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ALASKA PENINSULA AND ALEUTIAN ISLANDS MANAGEMENT  
AREAS SAC ROE HERRING REPORT, 1990

By

James N. McCullough

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## ABSTRACT

By regulation the 1990 herring sac roe season extends from April 15 through July 15 in Alaska Peninsula and Aleutian Islands waters. However, the opening of the Unimak, Akutan, and Unalaska Districts and that portion of the Umnak District located east of Samalga Pass occurred from April 15 through June 15; the Port Moller District was opened from May 30 through July 15; and the Sand Point, Pavlof, King Cove, Adak, Amak, and Port Heiden Districts were opened from April 15 through July 15.

In 1990, commercial catches occurred in North Peninsula waters from June 4 through June 19 and in South Peninsula waters from May 14 to June 14. No sac roe harvest occurred in the Aleutian Islands Management Area. The North Peninsula catch was 272.8 tons and the South Peninsula catch was 312.2 tons, producing a total Alaska Peninsula catch of 585.1 tons. The 1990 catch was 38.9% below the recent 5 year average of 957.6 tons. Nine purse seine vessels made 54 deliveries to two companies that purchased herring. The average roe recovery was 7.53% for the North Peninsula, 9.24% for the South Peninsula, and overall was 8.45%. The average price per ton was \$600 for 10% roe recovery and  $\pm$  \$60 for each percentage point above or below 10%, giving an ex-vessel value of about \$296,646 for the Alaska Peninsula. A total biomass estimate for the North Peninsula was not possible due to unfavorable survey conditions; at least 588 tons were observed in the Port Moller District. A total biomass estimate for the South Peninsula was not possible due to budget constraints; in areas where good surveys occurred the biomass increased from prior years.

KEY WORDS: Alaska Peninsula, Aleutian Islands, herring, catch, age, length, weight, sex

## INTRODUCTION

The Alaska Peninsula and Aleutian Islands Management Areas (Figure 1) are described as Management Area "M" and are divided into three subareas; (1) the South Peninsula, consisting of Pacific Ocean coastal waters extending west of Kupreanof Point to Scotch Cap; (2) the Aleutian Islands, consisting of Pacific Ocean and Bering Sea waters extending west of Unimak Pass to the international dateline; and (3) the North Peninsula, consisting of Bering Sea waters extending west from Cape Menshikof to Cape Sarichef (Figures 2-6).

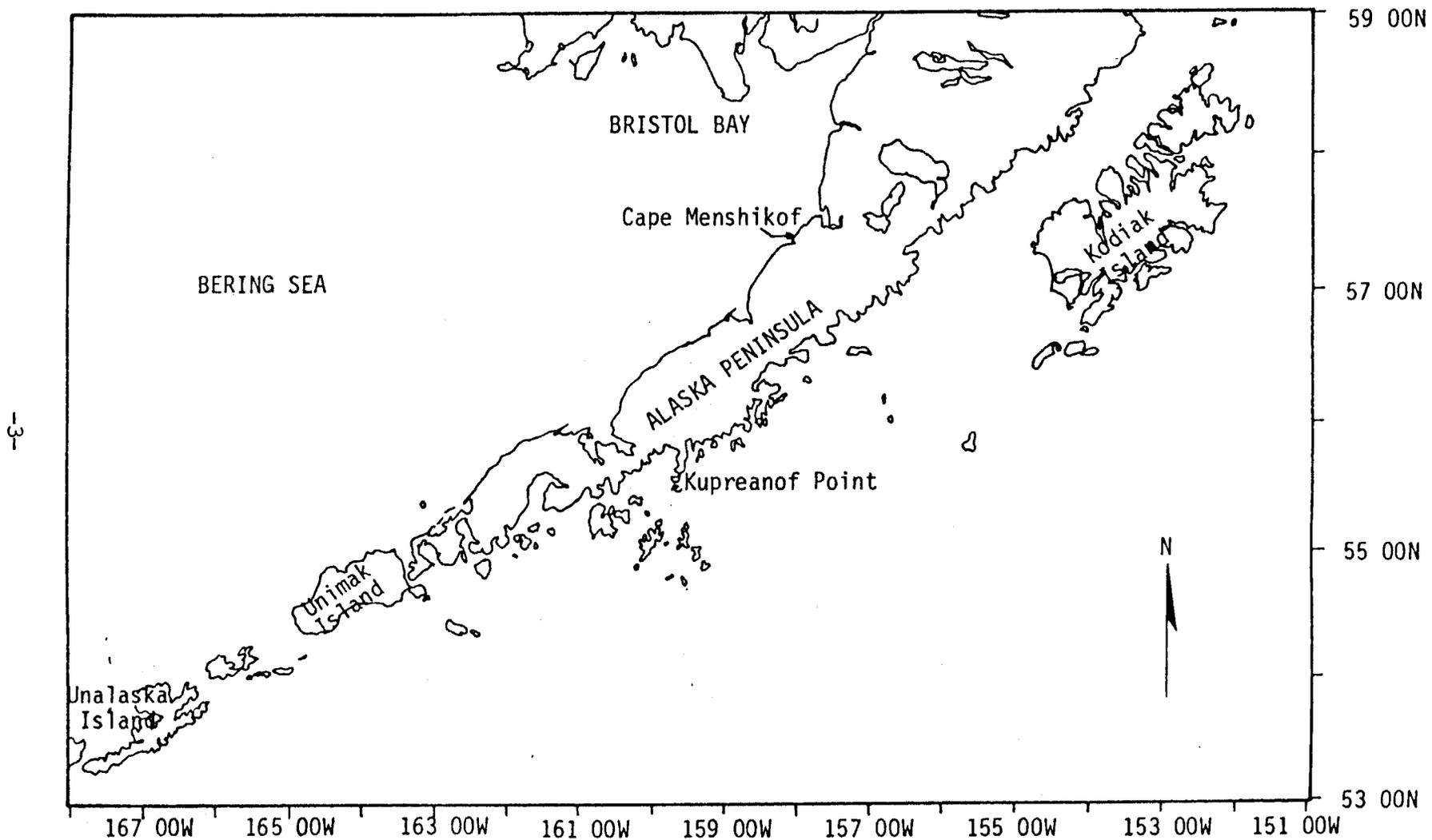
The North Peninsula is comprised of three districts and 23 statistical areas. The South Peninsula is comprised of four districts and 44 statistical areas, while the Aleutian Islands is comprised of four districts and 40 statistical areas. Commercial herring fishing normally begins about the last week of May in North Peninsula waters, about mid-May in South Peninsula waters, while the Aleutian Islands have had no reported sac roe harvest since at least 1979.

The majority of fishing effort in the North Peninsula occurs in the Bear River, Port Moller Bay, and Herendeen Bay Sections, while most of the effort in South Peninsula waters occurs in the Shumagin Islands and Stepovak, Pavlof, and Canoe Bays.

From 1981 through 1990, ADF&G has deployed field crews in the Alaska Peninsula for the purpose of collecting data and to monitor the fishery. Crews have been successful in collecting samples and documenting spawning areas and substrate. Aerial surveys have been used with limited success to monitor the fishery, primarily due to the large area involved, weather, water conditions, and the sporadic and currently unpredictable appearance of the herring. In the nine years that the Alaska Department of Fish and Game (ADF&G) has been conducting aerial surveys in the Alaska Peninsula, only surveys flown in 1989 are thought to have provided an accurate assessment of the total spawning biomass in the Port Moller area (personal communication, L. Schwarz, ADF&G, Division of Commercial Fisheries, 211 Mission Road, Kodiak, Alaska 99615).

Aerial surveys of the Port Moller area by Alaska Department of Fish and Game (ADF&G) personnel in 1976 reported numerous schools of herring in Herendeen Bay (Warner and Shafford 1979). The known presence of commercial quantities of sac roe herring in North Peninsula waters occurred in 1982 when 514 tons were harvested (Table 1). From 1985-89, an average of 631.1 tons have been harvested each year in the sac roe fishery. Most (54.3%) of the catch was taken from Herendeen and Moller Bays, while most of the balance of the catch (42.2%) was taken off the Bering Sea coast between Entrance Point and the Seal Islands (Table 2). Prior to 1982, fishing vessels destined to or returning from the Togiak herring fishery frequently looked for herring in the Port Moller area but they made no deliveries. Since 1982, a commercial sac roe fishery has developed in both Moller and Herendeen Bays and the Bering Sea coast eastward from Port Moller (Table 2). The run timing of the North Peninsula stocks appear to be later than the Togiak stocks.

The South Peninsula herring sac roe fishery continues to develop since it began in 1979, with about 29% of the 1990 catch harvested from areas that had only one prior landing reported in 1989 (Tables 1,3). Significant landings occurred in 1980 (454 tons), and peaked in 1981 (716 tons). The Board of Fisheries closed



**Figure 1. Map of the Alaska Peninsula and Eastern Aleutian Islands Management Areas, the study area on the Pacific Ocean portion of the map is from Kupreanof Point to Unalaska Island and on the Bering Sea from Unalaska Island to Cape Menshikof.**

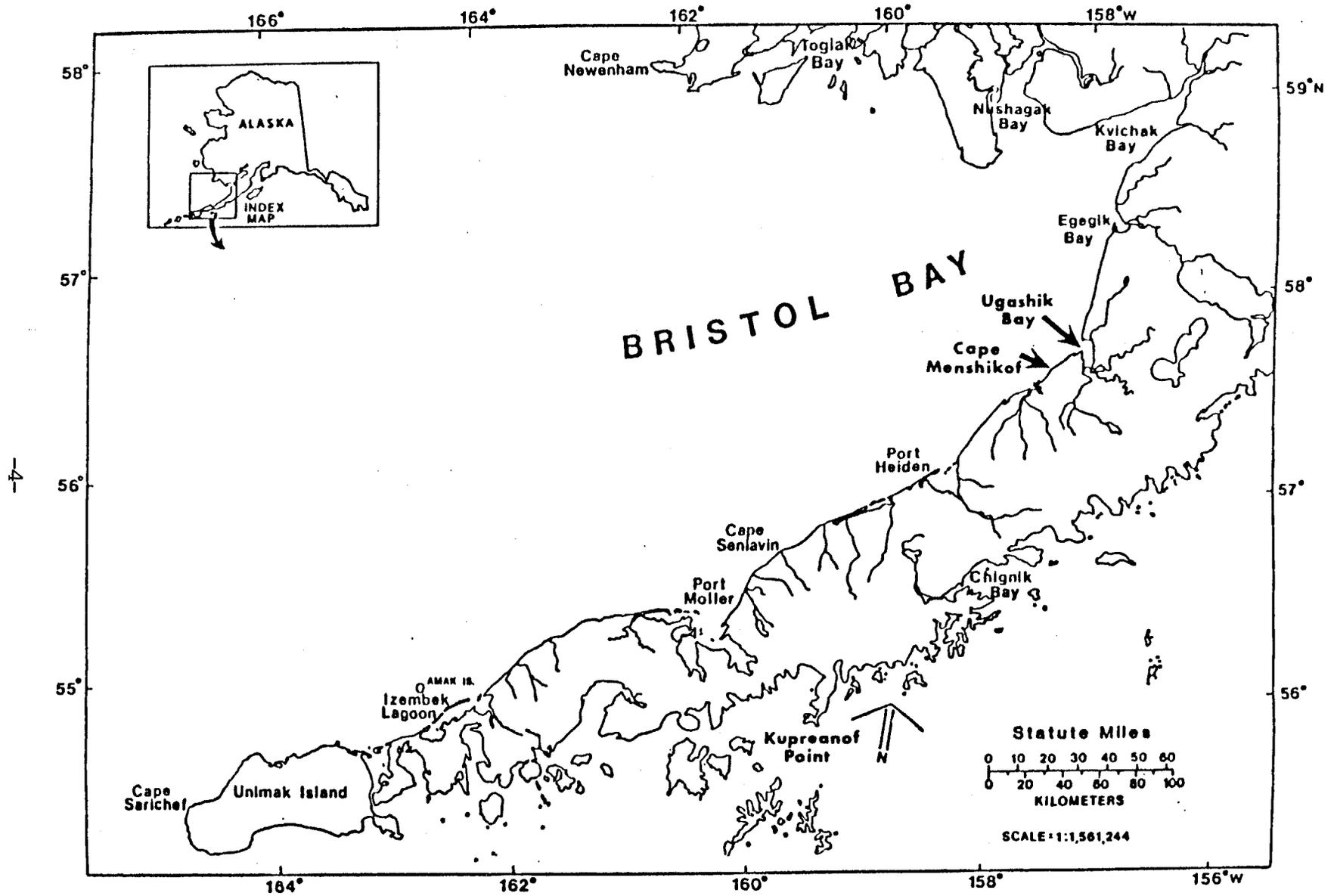


Figure 2. Map of the Alaska Peninsula Area from Kvichak Bay to Unimak Island.

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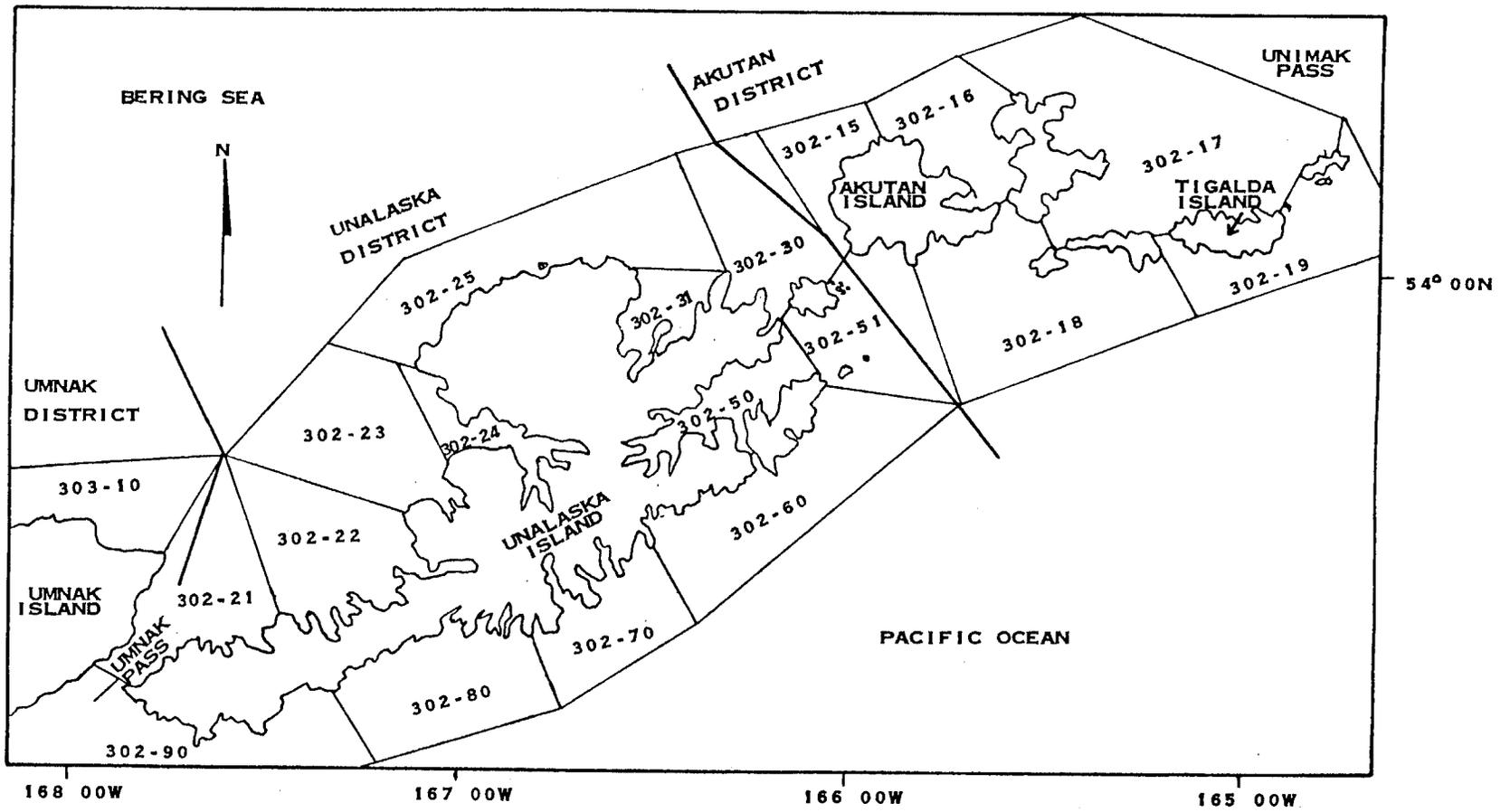


Figure 3. Map of the Aleutian Islands Area from Unmak Pass to Unimak Pass with the statistical herring fishing areas shown.

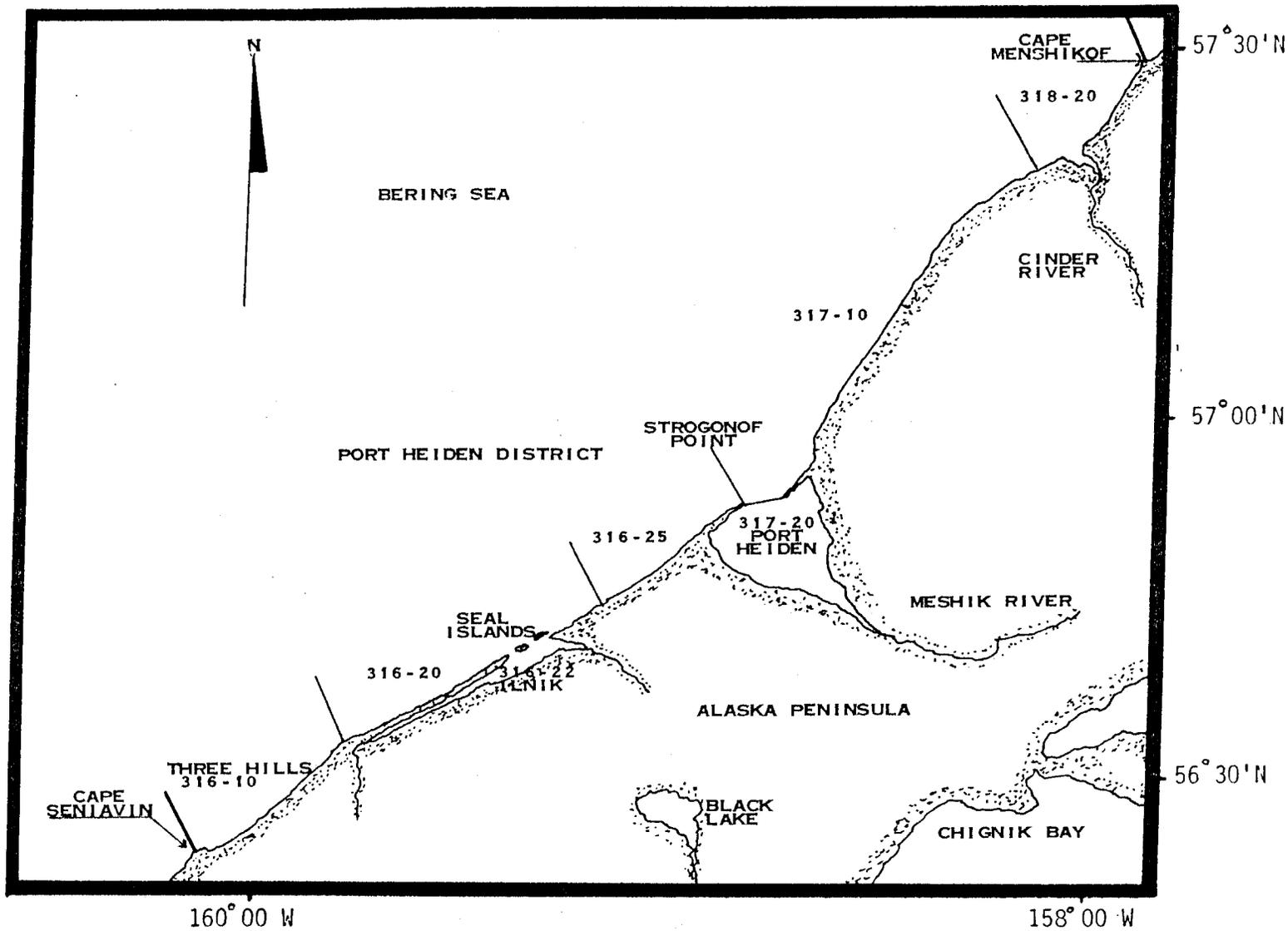


Figure 4. Map of the Alaska Peninsula Area from Cape Seniavin to Cape Menshikof with the statistical herring fishing areas shown.

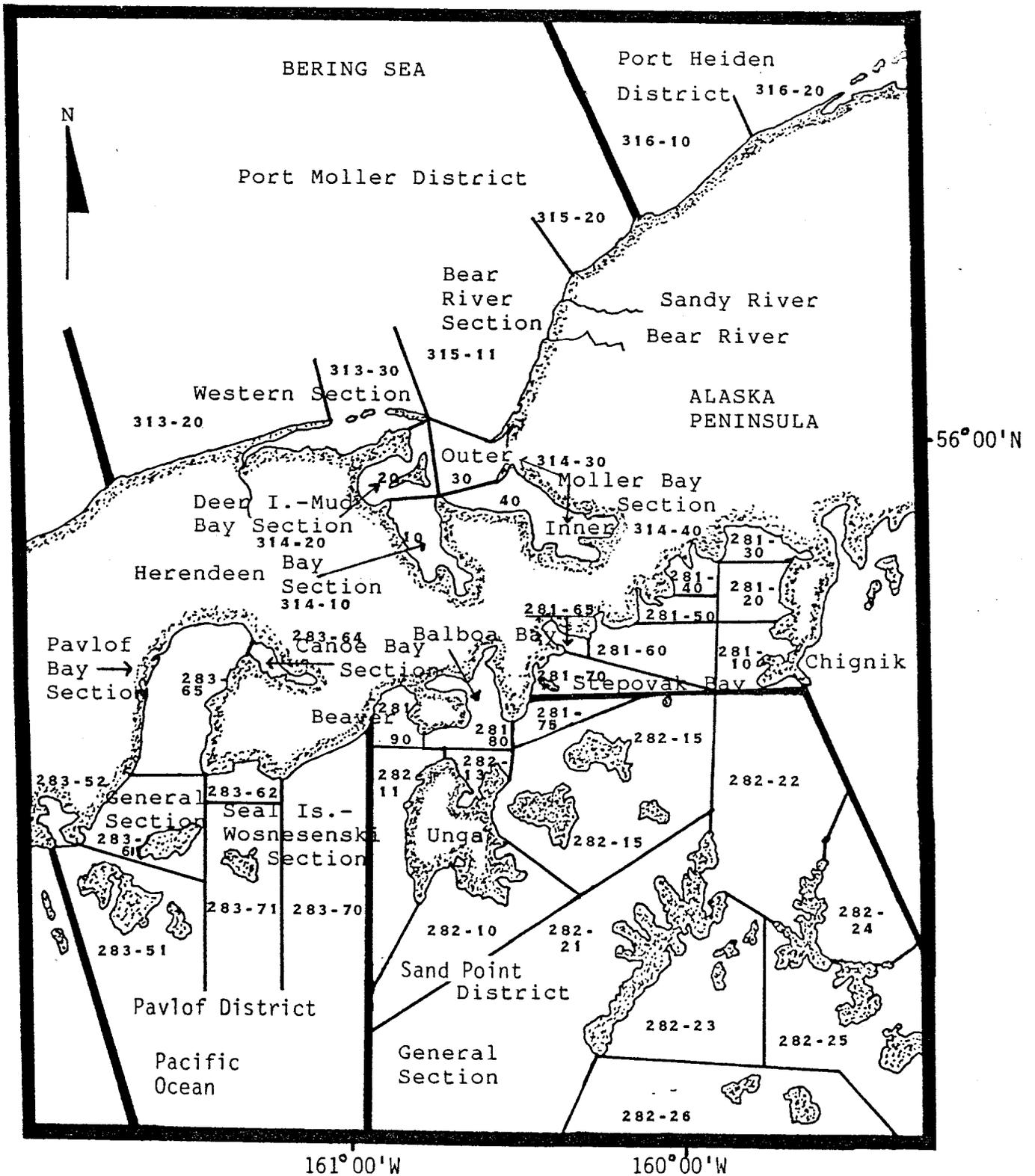


Figure 5. Map of the Alaska Peninsula Area from Bear Bay to Kupreanof Point with the statistical herring fishing areas shown.

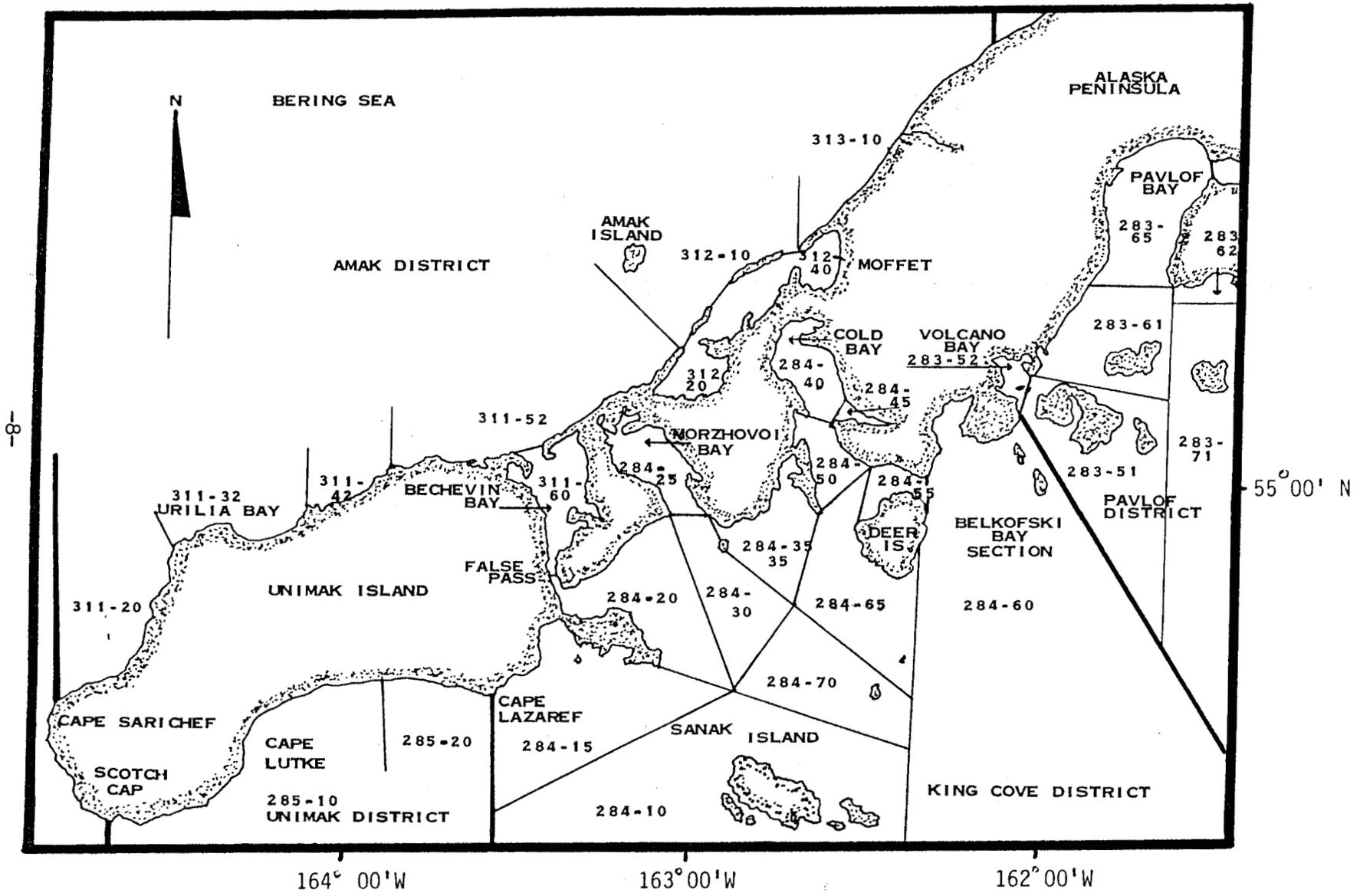


Figure 6. Map of the Alaska Peninsula Area from Cape Sarichef to Pavlof Bay with the statistical herring fishing areas shown.

Table 1. Alaska Peninsula Management Area herring sac roe catch by time period and area, 1979-90 (short tons).

Year	South Peninsula	South Peninsula Time Period	North Peninsula	North Peninsula Time Period	Total
1979	10.1	July 4-July 4	0.0		10.1
1980	453.0	May 18-July 14	0.0		453.0
1981	787.0	May 9-June 23	0.0		787.0
1982	176.2	May 31-June 14	513.5	May 31-June 12	689.7
1983	0.0		637.5	May 9-May 29	637.5
1984	210.4	May 13-June 1	431.2	May 24-June 8	641.6
1985	345.0	June 1-June 11	716.0	May 24-June 4	1,061.0
1986	281.5	June 7-June 14	888.9	May 18-May 30	1,170.4
1987	319.0	June 8-June 19	512.4	May 9-June 5	831.4
1988	376.8	May 31-June 20	293.7	May 17-June 15	670.5
1989	310.0	May 13-June 19	744.7	May 28-June 23	1,054.7
Average	326.5	a/	631.1		957.6
1990	312.2	May 14-June 14	272.8	June 4-June 19	585.0

a/ Five year 1985-89 average

Table 2. North Peninsula commercial herring sac roe catch by geographic area, 1982-90 (short tons).

Year	Deer Island	Herendeen Bay	Moller Bay	Bear River Bering Sea Coast	Total
1982	0.0	287.5	180.0	46.0	513.5
1983	0.0	520.5	36.0	81.0	637.5
1984	0.0	181.0	250.2	0.0	431.2
1985	73.0	100.0	256.0	287.0	716.0
1986	41.5	112.5	261.4	473.5	888.9
1987	0.0	160.8 a/	344.3	7.3	512.4
1988	0.0	8.2	285.5	0.0	293.7
1989	0.0	67.0	116.3	561.4	744.7
1985-89 Average	22.9	89.7	252.7	265.8	631.1
1990	0.0	155.8	117.1	0.0	272.8

a/ at least 11 tons were caught in the Deer Island-Mud Bay Section.

Table 3. South Peninsula commercial herring sac roe catch by geographic area, 1980-90 (short tons).

Year	Stepovak Bay a/	Balboa Bay	Pavlof Bay	Canoe Bay	Volcano-Dolgoi	Belkofski Bay	Lenard Harbor	Dolgoi Harbor	Shumagin Islands	Total
1980	195	132	114	12						453.0
1981	122	36	225	206	65	23	110			787.0
1982		5.0		171.2						176.2
1983 b/										0.0
1984	30.0	25.0		155.4						210.4
1985	11.0		95.0	239.0						345.0
1986 c/			61.0	140.5	13.0	8.0	59.0			281.5
1987 c/			92.0	118.0		38.0	59.0	12.0		319.0
1988	d/ 0.3	11.0	69.0	236.5	17.0	12.0	31.0			376.5
1989	39.0	17.0	53.0	148.0			9.0	5.0	39.0	310.0
1985-89 Average	16.7	14.0	74.0	176.4	15.0	19.3	39.5	8.5	39.0	252.3
1990	71.7	20.8		120.4		3.2	5.9		90.4	312.2

a/ The 1984-88 catches came from Ramsey Bay, the 1989 catch came from Granville Bay.

b/ In 1983 the South Peninsula sac roe fishery was closed, all herring catches were allocated to a food and bait fishery that did not develop.

c/ Stepovak Bay (Kupreanof Point to Swedania Point) was closed from 1986-87 due to the herring biomass being below the threshold required for a commercial fishery.

d/ Seven tons of green herring were dumped on May 7, and an additional two tons were dumped on May 11.

the South Peninsula sac roe fishery in 1983, allocating all catches to a food and bait fishery that failed to develop. Since 1984, the Board of Fisheries allocated the catch between the sac roe fishery (75% of the allowable harvest) and the food and bait fishery (25% of the allowable harvest). To date there has been no food and bait deliveries. During years in which commercial harvests occurred, landings were reported from 18 geographically separated locations, of these locations only Canoe Bay produced an annual harvest (Table 3).

The objectives of this report were: (1) to present the numbers of herring in the commercial catch for each statistical day in the Alaska Peninsula and Aleutian Islands Management Areas during 1990; (2) to estimate the age, and sex composition of harvests; (3) to estimate the mean length and weight of gonads and herring harvested in commercial fisheries; and (4) to estimate the biomass of herring within each area. This information will provide a data base for developing brood tables, forecasting runs, and evaluating management goals. This report is intended as a reference document; interpretation and discussion of the data are therefore limited.

## METHODS

Commercial catch data were compiled by the Division of Commercial Fisheries of the Alaska Department of Fish and Game (ADF&G). These data were based on computer tabulations originating from individual sale receipts (fish tickets) given to fishermen at the time of delivery. Fish tickets and the computer generated summaries were edited by ADF&G Alaska Peninsula staff for errors and omissions. Because extended fish ticket editing is usually required to finalize the data for any given year, later reports may contain minor differences in the catch information listed in this report.

Catches were sampled throughout the season from harvests in the fishing areas. Catch sampling occurred at Port Moller, Cold Bay, and Sand Point. Herring were randomly sampled, usually collected from the holds of tender vessels to minimize scale loss. The harvest area of each tender sampled was determined through vessel operator interviews and fish ticket information.

Tender operators purchased fish from catcher vessels operating in combine with them. Since all catch sampling occurred before sorting within the cannery, there was no preselection of herring other than from delivery areas; although not tested, each sample was assumed to be representative of the harvest within a sample area. While this insured that samples were randomly selected from each tender sampled, the samples may not be characteristic of the population structure because the distribution of the population is unknown in the fishery.

Age compositions were computed for the catch for each area sampled. Age was determined by examining scales (Warner and Shafford 1970). Scales were taken from the preferred area which was located on the left side of the herring three rows below the lateral line and three scales posterior to the center of the operculum plate (Anonymous 1986). One scale was taken from each herring. Ages were recorded in actual fish age in years. The accuracy of age determination was not tested.

Standard length measurements were taken from the anterior most portion of the fish, including the lower jaw with the mouth closed, to the end of the vertebra (hypural plate) using a meter stick with 1 mm gradations and reading the measuring device to within 1 mm. Accuracy of a length measurement was within  $\pm 5$  mm. Mean lengths were calculated from an unweighted composite of the data collected from each area sampled.

Weight measurements of fish were taken using a triple beam balance with 1.0 g gradations and reading the scale device to within 1.0 g. Accuracy of a weight measurement was within  $\pm 1.0$  g. Mean weights were calculated from an unweighted composite of the data collected from each area sampled.

Sex compositions and sexual maturity were computed for each area sampled. Sex and sexual maturity was determined by either squeezing the fish or by internal observation of the gonads. Sexual maturity of herring were classified as: (1) virgin herring, (2) virgin herring with small sexual organs, (3) gonads occupying about half the ventral cavity, (4) gonads almost as long as body cavity, (5) gonads fill body cavity, (6) ripe gonads, (7) spent herring, and (8) recovering spent herring.

Biomass estimates of herring schools occurred during aerial surveys. The methodology of these surveys is described by Anonymous (1986). Observers fly at a recommended altitude of 1,500 feet and count the number of schools of herring and measure the length and width of each school. Each school is classified into one of three size classes based on its surface area: small schools with an area  $\leq 50$  m<sup>2</sup>; medium-sized schools with a surface area  $>50$  m<sup>2</sup> and  $\leq 450$  m<sup>2</sup>; and large schools with a surface area  $>450$  m<sup>2</sup>. The number of schools in each size-class are converted to Relative Abundance Indices (RAI) by assuming that one small school equals one RAI, one medium-sized school equals five RAI, and one large school equals surface area/50 m<sup>2</sup>. Aerial observers also classify the conditions on each survey with a rating system: one equals excellent, two equals good, three equals fair, four equals poor, five equals unsatisfactory. A conversion factor of 1.52 short tons/RAI is used for schools observed in water depths of 16 feet or less and 2.58 short tons/RAI is used for schools observed in water depths of 16 to 26 feet. In deep water, no attempt was made to convert RAI units into tonnages due to the lack of data. Conversion factors were calculated from surveys of schools of known biomass and surface area in known water depths that were conducted with commercial fishing vessels in Bristol Bay in 1983. If more than one survey of an area was conducted in a single day, then the largest number of RAI's recorded in each area was chosen as the most accurate index of biomass, because observers were more likely to underestimate the biomass than they were to overestimate the biomass. Some schools of fish, especially in the Bering Sea and Stepovak Bay, may have been capelin or other finfish.

Harvest guidelines were established pre-season and were based on past fishing performance, age class data, and biomass estimates from ADF&G and industry aerial surveys (Table 4). Areas where little or no data on stock biomass was known were open for exploration.

## RESULTS

Table 4. Alaska Peninsula Management Area herring sac roe catch by guideline levels, 1990 (short tons). a/

Area	-----Guideline Harvest-----		
	Sac Roe	Food/Bait	Total
South Peninsula			
Sand Point District			
Stepovak Bay Section	56	19	75
Balboa Bay Section	15	5	20
Beaver Bay Section	23	7	30
Pavlof District			
Pavlof Bay Section	75	25	100
Canoe Bay Section	113	37	150
General Section (Volcano Bay)	23	7	30
King Cove District			
Belkofski Section	23	7	30
Cold Bay Section	45	15	60
Deer Passage Section	23	7	30
Total	396	129	525
North Peninsula			
Port Moller District b/			
Herendeen Bay Section	75		75
Inner Moller Bay Section	75		75
Outer Moller Bay Section	100		100
Bear River Section			
Total	250		250
<hr/>			
Total	646	129	775

a/The Aleutian Islands Management Area is open for exploration, no deliveries have occurred. Guideline harvest levels have not been established for areas open for exploration.

b/Herring abundance in the Port Moller District is difficult to estimate. If the Alaska Department of Fish and Game documents a herring biomass larger than expected the guideline harvest level will be adjusted inseason. Catches in the Port Heiden District may be subtracted from the Port Moller District guideline harvest if it is suspected that the herring are traveling into the Port Moller District.

In 1990, 54 landings were made in the Alaska Peninsula Management Area by nine purse seine permit holders. The 1990 catch of 585.1 tons of herring was about 38.9% lower than the 1985-89 average harvest and about half the 1989 catch (Table 1). The decreased catch was primarily due to below average Bering Sea Coast (Bear River Section) and Moller Bay catches.

In 1990, 19 purse seine permit holders indicated an interest in fishing in the Alaska Peninsula during the sac roe season. However, only nine purse seine permit holders made at least one landing. This was a decrease of eight purse seine permit holders making deliveries and three companies buying herring from the 1989 level.

The total 1990 commercial herring sac roe catch for the Alaska Peninsula and Aleutian Islands Management Areas was 585.1 tons, with an ex-vessel value of about \$296,646.

### Fishing Effort

Fishing effort during the last few years has stabilized, except in the Port Moller and Shumagin Islands areas.

In the Port Moller District during the 1986-88 seasons there was an average of 52 vessels present, although only a few permit holders actually made landings. Fishermen often stop in Port Moller on their way from the Togiak herring fishery for a few days to explore for herring stocks. In 1986 a trend began of increasing fishing effort effectively harvesting the early returning fish stocks. In order to shift fishing pressure from the earlier arriving stocks, to the later more abundant stocks, the Port Moller District opening was delayed until May 30 in 1989 and 1990. However, the fishery may have opened prior to May 30 by emergency order if a large biomass of herring was documented in the area. The later opening date in the past two seasons has caused a trend of decreasing effort. Fishermen returning from Togiak tend to pursue halibut or salmon fisheries rather than wait for the Port Moller herring fishery to open.

In 1990, a total of 10 tenders representing five processing companies registered for the Port Moller fishery. At least 19 purse seine skippers indicated interest in fishing for herring in the Port Moller District although only 5 purse seine permit holders made at least one delivery.

In areas open for exploration (Port Heiden District, Amak District, Unimak District, and General Sections of the King Cove and Sand Point Districts) liberal fishing time was allowed to give fishermen the opportunity to find and exploit unknown herring stocks. The liberal fishing time resulted in above average (1985-89) catches in the General Section of the Sand Point District (Table 3).

### North Peninsula

The 1990 projected guideline herring harvest for the North Peninsula fisheries was 250 tons (Table 4), which does not include herring harvested in sections open

for exploration (Shaul 1990, ADF&G 1990). The Port Heiden and Amak Districts were open for exploration continuously from April 15 through July 15. The Bear River and Outer Moller Bay Sections of the Port Moller District were open from May 30 through July 15. The Herendeen Bay and Deer Island-Mud Bay Sections of the Port Moller District were open from May 30 through 10:00 AM June 19, while the Inner Moller Bay Section was open from May 30 to 8:00 PM June 6 and from 9:00 PM June 14 through July 15.

Commercial catches of herring from Port Moller from 1982 to 1990 were landed from May 9 to June 23 (Figure 5, Table 1). Most catches were taken during a time period of 20 days or less. In 1990, the commercial catch occurred in two locations: Inner Moller Bay (117.1 tons; Table 5) and Herendeen Bay (155.8 tons). Herring appeared to be running late, and the first landing occurred on June 4 with a 56.0 ton catch (Table 5). In the Port Moller District from June 4 to June 19, 272.8 tons were harvested by five purse seine permit holders. The average roe recovery was 7.53% with an average price of \$600/ton for 10% roe recovery, making the ex-vessel value of the fishery worth \$123,251. About 19 purse seine permit holders indicated interest in fishing Port Moller waters, but only five purse seine permit holders made deliveries.

The first ADF&G aerial survey to document a biomass of herring occurred on May 23 in the Bear River Section (Table 6). ADF&G first documented herring in Moller Bay on June 7 (46 tons). By June 6, a total of 114.1 tons had been harvested in Moller Bay and the Inner Moller Bay Section was closed. On June 14, an additional 387 tons were observed in Inner Moller Bay Section, and the section was reopened for a guideline harvest of an additional 50 tons. On June 18, 3.0 tons were caught in Inner Moller Bay Section. Fishermen continued looking for herring for about two more days, but the schools were a mixture of ripe and spawnouts and no further catches occurred. In Herendeen Bay, aerial surveys did not document any herring until June 10. From June 10-12, small schools of herring (10-20 tons) moved into Herendeen Bay, although by June 10, 7.2 tons had already been caught. ADF&G surveys on June 10-12 documented 155 tons of herring biomass (Table 6). The Herendeen Bay and Deer Island-Mud Bay Sections were closed on June 19, with a total catch of 155.8 tons.

Intensive aerial surveys to document spawning biomass and locations are not possible due to the large area, weather, muddy water, currently unpredictable appearance of herring. Also, the later portion of the fishery takes place during the beginning of the June sockeye salmon fishery when personnel is limited. NOAA conducted trawling for herring larva and found hatched larva in Moller Bay that were deposited at least 10 days before the first observed biomass.

There were industry reports of small amounts of herring spawning and leaving the area from May 31 through June 19. On May 26, commercial spotter pilots reported 30-40,000 tons of capelin near Cinder River in the Port Heiden District. On May 31 in the Outer Moller Bay Section, a purse seine vessel set and released a school of juvenile (age 2) herring. On June 1, in the Inner Moller Bay Section, a 20 ton set on spent herring occurred, which were released. On June 2, industry reported 200-300 tons of mixed spawned out/green/ripe herring near Egg Island in Inner Moller Bay. The fish were set on and released. Commercial spotters also reported 225 tons of immature herring (2 year-olds) in 3 schools in Outer Moller Bay. On June 4, fishermen reported 120-130 tons of mixed ripe/spawnouts in 8 schools by Egg Island, 120 tons of ripe herring in Inner Moller Bay Section, 150 tons of green/ripe/spawnouts in 12 schools in Mud Bay Section, and 125-150

Table 5. North Peninsula commercial herring sac roe catch by area, day, and percent roe, 1990 (short tons).

Area	Date	Catch	Percent Roe
Inner Moller Bay	June 4	56.0	6.83
	June 5	20.9	7.85
	June 6	37.2	7.34
	June 18	3.0	7.71
	Total	117.1	7.19
Herendeen Bay	June 8	7.2	7.30
	June 11	12.8	7.90
	June 12	12.8	7.90
	June 13	10.8	8.50
	June 18	93.0	7.71
	June 19	19.2	7.80
	Total	155.8	7.79
Total		272.8	7.53

Table 6. Alaska Department of Fish and Game North Peninsula aerial herring biomass surveys, 1990 (short tons).

Date	Deer Island			Herendeen Bay			Moller Bay			Bear River		
	RAIa/	Tonsb/	Ratingc/	RAIa/	Tonsb/	Ratingc/	RAIa/	Tonsb/	Ratingc/	RAIa/	Tonsb/	Ratingc/
May 21							0	0	1	0	0	2
May 23	0	0	1	0	0	1	0	0	1	5	8	1
May 25							0	0	2	0	0	2
May 31										0	0	2
June 1	0	0	2	0	0	2	0	0	2	10	26	1
June 2							30	46	3			
June 5	0	0	3	0	0	3	0	0	3	0	0	3
June 7							25	38	2			
June 8	0	0	2	0	0	2						
June 10	0	0	3	12	31	3	15	39	2			
June 12	0	0	2	60	155 /d	2	0	0	2			
June 14							150	387 /d	2			

RAI units express the surface area of herring schools in terms of small schools (surface area equal to 532 square feet). For example, 10 RAI units are equivalent to 10 small herring schools, each with a surface area of 538 square feet.

a/Relative Abundance Index (RAI): small school (less than 538 square feet) = 1 RAI unit  
 medium school (532 square feet to 4,841 square feet) = 5 RAI units  
 large school (square feet/538 square feet)

b/Tons: RAI units are multiplied by 1.52 (schools in water less than 16 feet of depth).  
 RAI units are multiplied by 2.58 (schools in water 16 to 26 feet of depth).

c/Rating of survey: 1) Excellent, (2) Good, (3) Fair, (4) Poor, (5) Unsatisfactory

d/Used in calculating peak biomass estimate.

tons of spawnouts in Herendeen Bay. The spawnouts in Herendeen Bay were small 3-4 year old herring. Industry reported on June 8, 80 tons of spawnouts in Inner Moller Bay Section south of Harbor Point. On June 10, industry reported 2 large and 4 small schools going into Inner Moller Bay, totaling 110 tons. On June 11, industry reported 40 tons (2 schools) in Left Head Bay (Moller Bay), one school of 40 tons (spawnouts) in Herendeen Bay near Shingle Point, and 12 schools each of about 10 tons (three of these schools were caught for 25 tons) in Mud Bay Section. On June 16, industry surveys indicated more herring (400-500 tons) moving into Inner Moller Bay Section. On June 17-18, several sets were made in Inner Moller Bay, with most of the herring released because the schools were mixed ripe/spawnouts.

Table 6 lists ADF&G aerial surveys. From May 21 through June 14, 12 aerial surveys were flown in the Port Moller District. In past years biomass estimates have been difficult due to survey conditions, and the rapid arrival and departure of fish. In 1990, fish were visible in substantial numbers on six different surveys. Aerial survey estimates added with the catch of 114.1 tons taken prior to the June 14 survey resulted in an estimated biomass of 501 tons for Moller Bay. Herring spotted in Herendeen on June 12 were added to the catch of 20 tons harvested prior to the June 12 aerial survey resulted in an estimated biomass of 175 tons. This data established the biomass at 676 tons, resulting in an exploitation rate to 40%. On May 28, NOAA caught three herring larva near Egg Island in Inner Moller Bay from eggs that were probably laid on May 15-17. NOAA larva data indicated herring spawned in Moller Bay before any fish were observed. The last survey ADF&G flew was on June 14, it is possible that additional herring arrived in the area after the last survey date. These data indicate that the 676 ton estimate is a minimum estimate.

No herring were caught in the Amak and Port Heiden Districts nor in the Bear River or Outer Moller Bay Sections, although effort occurred in the Bear River and Outer Moller Bay Sections. Most of the fish observed in the Bear River Section were capelin, while most herring observed in the Outer Moller Bay Section were juveniles.

The Inner Moller and Herendeen Bays fishery was dominated by age 6 herring (Table 7, 8; Figure 7). Herendeen Bay catches had 57% age 6 and 15% age 7 herring, while Inner Moller Bay had 49% age 6 and 16% age 7 herring. Age 3 herring which are typically only partially recruited into the fishery as age 3 herring comprised 14% of the Herendeen Bay catch and 13% of the Inner Moller Bay catch. Typically a Bering Sea year class is not fully recruited into the fishery until age 5. The amount of age 3 herring in the catches in 1990 should produce substantial catches of age 4 herring in 1991 and again as age 5 herring in 1992. The age 2 herring caught in Outer Moller Bay were juvenile herring, a few herring were kept for ageing purposes from a purse seine set that later released all other herring from that set.

Two small schools of herring, each about five tons, were observed spawning at low tide in the Inner Moller Bay area. The schools were located Southwest of Harbor Point in shallow water, spawning among sand bars. No vegetation was visible from the air where spawning occurred. On June 7, industry reported two schools each of about 10 tons spawning in the sand Southwest of Harbor Point. On June 9, industry reported 30-40 tons of herring spawning on eel grass in the northeast corner of Inner Moller Bay Section. An ADF&G survey on June 10 saw

Table 7. Estimated age composition of herring catches from the North Peninsula by area and percent, 1985-90.

Year	Ages									
	2	3	4	5	6	7	8	9	10	11+
Herendeen Bay										
1985	0	5	49	21	15	6	4	0	0	0
1986	0	0	3	25	13	20	21	17	1	0
1987	0	2	4	22	24	17	13	10	6	2
1988	0	3	23	30	22	9	4	3	3	2
1989	0	0	2	62	22	5	1	1	0	7
1990	0	14	3	1	57	15	3	1	1	5
Inner Moller Bay										
1985	0	1	12	8	15	33	27	2	0	1
1986	0	1	7	21	12	18	19	20	1	1
1987	0	2	11	13	22	12	11	17	11	0
1988	0	1	30	29	12	6	5	5	8	5
1989	0	1	1	67	19	3	1	2	2	4
1990	0	13	4	2	49	16	5	2	2	6
Outer Moller-Bering Sea Coast										
1985	0	1	26	16	20	17	17	1	1	0
1986	0	0	2	22	13	21	23	18	1	0
1987	0	2	48	9	14	5	11	8	3	0
1988	No catch in this section									
1989	0	0	0	6	26	6	24	7	10	21
1990	90	10	0	0	0	0	0	0	0	0

Table 8. Estimated age composition of herring purse seine catches from the North Peninsula by area and day, 1990.

Date	Sample Size	Ages									
		2	3	4	5	6	7	8	9	10	11+
Herendeen Bay											
June 8	62	0.0	12.9	3.2	1.6	58.1	9.7	4.8	1.6	1.6	6.5
June 11	63	0.0	4.8	0.0	1.6	60.3	23.8	3.2	0.0	0.0	6.3
June 19	46	0.0	28.3	6.5	0.0	50.0	8.7	0.0	2.2	2.2	2.2
Total	171	0.0	14.0	2.9	1.2	56.7	14.6	2.9	1.2	1.2	5.3
Inner Moller Bay											
June 2	21	0.0	4.8	4.8	0.0	38.1	19.0	0.0	4.8	4.8	23.8
June 5	239	0.4	12.1	4.2	2.1	44.8	14.6	7.9	2.9	2.1	8.8
June 6	82	0.0	3.7	3.7	2.4	53.7	22.0	4.9	2.4	3.7	3.7
June 14	84	1.2	13.1	4.8	2.4	56.0	19.0	1.2	0.0	0.0	2.4
June 17	69	0.0	27.5	0.0	4.3	53.6	11.6	2.9	0.0	0.0	0.0
Total	495	0.4	12.7	3.6	2.4	49.1	16.4	5.3	2.0	1.8	6.3
Outer Moller-Bering Sea Coast											
May 31	10	90.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	10	90.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

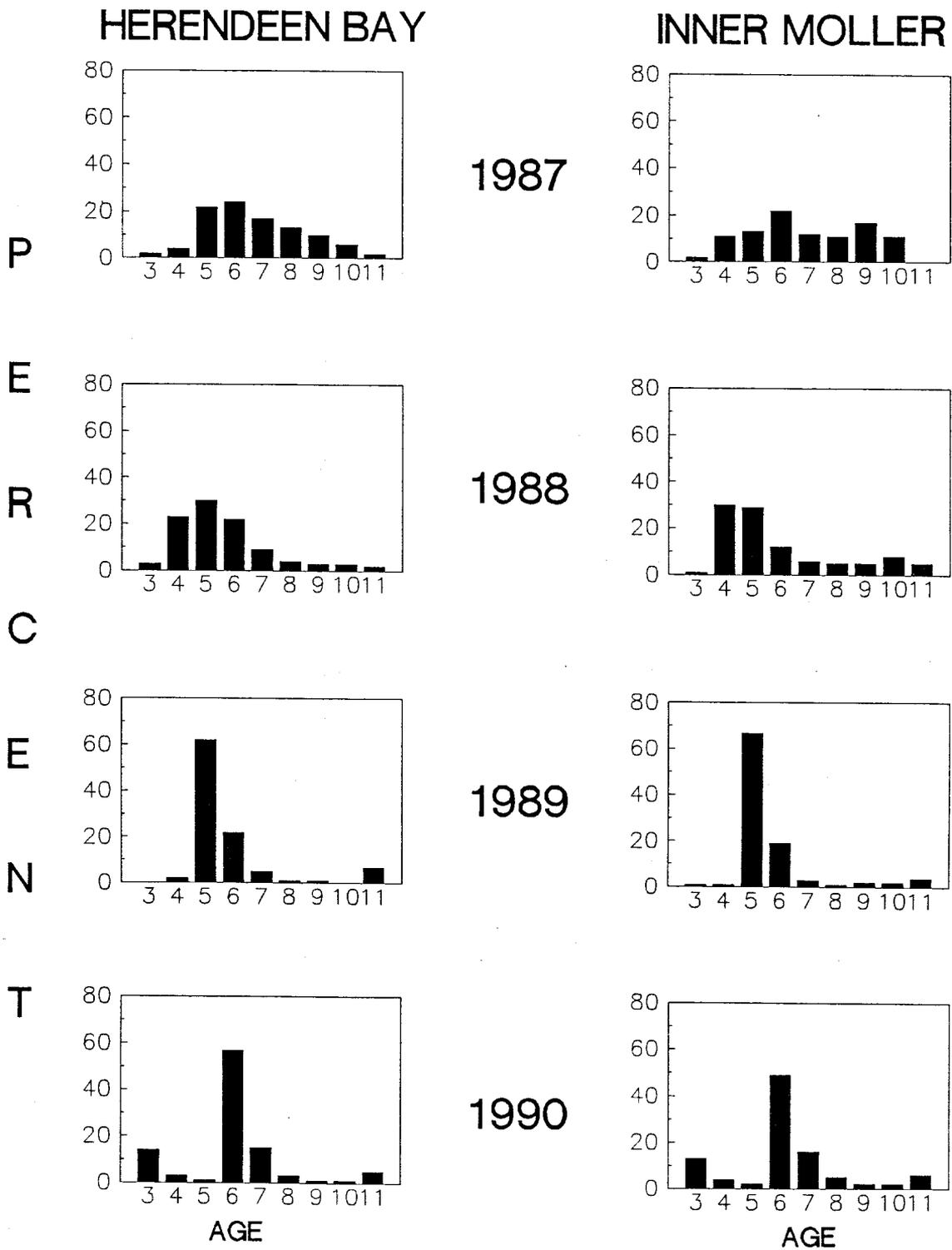


Figure 7. Age distribution of annual herring sac roe catches from Herendeen and Inner Moller Bays, 1987-90.

what was likely the same school near Harbor Point. On June 11, industry reported 40-60 tons of herring spawning in Inner Moller Bay Section near Harbor Spit.

### South Peninsula

The 1990 projected guideline herring harvest for the South Peninsula fisheries was 396 tons (Table 4), which does not include herring harvested in sections open for exploration (Shaul 1990, ADF&G 1990). The Shumagin Islands Section and Unimak District were open for exploration. The South Peninsula herring fisheries were open seven days a week through the closure of the sac roe season (July 15) except for the outer portion of the Shumagin Islands Section which closed on May 27, Stepovak Bay which closed June 7, Swedania Point-Balboa Bay Section which closed June 5, and Canoe Bay which closed June 9.

Commercial catches of herring from the South Peninsula from 1980 to 1990 were landed from May 9 to June 23 (Table 1). Most catches were taken during a time period of 20 days or less. In 1990, the commercial catch occurred in six locations: Stepovak Bay (71.7 tons), Shumagin Islands (90.4 tons), Balboa Bay (20.8 tons), Canoe Bay (120.4 tons), Belkofski Bay (3.2 tons), and Leonard Harbor (5.9 tons; Table 3). From May 14 to June 14, 312.2 tons were harvested by six purse seine permit holders. The average roe recovery was 9.24%, with an average price of \$600/ton for 10% roe recovery, making the ex-vessel value of the fishery worth \$173,395 (Table 9).

The first ADF&G survey to document a biomass of herring occurred on May 21 in Balboa Bay, where 30 tons were observed (Table 10). By May 28, 20.8 tons of herring had been caught in Balboa Bay and the Swedania Point-Balboa Bay Section was closed (Table 9). On June 3, an additional 152 tons of herring were observed in Balboa Bay and the Section was reopened but no more catches occurred. By June 7, 71.1 tons of herring had been caught in Stepovak Bay. An aerial survey of Stepovak Bay on June 7 resulted in an estimate of 600 tons, but the bay remained closed. ADF&G has restricted catches in Stepovak Bay in an attempt to rebuild stocks since their collapse due to the food and bait fishery in 1982. The outer Shumagin Islands were closed on May 27, after a catch of 90.4 tons. ADF&G attempted several surveys of the Shumagin Islands, but the only good survey was on May 21 and that survey failed to identify any herring. In Canoe Bay, the catch of herring was 120.4 tons by June 9 and the fishery was closed. Aerial surveys of Canoe Bay on June 10-12 resulted in an estimate of 387 tons of herring remaining in the bay after the fishery.

Intensive aerial surveys to document spawning biomass and locations are not possible due to the large area, weather, muddy water, currently unpredictable appearance of herring, and the later portion of the fishery takes place during the beginning of the June sockeye salmon fishery when personnel is limited. Table 10 lists surveys that were flown. In 1990, herring were visible in substantial numbers on five different surveys.

The biomass of 182 tons observed in Balboa Bay on May 21 and June 3 was used to estimate the spawning biomass of 182 tons. In Stepovak Bay, the June 7 observed 600 tons and the catch of 71.7 tons were used to determine the spawning biomass of 672 tons. In Canoe Bay, the aerial estimate of 387 tons and the catch prior

Table 9. South Peninsula commercial herring sac roe catch by area, day, and percent roe, 1990 (short tons).

Area	Date	Tons	Roe Percent
Stepovak Bay	May 20	22.9	9.20
	May 23	3.0	9.50
	June 5	16.6	9.42
	June 8	29.2	8.77
	Total	71.7	9.09
Balboa Bay	May 14	3.0	9.10
	May 20	0.5	9.20
	May 23	5.0	9.50
	May 28	12.3	11.40
	Total	20.8	10.56
Shumagin Islands	May 14	36.7	9.10
	May 26	53.7	9.84
	Total	90.4	9.54
Canoe Bay	May 29	4.0	9.10
	June 3	14.6	8.79
	June 5	5.5	9.42
	June 8	37.3	8.77
	June 9	59.0	8.94
	Total	120.4	8.90
Belkofski Bay	June 3	3.2	8.79
	Total	3.2	8.79
Leonard Harbor	June 14	5.9	9.23
	Total	5.9	9.23
Total		312.4	9.24

Table 10. Alaska Department of Fish and Game South Peninsula aerial biomass surveys, 1990 (short tons).

Date	Stepovak Bay			Balboa Bay			Beaver Bay			Shumagin Islands			Canoe Bay			Pavlof Bay		
	RAIa/	Tonsb/	Ratingc/	RAIa/	Tonsb/	Ratingc/	RAIa/	Tonsb/	Ratingc/	RAIa/	Tonsb/	Ratingc/	RAIa/	Tonsb/	Ratingc/	RAIa/	Tonsb/	Ratingc/
May 21	0	0	2	20	30 d/	1				0	0	1						
June 1													0	0	1	0	0	1
June 3				100	152 d/	2	0	0	1									
June 7	395	600 d/	2															
June 10													110	284	2			
June 12													150	387 d/	2	0	0	2

RAI units express the surface area of herring schools in terms of small schools (surface area equal to 532 square feet). For example, 10 RAI units are equivalent to 10 small herring schools, each with a surface area of 538 square feet.

a/Relative Abundance Index (RAI): small school (less than 538 square feet) = 1 RAI unit  
 medium school (532 square feet to 4,841 square feet) = 5 RAI units  
 large school (square feet/538 square feet)

b/Tons: RAI units are multiplied by 1.52 (schools in water less than 16 feet of depth).  
 RAI units are multiplied by 2.58 (schools in water 16 to 26 feet of depth).

c/Rating of survey: 1) Excellent, (2) Good, (3) Fair, (4) Poor, (5) Unsatisfactory

d/ Used in calculating peak biomass estimate.

to the survey of 120.4 tons resulted in a spawning biomass of 507 tons. These estimates plus the catches in the Shumagin Islands, Belkofski Bay, and Leonard Harbor resulted in a minimum biomass estimate of 1,460 tons for the South Peninsula. There were industry reports of herring spawning and leaving fishing areas from mid-May through late June, especially in the Shumagin Islands and Canoe Bay, where ADF&G aerial surveys were thought to either completely miss the herring or produced only a partial biomass estimate. The harvest of 312.4 tons represents a 21% exploitation rate of the 1,460 ton minimum biomass estimate. The 1,460 ton minimum biomass estimate may be well below the actual biomass.

The Stepovak Bay, Balboa Bay, Shumagin Islands, and Leonard Harbor fisheries were dominated by age 5 and age 6 herring (Table 11, 12, Figure 8). The Canoe Bay fishery was dominated by age 3, 5, and 6 herring. In Canoe Bay for 1991, age 4 and age 6 herring should produce most of the commercial catch.

No juvenile herring schools nor spawning were observed by ADF&G personnel in South Peninsula waters.

Table 11. Estimated age composition of herring catches from the South Peninsula by area and percent, 1985-90.

Year	Ages									
	2	3	4	5	6	7	8	9	10	11
Stepovak Bay										
1985	No samples									
1986	No catch									
1987	No catch									
1988	0	5	78	17	0	0	1	0	0	0
1989	0	3	31	50	13	0	0	0	2	0
1990	1	6	8	28	50	7	1	0	1	1
Balboa										
1988	0	32	50	9	0	1	3	1	2	3
1989	No samples									
1990	0	4	7	22	59	4	0	4	0	0
Shumagin Islands										
1989	0	1	15	79	1	0	0	3	0	2
1990	0	4	0	26	67	2	0	0	0	1
Canoe Bay										
1985	0	1	3	81	7	6	1	1	0	1
1986	0	6	0	3	82	6	2	0	1	0
1987	0	25	28	1	5	34	3	3	0	0
1988	0	24	31	20	0	1	16	4	2	1
1989	0	6	56	22	9	0	0	5	1	1
1990	0	23	5	49	17	5	0	0	1	0
Pavlof Bay										
1985	No samples									
1986	No samples									
1987	0	6	18	5	11	48	9	2	1	0
1988	0	34	50	5	0	2	7	0	2	0
1989	No samples									
1990	No catch									
Leonard Harbor										
1986	0	3	0	3	83	7	4	0	0	0
1987	0	67	5	0	3	25	0	0	0	0
1988	No samples									
1989	No samples									
1990	0	3	2	35	46	6	0	3	6	0

Table 12. Estimated age composition of herring purse seine catches from the South Peninsula by area and day, 1990.

Date	Sample Size	Ages									
		2	3	4	5	6	7	8	9	10	11
<b>Stepovak Bay</b>											
May 21	61	0.0	9.8	9.8	39.3	32.8	6.6	0.0	0.0	0.0	1.6
May 23	58	0.0	10.3	6.9	25.9	56.9	0.0	0.0	0.0	0.0	0.0
June 1	25	0.0	0.0	8.0	32.0	36.0	20.0	4.0	0.0	0.0	0.0
June 7	57	1.8	0.0	5.3	15.8	66.7	7.0	0.0	0.0	1.8	1.8
Total	201	0.5	6.0	7.5	27.9	49.8	6.5	0.5	0.0	0.5	1.0
<b>Balboa Bay</b>											
May 23	54	0.0	3.7	7.4	22.2	59.3	3.7	0.0	3.7	0.0	0.0
Total	54	0.0	3.7	7.4	22.2	59.3	3.7	0.0	3.7	0.0	0.0
<b>Shumagin Islands</b>											
May 16	111	0.0	2.7	0.0	29.7	64.9	1.8	0.0	0.0	0.0	0.9
May 27	59	0.0	6.8	0.0	18.6	71.2	3.4	0.0	0.0	0.0	0.0
Total	170	0.0	4.1	0.0	25.9	67.1	2.4	0.0	0.0	0.0	0.6
<b>Canoe Bay</b>											
May 29	27	0.0	37.0	14.8	25.9	14.8	3.7	0.0	0.0	3.7	0.0
June 1	126	0.0	15.9	5.6	57.9	16.7	4.0	0.0	0.0	0.0	0.0
June 2	76	0.0	42.1	7.9	31.6	13.2	3.9	0.0	0.0	0.0	1.3
June 3	30	0.0	80.0	6.7	10.0	0.0	3.3	0.0	0.0	0.0	0.0
June 8	129	0.0	1.6	0.0	65.1	23.3	7.8	0.0	0.0	2.3	0.0
Total	388	0.0	22.7	4.9	49.2	16.8	5.2	0.0	0.0	1.0	0.3
<b>Leonard Harbor</b>											
June 14	66	0.0	3.0	1.5	34.8	45.5	6.1	0.0	3.0	6.1	0.0
Total	66	0.0	3.0	1.5	34.8	45.5	6.1	0.0	3.0	6.1	0.0

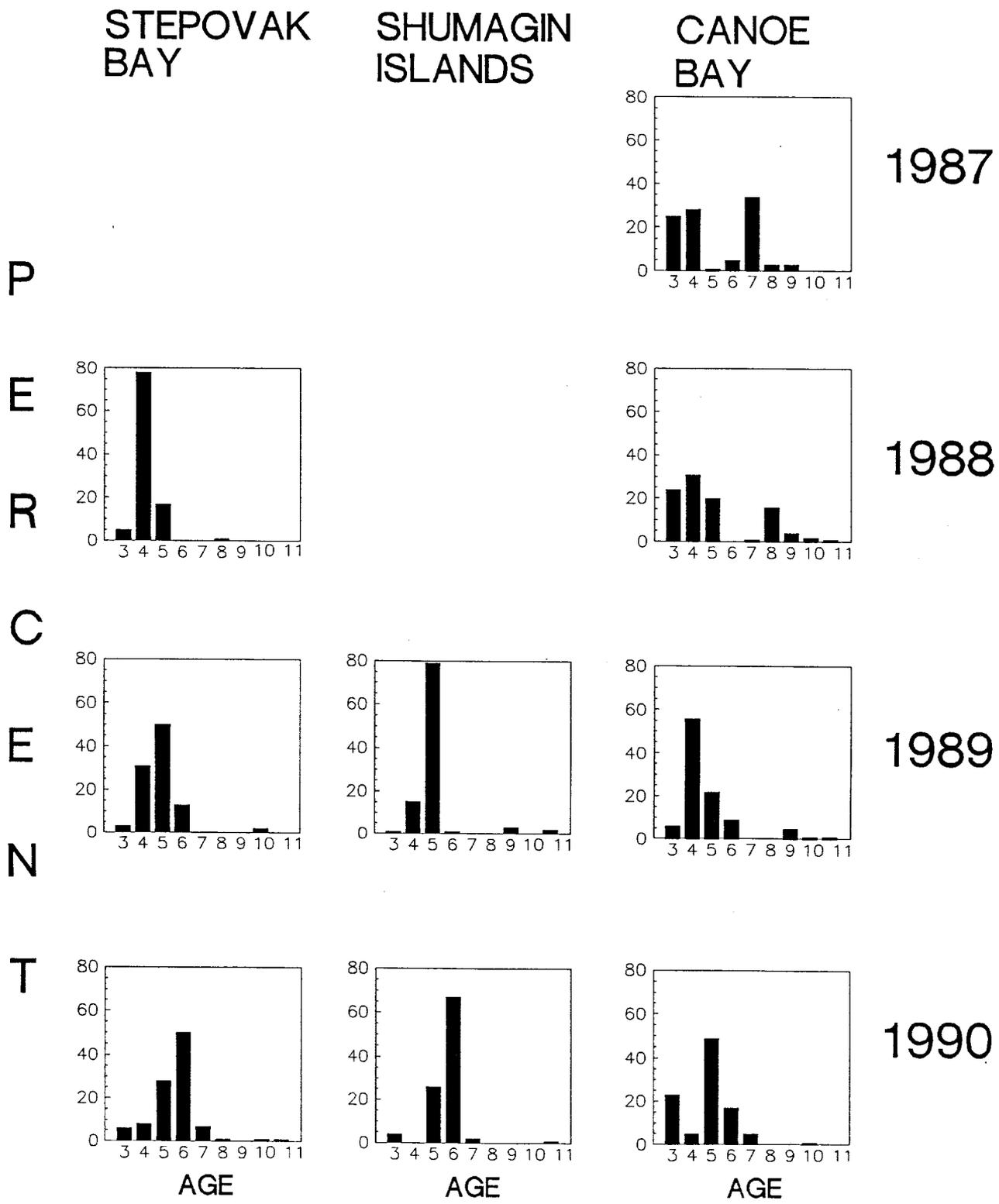


Figure 8. Age distribution of annual herring sac roe catches from Stepovak Bay, Shumagin Islands, and Canoe Bay, 1987-90.

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