900	596	7.7	196,170	15.3
Cape Romanzof	4,400	653	8.0	211,260	15.0
Norton Sound	22,800	3,965	8.8	1,500,000	17.3
Total	182,500	17,652	8.9	6,242,500	9.7
<u>1980</u>					
Togiak	62,300	17,774 1/	9.2	3,205,000	28.5
Security Cove	1,100	632	8.2	151,000	57.4
Goodnews Bay	1,100	406	9.5	97,000	36.9
Cape Romanzof	2,700	554	9.8	132,000	20.5
Norton Sound	7,600	2,224	8.1	500,500	29.3
Total	74,800	21,590	8.8	4,085,500	28.9
<u>1979</u>					
Togiak	216,800	10,115	8.6	6,700,000	4.7
Security Cove	19,500	385	8.5	327,000	2.0
Goodnews Bay	6,700	82	4.7	38,500	1.2
Cape Romanzof	2,700	0	-	-	0.0
Norton Sound	7,000	1,172	7.0	628,200	16.7
Total	252,700	12,406	8.0	7,694,000	4.9
<u>1978</u>					
Togiak	172,600	7,033	8.2	2,300,000	4.1
Security Cove	1,200	259	-	-	21.6
Goodnews Bay	400	0	-	-	0.0
Cape Romanzof	2,700	0	-	-	0.0
Norton Sound	4,800	13	-	-	0.3
Totals	181,700	7,305	8.2	2,300,000	4.0

1/ Does not include an estimated 5,200 m.t. of waste.

2/ Does not include an estimated 544 m.t. of waste.

Table 3. Commercial harvest of Pacific herring spawn-on-rockweek kelp in eastern Bering Sea Fishing District, Alaska, 1978-1983.

District	Harvest (m.t.)	Number of Buyers	Number of Pickers	Estimated Value (Dollars)
<u>1983</u>				
Togiak	122.8	4	125	284,400
Norton Sound	25.0 3/	1	35	38,500
Total	<u>147.8</u>			<u>233,778</u>
<u>1982</u>				
Togiak	106.5	8	214	176,193
Norton Sound	34.9	1	74	57,585
Total	<u>141.4</u>			<u>233,778</u>
<u>1981</u>				
Togiak	171.9	7	108	250,000
Norton Sound	37.2 1/	4	22	45,000 2/
Total	<u>209.1</u>			<u>295,000</u>
<u>1980</u>				
Togiak	86.0	21	78	94,600
Norton Sound	22.2	1	20	73,000
Total	<u>108.2</u>			<u>167,600</u>
<u>1979</u>				
Togiak	188.0	16	100	248,160
Norton Sound	11.8	1	19	15,576
Total	<u>199.8</u>			<u>263,736</u>
<u>1978</u>				
Togiak	149.6	11	160	119,800
Norton Sound	3.4	1	0	2,723
Total	<u>153.0</u>			<u>122,523</u>

1/ Does not include 5 m.t. dumped.

2/ Only 14 m.t. marketed, rest lost during tender accident.

3/ Does not include 1.5 m.t. wastage.

Table 4. Numbers of buyers and fishermen participating in eastern Bering Sea Pacific herring fisheries, Alaska, 1978-1983.

District	Number of Buyers	Number of Fishermen 1/	
		Gillnet	Purse Seine
<u>1983</u>			
Togiak	23	250	150
Security Cove	6	94	*
Goodnews Bay	4	84	*
Cape Romanzof	3	63	*
Norton Sound	9	272	*
<u>1982</u>			
Togiak	33	200	135
Security Cove	3	107	*
Goodnews Bay	3	84	*
Cape Romanzof	2	75	*
Norton Sound	7	237	*
<u>1981</u>			
Togiak	28	106	83
Security Cove	7	113	*
Goodnews Bay	5	175	*
Cape Romanzof	4	111	*
Norton Sound	13	332	*
<u>1980</u>			
Togiak	27	363	140
Security Cove	8	175	*
Goodnews Bay	4	165	*
Cape Romanzof	2	69	*
Norton Sound	8	294	*
<u>1979</u>			
Togiak	33	350	175
Security Cove	2	61	*
Goodnews Bay	1	41	*
Cape Romanzof		No Fishery Conducted	
Norton Sound	7	50	17
<u>1978</u>			
Togiak	16	40	25
Security Cove	3	-	-
Norton Sound	1	11	-

\* Purse seine gear prohibited.

1/ Refers to number of vessels in Togiak District.

Table 5. Subsistence herring catch (in metric tons) and effort data by selected areas, eastern Bering Sea, Alaska, 1975-1983. 1/

Village	1975	1976	1977	1978	1979	1980	1981	1982	1983
Nelson Island									
Tununak	19.8	13.9	51.9	34.6	31.0	59.2	36.0	43.8	85.0
Unkumiut	30.0	8.5	2.8	10.4	7.5	3.1	9.0	0	- 3/
Toksook Bay	31.0	31.8	19.3	33.5	46.5	26.6	13.0	31.6	- 3/
Total	80.8	61.2	74.0	78.5	85.0	88.9	58.0	75.4	85.0
Yukon-Kuskokwim Delta									
Scammon Bay	-	0.6	-	0.6	5.4	2.8	6.9	3.5	2.3
Chevak	-	0.6	0.1	-	2.1	3.2	1.7	1.8	1.3
Hooper Bay	2.5	2.7	2.1	3.5	2.8	3.3	3.6	4.2	4.7
Kwigillingok	-	9.6	0.9	-	7.2	12.0	-	12.0 2/	- 3/
Total	2.5	13.5	3.1	4.1	17.5	21.3	12.2	21.5	8.3
Areas Combined									
Total Catch	83.3	74.7	77.1	82.6	102.5	110.2	70.2	96.9	93.3
Number of Fish- ing Families	143	91	129	112	160	150	138	129	80

1/ Other areas with small catches have been surveyed irregularly (1975-1978 estimated total coastal yearly subsistence catch averaged 100 m.t.).

2/ Estimate based on post season observations.

3/ Not surveyed during 1983.

Table 6. Relative abundance index (RAI) and estimated biomass of eastern Bering Sea herring, Alaska, 1978-1983.

District	1978	1979	1980	1981	1982	1983
Relative Abundance Index (RAI) 1/						
Togiak	43,050	137,630	15,249	79,352	49,998	88,806
Security Cove	246	2,912	435	2,228	486 3/	1,602
Goodnews Bay	241	3,729	3/	1,593	3/	815
Nelson Island	1,079	3/	3/	1,072	3/	4,515
Cape Romanzof	539	3/	3/	4/	4/	5/
Norton Sound	1,277	1,860	2,242	6,516	4,548	6,796
<b>Total</b>	<b>46,432</b>	<b>146,131+</b>	<b>17,926+</b>	<b>90,761+</b>	<b>55,032+</b>	<b>102,534</b>
Estimated Biomass in m.t. 2/						
Togiak	172,600	216,800	62,300	143,900	88,800	128,600
Security Cove	1,200	19,500	1,100	7,500	4,600 3/	5,800
Goodnews Bay	400	6,700 3/	1,100 3/	3,900	2,400 3/	2,900
Nelson Island	5,400	5,400 3/	5,400 3/	3,600	3,600 3/	13,500
Cape Romanzof	2,700	2,700 3/	2,700 3/	4,400 4/	4,400 4/	5,000
Norton Sound	4,800	7,000	7,600	20,800	15,800	25,500
<b>Total</b>	<b>187,100</b>	<b>258,100</b>	<b>80,200</b>	<b>186,100</b>	<b>119,600</b>	<b>181,300</b>

1/ Number of fish schools equivalent to 50 m surface area, unadjusted for presence of non-herring pelagic species.

2/ Adjusted for presence of non-herring pelagic species. Estimates for 1978 and 1979 represent low end of estimate ranges from Barton and Steinhoff (1980), 1980 estimates from Kingsbury (1980).

3/ Incomplete data due to inclement weather and/or turbid waters, biomass estimates are questionable and are based on 1978, 1979 or 1981 data.

4/ No aerial surveys made, 1981 and 1983 estimates based upon assumption that commercial harvest represented 15 percent of total biomass; 1981 estimate used for 1982.

5/ No satisfactory aerial survey made, 1983 estimate based on assumption of slight increase in biomass over previous year.

Table 7. Conversion estimates (metric tons of Pacific herring per 50 m school surface area) obtained from test purse seine fishing, Togiak District, Alaska, 1978-1983.

Year	Water Depth (m)	Biomass per RAI unit (m.t./50 m)	Remarks
1981	2	1.1	Catch Landed
1980	3	1.2	Catch Landed
1983	3	1.0	Catch Estimated in Net
1983	3	1.8	Catch Estimated in Net
1983	4	1.1	Catch Estimated in Net
1983	4	1.7	Catch Estimated in Net
1983	4	2.2	Catch Estimated in Net
1980	5	1.1	Catch Landed
1980	5	1.2	Catch Estimated in Net
1979	6	2.4	Catch Landed
1980	6	3.0	Catch Estimated in Net
1980	6	2.6	Catch Estimated in Net
1981	6	1.7	Catch Landed
1980	8	1.6	Catch Estimated in Net
1981	8	4.0	Catch Landed
1982	8	1.9	Catch Estimated in Net
1983	8	1.5	Catch Estimated in Net
1978	?	6.7	Catch Estimated in Net
1978	?	11.0	Catch Estimated in Net

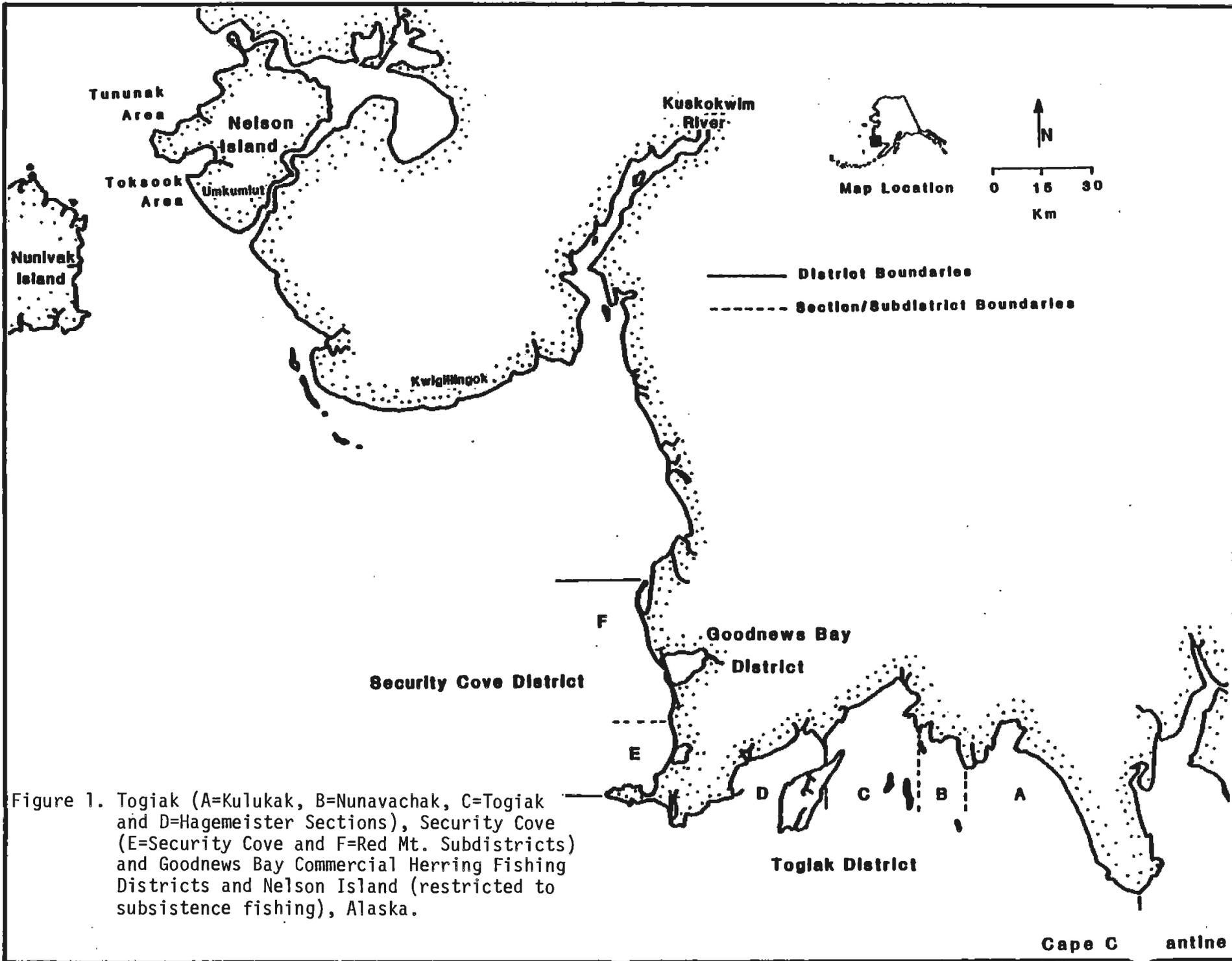


Figure 1. Togiak (A=Kulukak, B=Nunavachak, C=Togiak and D=Hagemeister Sections), Security Cove (E=Security Cove and F=Red Mt. Subdistricts) and Goodnews Bay Commercial Herring Fishing Districts and Nelson Island (restricted to subsistence fishing), Alaska.

Table 7. Conversion estimates (metric tons of Pacific herring per 50 m<sup>2</sup> school surface area) obtained from test purse seine fishing, Togiak District, Alaska, 1978-1982.

Year	Water Depth (m)	Biomass per RAI unit	(m.t./50 m )
1981	2	1.1	Catch Landed
1980	3	1.2	Catch Landed
1980	5	1.1	Catch Landed
1980	5	1.2	Catch Estimated in Net
1979	6	2.4	Catch Landed
1980	6	3.0	Catch Estimated in Net
1980	6	2.6	Catch Estimated in Net
1981	6	1.7	Catch Landed
1980	8	1.6	Catch Estimated in Net
1981	8	4.0	Catch Landed
1982	8	1.9	Catch Estimated in Net
1978	?	6.7	Catch Estimated in Net
1978	?	11.0	Catch Estimated in Net

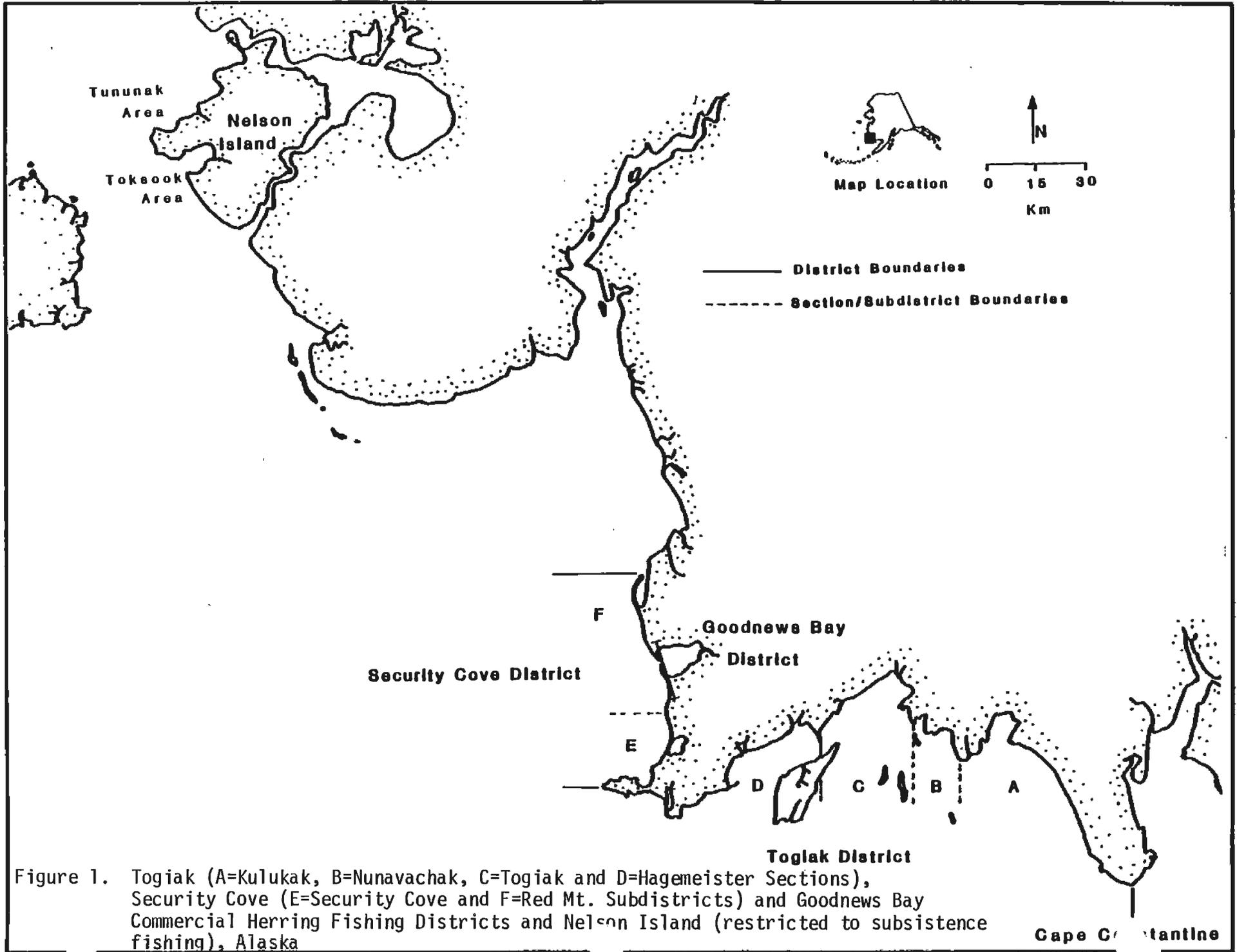


Figure 1. Togiak (A=Kulukak, B=Nunavachak, C=Togiak and D=Hagemeister Sections), Security Cove (E=Security Cove and F=Red Mt. Subdistricts) and Goodnews Bay Commercial Herring Fishing Districts and Nelson Island (restricted to subsistence fishing), Alaska

Cape Constantine

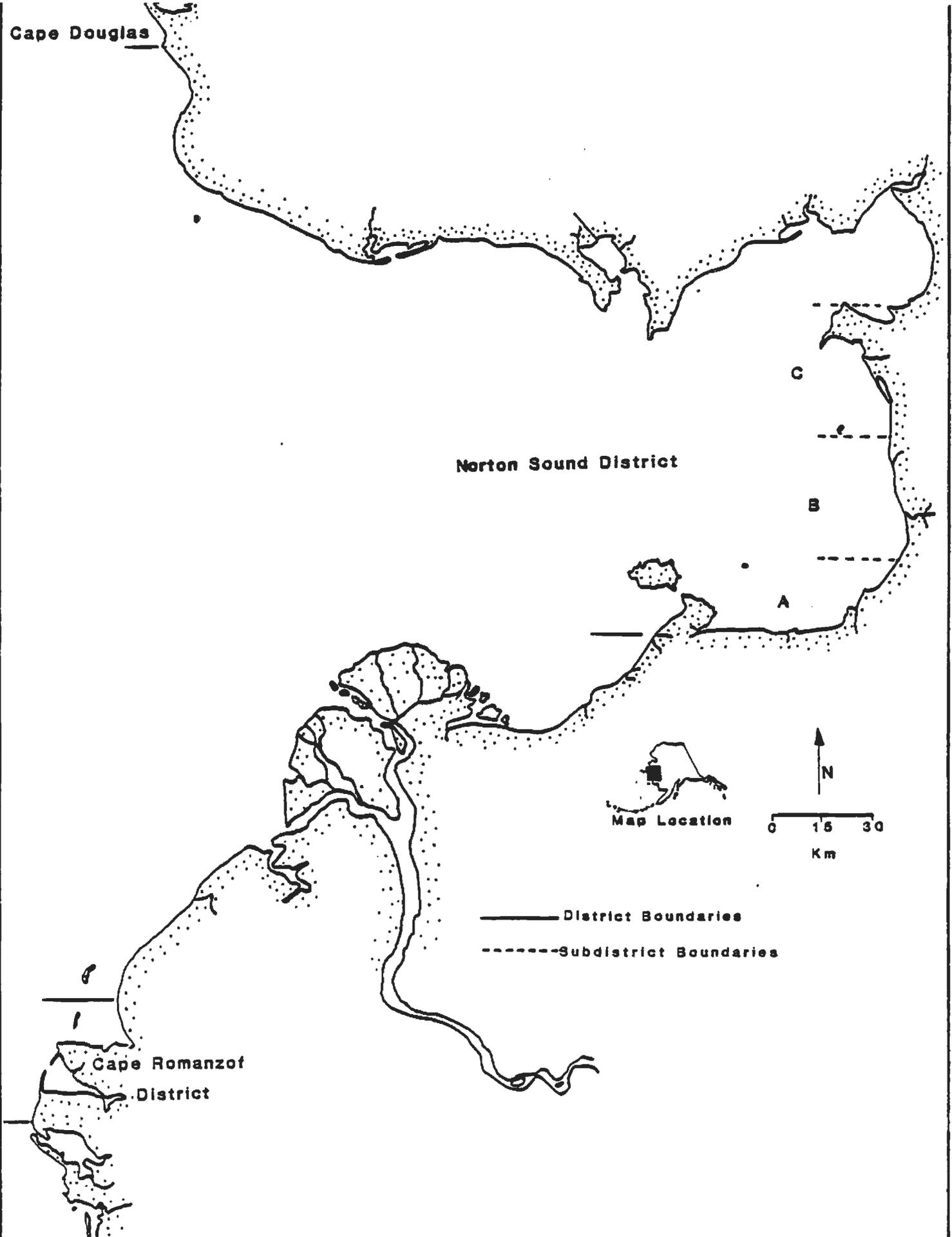


Figure 2. Cape Romanzof and Norton Sound (A=St. Michael, B=Unalakleet and C=Cape Denbigh Subdistricts) Commercial Herring Fishing Districts, Alaska

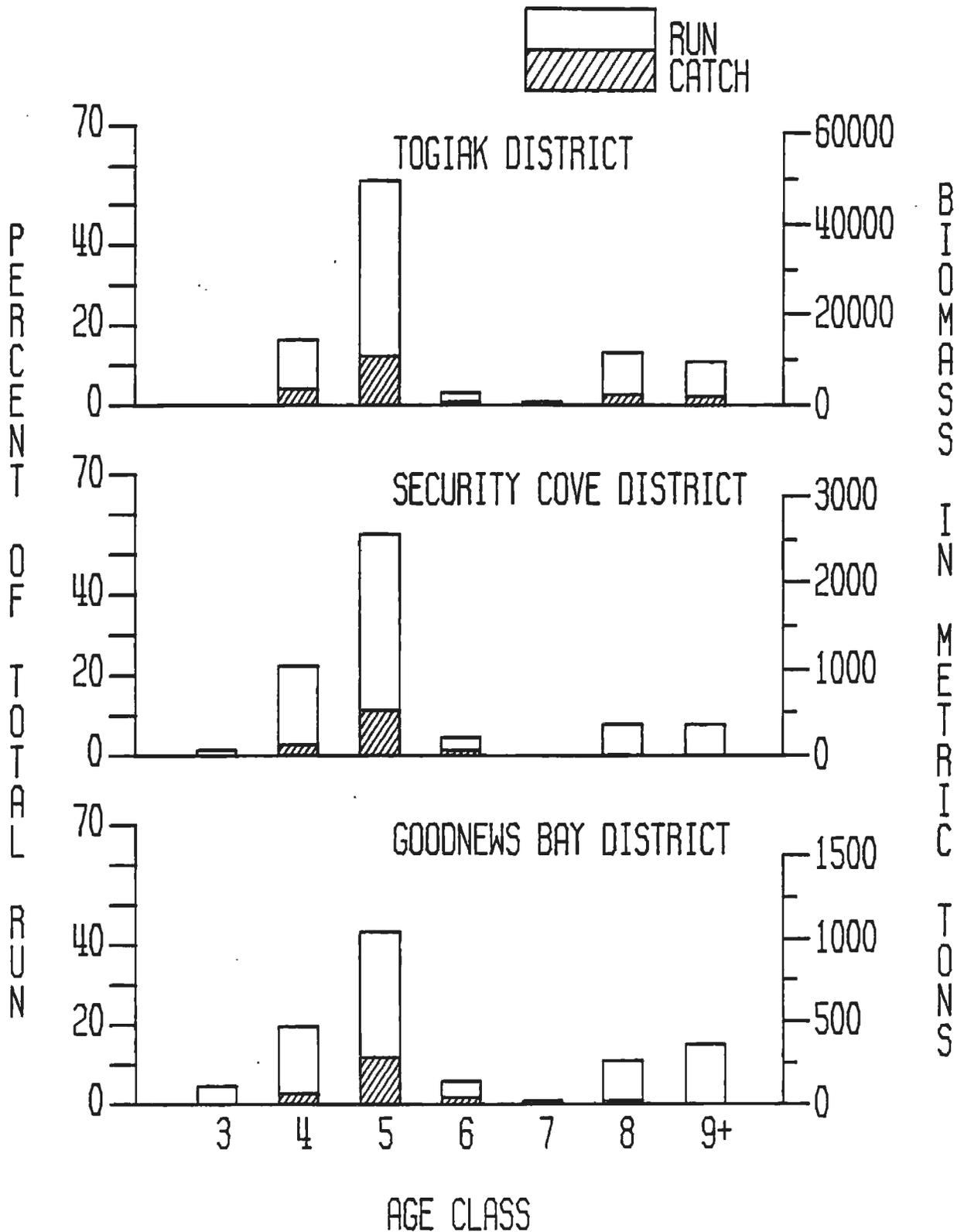


Figure 3. Age composition of Pacific herring in spawning populations and commercial harvests in Togiak, Security Cove and Goodnews Bay Commercial Herring Fishing Districts, Alaska 1982.

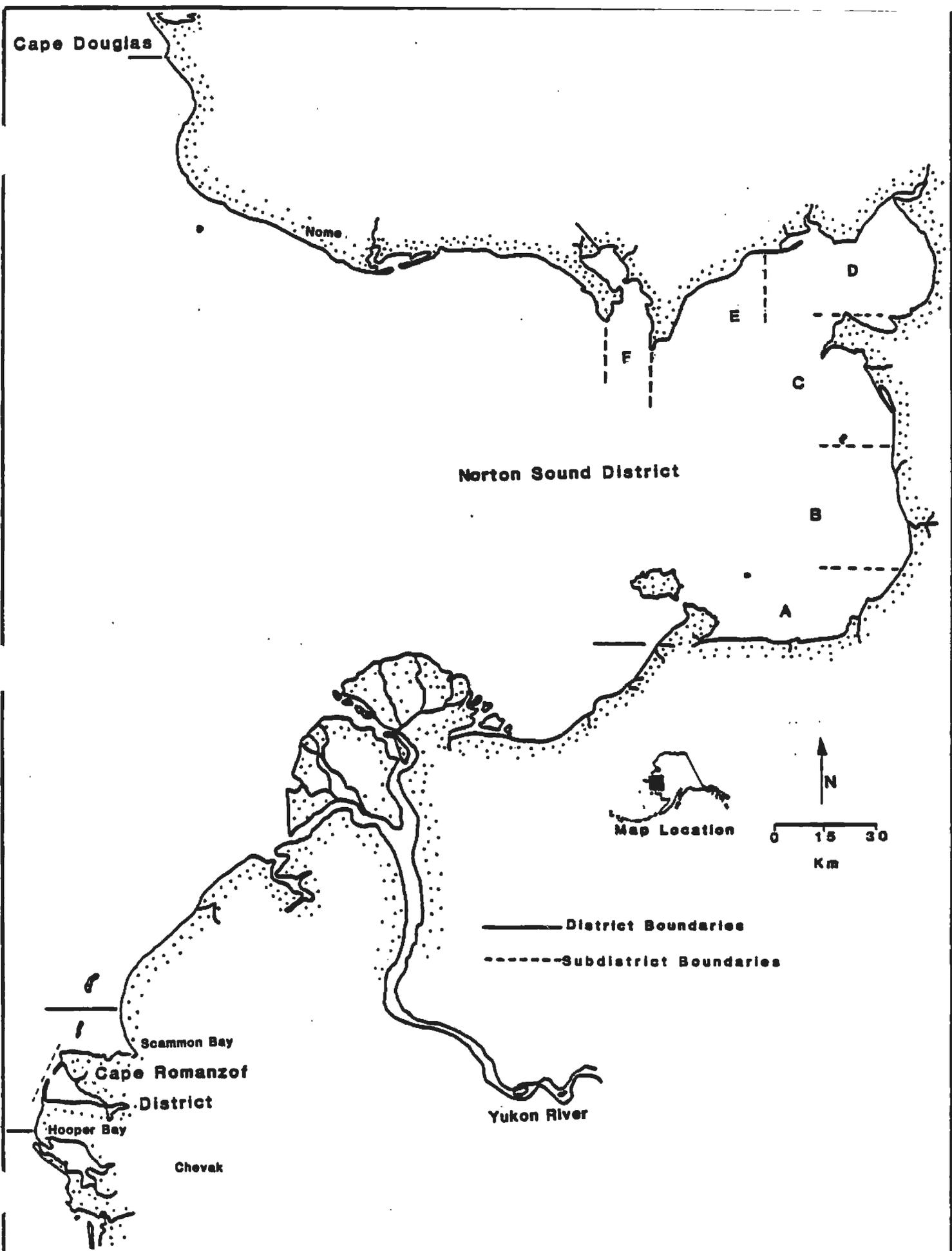


Figure 2. Cape Romanzof and Norton Sound (A=St. Michael, B=Unalakleet, C=Cape Denbigh, D=Norton Bay, E=Elim and F=Golovin Bay Subdistricts) Commercial Herring Fishing Districts, Alaska.

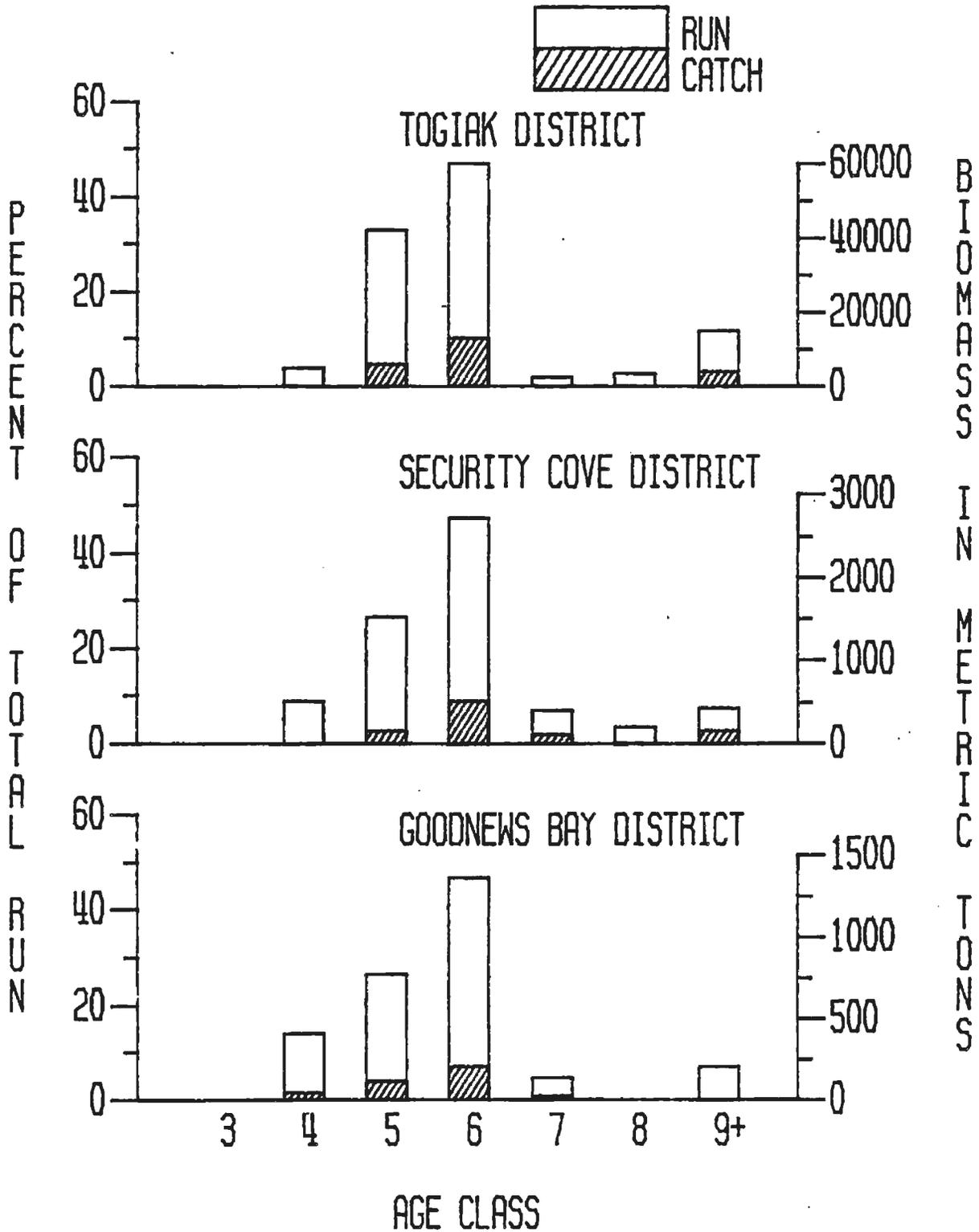


Figure 3. Age composition of Pacific herring in spawning populations and commercial harvests in Togiak, Security Cove and Goodnews Bay commercial herring fishing districts, Alaska, 1983.

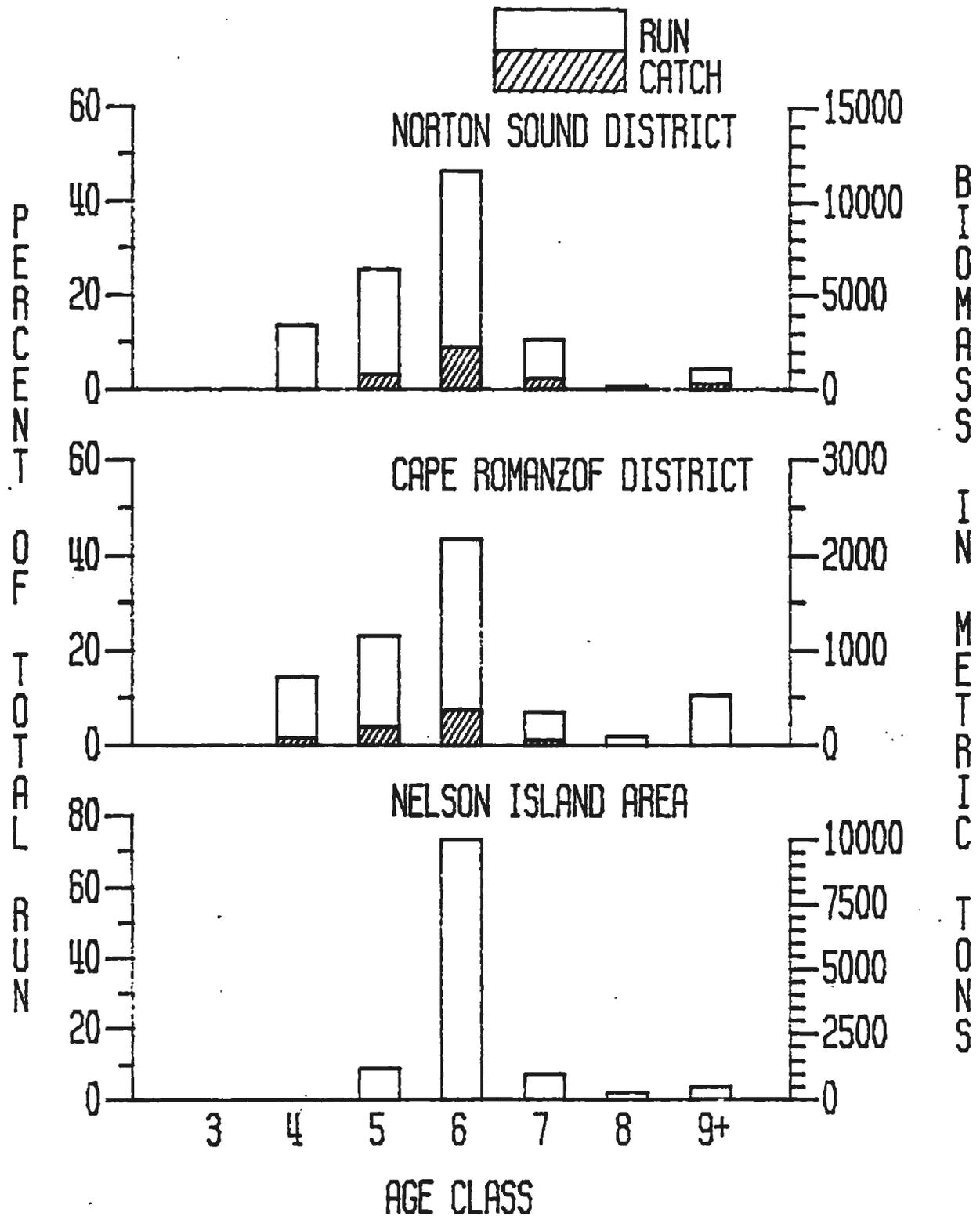


Figure 4. Age composition of Pacific herring in spawning populations and commercial harvests in Cape Romanzof and Norton Sound commercial herring fishing districts and the Nelson-Nunivak Island area, Alaska, 1983.



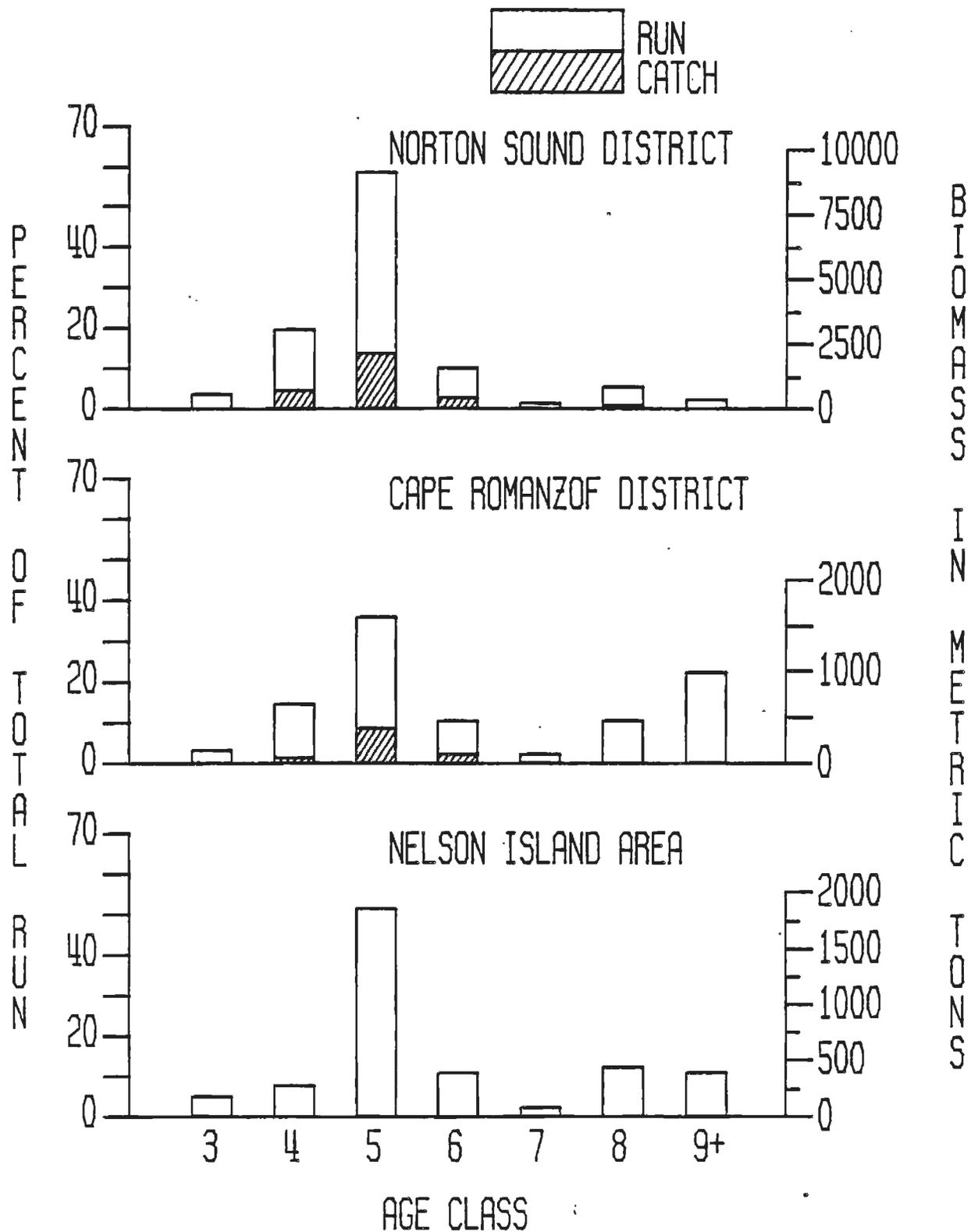


Figure 4. Age composition of Pacific herring in spawning populations and commercial harvests in Cape Romanzof and Norton Sound Commercial Herring Fishing Districts and the Nelson Island area, Alaska, 1982.

