State of Alaska

Steve Cowper, Governor

REGIONAL INFORMATION REPORT NO. 5J90-02

Preliminary Forecasts of Catch and Stock Abundance for 1990

Alaska Herring Fisheries

Edited by:

Fritz Funk

and

Herman Savikko

February 1990

Alaska Department of Fish and Game
PO Box 3-2000, Juneau, Alaska 99802

Don W.Collinsworth
Commissioner

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PRELIMINARY FORECASTS OF CATCH AND STOCK ABUNDANCE FOR 1990 ALASKA HERRING FISHERIES

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TABLE OF CONTENTS

	Page
LIST OF TABLES	iv
LIST OF FIGURES	vi
ABSTRACT	ix
EXECUTIVE SUMMARY	x
INTRODUCTION	1
SOUTHEAST REGION	3
Southeast Food and Bait Fishery	3
Kah Shakes Sac Roe Fishery	4
Seymour Canal Sac Roe Fishery	4
Sitka Sound Sac Roe Fishery	4
Hoonah Sound Roe-On-Kelp Pound Fishery	6
CENTRAL REGION	7
Prince William Herring Fisheries	7
Upper Cook Inlet Sac Roe, Food and Bait Fisheries	10
Lower Cook Inlet Sac Roe, Food and Bait Fisheries	11
Togiak District, Bristol Bay, Sac Roe and Spawn-on-Kelp Fisheries	14
ARCTIC-YUKON-KUSKOKWIM REGION	17
Introduction	17
Security Cove Sac Roe Fishery	18
Goodnews Bay Sac Roe Fishery	19
Cape Avinof Sac Roe Fishery	20
Nelson Island Sac Roe Fishery	22
Nunivak Island Sac Roe Fishery	23
Cape Romanzof Sac Roe Fishery	24
Norton Sound Sac Roe Fishery	26
Port Clarence Sac Roe Fishery	28
WESTWARD REGION	29
Kodiak Food and Bait Fishery	29
Kodiak Sac Roe Fishery	29
Chignik Sac Roe Fishery	30
Port Moller Sac Roe Fishery	30
South Peninsula Sac Roe Fisheries	30
Dutch Harbor Food and Bait Fishery	30

LIST OF TABLES

Table		Page
1.	Glossary of some terminology used in describing herring stock assessment	32
2.	Alaska herring fisheries, area management offices and fishery managers to contact for additional information	33
3.	Summary statistics of the 1989 Alaska herring season and the preliminary forecast for the 1990 season	34
4.	Summary of the 1989 Alaska commercial herring sac roe fishery harvests, values, roe percentages, and number of participating permittees	35
5.	Summary of the 1989 Alaska commercial herring spawn-on-kelp and directed food and bait fishery harvests, values, and number of permittees	36
6.	Estimates of the contribution of each year class and age class to the 1989 harvest, escapement, and total spawning biomass; and 1990 projected spawning biomass of Pacific herring in Prince William Sound	37
7.	Projection of the spawning biomass of Pacific herring in Prince William Sound in 1990	38
8.	Forecast of 1990 Kamishak herring abundance and projected harvest	39
9.	Togiak District year class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass	40
10.	Projection of the 1990 Pacific herring biomass in the Togiak District	41
11.	Security Cove District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish	42
12.	Goodnews Bay District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish	43

LIST OF TABLES (Continued)

Table		Page
13.	Cape Avinof year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish	44
14.	Nelson Island District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish	45
15.	Nunivak Island District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish	46
16.	Cape Romanzof District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish	47
17.	Norton Sound District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish	48

LIST OF FIGURES

Figure		Page
1.	Location of principal Alaska herring fisheries	49
2.	Herring harvests from all Alaska domestic herring fisheries, 1930-1989, with the projected 1990 harvest	50
3.	Alaska sac roe herring harvests from all areas, 1978-1989, with the projected 1990 sac roe harvest	51
4.	Generalized harvest policy for Southeast Alaska herring fisheries showing the relationship between allowable exploitation rate and the estimated biomass of the mature herring stock expressed as a multiple of the established threshold biomass level	52
5.	Southeast Alaska areas in which herring food and bait fisheries were allowed in 1989	53
6.	Map of Prince William Sound, Alaska	54
7.	Spawning biomass estimates and indices for Pacific herring in Prince William Sound, Alaska, 1975-1989	55
8.	Comparison of the age compositions (top by weight and bottom by number) of the 1989 spawning biomass and the 1989 projected spawning biomass of Pacific herring in Prince William Sound .	56
9.	Historical year-class strength of Prince William Sound herring in number of age-4 fish.	57
10.	Comparison of the age compositions (top by weight and bottom by number) of the 1989 spawning biomass to the 1990 projected spawning biomass of Pacific herring in Prince William Sound .	58
11.	Kamishak herring stock biomass, 1978-1989, with projected 1990 biomass	59
12.	Historical year-class strength at age 4 for the Kamishak herring stock, for the 1974-1985 year classes	60
13.	Age composition of the Kamishak herring stock in 1989 and 1990	61
14.	Age distribution of the 1990 population biomass and harvest for the Kamishak herring stock	62

LIST OF FIGURES (Continued)

Figure		Page
15.	Togiak District herring biomass as estimated from aerial surveys	63
16.	Historical year-class strength of Togiak District herring in numbers of 5-year-old fish	64
17.	Age composition by weight of the 1990 biomass forecast for Togiak District herring	65
18.	Performance of the Togiak District herring forecast based on the current schedule of increasing mortality with age	66
19.	Security Cove District herring biomass, 1978-1989, with 1990 projected biomass	67
20.	Historical year class strength of Security Cove District herring in numbers of 5-year-old fish	68
21.	Age composition of Security Cove herring population in 1989 and projected 1990 return	69
22.	Age composition by weight of the projected 1990 biomass of Security Cove District herring	70
23.	Goodnews Bay District herring biomass, 1978-1989, with 1990 projected biomass	71
24.	Historical year-class strength of Goodnews Bay District herring in numbers of 5-year-old fish	72
25.	Age composition of Goodnews Bay herring population in 1989 and projected 1990 return	73
26.	Age composition by weight of the projected 1990 biomass of Goodnews Bay District herring	74
27.	Age composition of Cape Avinof herring population in 1989 and projected 1990 return	75
28.	Age composition by weight of the projected 1990 biomass of Cape Avinof District herring	76
29.	Nelson Island District herring biomass, 1985-1989, with 1990 projected biomass	77

LIST OF FIGURES (Continued)

Figure		Page
30.	Historical year-class strength of Nelson Island District herring in numbers of 5-year-old fish.	78
31.	Age composition of Nelson Island herring population in 1989 and projected 1990 return	79
32.	Age composition by weight of the projected 1990 biomass of Nelson Island District herring	80
33.	Nunivak Island District herring biomass, 1985-1989, with 1990 projected biomass	81
34.	Historical year-class strength of Nunivak Island District herring in numbers of 5-year-old fish	82
35.	Age composition of Nunivak Island herring population in 1989 and projected 1990 return	83
36.	Age composition by weight of the projected 1990 biomass of Nunivak Island District herring	84
37.	Cape Romanzof District herring biomass, 1978-1989, with 1990 projected biomass	85
38.	Historical year-class strength of Cape Romanzof District herring in numbers of 5-year-old fish	86
39.	Age composition of Cape Romanzof herring population in 1989 and projected 1990 return	87
40.	Age composition by weight of the projected 1990 biomass of Cape Romanzof District herring	88
41.	Norton Sound District herring biomass, 1978-1989, with 1990 projected biomass	89
42.	Historical year-class strength of Norton Sound District herring in numbers of 5-year-old fish	90
43.	Age composition of Norton Sound herring population in 1989 and projected 1990 return	91
44.	Age composition by weight of the projected 1990 biomass of Norton Sound District herring	92

ABSTRACT

The total herring harvest for 1990 is projected to be about 37,449 tons from sac roe and food/bait fisheries, a decrease from the total 1989 harvest of 48,929 tons. Stock levels are projected to be lower in many areas with substantial reductions at Togiak Bay, Kamishak Bay, Sitka Sound, and Kah Shakes. The 1989 harvest had an estimated ex-vessel value of $18,776,473 a substantial decline from prior years because of the much reduced ex-vessel prices offered during the 1989 sac-roe season and the oil spill closures in Prince William Sound. Herring sac roe fisheries are projected to harvest 30,775 tons in 1990, down from the 1989 harvest of 41,387 tons. Herring food and bait fisheries are projected to harvest 6,674 tons in 1990, down from the 1989 harvest of 7,542 tons. The 408 ton projected 1990 herring spawn-on-kelp harvest is up from the 280 ton 1989 harvest, largely because spawn-on-kelp product was not harvested in Prince William Sound as a result of the Exxon Valdez oil spill. The Hoonah Sound pound fishery in Southeast Alaska will be open during 1990 for the first time with an 11 ton guideline harvest level for sac roe product. The strong 1984 year class will return as age 6 in 1989 and is expected to be a major component of the 1990 herring stocks in most areas of the Gulf of Alaska. The 1984 year class is not as strong in Bering Sea areas and is noticeably absent from the Togiak stock of Bristol Bay. No substantial recruitment has been observed in recent years to the important Togiak herring stock. The abundance of the Togiak stock is projected to decline rapidly as the previously strong 1977 and 1978 year classes are approaching senescence.

KEY WORDS: Herring, *Clupea harengus pallasi*, herring harvest projection, herring stock assessment, herring sac roe fishery, herring food and bait fishery, herring spawn-on-kelp

EXECUTIVE SUMMARY

Statewide Summary of 1989 Herring Harvests and 1990 Harvest Projections

Herring harvest projections are based on aerial surveys, spawn deposition surveys, hydroacoustical surveys, and age composition sampling of commercial and test fishing catches. All herring harvests and biomass estimates are reported in short tons (2,000 lbs), and 1989 harvests refer to the January 1, 1989 to December 31, 1989 calendar year.

The total harvest for 1990 is projected to be about 37,449 tons of herring from sac roe and food and bait fisheries and 408 tons of herring spawn-on-kelp, a decrease from the total 1989 harvest of 48,929 tons of herring and 280 tons of spawn-on-kelp. Stock levels are projected to be lower in many areas with substantial reductions at Togiak Bay, Kamishak Bay, Sitka Sound, and Kah Shakes. The 1989 harvest had an estimated ex-vessel value of $18,776,473, a substantial decline from prior years because of the much reduced ex-vessel prices offered during the 1989 sac-roe season. Herring sac roe fisheries are projected to harvest 30,775 tons in 1990, down from the 1989 harvest of 41,387 tons. Herring food and bait fisheries are projected to harvest 6,674 tons in 1990, down from the 1989 harvest of 7,542 tons. The 408 ton projected 1990 herring spawn-on-kelp harvest is up from the 280 ton 1989 harvest, largely because spawn-on-kelp product was not harvested in Prince William Sound as a result of the Exxon Valdez oil spill. The Hoonah Sound pound fishery in Southeast Alaska will be open during 1990 for the first time with an 11 ton guideline harvest level for sac roe product.

The strong 1984 year class will return as age 6 in 1989 and is expected to be a major component of the 1990 herring stocks in most areas of the Gulf of Alaska. The 1984 year class is not as strong in Bering Sea areas and is noticeably absent from the Togiak stock of Bristol Bay. No substantial recruitment has been observed in recent years to the important Togiak herring stock in Bristol Bay. The abundance of the Togiak stock is projected to decline rapidly as the previously strong 1977 and 1978 year classes are approaching senescence.

For major herring stocks, the Alaska Department of Fish and Game (ADF&G) conducts detailed stock assessment programs and makes formal projections of the expected biomass and harvests for the upcoming year. For other stocks, detailed stock assessment programs are not conducted and informal harvest outlooks are based on recent average harvest levels and other available information. While harvest projections and outlooks represent what is thought to be the best use of available information, caution is advised in the interpretation of the results. Many of the projections are based on preliminary information, and harvests have on occasion been substantially different than initial projections.

Summaries of Herring Harvest Projections by Area

Southeast Winter Food and Bait Fisheries

The 1989 harvest was 3,400 tons from herring stocks at Tenakee Inlet, Lisianski Inlet, and Craig, which was valued at $782,000. Good spawn coverage on the spawning grounds used by food/bait stocks during the spring of 1989 indicates a 1990 winter food and bait fishery close to the level of the 1989 season.

Kah Shakes Sac Roe Fishery

Spawning biomass for the Kah Shakes herring stock is projected to be 3,300 tons, based on spawn deposition surveys. Because the spawning biomass is under the 5,000 ton threshold, there will be no fishery at Kah Shakes in 1990.

Sitka Sound Sac Roe Fishery

The 1984 year class comprised 79% of the spawning biomass in 1989 and is expected to dominate the fishery again as the age-6 cohort in 1990. Size-at-age of this year class was again well below average in 1989 and affected roe product quality. For 1990 the exploitation rate will be 15%, allowing a harvest of 4,150 tons. Sitka Sound harvests are restricted to purse seine gear.

Seymour Canal Sac Roe Fishery

Unlike some other areas in Southeast Alaska, the 1984 year class has not appeared in substantial numbers at Seymour Canal. The spawning biomass is projected to be 3,120 tons, with a 10.0% exploitation rate allowed under the management plan framework for a projected harvest of 312 tons. The Seymour Canal commercial herring fishery is restricted to gill net gear.

Lynn Canal Sac Roe Fishery

The Juneau/Lynn Canal area herring stocks remain under the threshold specified in the management plan. No substantial recruitment has been observed. The fishery is projected to remain closed in 1990.

Hoonah Sound Spawn-on-Kelp Pound Fishery

The Alaska Board of Fisheries adopted new regulations that specified a spawn-on-kelp fishery in Hoonah Sound to begin in 1990. This will be the first such pound fishery in Southeast Alaska. The 150 ton allocation of herring and 11 ton spawn-on-kelp guideline harvest will be divided equally among all permit holders who have built completed pounds in the fishing area by April 5.

Prince William Sound Sac Roe, Spawn-on-Kelp, and Food and Bait Fisheries

The 1990 spawning biomass is projected to be approximately 51,692 tons. Twenty percent of the 1990 projected biomass or 10,392 tons of Pacific herring may be harvested during the 1990 management year. The management plan allocates: 1,694

tons to the 1989 food and bait fishery; 831 tons to the 1990 wild spawn-on-kelp fishery resulting in 104 tons of spawn-on-kelp product; 1,476 tons to the 1990 pound spawn-on-kelp fishery resulting in 118 tons of spawn-on-kelp product; 6,038 tons to the 1990 purse seine sac roe fishery; and 353 tons to the 1990 gill net sac roe fishery.

Impacts of the "Exxon Valdez" oil spill on the Prince William Sound herring stock are still under investigation. The likelihood of oil contamination from the "Exxon Valdez" oil spill necessitated a total closure of the 1989 spring herring fisheries in Prince William Sound. However, due to the oiling pattern, areas of heavy herring spawning, including the northern mainland shore were less affected than other areas of the Sound. If the 1990 spawning pattern is typical of recent years, the stocks returning to the northern mainland shore (Valdez Arm, Fairmount Bay, Unakwik Inlet etc.) should fulfill harvest allocations to all fisheries without any complicating factors from the oil spill. The 1990 management strategy will focus efforts on fulfilling harvest guidelines for all fisheries in this area. However, if harvest opportunities only occur in oil-contaminated areas, then restriction of the fishery may be necessary to prevent contamination of fishing gear or the harvest of tainted product.

Upper Cook Inlet Sac Roe and Food and Bait Fishery

Although the status of Upper Cook Inlet herring stocks appears somewhat improved over 1989, a conservative approach to harvest levels will be maintained for the 1990 season. While allowing for some inseason flexibility to adjust harvest levels based on age composition and abundance, the expected harvests for 1990 are: Eastside (food/bait) - 50 tons, Tuxedni Bay (sac-roe) -50 tons, and Chinitna Bay (sac-roe) - 30 tons.

Lower Cook Inlet Sac Roe and Food and Bait Fisheries

The 1990 herring forecast is for a biomass of 28,653 short tons and a projected harvest of 2,865 short tons. Mean weight is expected to be 201 g with 85% of the population being age 6 and older. The 1990 stock is expected to be dominated by ages 6 and 7 herring from the strong 1984 and 1983 year classes. The harvest allocation for the Kamishak sac roe fishery is 2,292 short tons and for the Shelikof Strait bait fishery is 573 short tons. The guideline harvest for sac roe fisheries in the Eastern and Outer Districts combined is 700 tons, while the Southern District guideline harvest level is 175 tons.

Kodiak Food and Bait Fishery

The 1988/1989 Kodiak food and bait fishery opened on August 1, 1988 and closed by regulation on February 28, 1989. Removals from the east Shelikof fishery on Kamishak spawning stocks totaled 327 tons of the 340 ton harvest, with the remaining 13 tons accounted for by local Kodiak spawning stocks. The harvest projection for 1990 is 573 tons. Under the management plan adopted by the Alaska Board of Fisheries, the food and bait herring fishery in eastern Shelikof Strait is allocated 2% of the spawning biomass of the Kamishak spawning herring stock.

Kodiak Sac Roe Fisheries

Oil from the Exxon Valdez spill reduced the allowable 1989 harvest in Kodiak to 2,229 tons. However, in 1989 1- and 2-year-old herring appeared to be present in the entire Kodiak Management Area at record levels which should start contributing significantly to the commercial harvest beginning in 1992. The guideline harvest level for 1990 is 2,100 tons.

Chignik Sac Roe Fishery

The herring sac-roe fishery in the Chignik Management Area can be characterized as a low yield, low participation fishery because of the low abundance and dispersed nature of the stocks. Although no formal forecasts for Chignik herring are produced, it is anticipated that the harvest level will be between 50 and 80 tons in 1990.

Dutch Harbor Food and Bait Fishery

Based on the forecast biomass at Togiak, the 1990 Dutch Harbor harvest would be 679 tons.

Togiak District, Bristol Bay, Sac Roe and Spawn-On-Kelp Fishery

The 1990 spawning biomass of herring in the Togiak District is projected to be 56,020 tons. Average size of fish is expected to be 361 grams. An estimated 49% of the biomass will be age 10 or older. In 1990 the recommended total allowable harvest is 11,204 tons and represents 20% of the forecasted biomass. In accordance with the management plan the allocation would then be 1,500 short tons for the spawn-on-kelp fishery, 679 short tons for the Dutch Harbor food and bait fishery, and 9,024 short tons for the sac roe fishery.

Arctic-Yukon-Kuskokwim (AYK) Region Herring Sac Roe Fisheries

Based upon apparent weak recruitment of young age classes (ages 3-5) and reduced returns of the abundant 1977 and 1978 year classes due to cumulative fishing effects and increased natural mortality, a decline in the total harvestable surplus of Pacific herring in the AYK region is expected for 1990. Projections from post-season escapement estimates, using mean rates of natural mortality and growth for each age class, indicate that the 1990 minimal spawning biomass for the northeastern Berring Sea Pacific herring stocks (Security Cove to Port Clarence) should be approximately 27,210 tons. A decrease in herring biomass compared to 1989 levels is expected for all fishing districts. Increased recruitment could increase the 1990 observed biomass over the projected biomass estimates. However in accordance with AYK Region harvest policy, newly recruited age classes (age 3-, 4-, and 5-year-old herring) will not be targeted by the commercial fishery.

INTRODUCTION

Commercial herring sac roe and food and bait fisheries for herring are conducted in over 25 locations in Alaska (Figure 1). This publication summarizes the 1989 commercial herring sac roe and food and bait fisheries in each of the areas, and describes harvest projections for the 1990 commercial herring fishing season. For major herring stocks, the Alaska Department of Fish and Game (ADF&G) conducts detailed stock assessment programs and makes formal projections of the expected biomass and harvests for the upcoming year. These programs and projections are described in detail in separate sections of this report for areas in which they occur. For other stocks, detailed stock assessment programs are not conducted and informal harvest outlooks are described based on recent average harvest levels and other available information. While harvest projections and outlooks represent what is thought to be the best use of the available information, caution is advised in the interpetation of the results. Many of the projections are based on preliminary information, and harvests have been substantially different than initial projections on occasion. A number of specialized terms used in describing herring stock assessment are defined in Table 1. All harvests and biomasses are reported in short tons (2,000 lbs) because of its extensive use in the herring harvesting and processing industry. The 1989 harvest totals refer to the January 1, 1989 to December 31, 1989 calendar year.

A booklet describing regulations for all Alaska herring fisheries is available from ADF&G offices. The management of many herring fisheries is further described in fishery management plans. In some cases these management plans are regulations adopted by the Alaska Board of Fisheries and appear in the herring regulation booklet. In other cases, fishery management plan documents are available from the area management office(s) located near the fishery. For most herring fisheries, fishermen and processors are required to register with the local fishery manager prior to the start of the fishing season. Table 2 lists herring fisheries and the appropriate fishery management contacts for more information about individual fisheries. During the fishing season, pre-recorded telephone messages describing the progress of the herring fisheries are available at most ADF&G area offices.

Since the full development of sac roe fisheries in 1980, statewide commercial herring harvests in all herring fisheries have ranged between 40,000 and 55,000 tons (Figure 2). The large harvests between the 1920's and the mid-1960's occurred during herring reduction fisheries. Reduction plants had ceased production by the mid-1960's, and only relatively small amounts of herring were taken for food and bait products until the development of sac roe fisheries in the early 1970's. In recent years, sac roe fisheries have accounted for about 85% of the total herring harvest.

The total harvest for 1990 is projected to be about 37,449 tons of herring from sac roe and food and bait fisheries (Table 3) and 408 tons of herring spawn-on-kelp, a decrease from the total 1989 harvest of 48,929 tons of herring and 280 tons of spawn-on-kelp. Stock levels are projected to be lower in many areas with substantial reductions at Togiak, Kamishak, Sitka Sound, and Kah Shakes. The 1989 harvest had an estimated ex-vessel value of $18,776,473 a substantial

decline from prior years, because of the much reduced ex-vessel prices offered during the 1989 sac-roe season. Herring sac roe fisheries are projected to harvest 30,775 tons in 1990, down from the 1989 harvest of 41,387 tons (Figure 3), which was valued at $16,322,874 (Table 4). Herring food and bait fisheries are projected to harvest 6,674 tons in 1990, down from the 1989 harvest of 7,542 tons which was valued at $2,005,775 (Table 5). The 408 ton projected 1990 herring spawn-on-kelp harvest is up from the 280 ton 1989 harvest, largely because spawn on kelp product was not harvested in Prince William Sound as a result of the Exxon Valdez oil spill. The Hoonah Sound pound fishery in Southeast Alaska will be open during 1990 for the first time with an 11 ton guideline harvest level for sac roe product.

The strong 1984 year class will return as age 6 in 1989 and is expected to be a major component of the 1990 herring stocks in most areas of the Gulf of Alaska. The 1984 year class is not as strong in Bering Sea areas and is noticeably absent from the Togiak stock of Bristol Bay. No substantial recruitment has been observed in recent years to the important Togiak herring stock in Bristol Bay. The abundance of the Togiak stock is projected to decline rapidly as the previously strong 1977 and 1978 year classes are approaching senescence.

Herring harvest projections are based on a number of sources of information. For the major stocks harvested during spring sac roe fisheries, estimates of the spawning biomass and age composition of the stock are derived each spring. Spawning biomass is estimated either from spawn deposition surveys or from aerial surveys. The age composition of the spawning biomass is estimated by sampling the commercial catch and from test fishing conducted by the Department of Fish and Game. Herring stock assessment forecasts for 1989 consist of projecting the numbers and average weight of each age class of the population, as assessed in 1988, forward to 1989, allowing for an age-specific level of natural mortality over the course of the year. Attempts are also made to predict the number recruit age-class fish (age 3 or 4, depending on the area) that will appear in the 1989 spawning population for the first time. In most cases these estimates are derived from the number of 2- and 3-year-old fish which appeared on the spawning grounds in 1988. These recruitment estimates contain a very large amount of uncertainty. In a few instances, additional growth and age composition information will be obtained from overwintering herring schools prior to the spring 1989 fishery. While hydroacoustic estimates of biomass are used to assess some populations harvested by food and bait herring fisheries, these methods are not used for quantitative assessment of stocks fished in spring roe fisheries at this time.

SOUTHEAST REGION

By

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Ketchikan

SOUTHEAST REGION

The Southeast Region 1989 herring harvest was 16,335 tons, up 1,073 tons from 1988. This was the highest regional harvest since 1964. The sac roe harvest contributed 12,935 tons to this total. Excluding the Sitka Sound sac-roe harvest, the estimated ex-vessel value is $1,480,000. A price settlement has not yet been reached for the Sitka Sound sac-roe harvest. The catch of 3,400 tons in the food and bait fishery was worth an estimated $782,000.

The Board of Fisheries has directed ADF&G to harvest from 10% to 20% of the estimated biomass of the Southeast Alaska herring stocks when the estimated biomass is above established threshold biomass levels. No fishery is allowed when the estimated biomass is below the threshold level. Exploitation rates are set at 10% when the biomass is equal to the threshold. Exploitation rates increase 2% each time the estimated spawning biomass increases by an amount equal to the threshold level (Figure 4). The exploitation rate reaches a maximum of 20% when the population is 6 times the threshold level.

The 1990 projected harvest for all Southeast Alaska sac roe fisheries is 4,458 tons, primarily from the Sitka Sound stock. The Juneau/Lynn Canal and Kah Shakes herring stocks are under the threshold specified in the management plan and no fishery will be allowed on these stocks in 1990.

Southeast Winter Food and Bait Fishery

In Southeast Alaska, food and bait herring harvests are allowed only on smaller stocks believed to be distinct from stocks harvested by spring sac roe fisheries. As for stocks harvested by the spring sac roe fisheries, biomass threshold levels have been established for each winter food and bait fishery stock, and when the stocks are above threshold levels, the exploitation rate varies between 10% and 20% according to the frameworked harvest policy.

Three distinct stocks were identified as having harvestable quantities of bait herring during the 1989 winter food and bait herring season: Tenakee Inlet, Lisianski Inlet, and Craig (Figure 5). Fishing in these areas opened at noon on January 4, 1989. The total food and bait harvest from these areas during 1989 was 3,400 tons.

Southeast Alaska winter food and bait fisheries were scheduled to open again in January 1990. Hydroacoustical surveys conducted during November and December, 1989, along with the results of spawning ground surveys conducted in the spring of 1989, were used to estimate the available biomass in each area and determine harvest quotas for individual areas. Good spawn in certain winter areas during the spring of 1989 indicates a 1990 winter food and bait fishery close to the level of the 1989 season.

Kah Shakes Sac Roe Fishery

Set gill net sac roe fisheries have occurred in the Kah Shakes area since 1976. Seasonal landings have ranged from 171 tons (1978) to 3,250 tons (1983). Gill nets are the only legal gear for the Kah Shakes herring fishery. The 1989 Kah Shakes fishery occurred on March 20 and was the first sac roe fishery of the 1989 herring sac roe season in Alaska. Participating permit holders were restricted to one 50 fathom net. The total harvest was 592 tons averaging approximately 12% roe. Fishermen received approximately $1,300/ton so that the total value of the fishery was approximately $780,000.

Spawning biomass for the Kah Shakes herring stock is projected to be 3,300 tons, based on spawn deposition surveys. The spawning biomass is below the required threshold of 5,000 tons, resulting in no fishery for the 1990 season.

Seymour Canal Sac Roe Fishery

The 1989 Seymour Canal fishery harvested a total of 547 tons during a 2.5 hour opening on April 28. A total of 94 permit holders achieved a roe percentage of 12.76%. Fishermen received approximately $1,300/ton resulting in an ex-vessel value of approximately $780,000.

Unlike some other areas in Southeast Alaska, the 1984 year class did not appear in substantial numbers in the 1989 harvests in Seymour Canal. The spawning biomass is projected to be 3,120 tons, with a 10% exploitation rate allowed under the harvest policy framework for a projected 1990 harvest of 312 tons. The Seymour Canal commercial herring fishery is restricted to gill net gear.

Sitka Sound Sac Roe Fishery

The Sitka Sound herring stock spawns from the northern inshore areas of Sitka Sound south to Whale Bay on the west coast of Baranof Island. While the stock was heavily exploited during earlier reduction fisheries, substantial harvests for sac roe did not begin until the early 1970's.

A record sac roe harvest of 11,700 tons was taken in 1989, with the fishery opening on March 31 and closing on April 8. The stock was dominated by age-5 fish of smaller-than-usual size, resulting in poor market quality. To maximize the market quality of the catch, all permit holders agreed to a non-competitive fishery in which the total harvest was divided equally among the 51 permit holders. This resulted in a long season duration. The 20% exploitation rate was based on the prior year's spawn deposition survey. While the fishery was the largest ever, extremely low prices are expected. Prices are not yet available, but may be as low as $100/ton.

Abundance estimates for the Sitka Sound herring stock for 1989 were determined by spawn deposition and hydroacoustical surveys. Hydroacoustical surveys were conducted during winter using a modified scientific sounder and echo integration techniques to estimate biomass. Spawn deposition surveys utilized a plot transect sampling design to estimate total egg deposition which was then converted to numbers of female spawning herring, based on fecundity sampling.

The age distribution of the herring stock was determined by scale analysis and length frequency distributions of herring samples collected from the commercial catch and test fishing. Sampling was also conducted by mid-water trawling by an ADF&G vessel from winter concentrations during hydroacoustical surveys. Just prior to the commercial fishery, samples were taken from test sets by commercial vessels. Sampling was also conducted from the spawning grounds using a small purse seine or cast net. The best estimate of the spawning age composition was from samples taken from the spawning grounds after the fishery. In 1989 spawning ground samples were taken from 11 different spawning areas by a series of cast nets. A total of 1,163 herring were aged by scale analysis.

According to stock assessment information collected over the period 1972-1989, Sitka Sound herring stocks were at very low levels until the late 1970's, and then increased rapidly as the strong 1976 and 1977 year classes recruited to the fishery. These stock abundance trends are a composite of spawning ground estimates, acoustical surveys, and commercial catch data. Since the late 1970's, strong year classes have recruited to the Sitka Sound herring population about every 3 or 4 years on the average. Strong year classes of 3 year olds were seen in 1979, (1976 year class), 1980 (1977 year class), 1983 (1980 year class), and 1987 (1984 year class). The very strong 1984 year class dominated the composition of the 1989 spawning population, greatly exceeding the size of all other year classes in numbers. Additional age composition sampling during spring hydroacoustical surveys will be used to assess the strength of the 1987 year class which will be recruiting to the fishery as 3 year olds in 1990.

The 1984 year class is expected to dominate the 1990 spawning population and commercial purse seine harvest as 6 year olds. The magnitude of newly recruited year classes cannot be reliably estimated until age composition sampling is completed in the spring of 1990.

The threshold biomass for the Sitka Sound herring stock has been established at 7,500 tons. No fishery is allowed when the biomass is below this level. When the biomass is above this level, exloitation rates vary from 10% to 20% according to the Board of Fisheries harvest policy framework. Based on the 1989 spawning escapement of 27,000 tons of herring, the 1990 harvest will be based on a 15% exploitation rate, resulting in a harvest quota of 4,150 tons. The Board of Fisheries has also specified that the harvest of small herring should be minimized.

The average weight for 1989 was 97 grams per herring. The growth increase from age 5 to age 6, which will comprise about 79% of the stock in 1990, is 0.18% on the average. This growth increase would result in an expected average size for 1990 to be 118 grams per herring. This assumes no significant recruitment of age-3 herring which would lower the average size. The average roe maturity from

1989 fish ticket data indicated and average roe recovery of 9.45%. The majority of herring are still expected to be small and roe recovery is estimated to be 10% to 11% at best. However the size of the 1990 roe skeins should be larger and improve the quality.

Hoonah Sound Roe-on-Kelp Pound Fishery

The Alaska Board of Fisheries adopted new regulations that specified a spawn-on-kelp fishery in Hoonah Sound to begin in 1990. This will be the first such pound fishery in Southeast Alaska. The 150 ton allocation of herring, the 11 ton spawn-on-kelp guideline harvest, and the 4,400 lbs kelp guideline harvest will be divided equally among all permit holders who have built completed pounds in the fishing area by April 5. Prospective pound operators are advised to consider the requirements that other agencies may have to construct and operate pounds in Hoonah Sound. Pound operators are encouraged to contact the Alaska Department of Natural Resources, the U.S. Forest Service and the National Marine Fisheries Service regarding specific requirements.

CENTRAL REGION

Prince William Sound Sac Roe, Spawn-on-Kelp, and Food and Bait Fisheries

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Togiak District, Bristol Bay, Sac Roe, and Spawn-on-Kelp Fisheries

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CENTRAL REGION

Prince William Sound Sac Roe, Spawn-on-Kelp, and Food and Bait Fisheries

Pacific herring (*Clupea harengus pallasi*) spawn throughout Prince William Sound each year from mid-April through early May. Even though the Pacific herring that spawn within Prince William Sound may be composed of several populations, the Pacific herring are managed as a single stock. This stock has been defined as the populations of Pacific herring that spawn within the coastal waters between Point Whitshed and Cape Fairfield (Figure 6).

A detailed stock assessment program has been conducted on Pacific herring in Prince William Sound each year. The program consists of: (1) monitoring the harvest from the fall food and bait, the purse seine and gill net sac roe, and the wild and pound spawn-on-kelp fisheries; (2) estimating the escapement and total spawning biomass of herring from both aerial surveys and spawn deposition surveys; (3) estimating the age, weight, length, and sex composition of Pacific herring in the commercial harvest, escapement, and total spawning biomass. The information from the stock assessment program is used to project the spawning biomass one year forward in time using the unharvested spawning biomass (escapement) from the previous year, and adjusting for growth, mortality, and recruitment.

Beginning in late March, Alaska Department of Fish and Game (ADF&G) staff survey the coastline of Prince William Sound twice weekly from small aircraft until a significant biomass of Pacific herring is observed. Daily surveys are then conducted to assess the accumulation of Pacific herring biomass, document the distribution of the Pacific herring, and map the observed miles of spawn. When the Pacific herring have completed spawning, ADF&G SCUBA divers estimate the mean density of spawn deposition. The total spawning biomass is back calculated from total number of eggs observed, mean fish weight, fecundity, and sex ratio.

In Prince William Sound, there are three independent estimates or indices of Pacific herring biomass (Figure 7). Aerial survey estimates of Pacific herring biomass date back to 1974 and have ranged from 1,323 tons in 1975 (an estimate thought to be low due to poor visibility) to 51,090 tons in 1981. The number of miles of spawning date back to 1978 and have ranged from 47.4 miles in 1978 to 166.3 miles in 1988. Spawn deposition surveys were conducted in 1983, 1984, 1988, and 1989. A spawning biomass of 57,580 tons was estimated in 1989. This estimate was 1.45 times larger than the 1989 peak aerial survey estimate of 39,635 tons. This ratio in 1989 was slightly smaller than the estimates in 1984 and 1988. The spawn deposition survey estimate was 1.73 and 1.75 times larger than the peak aerial survey estimate in 1984 and 1988.

Age, weight, length, and sex composition was estimated from Pacific herring collected during each commercial fishing period and from areas of significant biomass accumulation throughout Prince William Sound. In areas of biomass accumulation, either, commercial or department vessels made multiple purse seine sets to capture Pacific herring.

The gill net and purse seine sac roe fisheries, wild spawn-on-kelp, and pound spawn-on-kelp fisheries for Pacific herring were not opened in Prince William Sound in the spring of 1989 due to the Exxon Valdez oil spill on 24 March 1989. The 1989 fall food and bait fishery opened on November 1 and harvested 646.1 tons.

The total spawning biomass of Pacific herring in Prince William Sound 1989 was estimated (based upon spawn deposition surveys) at approximately 449 million Pacific herring that weighed 57,580 tons (Table 6). The 95% confidence limits of the 1989 biomass estimate ranged from 47,428 tons to 67,732 tons, which equated to a 95% confidence width of approximately 20% of the biomass estimate. The escapement of Pacific herring was equal to the total spawning biomass in 1989 because there were no spring sac roe and spawn-on-kelp fisheries in Prince William Sound. There were five major areas of biomass accumulation within Prince William Sound in 1989. A total of 3,916 Pacific herring were weighed, measured, and aged from these areas. The 1989 estimated spawning biomass was greater than the projected spawning biomass of 54,899 tons. Age-5 Pacific herring dominated the 1989 spawning biomass (Figure 8). In addition, more older Pacific herring were observed than predicted.

Year-class strength as age-4 fish has been estimated for 1969 through 1985 using catch-age analysis (Figure 9). Year-class strength has ranged from 505 million herring from spawning in 1984 to 13 million from spawning in 1973. Age-4 herring from the 1984 year class represented 81% of the total number of herring in the 1988 spawning population. This level of abundance has not been seen since the 1976 year class. Age-4 Pacific herring from the 1985 year class represented approximately 5% (by weight) of the 1989 spawning biomass.

The 1990 spawning biomass of herring in Prince William Sound is projected to be approximately 330 million fish weighing 51,692 tons (Tables 6 and 7). A natural mortality rate of ($M = 0.45$ at age 8) was assumed (Table 7). With the 1989 escapement being dominated by age-5 herring (75.2% by weight and 78.4% by number), the 1990 spawning biomass should be dominated by age-6 herring (77.4% by weight and 78.1% by number) (Figure 10). The mean size of an individual fish in 1990 is expected to be 142 grams.

The herring stock in Prince William Sound is managed on a sustained yield basis by following guideline harvest levels set forth by the Alaska Board of Fisheries in accordance with the Prince William Sound herring management plan (5AAC27.365). Guideline harvest levels allow for a sliding scale exploitation rate ranging from 0% to 20% of the projected spawning biomass. Commercial fishing would not be allowed if the estimated spawning biomass was less than 8,400 tons. If the projected spawning biomass is between 8,400 and 42,500 tons, the exploitation rate will be set between 0 and 20%, and will be based upon the Department's assessment of the status of the stock. If the projected spawning biomass exceeds 42,500 tons, then the exploitation rate will be set at the maximum of 20%. The guideline harvest of Pacific herring is allocated to each fishery as follows: 16.3% to the fall food and bait fishery; 8% to the natural spawn-on-kelp fishery; 14.2% to the pound spawn-on-kelp fishery; 58.1% to the purse seine sac roe fishery, and 3.4% to the gill net sac roe fishery.

Twenty percent of the 1990 projected biomass or 10,392 tons of herring may be harvested during the 1990 management year. The management plan allocates: 1,694 tons to the 1989 food and bait fishery; 831 tons to the 1990 wild spawn-on-kelp fishery resulting in 104 tons of spawn-on-kelp product; 1,476 tons to the 1990 pound spawn-on-kelp fishery resulting in 118 tons of spawn-on-kelp product; 6,038 tons to the 1990 purse seine sac roe fishery; and 353 tons to the 1990 gill net sac roe fishery.

Impacts of the "Exxon Valdez" oil spill on the Prince William Sound herring stock are still under investigation. The likelihood of oil contamination from the "Exxon Valdez" oil spill necessitated a total closure of the 1989 spring herring fisheries in Prince William Sound. However, due to the oiling pattern, areas of heavy herring spawning, including the northern mainland shore were less affected than other areas of the Sound. If the 1990 spawning pattern is typical of recent years, the stocks returning to the northern mainland shore (Valdez Arm, Fairmount Bay, Unakwik Inlet etc.) should fulfill harvest allocations to all fisheries without any complicating factors from the oil spill. The 1990 management strategy will focus efforts on fulfilling harvest guidelines for all fisheries in this area. However, if harvest opportunities only occur in oil-contaminated areas, then restriction of the fishery may be necessary to prevent contamination of fishing gear or the harvest of tainted product.

Upper Cook Inlet Sac Roe, Food and Bait Fishery

The 1989 food/bait herring fishery along the east shore of the Northern and Central Districts of Cook Inlet opened by regulation on April 15 with the first harvest occurring April 30 on the southern beaches. The harvest progressed slowly and sporadically with a small peak during the second week of May. The total harvest of 45 tons was below average but similar to 1988. Samples taken throughout the fishery indicated 62% of the harvested fish were ages 5 and 6.

The herring sac-roe season opened on the western shore of Cook Inlet by regulation on April 22. Most of the 35 tons of herring taken from Tuxedni Bay were taken from May 3 through May 11. Herring abundance in the bay was improved over 1988 but still considered poor. The average mature roe content was approximately 10%. The sac-roe fishery in Chinitna Bay began very slowly but herring abundance increased dramatically by May 15. A lack of tenders led to the dumping of an estimated 50-80 tons while 137 tons were ultimately sold. The harvest was comprised of primarily age 5 and 6 fish having a mature roe percentage of approximately 10.5%.

Although the status of Upper Cook Inlet herring stocks appears somewhat improved over 1988, a conservative approach to harvest levels will be maintained for the 1990 season. While allowing for some inseason flexibility to adjust harvest levels based on age composition and abundance, the expected harvests for 1990 are: Eastside (food/bait) - 50 tons, Tuxedni Bay (sac-roe) - 50 tons, and Chinitna Bay (sac-roe) - 30 tons.

Lower Cook Inlet Sac Roe, Food and Bait Fishery

Introduction

In 1989, there were two sac roe fisheries in the Lower Cook Inlet herring management area. The Kamishak District harvest was 4,801 short tons (4,365 metric tonnes) while the Southern District harvest was 171 short tons (156 metric tonnes). The Outer and Eastern Districts were closed as a result of the Exxon Valdez oil spill. This stock assessment is for the Kamishak District only.

Kamishak Herring Stock Assessment for 1990

The first opening in the Kamishak district occurred on April 18, in accordance with the preseason management plan, but fish were immature on the first day and no deliveries were made. Fishing scheduled for April 19 was cancelled due to weather and the lack of catches on April 18. The first deliveries were made on April 20, but roe percentages were low and there was a high proportion of males in the catch samples. Fishing in area 11 was curtailed due to oil sheen and "mousse" reported in the area. Strong westerly winds blowing on April 21 prevented aerial surveys of the area. The fishery was postponed to allow roe content to improve. Very strong winds prevented any sampling effort in the southern part of the district on April 23. By April 25 roe percentages were improving and the fleet concentrated in the Chenik-Nordyke area. On April 27, after a review of the catch age composition, the total allowable harvest was reduced 500 tons to 4,500 tons. Age 3 herring were totally absent in the population and age 4 herring comprised only 2 to 3% of the population. As expected, the weak 1982 year class, age 7 herring, contributed only 4% to the total population. The fishery averaged 8.9% roe recovery. The total observed biomass was estimated to be 35,300 short tons (32,091 metric tonnes), of which 11,725 short tons (10,659 metric tonnes) were seen on June 12, long after the fishing season had ended. These fish were not sampled and may not have been previously included as part of the spawning biomass estimate.

Methods. This forecast is for total Kamishak biomass observed on the spawning grounds, as opposed to total cohort which includes herring offshore but not detected by or recruited into the fishery for a variety of reasons. The forecast is the product of future numbers of fish and future mean weight:

$$\text{Biomass}_t = \Sigma\ N_{i,t} \times wt_{i,t};$$

where $N_{i,t} = \text{escapement}_{i-1,t-1} \times e^{Z_{i-1,t-1}}$. N = future number of herring observed in both catch and escapement, i = age group, t = year, Z = a instantaneous measure of concurrent recruitment and total mortality with positive Z values indicating recruitment in excess of mortality and vice versa. The Z values used in this forecast were median Z values for ages 2-4, median Z values for age 5, average of the 2 greatest Z values for age 6, and Z values estimated from the regression of + Z values on age for ages 7-13. An average recruitment of age 3 herring of 3 million was assumed for 1990.

Mean weights anticipated in 1990 were predicted from $wt_{i,t} = 47.16215 + 1.784287 (age_{i-1,t-1}) + 0.774494 (wt_{i-1,t-1})$. This regression was based on all available weight data and from 1973 to 1988 and from age 2 to 14. The regression explains about 91% of the variation observed in mean weights. The 1989 harvest and early spawning herring mean weights were obtained from the catch samples while the late spawning herring mean weights were estimated from the regression of late on early spawning herring mean weights. This regression explains about 99% of the variation observed in the shift in early to late spawning herring mean weights.

Age composition of the catch and early spawning herring were determined from counting scale annuli. In 1989, 3,191 readable herring scales were examined. Age composition of the late spawning herring, essentially the younger aged herring, was estimated from the regression of late spawning herring on early spawning herring and age. This regression is based on data from 1987 and 1988 and explains about 65% of the variation observed in the shift in early to late spawning herring age composition. Catch biomass was obtained from fish ticket summaries. The 1989 late spawn biomass was also estimated from the age composition regression model described above. This estimate was used to prepare the 1990 forecast.

Herring harvest policy calls for harvest rates of 10 to 20%. Past management strategies in Lower Cook Inlet has allowed for a 10% harvest rate on herring age 5 and younger and 20% on age 6 and older. However, the strength of the Kamishak stock is based on only two age classes, 5 and 6. In 1989, the age 3, 4, and 7 herring were absent in the fishery. Although the numbers of older fish are expected to decline over the next few years, their biomass will increase over a short period of time as growth rates exceed mortality rates. Thus, biomass levels are expected to peak two years from now. Reducing the harvest rate to 10%, will allow the fishery to be extended by another year. Therefore, a 10% harvest rate is being considered initially as a conservative management strategy until the strength of the 4- and 5-year-old age classes can be better assessed during 1990. Of the total spawning biomass observed by aerial survey in the spring, 2% is allocated to the Shelikof Strait winter bait fishery occurring the subsequent fall. For the purposes of this forecast, an estimate of this 2% bait allocation is subtracted from the predicted total allowable herring harvest for the year and the remainder is allocated to the spring sac roe fishery. This prevents the total sac roe fishery and bait harvest from exceeding the allowable biological harvest.

Results. Sac roe harvests of Pacific herring have been documented in the Kamishak District since 1973. A total closure of the sac roe fishery in Lower Cook Inlet occurred between 1980 and 1984 due to low stock abundance. Only the Kamishak, Eastern, and Outer Districts were reopened in 1985. If the forecast is correct, the Kamishak biomass appears to be relatively high but stable (Figure 11). While the numbers of fish are declining, they are getting heavier with age. The 1984 and 1983 year classes have contributed the dominant age groups during the recent years (Figure 12), e.g., age 5 and 6 in 1989.

The 1990 herring forecast is for a biomass of 28,653 short tons (26,048 metric tonnes) and a projected harvest of 2,865 short tons (2,604 metric tonnes, Table 8). Mean weight is expected to be 201 g with 85% of the population being age

6 and older. The 1990 stock is expected to be dominated by ages 6 and 7 herring (Figure 13) from the strong 1984 and 1983 year classes. The distribution of biomass and catch at age is illustrated in Figure 14. The harvest allocation for the Kamishak sac roe fishery (2,292 short tons) and the Shelikof Straits bait fishery (573 short tons) is presented in Table 3.

Discussion. Because of the absence of age 3 and 4 herring during the 1989 fishery and the dependence of the fishery on two age classes, a very conservative approach to the 1990 Kamishak harvest is anticipated. Initially, harvest levels will be based on a 10% harvest rate for all age classes. When data become available indicating a good recruitment of age 5 and younger herring or a very large older herring biomass, a decision will be made inseason concerning additional harvest.

If this forecast were in error, it would most likely underforecast the 1990 biomass. Potentially, the biomass could be as large as 42,625 short tons (38,750 metric tonnes). Mean weight would be greater, 212 g, because 91% of the population would age 6 and older. If harvest rates on herring age 5 and older were increased to 20%, projected harvest levels would be more than doubled.

Togiak District, Bristol Bay, Sac Roe and Spawn-on-Kelp Fisheries

The Togiak District of Bristol Bay extends from Cape Constantine to Cape Newenham and supports the largest spawning population of Pacific herring in the eastern Bering Sea. Though studies have yet to prove genetic variation between these Bering Sea spawning populations, differences in growth due to environmental influences are apparent. Herring that spawn in the Togiak District are most similar to herring from the Security Cove and Goodnews Bay Districts, but show significant differences in growth and timing from herring which spawn along the Alaska Peninsula and north of Kuskokwim Bay. Herring move into the Togiak District from their overwintering grounds near the Pribilof Islands in the spring to spawn. These herring then feed during their post spawning migration southward along the Alaska Peninsula, concentrate in the vicinity of Unalaska Island, and return to their overwintering grounds in the fall. The primary harvest of this herring stock occurs in the Togiak District by a sac roe fishery during the spring spawning migration. Lesser harvests are taken during the summer months in the Dutch Harbor food and bait fishery and as bycatch in the domestic pollock trawl fishery in the Dutch Harbor and Unimak Island areas.

Beginning in late April the nearshore area of Togiak District is surveyed daily from small aircraft to determine relative abundance, distribution, and spawning success of Pacific herring. Biomass estimates are derived from the number and size of herring schools observed during these surveys. The use of aerial surveys to estimate the Togiak herring spawning biomass began in 1978. Observed abundance has ranged from 242,298 short tons in 1979 to 76,960 tons in 1980 (Figure 15). The 1980 biomass is believed to be an underestimate due to poor visibility and overall poor survey conditions experienced that season.

Year-class strength represented by abundance of 5-year-old herring was derived from aerial survey results and annual age composition estimates. In the Togiak District strong recruitment was last detected in 1982-83 when the 1977 and 1978 year classes joined the spawning biomass representing 197 and 189 million age-5 fish (Figure 16). Recruitment has since averaged 14 million fish annually. The 1974 year class was the largest in this series and contributed 586 million 5-year-old recruits to the 1979 biomass.

In 1989, small schools of herring were first observed in Togiak District on May 5. The peak aerial survey count occurred May 9 at 66,290 tons. Biomass estimates, though performed under poor survey conditions, decreased thereafter and again increased to 63,698 tons observed on May 13. The final survey conducted 10 days later, May 24, produced an estimate of 25,658 tons of herring. Poor weather conditions prevented successful completion of any aerial surveys between May 14 and May 23. Reports from spotter pilots and continuing catches of ripe herring in test fish nets by ADF&G crews indicate that herring were moving through the district during this 11 day period.

Data collected from May 5 through May 9 indicated that the initial biomass in the Togiak District was comprised of 92% herring age 8 and older and 8% herring age 7 and younger. Age composition data for the second peak aerial survey

estimate occurring May 13 showed an increase of herring age 7 and younger to 19%. Age composition representing the final aerial survey estimate May 24, indicated a presence of 30% age 7 and younger herring and 70% herring age 8 and older. The revised biomass estimate of 98,965 tons for the 1989 season consisted of all age 8 and older herring from the survey conducted May 9, the component of the biomass consisting of age 7 and younger herring on May 13 and the entire biomass observed May 24.

The commercial sac roe harvest for the Togiak District totaled 12,258 tons during the 1989 season. Harvest decreased from the 1988 harvest of 13,986 tons and was below the five-year average of 15,721 tons. Herring sold for a sac roe product comprised 97% of the harvest with the remaining 3% of the catch purchased for food and bait. Roe recovery averaged 8.4% for combined gear types. The purse seine fleet of 310 vessels caught 76.8% of the total Togiak District harvest. The catch of 9,413 tons was taken during two fishing periods ocurring May 12 and May 13. The gill net harvest of 2,843 tons was taken by 320 permit holders. The catch comprised 24.2% of the total harvest and includes 90 tons of wastage from abandoned gill nets. A record spawn on kelp harvest was taken by 487 permit holders. The harvest totaled 559,780 pounds and was collected during a four hour period.

The 1989 age distribution was estimated from herring collected during the commercial fishery and daily from areas of significant biomass sightings throughout Togiak District. Volunteered commercial or departmental vessels made multiple purse seine or gill net sets to capture herring throughout the spawning migration. Age structure of the population was determined from herring captured by variable mesh gill net or purse seine gear. Samples were pooled across three day periods where possible to represent major fluctuations in estimated biomass for each fishing section. Herring from the commercial harvest were also sampled for age, size, and gonad condition. Samples were collected from tenders and fishing boats for each gear type and fishing section at the close of the commercial fishing period. Approximately 8,600 herring were sampled for biological data over the period of May 5 through May 23, 1989.

The 1989 Togiak District spawning migration consisted of 258 million herring weighing 98,965 tons (Table 9). Herring age 10 and older comprised 60% of the estimated biomass (Figure 17). The 1977 (age 11) and 1978 (age 12) year classes that have dominated the herring fishery since 1984 comprised 39% of the total biomass. An estimated 82,526 tons remained after all removals by the food and bait and trawl fisheries were also subtracted from the spawning biomass.

A schedule of increasing natural mortality with age was used to project the abundance of the 1990 population (Table 10). An estimated 141 million herring, with a biomass of 56,020 tons is expected to return to the Togiak District in 1990. Herring age 10 or older will comprise 49% of the forecasted biomass. The contribution of the 1977 and 1978 year classes appearing as age 12 and age 13 is expected to decrease next season to 27% as natural mortality rates on these fish increase with age. Year classes which follow in abundance are 1981 (age 9), and 1983 (age 7) with respective forecasted contributions of 17 % and 20% (total 35.6%) of the biomass.

Few herring cohorts have survived to these ages and estimates of mortality for age 10 and greater are based on very few observations. Considerable uncertainty concerning the survival of these older age classes remains. The potential exists for lower survival of these fish which would result in a return less than forecast. The older herring age classes in past years arrived on the fishing grounds before the younger or recruit age classes. The emphasis of the fishery and therefore biomass assessment is directed towards the older fish. This separation of older and younger age classes results in a paucity of information regarding the younger and later appearing age classes. Projection of the youngest age classes (age 3 and 4) which are not fully recruited are difficult as no age-2 or -3 fish were detected in the Department's 1989 sampling program.

The forecast is based on the revised biomass estimate of the prior season. Because the herring fishery was not surveyed for 11 days, any biomass observed during that time was not considered, and the resultant forecast is believed to be a minimum estimate. Conversely, this approach should also be treated with caution as the loss of the older aged herring due to natural mortality, the lack of recruitment, and the impact of the herring bycatch by the domestic trawl fleet upon the Togiak herring stock are unknown. The 1990 spawning biomass of herring in the Togiak District is projected to be 56,020 tons (Table 10). The average size of an individual is expected to be 361 grams. An estimated 49% of the biomass will be age 10 or older (Figure 17). The performance of the forecast has been conservative since 1984 (Figure 18) with an average forecast error (1984-89) of 27%.

The Bristol Bay Herring Management Plan (AAC27.865) allows for a maximum 20% exploitation of the Togiak herring population. Before opening the sac roe fishery the Department shall set aside approximately 1,500 short tons for the Togiak District herring spawn-on-kelp harvest followed by a 7% reduction for the Dutch Harbor food and bait fishery. The remaining harvestable surplus is allocated to the sac roe fishery and is managed for a removal of 25% by the gill net fleet and 75% by the purse seine fleet. In years when circumstances prevent adequate biomass assessment, the fishery will be exploited on the pre-season projected return. Should a manageable separation of the year classes occur, a harvest of the younger age classes may transpire if a threshold of 20,000 tons of these younger fish are present on the grounds.

In 1990 the recommended total allowable harvest is 11,204 tons and represents 20% of the forecasted biomass. In accordance with the management plan the allocation would then be 1,500 short tons for the spawn-on-kelp fishery, 679 short tons for the Dutch Harbor food and bait fishery, and 9,024 short tons for the sac roe fishery.

ARCTIC-YUKON-KUSKOKWIM REGION

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ARCTIC-YUKON-KUSKOKWIM REGION

Introduction

The Arctic-Yukon-Kuskokwim (AYK) Region includes eight commercial herring fishing districts located in coastal areas of the northeastern Bering Sea. These are the Security Cove, Goodnews Bay, Cape Avinof, Nelson Island, Nunivak Island, Cape Romanzof, Norton Sound and Port Clarence districts.

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 to mid-June. Spawning generally progresses in a northerly direction and may continue as late as July.

Aerial surveys are flown throughout the herring spawning season in all AYK districts to determine relative abundance, distribution, timing and biomass of herring. Occurrence and extent of milt, numbers of fishing vessels, and visibility factors affecting survey quality are also recorded. Aerial surveys have been used since 1978 in the Bering Sea to estimate herring spawning biomass. However, adverse weather conditions often limit the frequency and quality of surveys. Historically, it has been difficult to obtain biomass estimates from aerial surveys in the AYK area due to poor survey conditions caused by unfavorable weather, ice conditions or turbid water.

The 1989 herring harvest for the AYK Region was approximately 7,300 tons with a total estimated ex-vessel value of $3,561,000. Harvest identified as food and bait primarily occurs during the sac roe fishery when fish are sold with a roe content that is below buyer's acceptable minimums. Food and bait sales totaled 595 tons, with the remaining harvest sold for sac roe product. A total of 1,074 fishermen participated in AYK sac roe herring fisheries during the 1989 season. Two hundred forty three more fishermen fished in 1989 than in 1988.

The total estimated herring biomass of 43,970 tons for the surveyed portion of the AYK herring districts was two-thirds of the 1988 estimate of 64,760 tons. Ages 7, 8, and 10 herring dominated the AYK herring biomass. Older herring, age 9 and older, comprised 47% of the return. Recruits, age 3, 4, and 5 year old herring, accounted for 8% of the total biomass.

The AYK harvest was taken by gill nets with the exception of Norton Sound, where a small portion of the harvest was taken by beach seine. An attempt was made to sample at least 210 herring from each commercial harvest by gear for each fishing period. Similar sampling goals were set for all test fishing projects for each weekly sampling period. The age class composition of the escapement was based on the age class composition of test fish or commercial samples obtained from non-selective gear types (ADF&G variable-mesh gill net and commercial beach seine catches). Age composition of the entire run was calculated by combining the numbers of fish by age class in the commercial catch with those in the escapement. Herring ages were determined from scales.

In 1989, herring from test fish and commercial catches were sampled in all but the Port Clarence District to estimate age, size, and sexual maturity of herring and to note occurrence of other schooling fishes. Over 18,000 herring from commercial and test catches were sampled from seven of the eight AYK herring districts during the 1989 fishing season. This is more than twice the number sampled in 1988. This increased sample effort was necessary to obtain sufficient samples for a stock identification study of Bering Sea herring requested by the North Pacific Fishery Management Council. The intent of this study is to identify stocks caught in the herring bycatch by the domestic trawl fleet in the southeastern Bering Sea.

A schedule of increasing mortality with age was used to project the 1990 population. Methods to reliably estimate recruitment have not been developed. Therefore, returns of ages 3- through 5-year-old herring could increase the 1990 observed herring biomass over the projected biomass estimates. Inseason assessment of herring biomass will supercede projected biomass for management of the herring fisheries in all AYK districts except in situations where an inseason estimate is not available.

Based upon apparent weak recruitment of younger age classes (ages 3-5) and reduced returns of the abundant 1977 and 1978 year classes due to high natural mortality of older aged herring, a decline in the total harvestable surplus of Pacific herring in the AYK region is expected for 1990. Projections from post-season escapement estimates, using mean rates of natural mortality and growth for each age class, indicate that the 1990 minimal spawning biomass for the northeastern Berring Sea Pacific herring stocks (Security Cove to Port Clarence) should be approximately 27,210 tons. A decrease in herring biomass compared to 1989 levels is expected for all fishing districts. Increased recruitment could raise the 1990 observed biomass over the projected biomass estimates. However in accordance with AYK Region harvest policy, newly recruited age classes (age 3-, 4-, and 5-year-old herring) will not be targeted by the commercial fishery.

Security Cove Sac Roe Fishery

The Security Cove District consists of all waters between the latitudes of Cape Newenham and the Salmon River.

Historically, the estimated biomass of herring in the Security Cove District has ranged from 1,200 tons in 1980 to 21,500 tons in 1979 (Figure 19). During 1989, nine aerial surveys were flown from May 8 to May 24 in the district to estimate herring biomass and spawning activity. Seven of these surveys were flown under poor or unacceptable survey conditions. Herring were first seen in the district on May 11 when the season's largest biomass of 2,830 tons was observed under fair conditions. Light spawning activity was first documented during an aerial survey on May 13. A total of 3.1 linear miles of spawn was documented during the season.

The total 1989 harvest of 554 tons of herring was taken during one four hour opening on May 17. The harvest included 544 tons of sac roe herring with an average roe percentage of 9.4% and 10 tons of bait quality herring. The harvest

was 20% of the estimated biomass. Eight processors in Security Cove paid the 110 participating fishermen approximately $450 per ton for 10% sac roe herring and $50 per ton of bait quality herring. The total ex-vessel value of the harvest was approximately $256,500.

Department test fishing was conducted from May 10 to May 22 using variable mesh gill nets. Approximately 230 herring were sampled for age, sex, length, and weight data. Scales from an additional 1,440 herring were collected for the stock identification project. A sample of 225 herring was taken from the commercial catch.

Herring in this area are near full recruitment by age 5. Substantial recruitment in the Security Cove District was last observed in 1982 and 1983 when approximately 12 million and 6.4 million age 5 herring from the 1977 and 1978 year classes, respectively, were estimated in the spawning population (Figure 20).

In 1989, ages 8, 10, and 11 dominated the spawning population in both numbers and biomass of fish (Figure 21 and Table 11). Nearly 60% of the biomass consisted of age 9 and older herring. Recruits, ages 4 and 5 herring, represented approximately 6% of the biomass.

The 1990 projected return is 1,560 tons which at a 15% exploitation rate would result in a harvest of about 235 tons (Table 11). Ages 9, 7, and 11 fish are expected to dominate in numbers of fish (Figure 22). Age 9 and older herring are expected to comprise 70% of the biomass.

Emergency order authority will be used to adjust the occurrence and length of fishing periods commensurate with stock strength, fishing effort, and spawning activity. Commercial fishing will not be allowed until total biomass reaches 1,200 tons or significant spawning activity is documented. The harvest level will be maintained at 15% or less, unless available biomass significantly exceeds the 1990 projection. If this occurs, an exploitation rate of up to 20% may be allowed.

Goodnews Bay Sac Roe Fishery

The Goodnews Bay District consists of the waters of Goodnews Bay inside the north and south spits and a line between the Ufigag River and the Tunulik River. Historically, the estimated biomass of herring in the Goodnews Bay District has ranged from 400 tons in 1980 to 7,400 tons in 1979 (Figure 23). These years also represent the lowest and highest herring biomass observed in Togiak and Security Cove. However in many years including 1979, there was no biomass estimate from aerial survey due to poor survey conditions. In these years, the preseason projection was generally used to estimate herring biomass. In 1989, nine aerial surveys were flown from May 8 to May 24 in the Goodnews Bay District. Seven of these surveys were flown under poor to unacceptable conditions. The peak inseason biomass estimate of 4,044 tons was observed on May 24. A total of 1.2 linear miles of milt was observed in three sightings during aerial surveys. The Department test fish crew first documented spawning activity on May 11.

The 1989 herring harvest in the Goodnews Bay District totaled 616 tons. The district was opened to commercial fishing on May 23. Eight fishing periods were scheduled from May 23 to May 29 for a total of 56 hours of fishing time. There was limited fishermen participation during two eight hour openings on May 26 and 27 due to bad weather. The initial harvest guideline of 460 tons was increased to 660 tons on May 24 when 4,044 tons of herring were sighted during an aerial survey. The harvest included 454 tons of sac roe herring with an average roe content of 8.4% and 162 tons of bait quality herring. The harvest was 15.2% of the estimated spawning biomass. There were 138 fishermen who made 533 deliveries to six processors. Fishermen received approximately $540 per ton for 10% sac roe herring and $50 per ton for bait quality herring. The total ex-vessel value of the harvest was approximately $335,000.

A Department test fish crew caught 3,600 herring in variable mesh gill nets from May 6 to May 29. Approximately 640 of these were sampled for age, sex, length and weight data. Scales were collected from an additional 1,550 herring for the stock identification project. A total of 500 herring were sampled from the Goodnews Bay commercial catch.

Similar to Security Cove and Togiak Districts, the 1977 year class, which returned as 5 year olds in 1982, represents the largest year class in the data series (Figure 24).

In 1989, ages 10 and 11 contributed the major portion of the biomass, however ages 10 and 5 dominated in numbers of fish (Figure 25). Nearly 70% of the total run by weight was age 9 and older herring. Recruits, ages 3, 4, and 5 herring, represented nearly 10% of the biomass.

The 1990 projected return is 2,330 tons which at a 15% exploitation rate would result in a harvest of about 350 tons (Table 12). In 1990, 6, 11, and 7 year old herring are expected to dominate the run in numbers of fish and ages 11, 6, and 12 are expected to dominate the biomass (Figures 25 and 26). Age 9 and older herring are expected to comprise approximately 65% of the biomass.

The management strategy for this district will be similar to that used for Security Cove. The season will be opened by emergency order. Commercial fishing will not be allowed until total biomass reaches 1,200 tons or significant spawning activity is documented. The harvest level will be 15% or less, unless available biomass greatly exceeds the 1990 projection at which time a higher exploitation rate may be allowed.

Cape Avinof Sac Roe Fishery

The Cape Avinof District consists of all waters extending inshore of Kikegteg, Pingurbek, and Kwigluk Islands from the longitude of Tsintulik Slough to the longitude of Ursukfak River. The Cape Avinof District was created as a commercial herring district at the December 1987 Alaska Board of Fisheries meeting and therefore was opened to the commercial harvest of herring for the first time in 1988. In 1989, at the request of the Kwigillingok IRA Council, the eastern

boundary of the Cape Avinof District was extended to three miles east of the village of Kwigillingok on May 1 by emergency order.

Aerial surveys have been conducted systematically in the Cape Avinof area since 1985. An estimated herring biomass of 2,000 tons, 1,225 tons, and 4,100 tons were observed in 1985, 1987, and 1988, respectively. Weather conditions precluded an aerial survey biomass estimate in 1986. In 1989, ice conditions hindered aerial survey efforts and delayed the start of test fishing until June 1. Only one of the seven aerial surveys of the Cape Avinof District was flown under acceptable conditions. During an aerial survey on May 31, department biologists observed 689 tons of herring among ice floes. Spawning activity was first documented by the test fish crew on June 1. The peak biomass estimate of 689 tons was observed under unsatisfactory conditions on May 31. Only 0.04 linear miles of spawn was observed during aerial surveys.

In 1989, the Cape Avinof District was opened to commercial fishing for eight hours on June 4. Due to low catch rates, this opening was extended until further notice. Catch rates during the 1989 season remained low and on June 9 the last processor departed the district. Cape Avinof was closed to commercial fishing on June 12 when it became apparent that no processors were available. A total of 194 hours of fishing time resulted in a harvest of 129 tons of herring, which was 288 tons short of the harvest guideline. The harvest was 18.7% of the peak observed biomass and 5% of the preseason projected biomass. The harvest included 90.4 tons of sac roe herring with an average roe recovery of 8.0% and 38.5 tons of bait quality herring. Three processors paid the 147 fishermen an average of $410 per ton for 10% sac roe herring and $50 per ton for bait quality herring for a total ex-vessel value of $54,000.

Department test fishermen caught 2,030 herring in variable mesh gill nets from June 1 to June 12. Approximately 320 of these were sampled for age, sex, length and weight data. Scales were collected from the remaining 1,690 herring for the stock identification project. A total of 500 herring were sampled from the Cape Avinof commercial catch.

Age 10 herring from the 1979 year class represented 18% of the run by weight whereas age 5 herring dominated the return in numbers of fish (Table 13 and Figures 27 and 28). Age 9 and older herring comprised approximately 50% of the biomass. Younger herring, ages 3, 4 and 5, represented approximately 17% of the return by weight.

Since the peak aerial survey estimate of biomass in 1989 was observed under unacceptable survey conditions, the 1989 preseason projection of 2,800 tons was used to estimate the 1990 return. The return to the Cape Avinof District in 1990 is estimated to be 2,024 tons, which at an exploitation rate of 15% would result in a 300 ton harvest (Table 13). Age 6 herring are expected to be the largest age group in both biomass and numbers of fish (Figures 27 and 28). Age 9 and older herring are expected to comprised 50% of the return.

The 1990 Cape Avinof District commercial herring fishery will be regulated by emergency order. Commercial fishing will not be allowed until the total biomass

reaches 500 tons or significant spawning is observed. Commercial harvest of Pacific herring will be up to 15% of the total spawning biomass.

Nelson Island Sac Roe Fishery

The Nelson Island District consists of all waters north of Chinigyak Cape and south of the southeast tip of Kigigak Island and east of 165° 30′ W longitude.

Since 1985, the biomass estimates of herring in the Nelson Island District have ranged from 3,316 tons in 1989 to 9,500 tons in 1985 (Figure 29). During the 1989 herring season, twelve aerial surveys were flown from May 24 to June 12. Nine of these surveys were rated either poor or unacceptable. The peak biomass of 2,800 tons was seen under fair conditions on May 25. A total of 6.55 linear miles of spawn was observed in 16 sightings during aerial surveys with peak spawn observed on May 26. A second peak biomass of 517 tons was observed on June 1. The difference in age composition between Department test fish samples collected around May 25 and June 1 indicates that the fish observed on May 25 were different from those on June 1. Biomass observations made on May 25 and June 1 were added together to estimate a total biomass of 3,316 tons for the district.

The district was first opened to commercial herring fishing on May 28. Five fishing periods were scheduled from May 28 to June 7 for a total of 15 hours of fishing time. The 233 ton harvest included 122 tons of sac roe herring with an average roe recovery of 8.5%, 100 tons of bait and 11 tons could not be sold and were discarded. The harvest was 7% of the estimated spawning biomass. During the May 27 opening, most herring were located within closed areas and therefore were unavailable to fishermen. Unfavorable ice conditions also complicated the fishery in 1989, especially for Toksook Bay fishermen. Four processors paid the 162 participating fishermen an average of $500 per ton for 10% sac roe herring and $50 per ton for bait quality herring. Total ex-vessel value of the harvest was $57,000.

A Department test fish crew caught approximately 2,140 herring in variable mesh gill nets from May 23 to June 8 and sampled 500 of these for age, sex, length and weight composition. Scales from an additional 1,640 herring were collected for the stock identification project. A sample of 388 herring was taken from the commercial catch.

Since 1980, recruitment strength, as represented by the abundance of age 5 herring, has ranged from less than one million recruits from the 1982 year class, which were observed in the 1987 return, to approximately 11 million fish from the 1977 year class, which were observed during the 1982 department test fishery (Figure 30).

Age 10 and 11 herring dominated the 1989 return by weight and numbers (Table 14 and Figure 31). Recruits, ages 3, 4 and 5, represented 16% of the biomass. Seventy percent of the biomass consisted of age 9 and older herring.

The spawning biomass projected to return to the Nelson Island District during 1990 is 2,050 tons. This is below the 2,500 ton threshold required to open the fishery. However, processors and fishermen are advised that management of the 1990 fishery will be based on observed biomass. Commercial fishing will not be allowed until total biomass reaches 2,500 tons or significant spawning activity is documented.

In 1990, ages 11 and 6 are expected to dominate the return in numbers of fish (Figure 31). Herring of age 9 and older are expected to comprise over 70% of the biomass (Figure 32). The harvest level will be maintained at 10% unless available biomass significantly exceeds the 2,500 ton threshold level.

As in 1989, the Nelson Island commercial fishery will be regulated by emergency order. To provide additional protection for the subsistence harvest of Pacific herring, the following guidelines will be followed:

1. The commercial fishery will be allowed to take up to 15% of the herring biomass, compared to up to 20% for most other fisheries having stocks of similar size and condition.

2. The commercial fishing season will be opened when a biomass of 2,500 tons or significant spawning activity is documented.

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

4. 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.

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

Nunivak Island Sac Roe Fishery

The Nunivak Island District consists of all waters extending three miles seaward of mean low water from Kikoojit Rocks to the small bay approximately two miles east of Ingrirak Hill.

Since 1985, the observed biomass in the Nunivak Island District has ranged from 600 tons in 1989 to 6,000 tons in 1986 (Figure 33). During 1989, ten aerial surveys were flown between May 19 and June 12 with peak biomasses of 480 tons and 137 tons observed on May 24 and June 2, respectively. Half of these were flown in poor to unacceptable survey conditions. Based on differences in age composition and the length of time between the two observed peaks, these fish were judged to be different groups of fish. Therefore, the estimated biomass of 617 tons for the Nunivak Island District is a combination of these two peaks.

Nearly 3 linear miles of milt was observed in the district during aerial surveys.

The district was first opened to commercial herring fishing on May 25 after an aerial survey on May 24 documented 480 tons of herring and spawning activity. The fishery was opened until further notice on May 27 and closed on June 3. Catch rates during the 1989 season were low. A harvest of 116 tons was taken by 45 fishermen in 186 hours. This harvest included 79 tons of sac roe product with 9.4% roe and 37 tons of bait quality herring. Three processors paid 45 fishermen an average of $500 per ton for 10% sac roe herring and $50 per ton for bait quality herring. The total ex-vessel value of the Nunivak Island harvest was $42,000.

A Department test fish crew caught approximately 1,320 herring in variable mesh gill nets from May 21 to June 12 and sampled 490 of these for age, sex, length and weight composition. Scales from an additional 830 herring were collected for the stock identification project. A total of 480 herring were sampled from the commercial catch.

Since 1985, the strongest year class as determined by the abundance of 5 year olds in the spawning population was the 1981 year class which contributed 3.4 million recruits to the 1986 run (Figure 34).

Ages 10 and 11 herring dominated the return in both numbers and biomass (Figure 35 and Table 15). Seventy-five percent of the biomass consisted of age 9 and older herring. Younger fish, age 3, 4, and 5 herring, represented only 2% of the run.

The biomass of herring projected to return to the Nunivak Island District during 1990 is 320 tons. This is below the threshold of 1,500 tons needed to open the fishery. However processors and fishermen are advised that management of the 1990 fishery will be based on observed biomass. As in 1989, the Nunivak Island District commercial herring fishery will be regulated by emergency order. Commercial harvest of Pacific herring will be up to 15% of the observed spawning biomass. Commercial fishing will not be allowed until total biomass reaches 1,500 tons or significant spawning activity is documented.

Ages 11 and 12 year old herring are expected to dominate the spawning population in both biomass and numbers of fish. Age 9 and older herring are expected to comprise 74% of the return (Figures 35 and 36).

Cape Romanzof Sac Roe Fishery

The Cape Romanzof District consists of all waters between the latitude of Dall Point and 62° N latitude.

Since 1975, the estimated biomass of herring in the Cape Romanzof District has ranged from 3,000 tons in 1978 to 7,500 tons in 1986 (Figure 37). Due to excessive water turbidity, it is generally not possible to estimate herring

biomass from aerial surveys. Therefore, biomass has been estimated using a combination of information from test and commercial catches, spawn deposition, and age composition. In 1989, aerial surveys were flown on May 24, 25, 26 and 30. A very small number of herring were observed under unsatisfactory survey conditions on May 24. Several large schools were observed in Scammon Bay on May 26, but no biomass estimate was obtained. It was not possible to estimate herring spawning biomass based on aerial surveys due to turbid water conditions during 1989. Evaluation of spawn deposition surveys, test fishing, and age composition data from test and commercial catches resulted in an estimate of 4,400 tons.

The 1989 commercial herring season in the Cape Romanzof District opened on May 26. The total harvest of 926 tons was taken during four fishing periods, established by emergency order, from May 26 to May 31. A total of 13 hours of fishing time was allowed. The majority of the harvest was sac roe with an average roe recovery of 9.3%; only 1 ton was bought as bait herring. The harvest was 21% of the estimated available biomass. A total of 115 fishermen participated in the fishery, the second highest number on record. Six buyers in the Cape Romanzof District paid fishermen approximately $560 per ton for 10% sac roe herring and $51 for bait quality herring. The total ex-vessel value of the harvest was approximately $486,500.

Department test fishing was conducted from May 22 to June 3 using variable mesh gill nets. A total of 2,003 herring were caught, of which 451 were sampled for age, sex, length, and weight data. Scales were collected from the remaining 1,552 herring as part of the stock identification project. A sample of 866 herring was taken from the commercial catch.

Ground surveys indicated that spawn deposition occurred from May 24 through the termination of the project on June 3 with the majority of spawn deposited from May 25 to June 2. Heavy snow fall, cold temperatures, and a large amount of ice in Kokechik Bay affected the timing of spawning. Shore ice, which covered many spawning areas also delayed deposition. The first indication of spawn deposition occurred on May 24, five days later than in 1988. A large storm on May 28 increased egg mortality by eroding eggs from rock and *Fucus* substrates. Spawn deposition occurred over an extended time period and averaged between 1 and 2 egg layers in primary spawning areas.

Year class strength, as measured by the number of age 5 herring in the spawning population, has ranged from less than half a million recruits from the 1975 year class, which returned as 5 year olds in 1980 to nearly 9 million recruits from the 1977 year class, which were observed in the 1982 spawning population (Figure 38).

Approximately 20% of the 1989 return by weight and numbers of fish was composed of age 8 herring (Table 16 and Figure 39). Age 9 and older herring comprised 54% of the biomass. Recruits, age 3, 4, and 5 herring, represented 9% of the biomass.

The projected return for 1990, based upon limited data, is 2,410 tons which at a 15% exploitation rate would result in a 360 ton harvest (Table 16). Age 9

herring are expected to comprise the largest age group in biomass (Figure 40). Age 6 fish are expected to dominate the return in numbers of fish.

Emergency order authority will be used to adjust the occurrence and length of fishing periods. A minimum level of biomass cannot be used to determine the timing and duration of commercial fishing periods since turbid water conditions usually preclude aerial biomass assessments. Therefore, spawn deposition observations and test and commercial catch rates will be used to determine timing and duration of commercial fishing periods and relative stock abundance.

Norton Sound Sac Roe Fishery

The Norton Sound District consists of all waters of Alaska between the latitude of the westernmost tip of Cape Douglas and the latitude of Canal Point Light.

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.

Herring biomass in the Norton Sound District has fluctuated from 5,300 tons in 1978 to nearly 34,000 tons in 1988 (Figure 41). During 1989, seventeen surveys were flown on fourteen different days, from May 16 to June 7, for a total of 45 hours of aerial survey time. Fifteen of these surveys were rated poor or unacceptable. Two peak biomasses were observed during aerial surveys. These were judged to be different groups of fish based on age composition, the length of time between the peaks and knowledge of herring migratory patterns and residence time in Norton Sound. The first peak of 6,896 tons was observed May 27 and the second peak of 19,085 tons occurred on June 2. Both peaks were observed under unacceptable aerial survey conditions. The biomass seen on May 27 was added to that observed on June 2 to give a combined biomass estimate of 25,980 tons. Because of the exceptionally poor survey conditions in 1989, it is likely that this is an underestimation of the actual biomass that was present in Norton Sound. A total of 64 linear miles of spawn was observed during aerial surveys.

The 1989 Norton Sound herring fishery opened by emergency order on May 27. A total of three gill net openings for 10 hours of fishing and four beach seine openings for 14 hours of fishing occurred this season. The entire district was closed on May 30. The harvest of 4,741 tons of herring was 18% of the estimated biomass. The harvest included 4,494 tons of sac roe herring with an average roe recovery of 9.2% and 247 tons of bait herring. In addition, approximately 30 tons were estimated to have been wasted in abandoned gill nets and a lost beach seine set. There were 357 fishermen, who made at least one delivery during the season, consisting of 351 gillnetters and 6 beach seiners. This is the second highest effort on record. The harvest by gill nets was 4,352 tons with 9.3% average roe recovery. Beach seiners landed 390 tons herring with 8.5% roe. Nine companies registered 12 processing vessels and 53 tenders to operate in Norton Sound for the 1989 season. Fishermen received approximately $555 per ton for

10% sac roe herring and $51 per ton of bait quality herring. The total value of the herring harvest to fishermen was approximately $2,322,274.

Waters from Wood Point to Shaktoolik were ice free during the fishery and aerial surveys. However, these waters were turbid due to strong winds during the ice free period prior to the fishery, and never cleared sufficiently for acceptable aerial surveys. Shore ice was present in all subdistricts prior to the opening of the fishery but sea ice had broken up and begun moving early in the season; the Cape Denbigh (Shaktoolik subdistrict), Unalakleet and St. Michael areas were predominantly ice free by the fishery opening. Winter weather conditions prevailed in the northern subdistricts until well after the fishery, which took place in the southern subdistricts.

Two department test fishing projects operated during the 1989 season. One project was located at Cape Denbigh and operated from May 25 to June 13. A second crew started fishing in Unalakleet on May 26 but moved to the Klikitartik camp on May 27, and continued there until June 6. Test fish crews sampled 1,074 herring caught with variable mesh gill nets for age, sex, length and weight data. Scales from an additional 1,810 herring were collected for the stock identification project. A sample of 870 herring was taken from the commercial catch.

Historical year class strength in Norton Sound, as measured by the number of age 5 herring in the spawning population, has ranged from 3 million recruits from the 1983 year class, which returned as 5 year olds in 1988, to nearly 55 million recruits from the 1977 year class, which were observed in the 1982 spawning population (Figure 42).

Approximately one-third of the return by weight and by number consisted of age 7 herring; age 8 comprised 19% of the run by weight (Table 17 and Figures 43 and 44). Recruits, ages 3, 4 and 5 represented approximately 7% of the biomass. A large number of three year olds were caught in the Cape Denbigh test net on June 13. However, these fish were not included in age composition summaries of the population since there was no aerial survey estimate for this time period.

The projected return for 1990 is 16,520 tons which at a 20% exploitation rate would result in a harvest of 3,300 tons. The 1990 spawning population is expected to be dominated primarily by 8 year olds (Figures 43 and 44).

Inseason assessment of herring biomass will supercede projected biomass for management of the Norton Sound herring fishery except where weather prevents obtaining an inseason estimate. The harvest by the beach seine fishery is already set by regulation at 10% of the allowable harvest. The actual return of herring in 1990 may exceed the projection due to the return of younger fish which were not included in the projection and the conservative 1989 biomass estimate from poor aerial survey conditions.

The 1990 herring fishery will be opened by emergency order. The fishery will close by emergency order when up to 20% of the available Pacific 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. The beach seine guideline harvest level will be 330 tons.

Port Clarence Sac Roe Fishery

The Port Clarence District consists of all waters between the latitude of Cape Douglas and the latitude of Cape Prince of Wales.

This district is characteristically not surveyable due to ice, water stain, or poor weather. In addition, it is difficult to identify herring due to the large numbers of saffron cod, whitefish, and other pelagic species in the area. The herring biomass in 1987 and 1988 was estimated to be 900 tons and 788 tons, respectively. These observations were made during poor to unacceptable aerial survey conditions. Two aerial surveys were flown in 1989. Conditions were unacceptable due to poor weather conditions and no fish were observed.

There was no commercial or test fishery in Port Clarence in 1989 since there was no buyer in the district. Therefore, there is no age composition data available for the 1989 return. Age composition of Port Clarence herring in 1988 was different from any other AYK district for that year; one-half of the biomass consisted of age 6 or younger herring.

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 as set by the Board of Fisheries in 1981 will determine the allowable harvest in 1990. This harvest guideline is based on 2 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. In 1989, 6 and 7 year old herring were expected to dominate the return in both numbers and biomass of fish. Therefore ages 7 and 8 are expected to dominate the 1990 return.

WESTWARD REGION

By

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WESTWARD REGION

Kodiak Food and Bait Fishery

The 1988/1989 Kodiak food and bait fishery opened on August 1, 1988 and closed by regulation on February 28, 1989. Removals from the east Shelikof fishery on Kamishak spawning stocks totaled 327 tons of the 340 ton harvest, with the remaining 13 tons accounted for by local Kodiak spawning stocks. The harvest projection for 1990 is 573 tons. Under the management plan adopted by the Alaska Board of Fisheries, the food and bait herring fishery in eastern Shelikof Strait is allocated 2% of the spawning biomass of the Kamishak spawning herring stock.

Kodiak Sac Roe Fishery

The Kodiak commercial sac-roe herring season began at 12:00 noon April 15. Fishing continued through 12:00 noon June 30 with 24 hour fishing periods separated by 24 hour closures. Eighty-two gillnet permit holders and 37 purse seine permits made a total of 792 landings which accounted for 2,249 tons of herring harvested. Sixty-seven percent of the harvest was taken by seine gear and thirty-three percent was taken by gillnet gear. Seven buyers/processors participated in 1989. Roe percentage averaged approximately ten percent. Age 5- and 6-year-old herring comprised the majority of the harvest with an overall average weight of approximately 200 grams. Oil from the Exxon Valdez spill on March 24 resulted in 34 management unit closures due to the potential contamination and subsequent waste of the herring harvested. Twenty-six units were closed prior to any harvest. Six management units were closed after initial harvests had occurred. The pre-season guideline harvest level for these units was 670 tons. There were 153 tons harvested prior to closures leaving a guideline harvest level balance of 516 tons not available for harvest. The preseason guideline harvest level for the entire management area was 2,415 tons, less the 518 tons not available for harvest. A guideline harvest level of 1,897 tons remained for the managements units not affected by oil contamination during the course of the herring fishery. The actual harvest of 2,229 tons was approximately 332 tons higher than the pre-season guideline harvest level; this was primarily due to new stocks being exploited and better than expected spawning biomass in major management units. Age 1- and 2-year-old herring appear to be present in the entire Kodiak Management Area at record levels which should start contributing significantly to the commercial harvest beginning in 1992. The guideline harvest level for 1990 is 2,100 tons.

Chignik Sac Roe Fishery

A total of six seiners participated in the 1989 Chignik sac roe herring fishery. The fishery was open April 15 through June 30 on odd days only, with the harvest totaling 66.1 tons. The herring sac-roe fishery in the Chignik Management Area can be characterized as a low yield, low participation fishery because of the low abundance and dispersed nature of the stocks. Although no formal forecasts for Chignik herring are produced, it is anticipated that the harvest level will be between 50 and 80 tons in 1990.

Port Moller Sac Roe Fishery

On May 28 some harvest occurred just north of the Port Moller District boundary. After May 28 all the harvest occurred in the Port Moller District. From May 28 to June 23, 8 seiners harvested 744.7 tons. For the first time since 1985, Port Moller was not inundated by seine vessels immediately after the Togiak season closed. The average roe recovery was 9.6% with an average price of $425.00/ton, with $42 for every percentage point above or below 10%. The North Peninsula fishery was worth approximately $304,000 to the fishermen.

South Peninsula Sac Roe Fisheries

Harvest guidelines were established preseason based on past fishing performance and general information on stock size gathered from department and industry aerial surveys. Areas where little information on stock size was known were left open for exploration. The commercial sac-roe fishery on the South Peninsula occurred in 7 locations: Canoe Bay, Paylof Bay, Lenard Harbor, Stepovak, Shumagin Islands, Balboa Bay, and Dolgoi Island. As usual, the majority of the harvest (48%) came from Canoe Bay. From May 13 to June 17, 310 tons were harvested by 12 seine vessels. The average roe recovery was 7.7% with an average price of $500/ton for 10% roe recovery making the value to the fishery approximately $113,000 to the fishermen.

Dutch Harbor Food and Bait Fishery

The revised 1989 Togiak herring biomass for the season was 110,108 short tons. At a 20% exploitation rate, the allowable harvest was then 20,022 tons. The 1989 Togiak roe on kelp harvest was 2,469 short tons which resulted in an exploitation rate of 15% or 12,039 tons for the spring sac-roe fishery. The remaining unutilized harvestable biomass then totaled 5,514 tons. According to the Bering Sea Herring Fisheries Management Plan adopted in November, 1987 by the Board of Fisheries, the Dutch Harbor fishery allocation may not exceed 3,100 short tons. Therefore, The 1989 Dutch Harbor food and bait herring harvest quota was 3,100 short tons. The Dutch Harbor food and bait herring fishery started

July 16, 1989 at 12:01 A.M., with a total of seven seiners, two gillnetters, and six tenders participating. The season ended 21 days later at 12:00 midnight August 5, 1989, with an estimated 3,101 short tons harvested. Of that total, approximately 800 tons were processed as food herring at $1.25/lb for an ex-vessel value of $200,000 and 2,301 tons were processed as bait herring at $0.15/lb for an ex-vessel value of $690,000. The nine vessels participating in the fishery averaged 150 tons of herring harvested per day in the 21 day fishery for five different processing companies.

Table 1. Glossary of some terminology used in describing herring stock assessment.

Term	Definition
Age class	A group of fish of the same age from the same population, referenced by their current age, e.g., the 5-year-old age class of 1989 was spawned in 1984.
Cohort	A group of fish of the same age from the same population, referenced by the year in which they were spawned, e.g., the 1984 cohort was spawned in 1984.
Escapement	That portion of the population returning to spawn which survives the commercial fishery.
Natural mortality	All non-commercial fishing sources of mortality.
Pound Spawn-On-Kelp Fishery	A fishery that suspends harvested kelp in floating enclosures in which herring are held after being captured by purse seines until spawning occurs.
Recruits	A young age class of fish during the first year in which they appear on the spawning grounds in substantial numbers, usually at age 3 or 4.
Short Ton	2,000 pounds
Spawning Biomass	The weight of the spawning herring stock.
Spawning Population	The number of fish in the spawning herring stock.
Wild Spawn-On-Kelp Fishery	A fishery which harvests naturally occurring kelps on which herring eggs have been deposited.
Year Class	Same definition as cohort.

Table 2. Alaska herring fisheries, area management offices and fishery managers to contact for additional information.

Fishery	Office	Manager Name	Telephone (907)
All Southeast Region Fisheries	Juneau	Paul Larson	465-4250
Kah Shakes Sac Roe	Ketchikan	Philip Doherty	225-5195
Sitka Sound Sac Roe	Sitka	Robert DeJong	747-6688
Seymour Canal Sac Roe	Petersburg	William Bergmann	772-3801
Southeast Food and Bait	Juneau	Paul Larson	465-4250
All Central Region Fisheries	Anchorage	Dennis Haanpaa	344-0541
Prince William Sound	Cordova	James Brady	424-3213
Lower Cook Inlet	Homer	Wes Bucher	235-8191
Upper Cook Inlet	Soldotna	Paul Ruesch	262-9368
Togiak	Dillingham	Jeff Skrade	824-5227
All AYK Region Fisheries	Anchorage	Richard Cannon	267-2128
Kuskokwim Area Fisheries	Bethel	Kim Francisco	543-2433
Cape Romanzoff	Anchorage	Dan Bergstrom	267-2128
Norton Sound	Nome	Charles Lean	443-5167
Port Clarence	Nome	Charles Lean	443-5167
All Westward Region Fisheries	Kodiak	Peter Probasco	486-4791
Kodiak Area Fisheries	Kodiak	Larry Malloy	486-4791
Chignik	Kodiak	Michael Thompson	486-4791
Dutch Harbor Food and Bait	Dutch Harbor	Al Quimby	581-1239
Port Moller	Kodiak	Arnold Shaul	486-4791
South Peninsula	Kodiak	Len Schwarz	486-4791

Table 3. Summary of the 1989 Alaska herring season and the preliminary forecast for the 1990 season. Harvests and spawning biomasses are listed in short tons (2,000 lbs).

Stock/Fishery	1989 Opening or First Harvest	1989 Harvest	1990 Harvest	1990 Exploitation Rate	1990 Mean Wt. (g)	1990 Spawning Biomass	1990 Stock Status Level	1990 Stock Status Trend
Southeastern								
Kah Shakes	3/20	592	0			3,300	Depressed	Declining
Sitka	3/31	12,135	4,150	15.0%	118	27,000	Moderate	Declining
Seymour Canal	4/28	547	312	10.2%		3,150	Depressed	Declining
Lynn Canal	Closed due to low stock abundance						Depressed	Stable
Hoonah Snd. Pound			11[a]			4,000	High	
Food and Bait	1/01	3,400	3,400				Moderate	Stable
Prince Wm. Sound								
Seine	Closed due to oil		6,038					
Gill Net	Closed due to oil		353					
Pound Kelp	Closed due to oil		118[a]					
Wild Kelp	Closed due to oil		104[a]					
Food and Bait	11/01	656	1,694[b]					
Total			10,392[c]	20.1%[d]	142	51,692[d]	High[d]	Stable[d]
Lower Cook Inlet								
Eastern and Outer Districts	Closed due to oil		700					
Southern District	4/20	171	175					
Kamishak District	4/20	4,800	2,292	10.0%[e]	201	28,653	High	Stable
Upper Cook Inlet								
Sac Roe	4/22	172	80			Unknown	Depressed	Increasing
Food and Bait	4/30	45	50			Unknown	Depressed	Increasing
Kodiak								
Sac Roe	4/15	2,249	2,100		200		Moderate	Stable
Food and Bait								
Eastern Shelikof	8/01	327	573					
Other Kodiak	8/01	13	278		200	Unknown	Moderate	Stable
Chignik Sac Roe	4/15	66	65			Unknown		
Alaska Peninsula								
Port Moller	5/28	745	375		220	2,500	Moderate	stable
South Peninsula	5/13	310	400		250	Unknown	Moderate	stable
Dutch Harbor								
Food and Bait	7/16	3,101	679					
Bristol Bay (Togiak)								
Seine	5/12	9,413	6,769					
Gill Net	5/09	2,843	2,256					
Spawn on Kelp	5/14	280[a]	175[a]					
Total		16,857[f]	11,204[f]	20.0%	361	56,020	Moderate	Declining
Kuskokwim Area								
Security Cove	5/17	554	235	15.0%		1,560	Moderate	Declining
Goodnews Bay	5/23	616	350	15.0%		2,330	Moderate	
Cape Avinof	6/04	129	300	15.0%		2,020		
Nunivak Island	5/22	116	[g]	15.0%		320		Declining
Nelson Island	5/28	233	[g]	10.0%		2,050		Declining
Cape Romanzof	5/26	926	360	15.0%		2,410		Declining
Norton Sound								
Gill Net	5/27	4,381						
Beach Seine	5/27	390						
Total		4,771	3,300	20.0%		16,520	Moderate	Stable
Port Clarence	No harvest		165					
Sac Roe Harvest Total:[h]		41,387	30,775					
Food and Bait Harvest Total:		7,542	6,674					
Total Herring Harvest:		48,929	37,449					

[a] Harvest of spawn-on-kelp product in short tons.

[b] Preliminary 1989 food/bait guideline. The 1990 guideline will be set after 1990 sac-roe season.

[c] Includes mortality allowances of 1,532 and 863 tons for pound and wild spawn on kelp fisheries.

[d] Preliminary forecast pending evaluation of Exxon Valdez oil spill impacts. Subject to revision.

[e] Kamishak District exploitation rate includes the eastern Shelikof food and bait harvests.

[f] Togiak total harvest includes an allowance for 1,500 tons mortality for the spawn-on-kelp fishery.

[g] Projected biomass below minimum for commercial harvest; fishery will be opened if threshold biomass observe

[h] Sac roe statewide total harvests do not include allowances for spawn-on-kelp fishery mortality.

Table 4. Summary of the 1989 Alaska commercial herring sac roe fishery harvests, values, roe percentages, and number of participating permittees.

Fishery	Harvest (tons)	Estimated Price Per Ton	Estimated Ex-Vessel Value	Average Roe Percent	No. of Participating Permittees
Southeastern					
Kah Shakes	592	$1,310	$780,000	12.0%	88
Sitka Sound	12,135	$100	$1,213,500	9.4%	51
Seymour Canal	547	$1,290	$708,000	12.7%	104
Lynn Canal	Closed due to low stock abundance				
Prince William Sound					
Seine	Closed due to oil				
Gill Net	Closed due to oil				
Total					
Lower Cook Inlet					
Eastern District	Closed due to oil				
Outer District	Closed due to oil				
Southern District	171	$500	$86,000	9.5%	10
Kamishak District	4,800	$500	$2,400,000	9.5%	80
Upper Cook Inlet	172	$500	$86,000	10.3%	50
Kodiak	2,249	$850	$1,911,225	10.0%	119
Chignik	66	$440	$29,100	No data	6
Alaska Peninsula					
Port Moller	745	$400	$304,000	9.6%	8
South Peninsula	310	$360	$113,000	7.7%	12
Bristol Bay (Togiak)					
Seine	9,413	$410	$3,928,275	8.6%	310
Gill Net	2,843	$420	$1,210,400	8.0%	320
Total	12,256		$5,138,675		
Kuskokwim Area					
Security Cove	554	$460	$256,500	9.4%	110
Goodnews Bay	616	$540	$335,000	8.4%	138
Cape Avinof	129	$410	$54,000	8.0%	147
Nunivak Island	116	$360	$42,000	9.4%	45
Nelson Island	233	$240	$57,000	8.5%	162
Cape Romanzof	926	$560	$486,500	9.3%	115
Norton Sound					
Gill Net	4,381	$555	$2,122,068	9.3%	351
Beach Seine	390	$555	$200,306	8.5%	6
Total	4,771	$555	$2,322,374	9.2%	357
Port Clarence	No fishery due to lack of buyers				
Total	41,387		$16,322,874		

Table 5. Summary of the 1989 Alaska commercial herring spawn-on-kelp and directed food and bait fishery harvests, values, and number of permittees.

Fishery	Product Harvest (tons)	Estimated Price Per Ton	Estimated Ex-Vessel Value	No. of Participating Permittees
Spawn-on-Kelp Fisheries				
Prince William Sound				
Pound Spawn-on-Kelp	Closed due to oil			
Natural Spawn-on-Kelp	Closed due to oil			
Bristol Bay Spawn on Kelp	280	$1,600	$447,824	487
Spawn-on-Kelp Total	280		$447,824	
Directed Food and Bait Fisheries				
Southeast	3,400	$230	$782,000	25
Prince William Sound	656	$250	$164,025	4
Upper Cook Inlet	45	$750	$33,750	35
Kodiak				
Eastern Shelikof[a]	327	$400	$130,800	12
Other Kodiak	13	$400	$5,200	12
Dutch Harbor	3,101	$280	$890,000	9
Food and Bait Fishery Total:	7,542		$2,005,775	

[a] Harvest of Kamishak stocks in the Kodiak food and bait fishery which occurs in eastern Shelikof Strait.

Table 6. Estimate of the contribution of each year class and age class to the 1989 harvest, escapement, and total spawning biomass; and 1990 projected spawning biomass of Pacific herring in Prince William Sound, Alaska. Natural mortality rate (M) at age 8 = 0.450.

		1989 Pacific Herring Harvest and Utilization (Ton)[a,b]							1989 Spawning Biomass				1990 Projected Spawning Biomass						
		Sac Roe Fisheries		Spawn-on-Kelp Fisheries			1989			Number	Percent	Percent					Number	Percent	Percent
Year Class	Age Class	Purse Seine	Gill Net	Pound	Wild	Total	Escapement (Tons)	Mean Weight	Biomass (Tons)	of Fish (X 1,000)	by Weight	by Number	Year Class	Age Class	Mean Weight	Biomass (Tons)	of Fish (X 1,000)	by Weight	by Number
1988	1	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	1989	1		0.0	0.0	0.0	0.0
1987	2	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	1988	2		0.0	0.0	0.0	0.0
1986	3	0.0	0.0	0.0	0.0	0.0	168.4	71	168.4	2,160.5	0.3	0.5	1987	3		0.0	0.0	0.0	0.0
1985	4	0.0	0.0	0.0	0.0	0.0	3,084.2	88	3,084.2	31,833.1	5.4	7.1	1986	4	103	381.9	3,365.5	0.7	1.0
1984	5	0.0	0.0	0.0	0.0	0.0	43,277.2	112	43,277.2	351,952.2	75.2	78.4	1985	5	124	3,749.8	27,503.7	7.3	8.3
1983	6	0.0	0.0	0.0	0.0	0.0	3,163.4	132	3,163.4	21,771.3	5.5	4.8	1984	6	141	39,987.3	257,437.8	77.4	78.1
1982	7	0.0	0.0	0.0	0.0	0.0	2,004.1	158	2,004.1	11,500.5	3.5	2.6	1983	7	155	2,799.4	16,406.8	5.4	5.0
1981	8	0.0	0.0	0.0	0.0	0.0	3,042.6	171	3,042.6	16,188.7	5.3	3.6	1982	8	166	1,489.6	8,153.8	2.9	2.5
1980	9	0.0	0.0	0.0	0.0	0.0	1,959.8	186	1,959.8	9,539.2	3.4	2.1	1981	9	174	2,039.6	10,619.3	3.9	3.2
1979	10	0.0	0.0	0.0	0.0	0.0	460.5	201	460.5	2,076.0	0.8	0.5	1980	10	181	1,043.6	5,237.1	2.0	1.6
1978	11	0.0	0.0	0.0	0.0	0.0	234.7	190	234.7	1,122.2	0.4	0.2	1979	11	186	156.3	763.1	0.3	0.2
1977	12	0.0	0.0	0.0	0.0	0.0	184.9	224	184.9	749.2	0.3	0.2	1978	12	190	36.3	173.7	0.1	0.1
1976	13	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	1977	13	192	8.1	38.3	0.0	0.0
Total		0.0	0.0	0.0	0.0	0.0	57,579.7	116	57,579.7	448,892.9	100.0	100.0	Total		142	51,691.8	329,699.1	100.0	100.0

[a] Does not include the Food and bait harvest of 1,341 tons, 1-5 November 1988.
[b] Fisheries were closed due to the oil spilled from the grounding of the M/V Exxon Valdez on 24 March 1989.

Table 7. Projection of the spawning biomass of Pacific herring in Prince William Sound in 1990. Natural mortality rate (M) at age 8 = 0.450.

Age (t)	Mean Weight at time t (g)[a]	Age Interval	G_t[b]	M_t[c]	e^{G-M}	A_t[d]	A_{t+1}/A_t	$A_{t+1}/A_t e^{G-M}$	Age Class	1989 Escapement (Tons)	1990 Projected Spawning Biomass			
											1990[e] Projection (Tons)	Number of Fish (X 1,000)	Percent by Weight	Percent by Number
2	53.4	2-3	0.392	0.343	1.05		2.45	2.58	2	0.0	0.0	0.0	0.0	0.0
3	79.1	3-4	0.264	0.343	0.92	0.22	2.45	2.27	3	168.4	0.0	0.0	0.0	0.0
4	102.9	4-5	0.184	0.343	0.85	0.54	1.43	1.22	4	3,084.2	381.9	3,365.5	0.7	1.0
5	123.7	5-6	0.130	0.343	0.81	0.77	1.14	0.92	5	43,277.2	3,749.8	27,503.7	7.3	8.3
6	140.9	6-7	0.094	0.344	0.78	0.88	1.14	0.88	6	3,163.4	39,987.3	257,437.8	77.4	78.1
7	154.8	7-8	0.068	0.365	0.74	1.00	1.00	0.74	7	2,004.1	2,799.4	16,406.8	5.4	5.0
8	165.7	8-9	0.050	0.450	0.67	1.00	1.00	0.67	8	3,042.6	1,489.6	8,153.8	2.9	2.5
9	174.2	9-10	0.037	0.667	0.53	1.00	1.00	0.53	9	1,959.8	2,039.6	10,619.3	3.9	3.2
10	180.8	10-11	0.027	1.108	0.34	1.00	1.00	0.34	10	460.5	1,043.6	5,237.1	2.0	1.6
11	185.8	11-12	0.020	1.887	0.15	1.00	1.00	0.15	11	234.7	156.3	763.1	0.3	0.2
12	189.5	12-13	0.015	3.139	0.04	1.00	1.00	0.04	12	184.9	36.3	173.7	0.1	0.1
13	192.4	13-14	0.011	5.020	0.01	1.00	1.00	0.01	13+	0.0	8.1	38.3	0.0	0.0
14	194.5	14-15												
									Total	57,579.7	51,691.8	329,699.1	100.0	100.0

[a] Weight at time t: $W_t = 200.943[1-e^{-0.293(t+1.689)}]^{3.196}$.
[b] Instantaneous growth rate at age t: $G_t = \ln(W_{t+1}/W_t)$.
[c] Instantaneous natural mortality rate at age t: M_t.
[d] Availability schedule at age t: A_t.
[e] $\text{Projection}_{1990,t+1} = \text{Escapement}_{1989,t} (A_{t+1}/A_t e^{G-M})$.

Table 8. Forecast of 1990 Kamishak herring abundance and projected harvest.

Age	1989[a] Escapement (millions)	Mortality Rate Z	1990[a] Population (millions)	Mean Wt. (g)	1990[b] Biomass	% by No.	Harvest Rate	1990[b] Harvest	% by Wt.
3	0.3	-1.279	3	76	251	0.02	0.10	25	0.01
4	5.3	-0.636	1	105	127	0.01	0.10	13	0.00
5	39.5	-0.510	10	142	1,563	0.07	0.10	156	0.05
6	22.2	-0.301	66	174	12,611	0.49	0.10	1,261	0.44
7	4.1	0.033	30	209	6,901	0.22	0.10	690	0.24
8	12.1	0.182	4	232	1,010	0.03	0.10	101	0.04
9	7.0	0.332	10	250	2,768	0.07	0.10	277	0.10
10	4.9	0.482	5	260	1,443	0.04	0.10	144	0.05
11	4.0	0.631	3	271	902	0.02	0.10	90	0.03
12	2.8	0.781	2	288	666	0.02	0.10	67	0.02
13	1.1	0.931	1	292	411	0.01	0.10	41	0.01
Total			135		28,653			2,865 = Total	

[a] Population size and escapement are given as millions of fish.
[b] Biomass and harvest are given in short tons (2,000 lbs).

Table 9. Togiak District year class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass.

		1989 Harvest (tons)					1989 Total Run				1990 Togiak Projected Herring Biomass					
		Sac Roe		Food/Bait		1989		No.of Fish	% by	% by				No.of Fish	% by	% by
Year Class	Age Class	P.Seine	G.Net	Dom. Bycatch	Total	Escapement (tons)	(tons)	(* 1,000)	Weight	Number	Year Class	Age Class	(tons)	(* 1,000)	Weight	Number
1988	1	0	0	0	0	0	0	0	0.0	0.0						
1987	2	0	0	0	0	0	0	0	0.0	0.0	1988	2	0	0	0.0	0.0
1986	3	0	0	0	0	0	0	0	0.0	0.0	1987	3	0	0	0.0	0.0
1985	4	6	0	0	6	24	30	236	0.0	0.1	1986	4	0	0	0.0	0.0
1984	5	383	8	61	452	4,709	5,161	24872	5.2	9.6	1985	5	31	132	0.1	0.1
1983	6	524	157	105	786	10,504	11,290	43642	11.4	16.9	1984	6	5,295	18,824	9.5	13.4
1982	7	265	119	74	458	3,031	3,489	10671	3.5	4.1	1983	7	10,994	33,721	19.6	23.9
1981	8	1,309	613	269	2,191	12,168	14,359	38308	14.5	14.8	1982	8	2,722	7,416	4.9	5.3
1980	9	553	229	162	944	4,369	5,313	12733	5.4	4.9	1981	9	9,454	23,413	16.9	16.6
1979	10	1,668	485	619	2,772	15,181	17,953	41391	18.1	16.0	1980	10	2,949	6,755	5.3	4.8
1978	11	2,505	712	1,293	4,510	18,687	23,197	50465	23.4	19.5	1979	11	8,941	19,222	16.0	13.7
1977	12	1,923	437	1,329	3,689	11,657	15,346	30905	15.5	12.0	1978	12	9,631	19,654	17.2	14.0
1976	13	124	22	174	320	1,135	1,455	2849	1.5	1.1	1977	13	5,264	10,290	9.4	7.3
1975	14	119	43	51	213	830	1,043	1743	1.1	0.7	1976	14	450	850	0.8	0.6
1974	15	34	18	46	98	231	329	665	0.3	0.3	1975	15	289	530	0.5	0.4
	Total	9,413	2,843	4,183	16,439	82,526	98,965	258,480	100	100			56,020[a]	140,807	100.0	100.0

[a] Predicted mean weight of fish is 361 grams.

Table 10. Projection of the 1990 Pacific herring biomass in the Togiak District.

Age (i)	Mean Wt.[a] at time (g)	Age Interval	G[b]	M[c]	$e^{(G-M)}$	Ai[d]	$A_{(i+1)}/A_{(i)}$	$A_{(i+1)}/A_{(i)}e^{(G-M)}$	Age Class	1989 Escapement (tons)	1990 Projection[e] (tons)	% by Weight	Number of fish(*1,000)	% by Number
2	81.1	2-3	0.413	0.103	1.36		2.01	2.73	2					
3	122.7	3-4	0.309	0.103	1.23	0.43	2.01	2.46	3	0	0	0.0	0	0.0
4	167.1	4-5	0.237	0.103	1.14	0.86	1.13	1.29	4	24	0	0.0	0	0.0
5	211.9	5-6	0.186	0.103	1.09	0.97	1.04	1.12	5	4,709	31	0.1	132	0.1
6	255.2	6-7	0.148	0.103	1.05	1.00	1.00	1.05	6	10,504	5,295	9.5	18,824	13.4
7	295.8	7-8	0.118	0.226	0.90	1.00	1.00	0.90	7	3,031	10,994	19.6	33,721	23.9
8	332.9	8-9	0.096	0.348	0.78	1.00	1.00	0.78	8	12,168	2,722	4.9	7,416	5.3
9	366.3	9-10	0.078	0.471	0.67	1.00	1.00	0.67	9	4,369	9,454	16.9	23,413	16.6
10	396.0	10-11	0.064	0.593	0.59	1.00	1.00	0.59	10	15,181	2,949	5.3	6,755	4.8
11	422.0	11-12	0.052	0.715	0.52	1.00	1.00	0.52	11	18,687	8,941	16.0	19,222	13.7
12	444.6	12-13	0.043	0.838	0.45	1.00	1.00	0.45	12	11,657	9,631	17.2	19,654	14.0
13	464.1	13-14	0.035	0.960	0.40	1.00	1.00	0.40	13	1,135	5,264	9.4	10,290	7.3
14	480.8	14-15	0.029	1.083	0.35	1.00	1.00	0.35	14	830	450	0.8	850	0.6
15	495.1	15-16							15	231	289	0.5	530	0.4
									Total :	82,526	56,020	100.0	140,807	99.6
									1990 Mean Weight:		361			

[a] Weight at time i = $572.24\ [\ 1-\exp(-0.18(i+2.43))]^{3.262}$

[b] Instantaneous growth rate $G = \ln(W_{i+1}/W_i)$.

[c] Instantaneous natural mortality (M) schedule based on the average age-specific mortality for 1978-88.

[d] Availability (A) schedule from Westpestad and Fried (1985).

[e] Projection $_{(i+1)} = A_{(i+1)}/A^{(i)}e^{(G-M)}$

Table 11. Security Cove District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish.

Year Class	Age Class	Gillnet Harvest (tons)	Escapement (tons)	Total Run				1990 Projection[a]			
				(tons)	No. of Fish (* 1,000)	% by Number	% by Weight	(tons)	No. of Fish (* 1,000)	% by Number	% by Weight
1986	3	0	0	0	0	0.0	0.0	0	0	0.0	0.0
1985	4	0	0	0	0	0.0	0.0	0	0	0.0	0.0
1984	5	13	142	155	789	9.8	5.5	0	0	0.0	0.0
1983	6	56	225	281	1,130	14.1	9.9	147	591	14.1	9.4
1982	7	48	144	192	647	8.0	6.8	204	687	16.4	13.1
1981	8	139	407	546	1,558	19.4	19.3	119	340	8.1	7.6
1980	9	92	287	378	967	12.0	13.4	309	791	18.9	19.8
1979	10	94	476	570	1,365	17.0	20.1	191	458	10.9	12.3
1978	11	84	453	537	1,208	15.0	19.0	288	648	15.4	18.4
1977	12	26	113	139	313	3.9	4.9	240	541	12.9	15.4
1976	13+	4	28	32	64	0.8	1.1	62	140	3.3	4.0
Total		554	2,276	2,830	8,041	100.0	100.0	1,560	4,194	100.0	100.0

[a] Biomass projection for older aged fish (>10) were based upon natural mortality and growth rates derived from regression analysis of previous years' rates.

Table 12. Goodnews Bay District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish.

Year Class	Age Class	Gillnet Harvest (tons)	Escapement (tons)	Total Run				1990 Projection[a]			
				(tons)	No. of Fish (* 1,000)	% by Number	% by Weight	(tons)	No. of Fish (* 1,000)	% by Number	% by Weight
1986	3	0	2	2	16	0.1	0.1	0	0	0.0	0.0
1985	4	0	11	11	82	0.7	0.3	4	33	0.5	0.2
1984	5	1	377	379	2,259	18.6	9.4	13	80	1.2	0.6
1983	6	26	322	349	1,542	12.7	8.6	389	1,721	25.7	16.7
1982	7	19	128	147	523	4.3	3.6	292	1,037	15.5	12.5
1981	8	104	342	445	1,302	10.7	11.0	106	311	4.6	4.6
1980	9	121	329	449	1,174	9.7	11.1	260	678	10.1	11.2
1979	10	190	804	994	2,380	19.6	24.6	219	525	7.8	9.4
1978	11	105	725	830	1,894	15.6	20.5	486	1,109	16.5	20.9
1977	12	40	340	380	848	7.0	9.4	384	857	12.8	16.5
1976	13+	9	49	58	118	1.0	1.4	173	351	5.2	7.4
Total		615	3,429	4,044	12,139	100.0	100.0	2,326	6,701	100.0	100.0

[a] Biomass projection for older aged fish (>10) were based upon natural mortality and growth rates derived from regression analysis of previous years' rates.

Table 13. Cape Avinof year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish.

Year Class	Age Class	Gillnet Harvest (tons)	Escapement (tons)	Total Run				1990 Projection[a]			
				(tons)	No. of Fish (* 1,000)	% by Weight	% by Number	(tons)	No. of Fish (* 1,000)	% by Number	% by Weight
1987	2	0	6	6	101	0.2	0.9	0	0	0.0	0.0
1986	3	0	31	31	369	1.1	3.4	13	150	1.9	0.6
1985	4	0	63	63	469	2.3	4.3	65	487	6.3	3.2
1984	5	1	362	362	2,314	13.1	21.1	77	491	6.4	3.8
1983	6	1	262	263	1,409	9.5	12.8	373	2,001	25.9	18.4
1982	7	3	299	303	1,249	10.9	11.4	237	980	12.7	11.7
1981	8	16	385	400	1,321	14.4	12.0	248	816	10.6	12.2
1980	9	32	304	336	1,027	12.1	9.4	292	894	11.6	14.4
1979	10	32	453	485	1,362	17.5	12.4	203	569	7.4	10.0
1978	11	32	297	329	851	11.8	7.8	274	709	9.2	13.5
1977	12	11	185	196	499	7.1	4.5	157	401	5.2	7.8
1976	13+	2	0	2	6	0.1	0.1	84	216	2.8	4.1
Total		129	2,648	2,777	10,976	100.0	100.0	2,024	7,715	100.0	100.0

[a] Biomass projection for older aged fish (>10) were based upon natural mortality and growth rates derived from regression analysis of previous years' rates.

Table 14. Nelson Island District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish.

Year Class	Age Class	Gillnet Harvest (tons)	Escapement (tons)	Total Run				1990 Projection[a]			
				(tons)	No. of Fish (* 1,000)	% by Number	% by Weight	(tons)	No. of Fish (* 1,000)	% by Number	% by Weight
1986	3	0	3	3	37	0.4	0.1	0	0	0.0	0.0
1985	4	0	24	24	203	2.1	0.7	6	53	0.9	0.3
1984	5	0	210	210	1,271	13.0	6.3	29	178	3.1	1.4
1983	6	1	195	196	871	8.9	5.9	217	963	16.7	10.6
1982	7	7	138	145	554	5.7	4.4	176	673	11.7	8.6
1981	8	23	425	449	1,322	13.5	13.5	114	337	5.9	5.6
1980	9	30	409	439	1,116	11.4	13.3	323	821	14.3	15.8
1979	10	76	682	758	1,895	19.4	22.9	273	682	11.9	13.3
1978	11	57	638	696	1,618	16.6	21.0	412	959	16.7	20.1
1977	12	32	303	336	762	7.8	10.1	338	766	13.3	16.5
1976	13+	6	55	61	124	1.3	1.8	159	324	5.6	7.7
Total		233	3,083	3,316	9,772	100.0	100.0	2,048	5,757	100.0	100.0

[a] Biomass projection for older aged fish (>10) were based upon natural mortality and growth rates derived from regression analysis of previous years' rates.

Table 15. Nunivak Island District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish.

Year Class	Age Class	Gillnet Harvest (tons)	Escapement (tons)	Total Run				1990 Projection[a]			
				(tons)	No. of Fish (* 1,000)	% by Number	% by Weight	(tons)	No. of Fish (* 1,000)	% by Number	% by Weight
1986	3	0	0	0	3	0.2	0.0	0	0	0.0	0.0
1985	4	0	1	1	6	0.3	0.1	0	3	0.3	0.1
1984	5	0	14	14	87	4.9	2.2	1	6	0.7	0.3
1983	6	0	22	22	109	6.2	3.5	14	71	7.9	4.4
1982	7	1	32	33	126	7.1	5.4	20	74	8.3	6.1
1981	8	10	74	85	262	14.7	13.7	27	83	9.3	8.4
1980	9	15	65	79	218	12.3	12.9	57	156	17.5	17.7
1979	10	37	119	156	418	23.5	25.4	43	115	13.0	13.5
1978	11	36	110	147	358	20.2	23.8	72	176	19.8	22.5
1977	12	15	58	72	169	9.5	11.7	58	136	15.3	18.2
1976	13+	2	6	8	20	1.1	1.3	29	70	7.9	8.9
Total		116	501	617	1,776	100.0	100.0	320	890	100.0	100.0

[a] Biomass projection for older aged fish (>10) were based upon natural mortality and growth rates derived from regression analysis of previous years' rates.

Table 16. Cape Romanzof District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish.

Year Class	Age Class	Gillnet Harvest (tons)	Escapement (tons)	Total Run				1990 Projection[a]			
				(tons)	No. of Fish (* 1,000)	% by Number	% by Weight	(tons)	No. of Fish (* 1,000)	% by Number	% by Weight
1986	3	0	5	5	63	0.4	0.1	0	0	0.0	0.00
1985	4	0	26	26	221	1.5	0.6	10	87	1.1	0.43
1984	5	4	344	348	2,098	14.3	7.9	33	197	2.6	1.35
1983	6	23	229	253	1,162	7.9	5.7	359	1,649	21.4	14.86
1982	7	96	407	503	1,929	13.2	11.4	206	792	10.3	8.54
1981	8	249	636	885	2,920	20.0	20.1	338	1,116	14.5	14.00
1980	9	112	307	419	1,196	8.2	9.5	474	1,354	17.6	19.63
1979	10	188	501	689	1,890	12.9	15.7	206	564	7.3	8.51
1978	11	159	621	780	1,983	13.5	17.7	295	750	9.8	12.23
1977	12	84	347	431	1,025	7.0	9.8	323	768	10.0	13.37
1976	13+	12	51	62	149	1.0	1.4	171	411	5.3	7.09
Total		926	3,474	4,400	14,636	100.0	100.0	2,415	7,688	100.0	100.0

[a] Biomass projection for older aged fish (>10) were based upon natural mortality and growth rates derived from regression analysis of previous years' rates.

Table 17. Norton Sound District year/age class composition of the 1989 Pacific herring harvest, escapement, and total run biomass and the 1990 projected biomass by weight and number of fish.

Year Class	Age Class	Gillnet Harvest (tons)	Beach Seine Harvest (tons)	Total Commercial Harvest (tons)	Escapement (tons)	Total Run (tons)	Total Run No. of Fish (* 1,000)	Total Run % by Number	Total Run % by Weight	1990 Projection[a] (tons)	1990 Projection[a] No. of Fish (* 1,000)	1990 Projection[a] % by Number	1990 Projection[a] % by Weight
1986	3	0	0	0	312	312	3,987	4.2	1.2	0	0	0.0	0.0
1985	4	0	0	0	272	272	2,416	2.6	1.0	711	6,324	11.0	4.3
1984	5	19	3	22	1,198	1,221	7,004	7.4	4.7	341	1,958	3.4	2.1
1983	6	77	32	109	2,011	2,121	10,109	10.7	8.2	1,249	5,953	10.4	7.6
1982	7	685	131	816	6,428	7,244	28,320	30.0	27.9	1,808	7,068	12.3	10.9
1981	8	1,311	99	1,410	3,499	4,908	15,590	16.5	18.9	5,342	16,966	29.6	32.3
1980	9	747	53	800	2,523	3,323	9,455	10.0	12.8	2,606	7,417	13.0	15.8
1979	10	892	49	941	3,087	4,028	11,132	11.8	15.5	1,690	4,672	8.2	10.2
1978	11	426	21	447	1,450	1,897	4,690	5.0	7.3	1,821	4,504	7.9	11.0
1977	12	186	1	187	333	520	1,282	1.4	2.0	754	1,856	3.2	4.6
1976	13+	8	0	8	128	136	351	0.4	0.5	203	523	0.9	1.2
Total		4,351	390	4,741	21,240	25,981	94,335	100.0	100.0	16,525	57,240	100.0	100.0

[a] Biomass projection for older aged fish (>10) were based upon natural mortality and growth rates derived from regression analysis of previous years' rates.

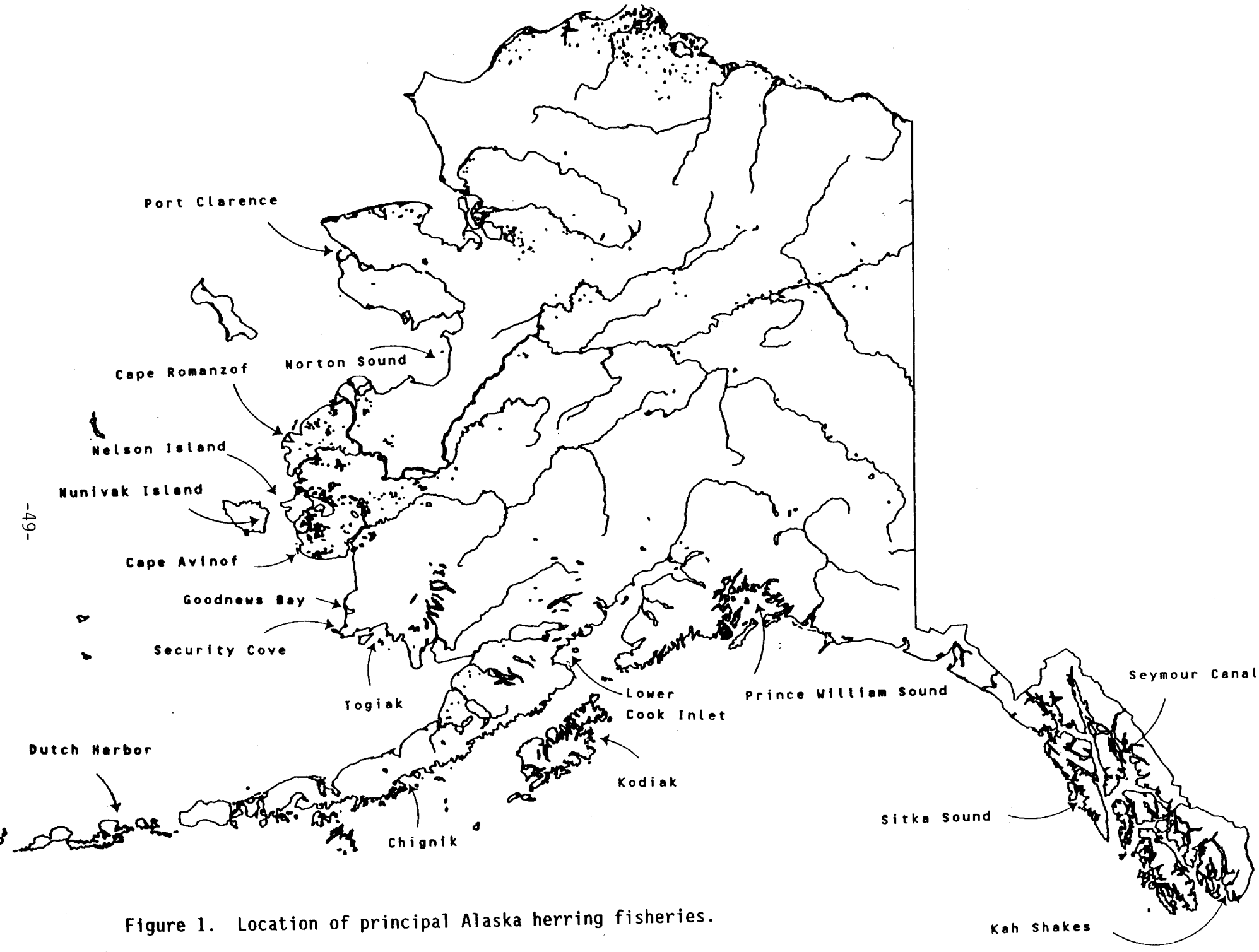

Figure 1. Location of principal Alaska herring fisheries.

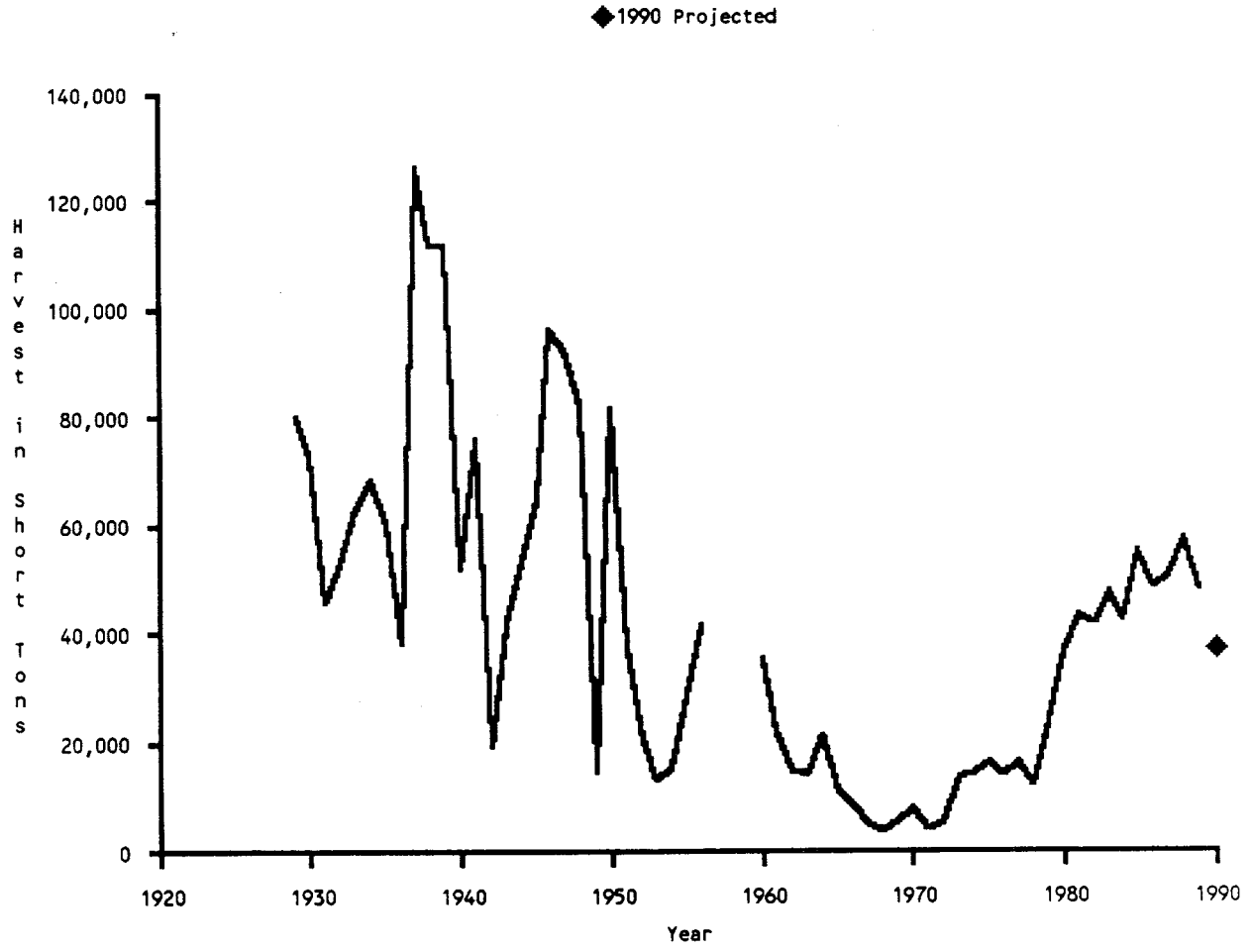

Figure 2. Herring harvests from all Alaska domestic herring fisheries, 1930-1989, with the projected 1990 harvest.

Figure 3. Alaska sac roe herring harvests from all areas, 1978-1989, with the projected 1990 sac roe harvest.

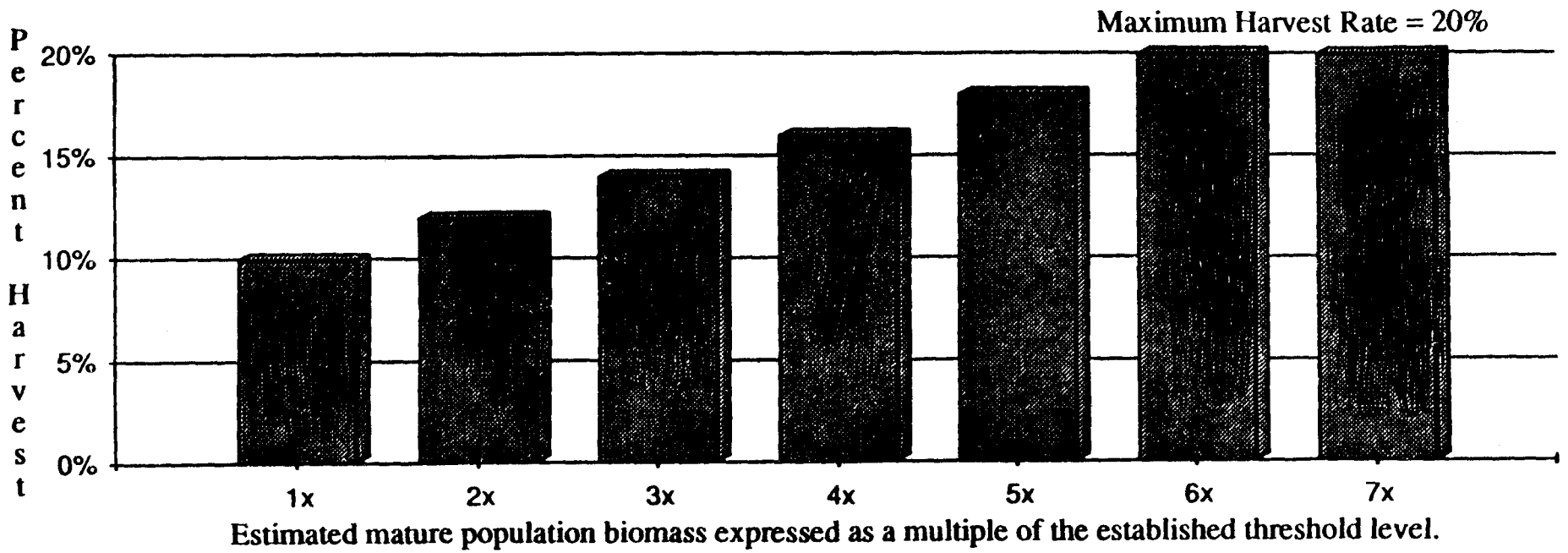

Figure 4. Generalized harvest policy for Southeast Alaska herring fisheries showing the relationship between allowable exploitation rate and the estimated biomass of the mature herring stock expressed as a multiple of the established threshold biomass level.

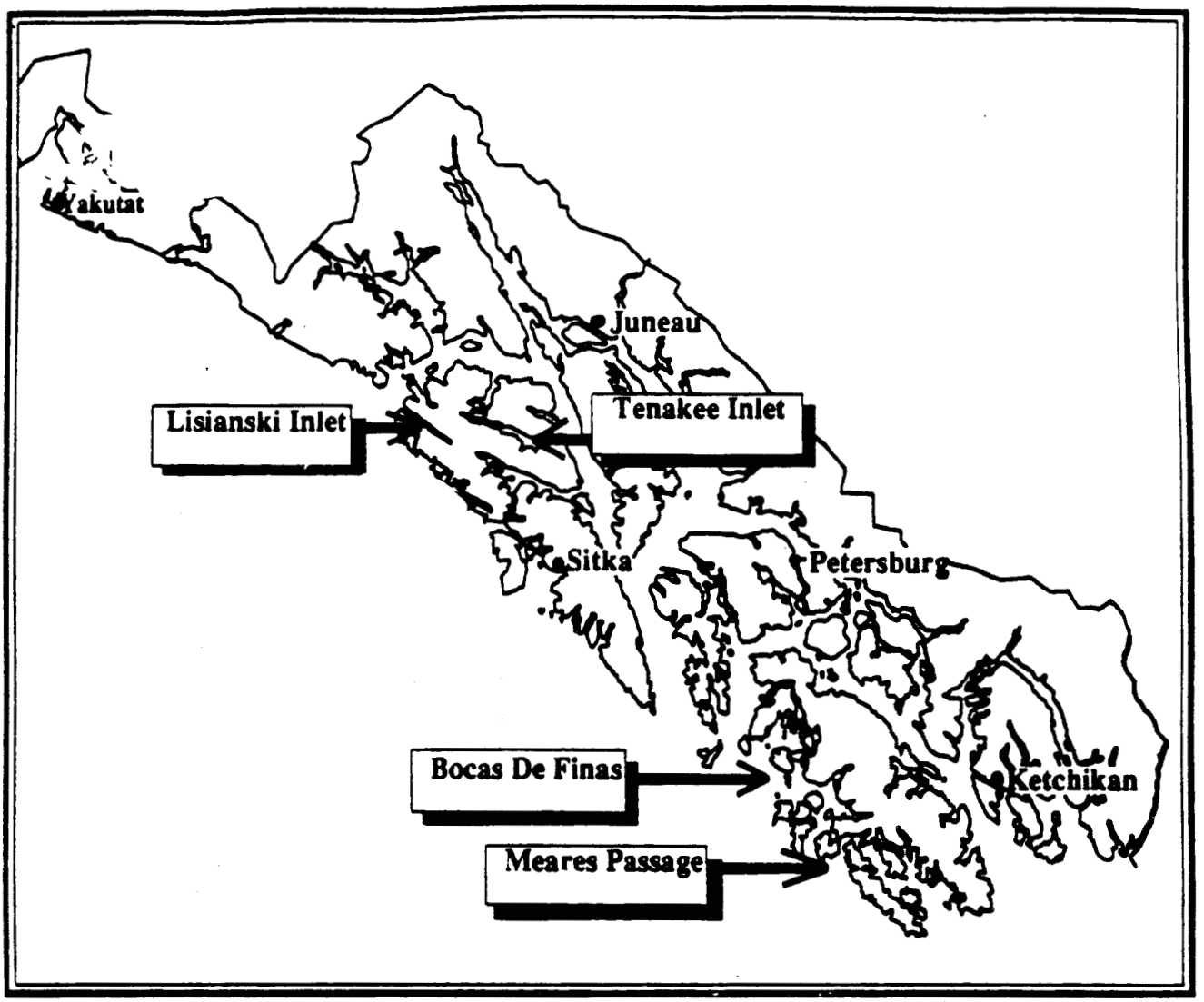

Figure 5. Southeast Alaska areas in which herring food and bait fisheries were allowed in 1989.

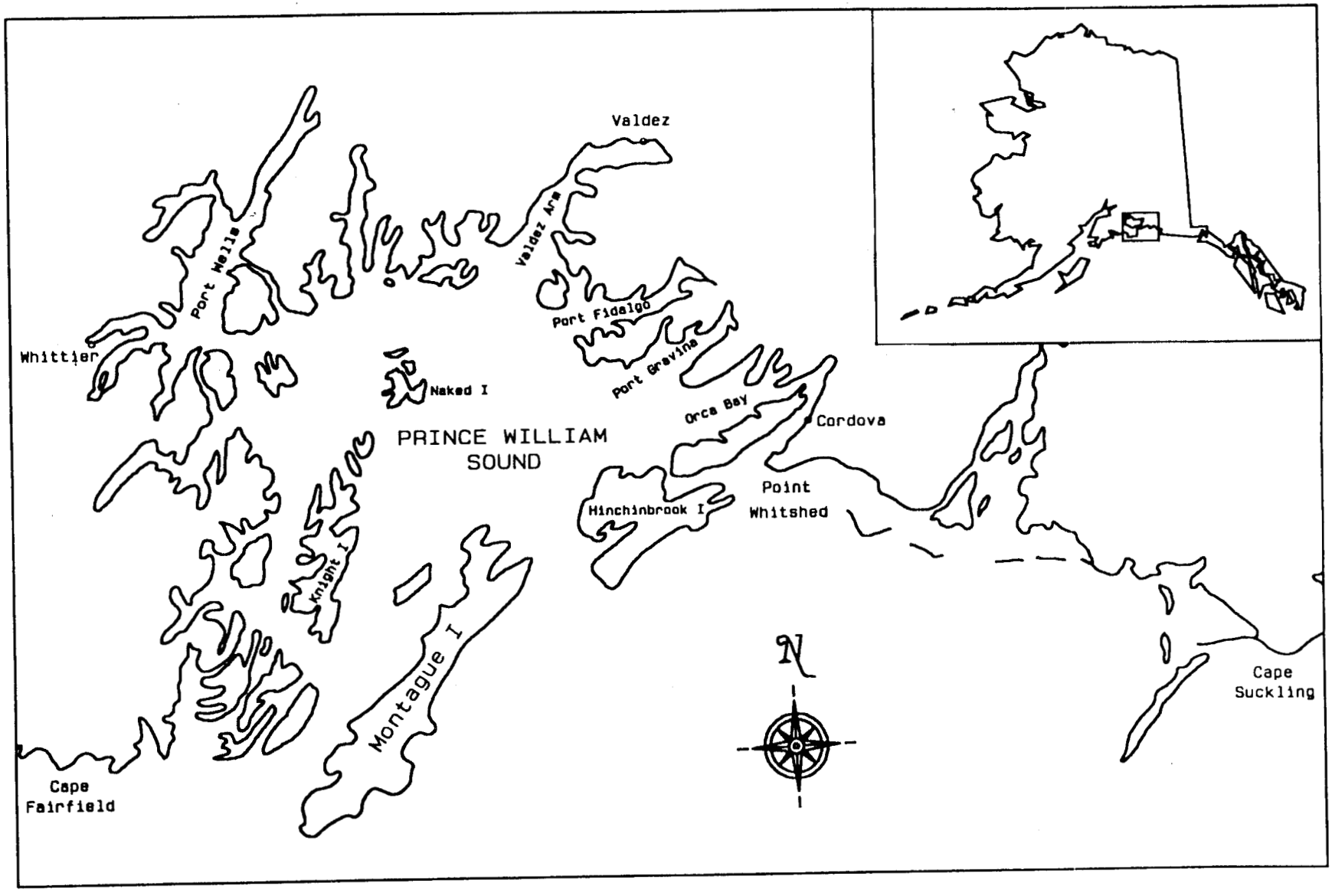

Figure 6. Map of Prince William Sound, Alaska.

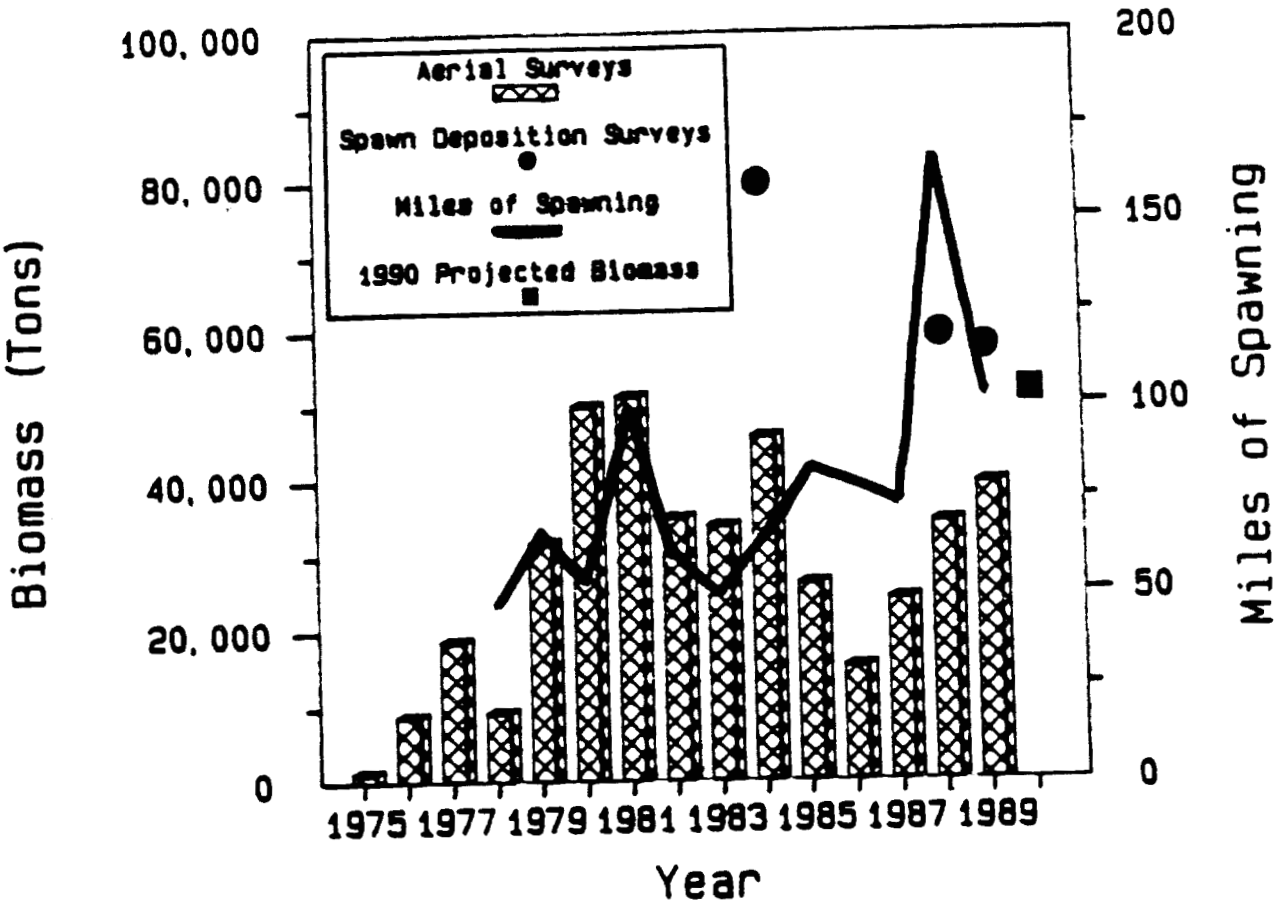

Figure 7. Spawning biomass estimates and indices for Pacific herring in Prince William Sound, Alaska, 1976-1989. Included is the projection of the 1990 spawning biomass.

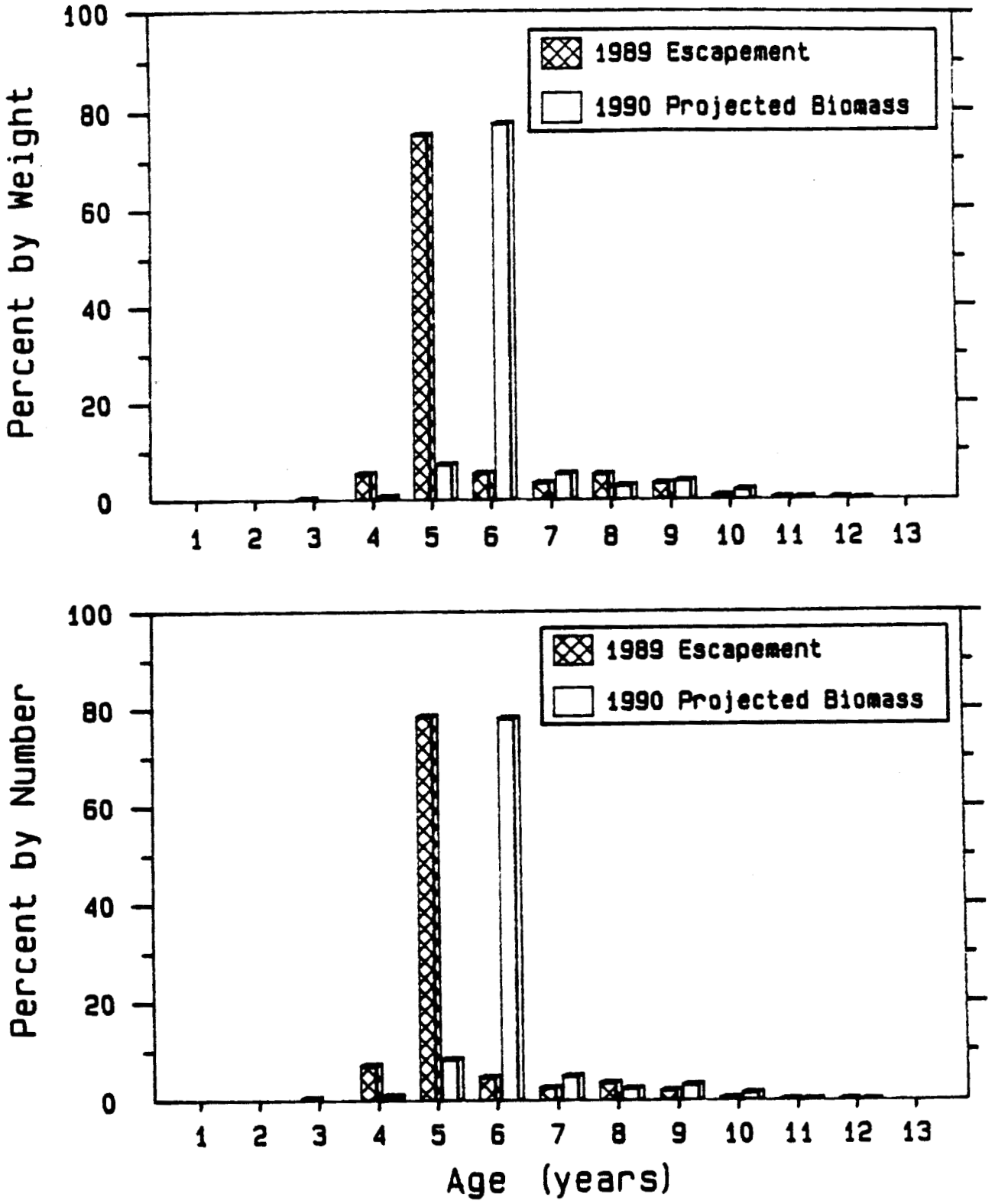

Figure 10. Comparison of the age compositions (top by weight and bottom by number) of the 1989 spawning biomass to the 1990 projected spawning biomass of Pacific herring in Prince William Sound.

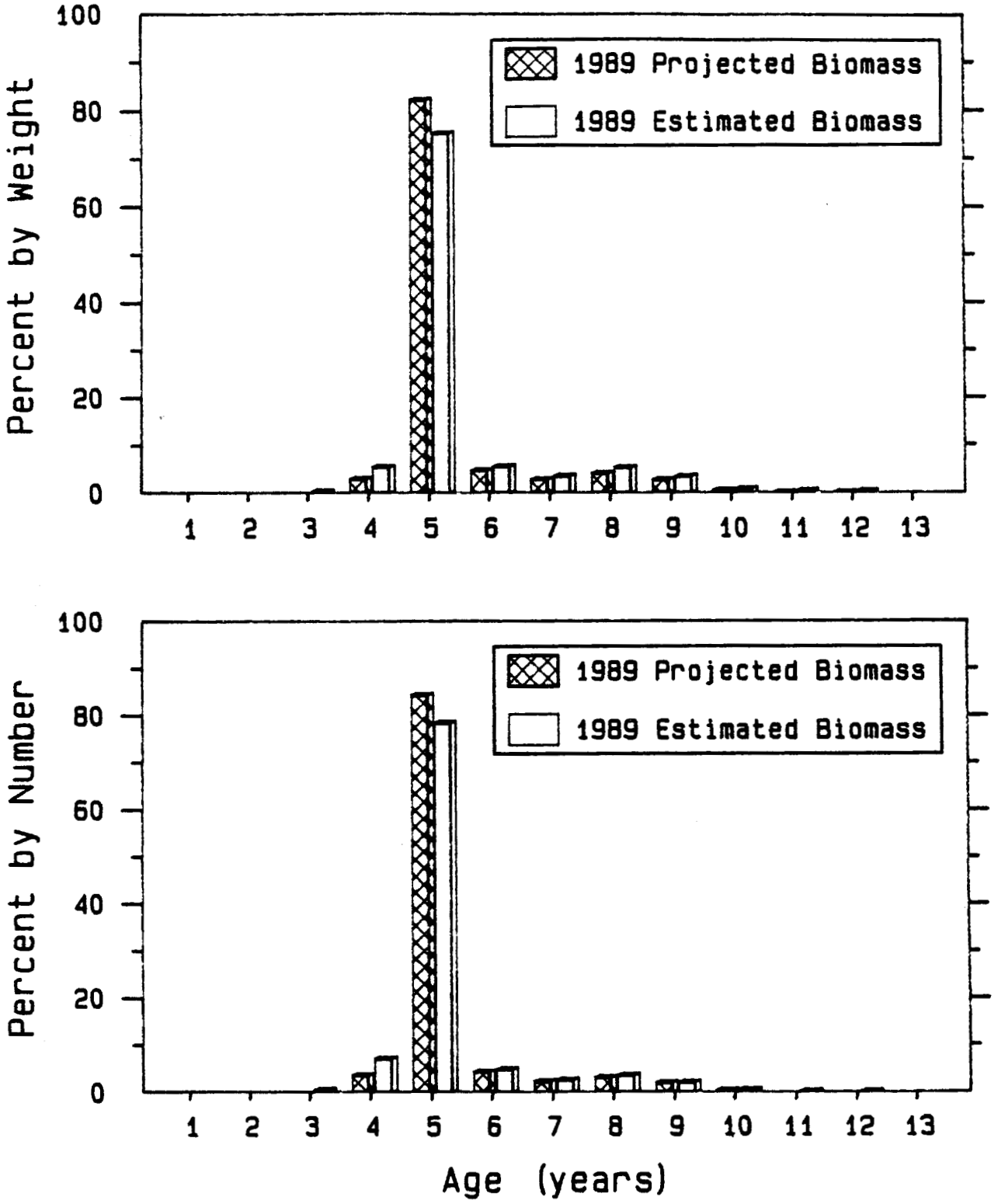

Figure 8. Comparison of the age compositions (top by weight and bottom by number) of the 1989 spawning biomass and the 1989 projected spawning biomass of Pacific herring in Prince William Sound.

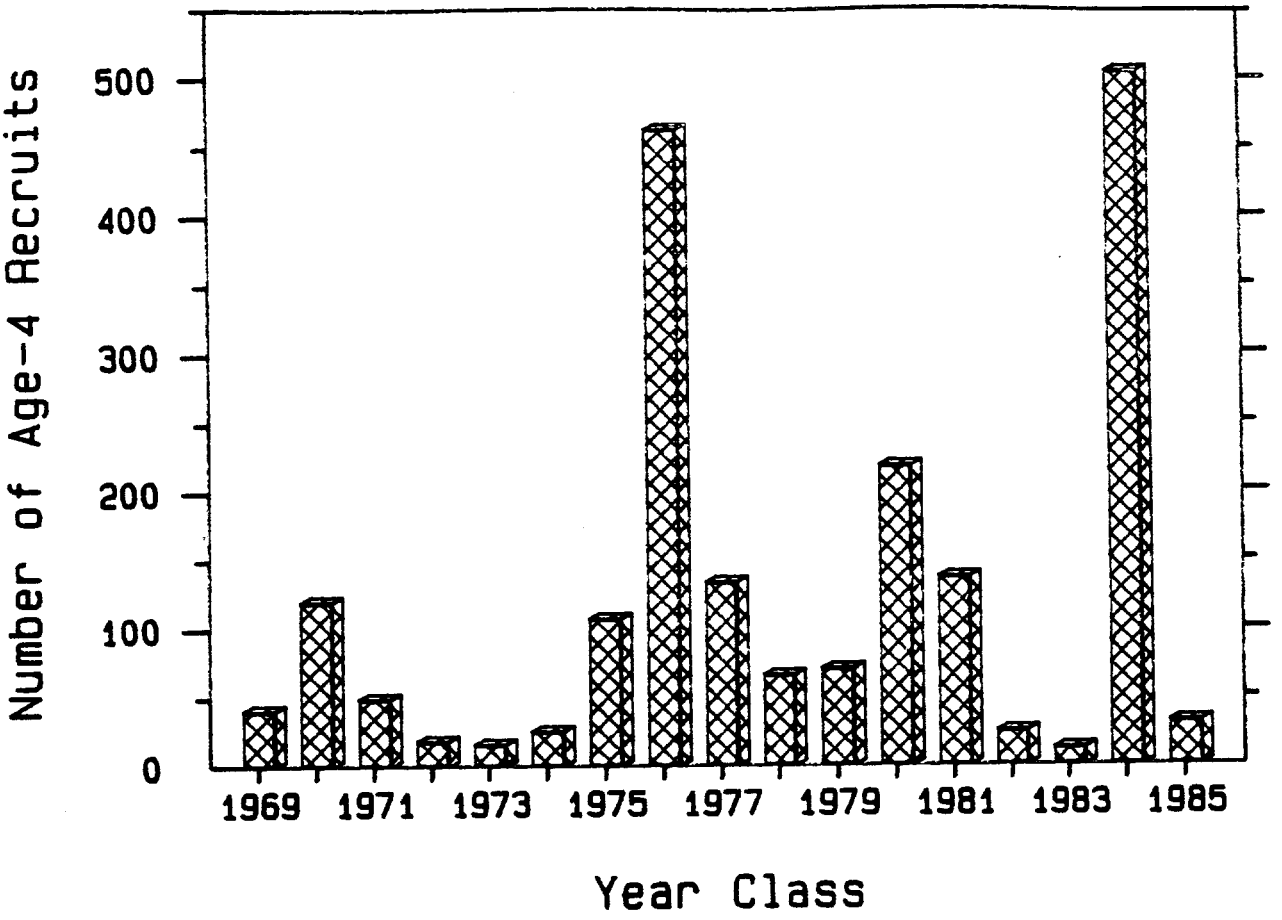

Figure 9. Historical year class strength of Prince William Sound herring in number of age-4 fish.

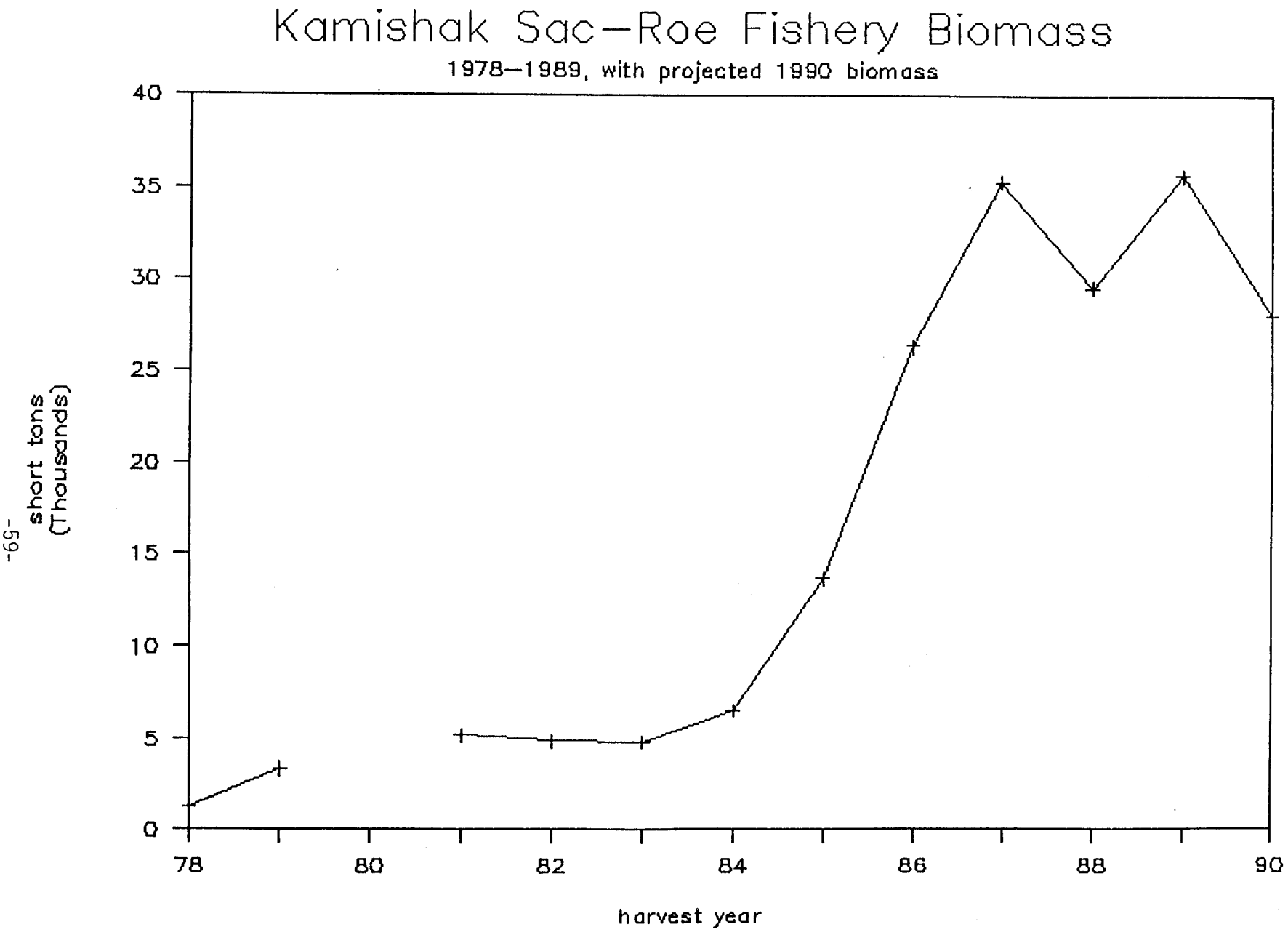

Figure 11. Kamishak herring stock biomass, 1978-1989, with projected 1990 biomass.

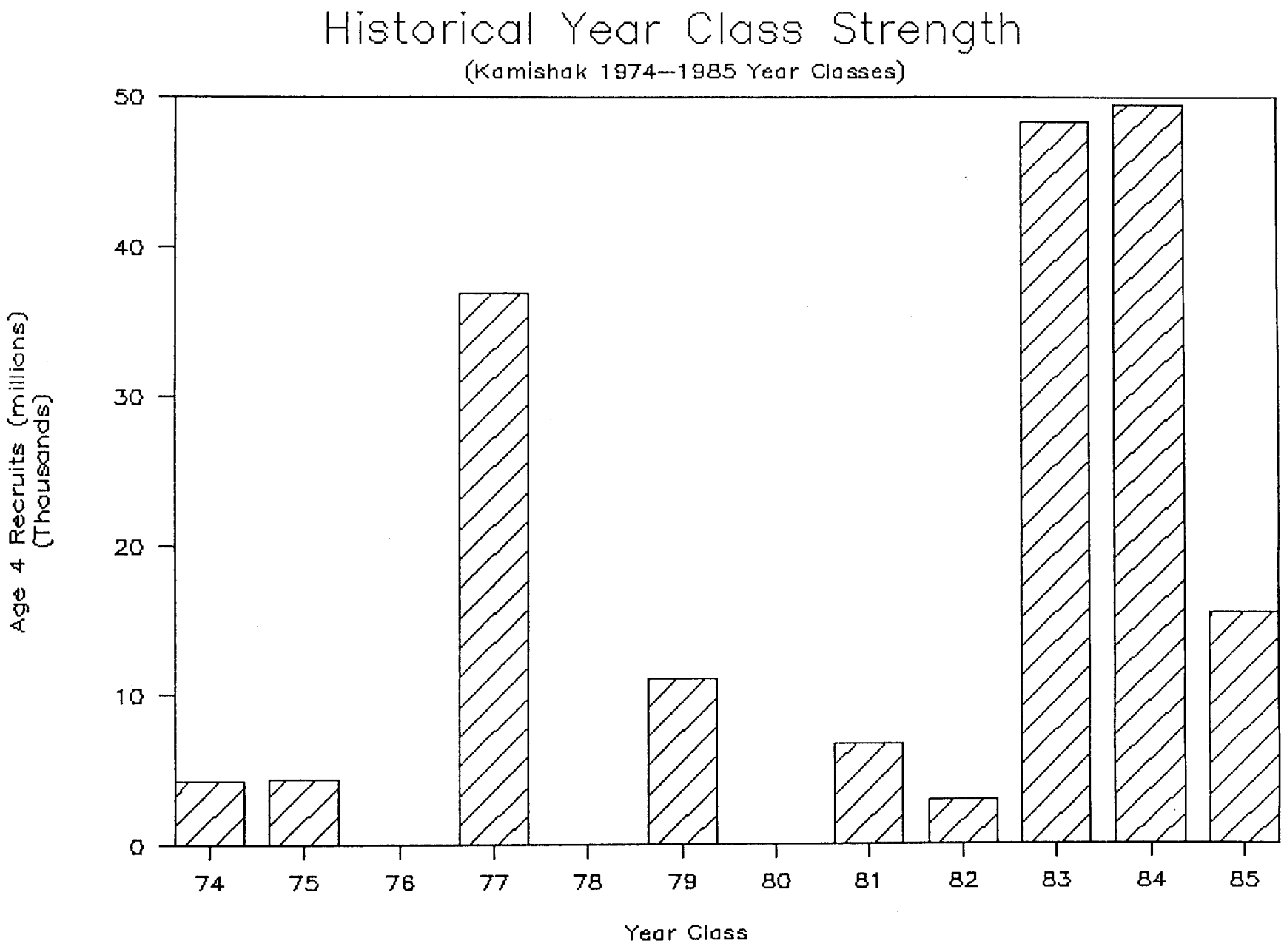

Figure 12. Historical year class strength at age 4 for the Kamishak herring stock, for the 1974-1985 year classes.

Figure 13. Age composition of the Kamishak herring stock in 1989 and 1990.

Figure 14. Age distribution of the 1990 population biomass and harvest for the kamishak herring stock.

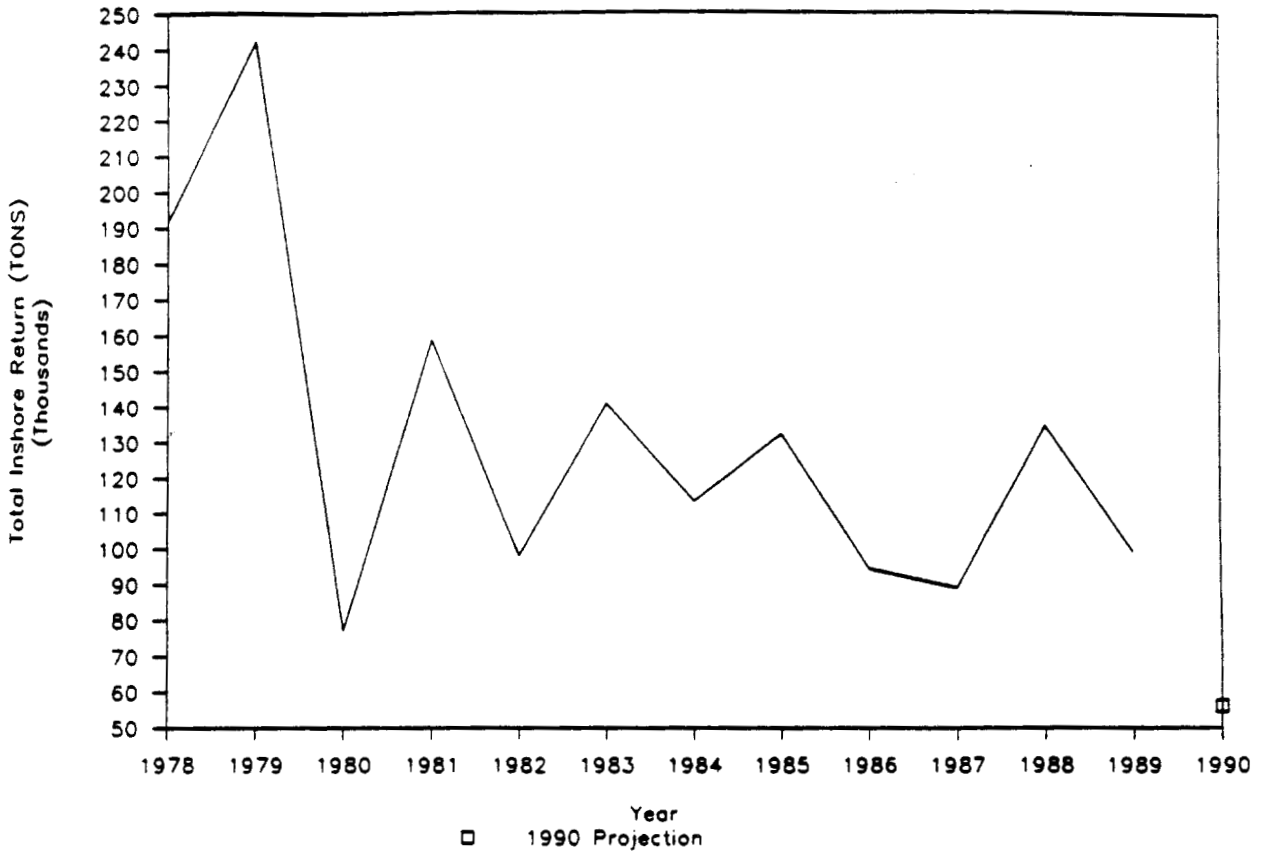

Figure 15. Togiak District herring biomass as estimated from aerial surveys. The 1990 biomass (block) was projected from the 1989 unharvested spawning biomass.

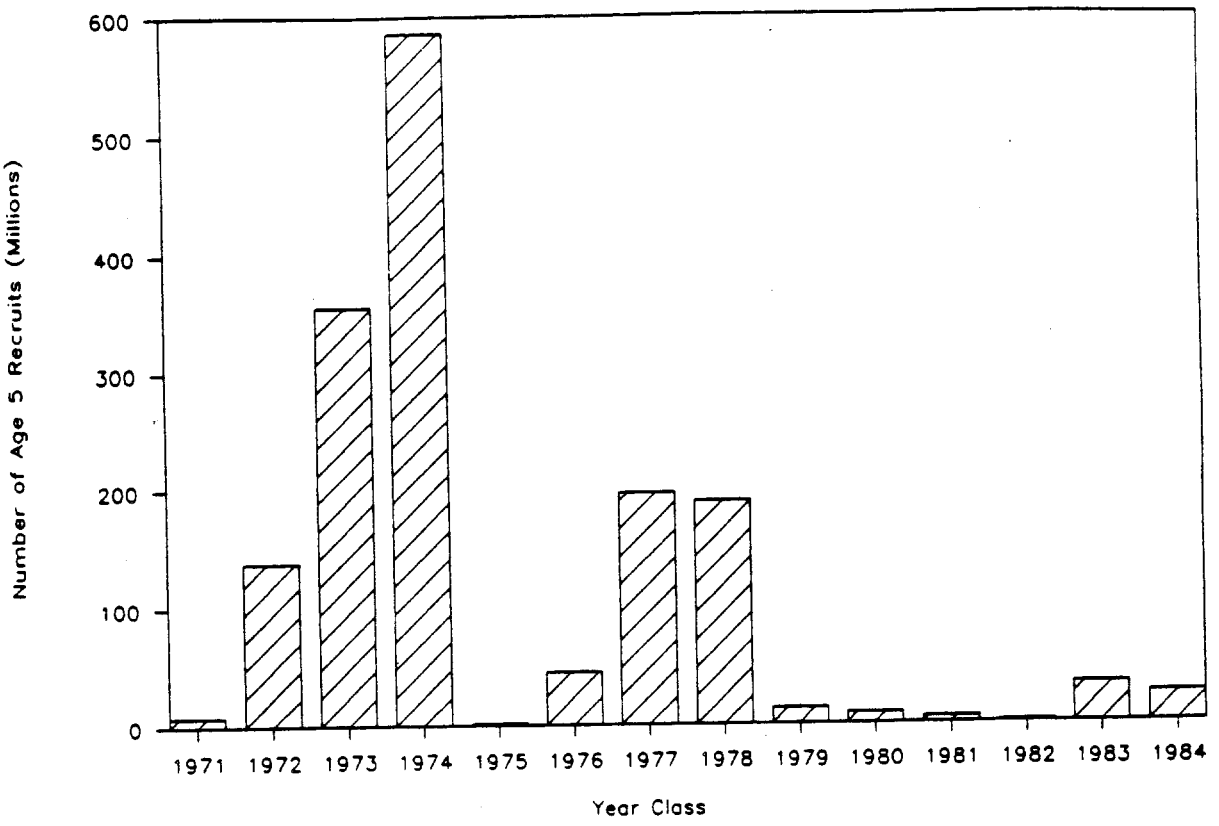

Figure 16. Historical year class strength of Togiak District herring in numbers of 5-year-old fish.

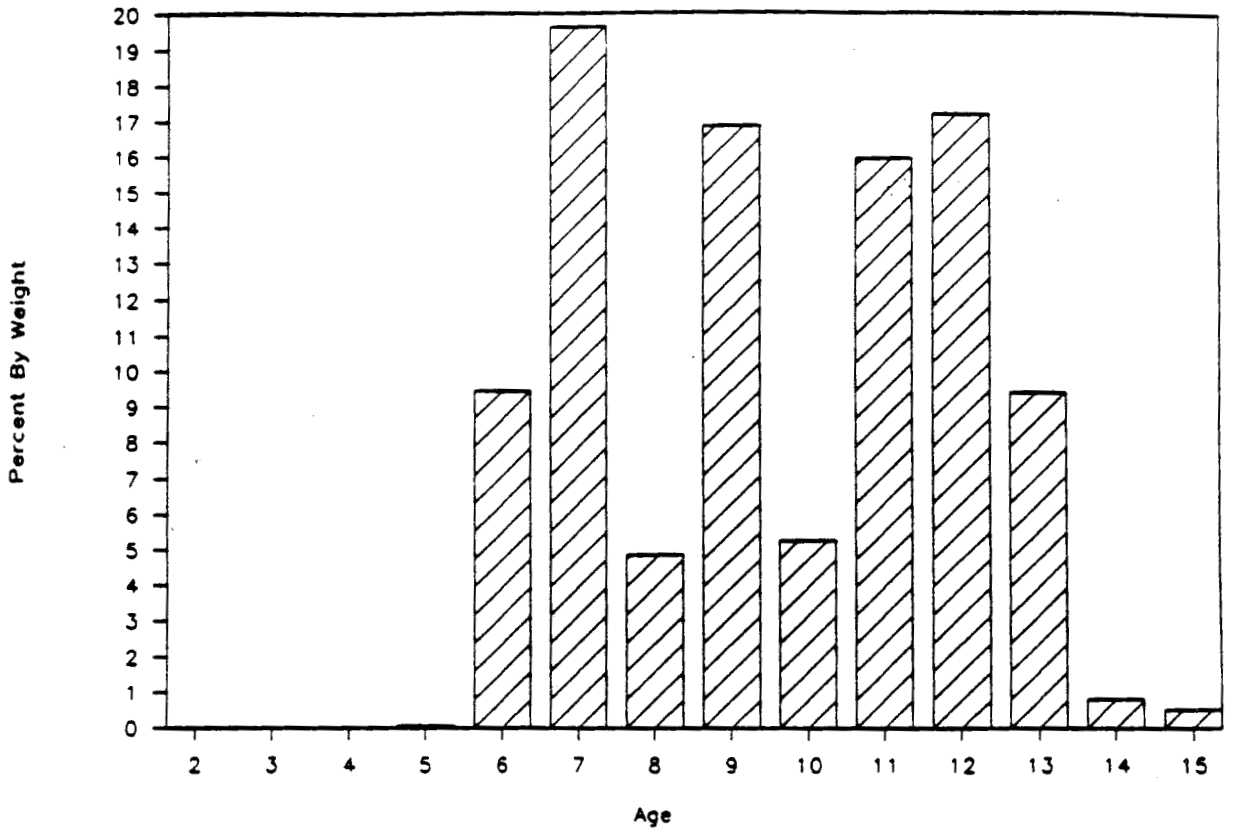

Figure 17. Age composition by weight of the 1990 biomass forecast for Togiak District herring. The mean weight is projected at 361 grams.

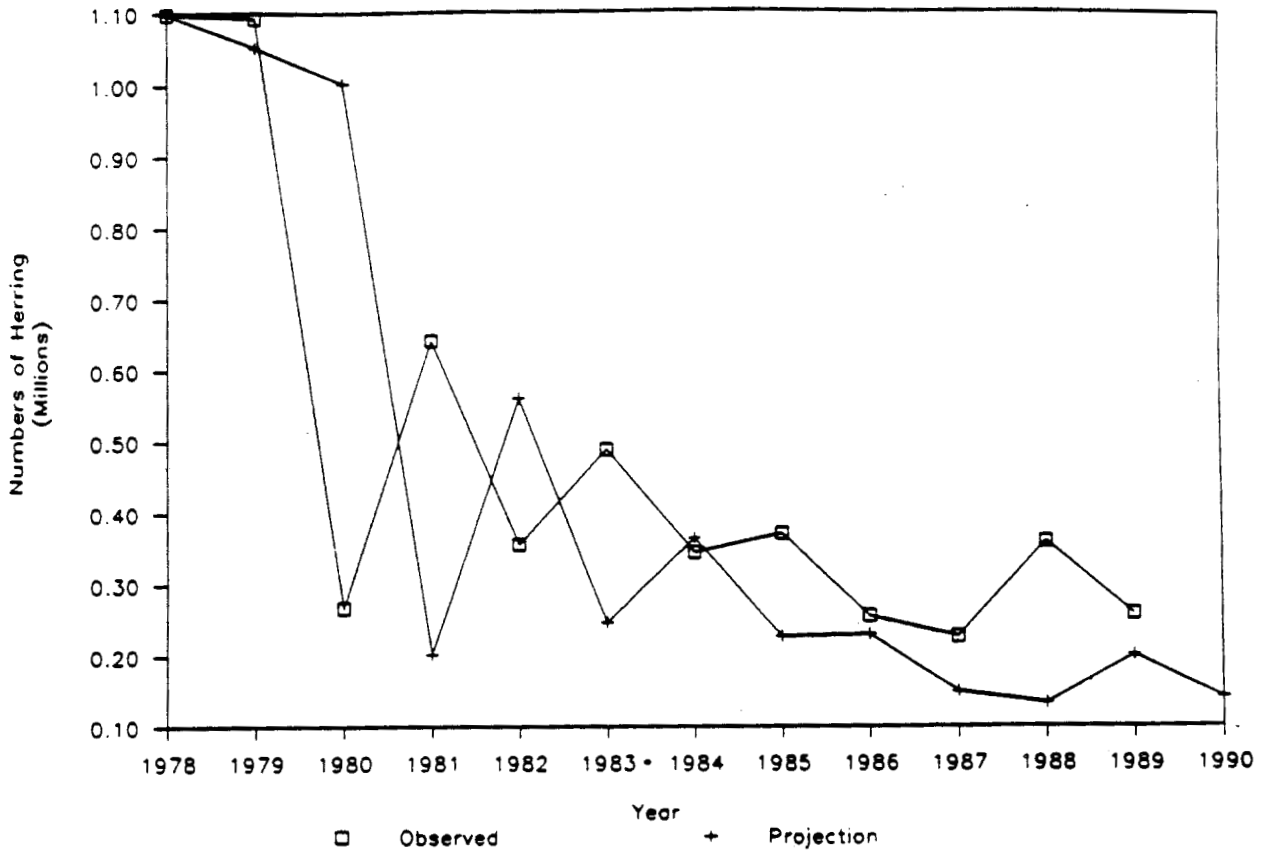

Figure 18. Performance of the Togiak District herring forecast based on the current schedule of increasing mortality with age.

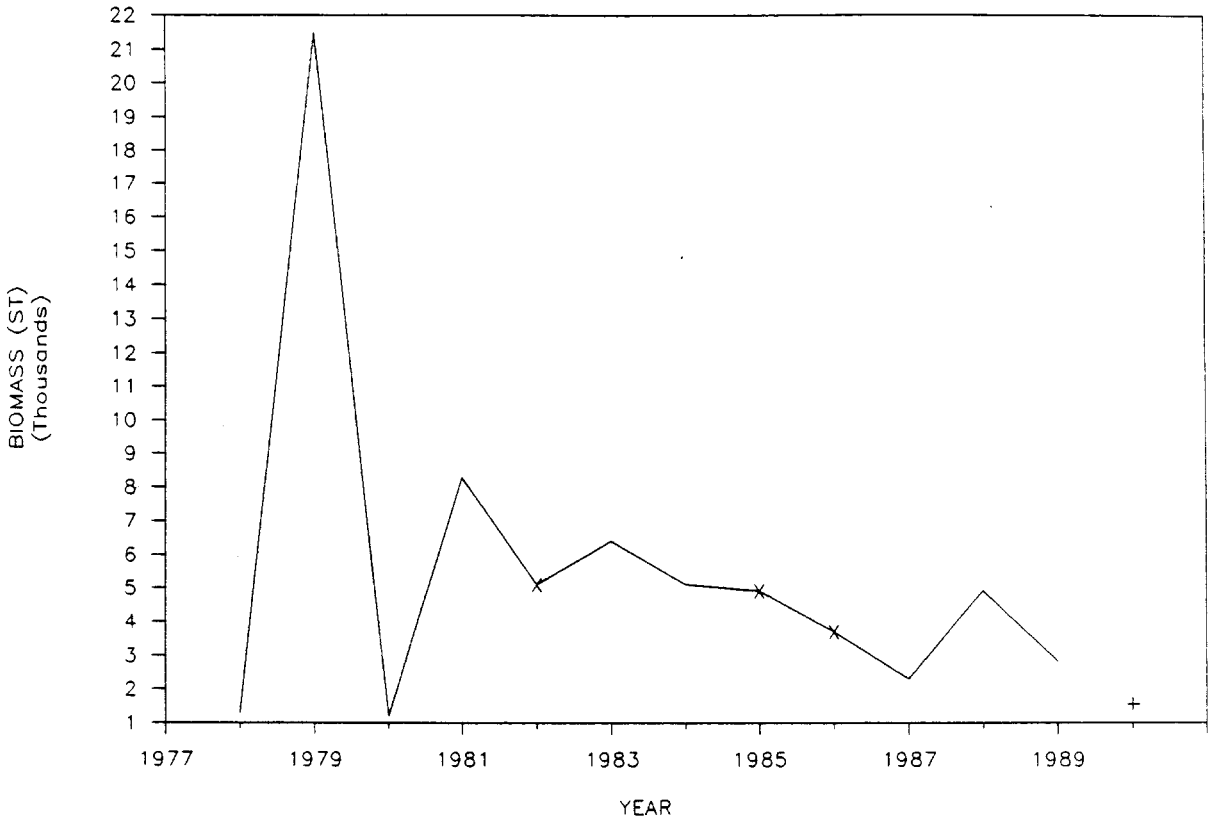

Figure 19. Security Cove District herring biomass, 1978-1989, with 1990 projected biomass (+). In some years (X), it was not possible to obtain an aerial survey estimate of biomass; therefore the preseason projection was used instead.

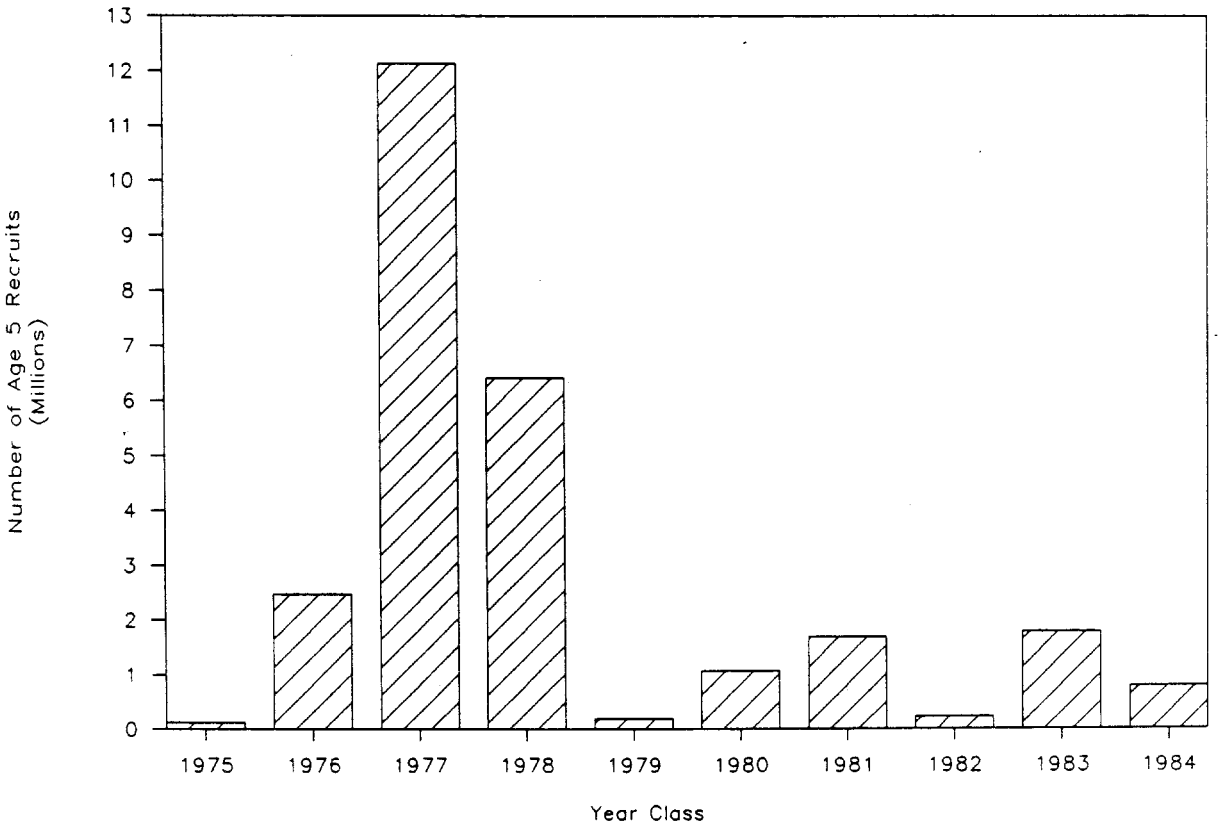

Figure 20. Historical year class strength of Security Cove District herring in numbers of 5-year-old fish.

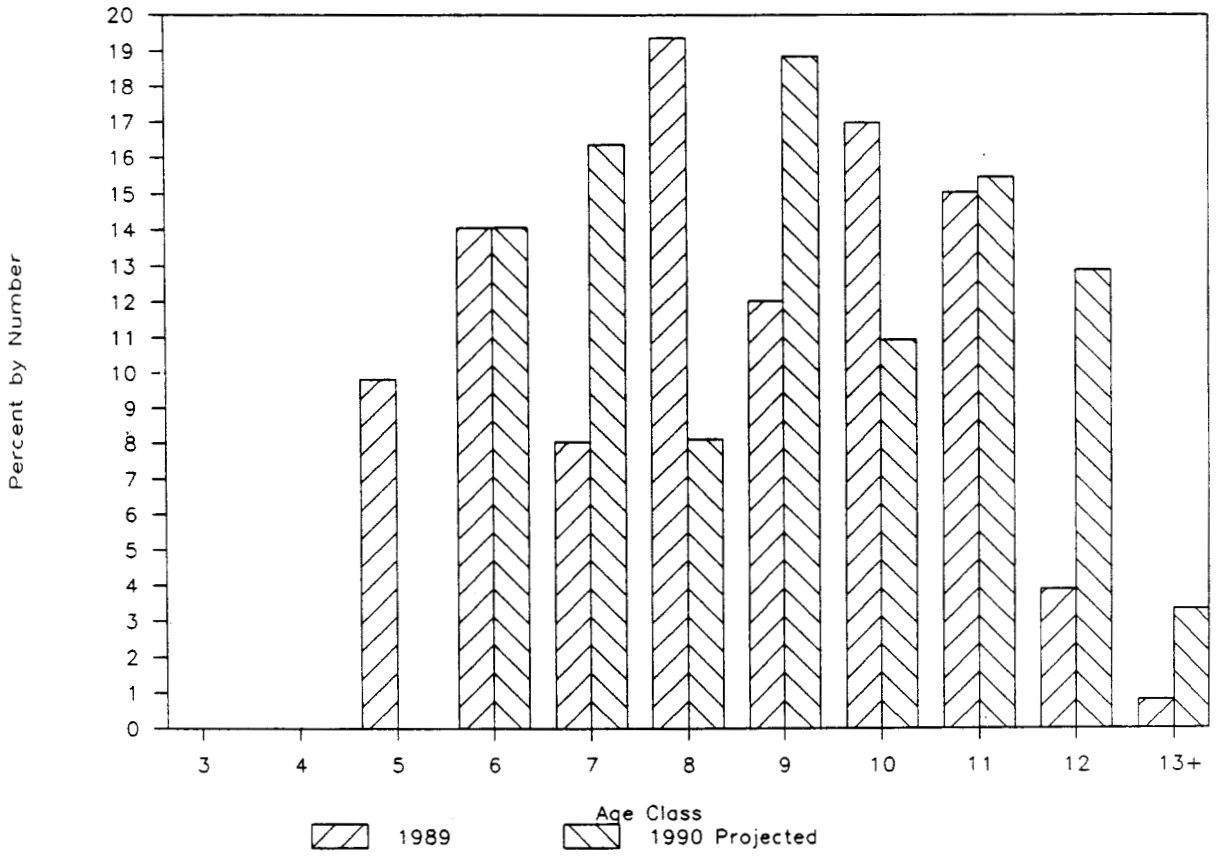

Figure 21. Age composition of Security Cove herring population in 1989 and projected 1990 return.

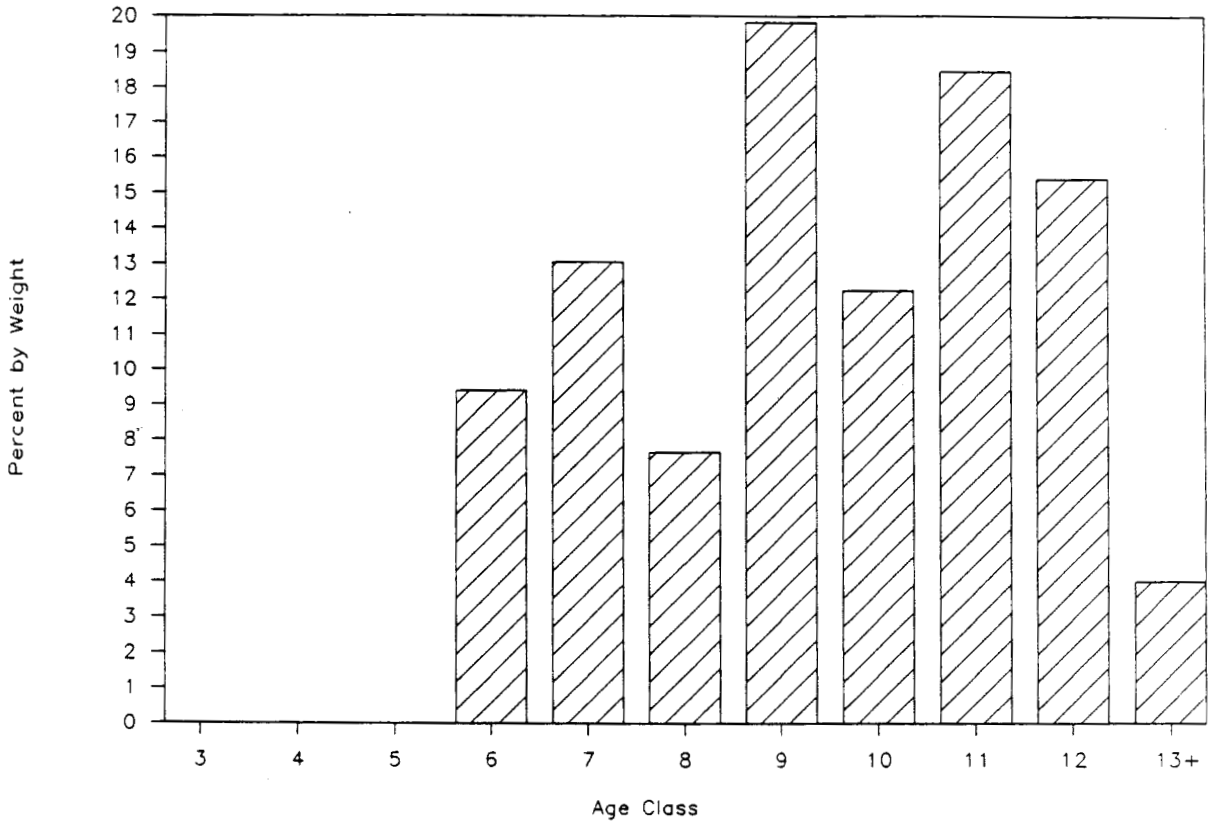

Figure 22. Age composition by weight of the projected 1990 biomass of Security Cove District herring.

Figure 23. Goodnews Bay District herring biomass, 1978-1989, with 1990 projected biomass (+). In some years (X), it was not possible to obtain an aerial survey estimate of biomass; therefore the preseason projection was used instead.

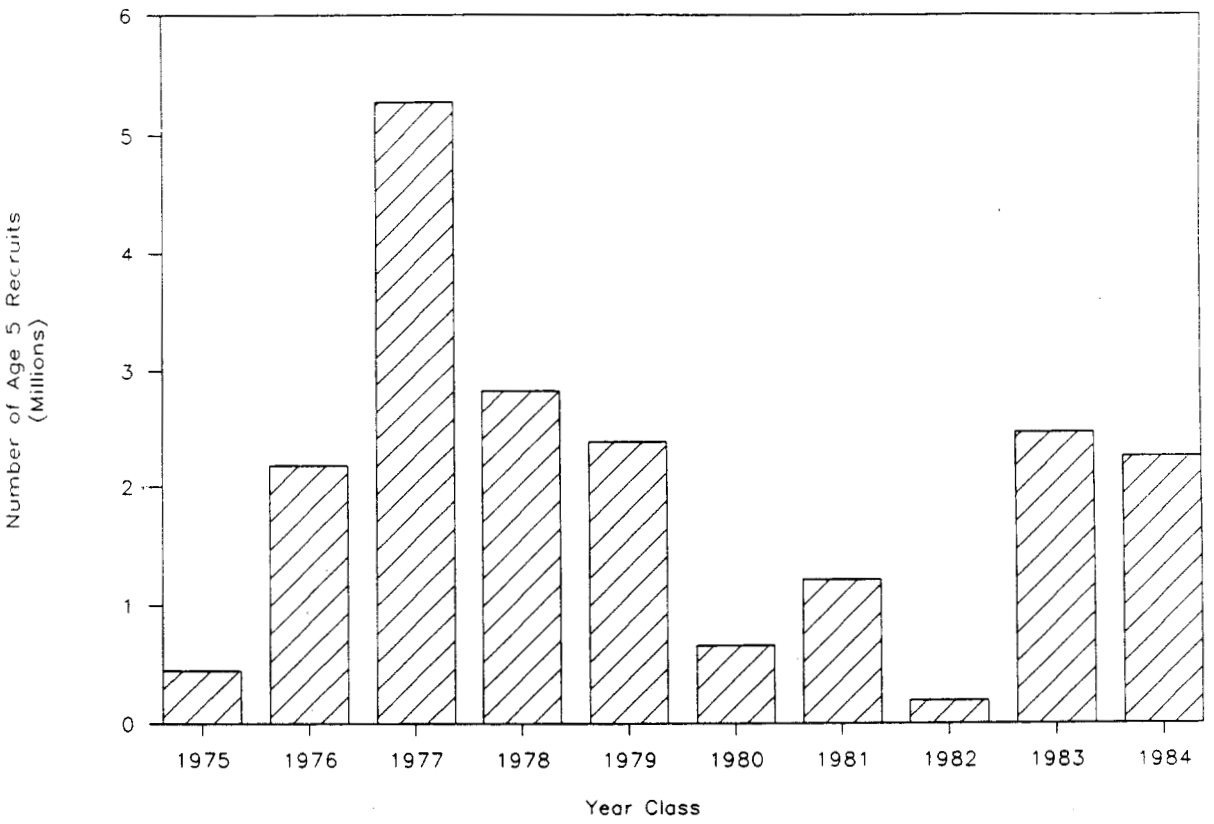

Figure 24. Historical year class strength of Goodnews Bay District herring in numbers of 5-year-old fish.

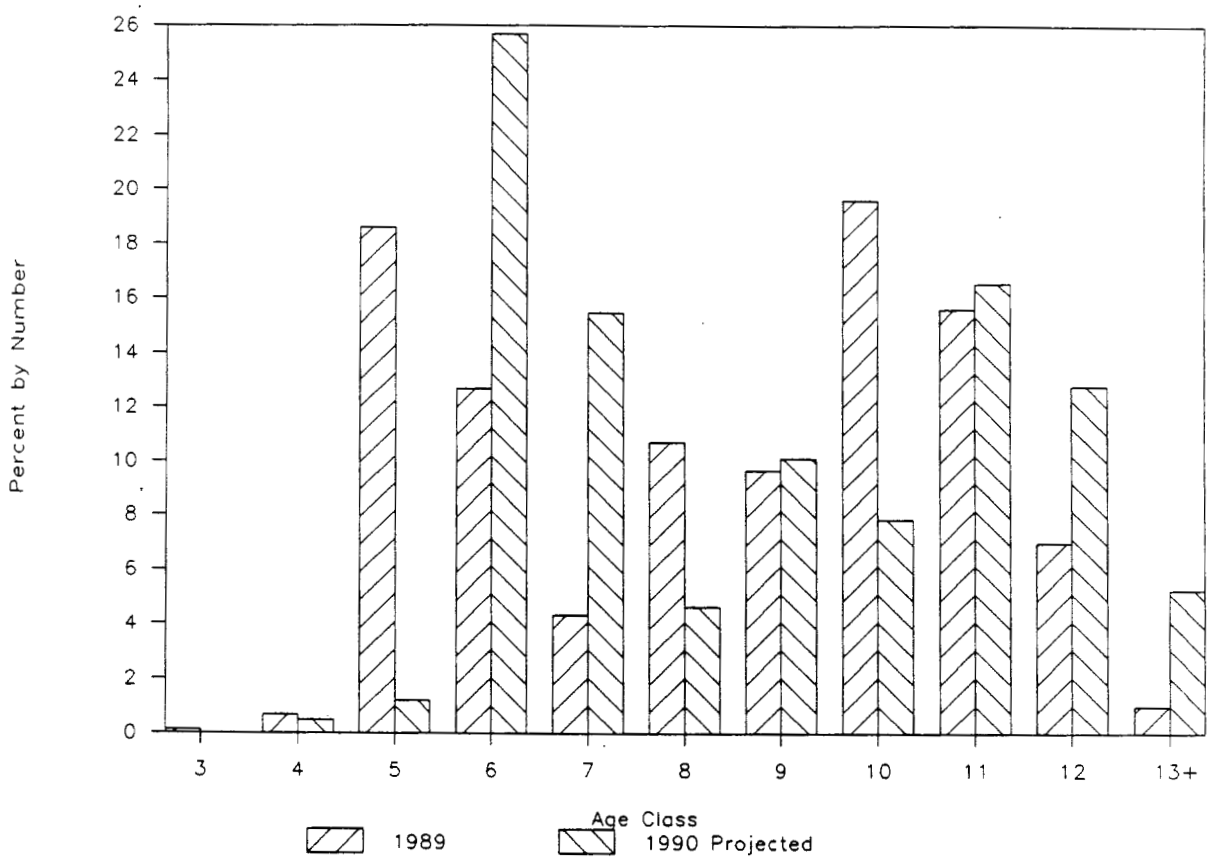

Figure 25. Age composition of Goodnews Bay herring population in 1989 and projected 1990 return.

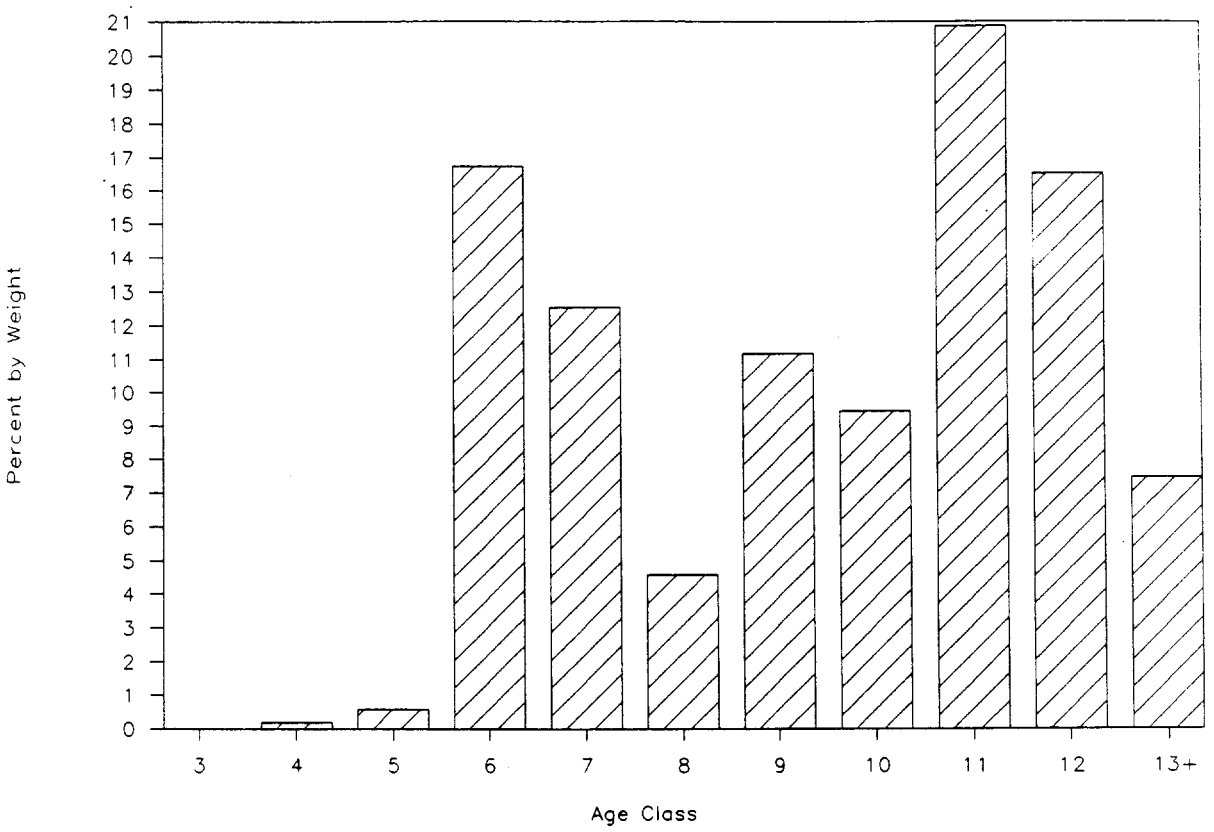

Figure 26. Age composition by weight of the projected 1990 biomass of Goodnews Bay District herring.

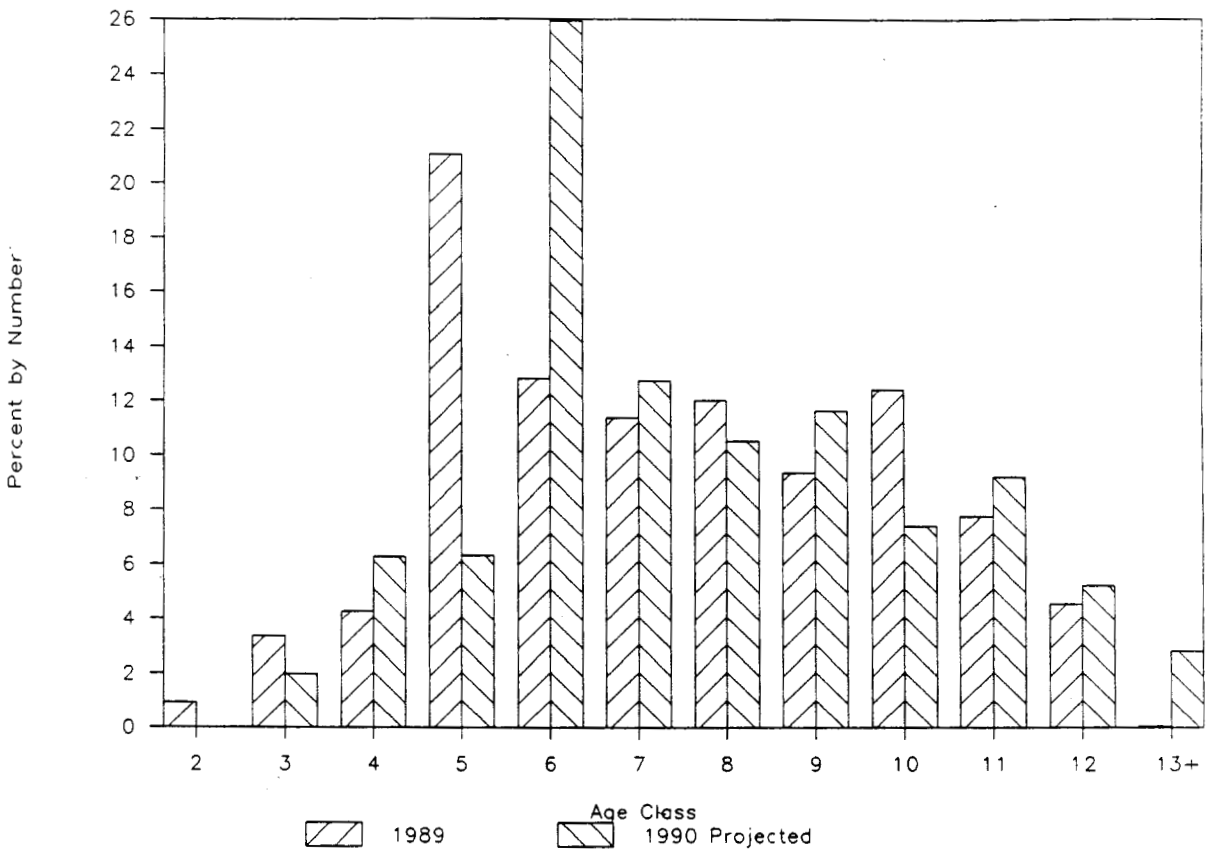

Figure 27. Age composition of Cape Avinof herring population in 1989 and projected 1990 return.

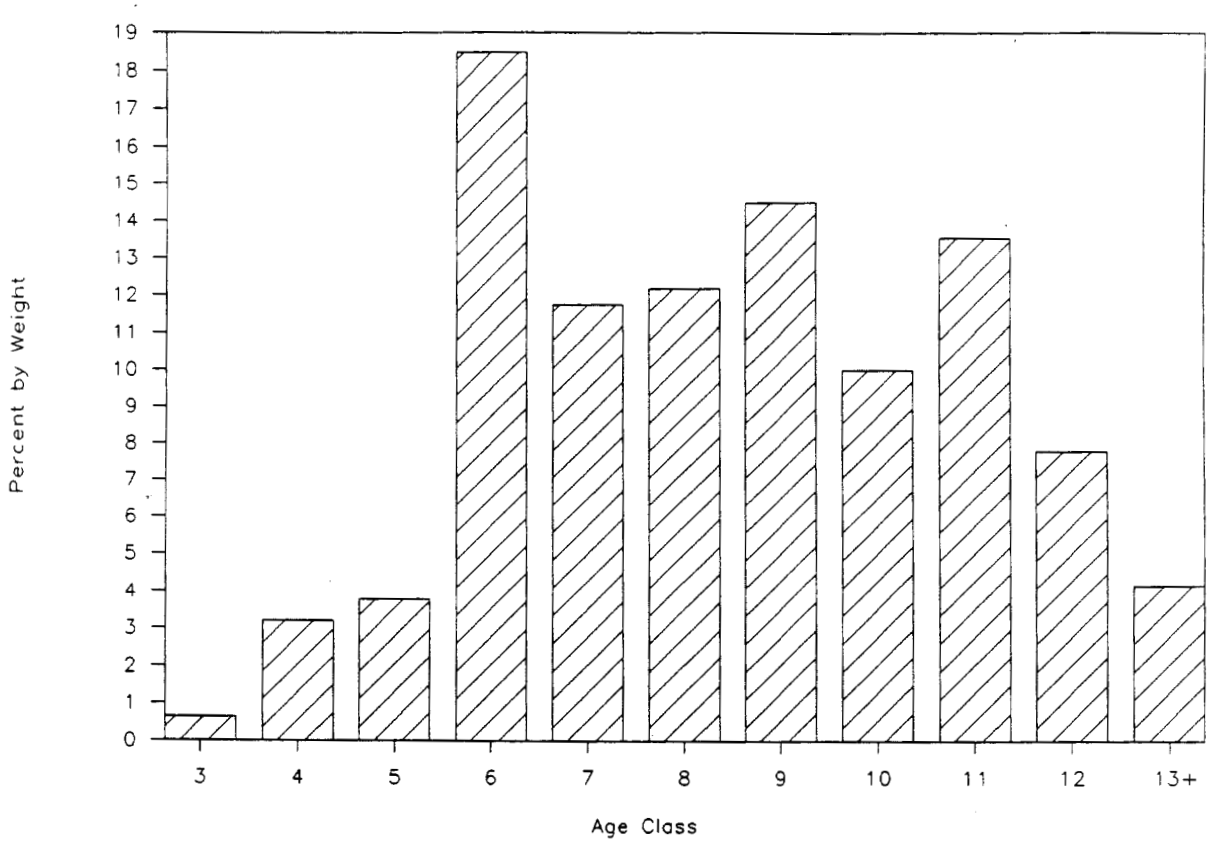

Figure 28. Age composition by weight of the projected 1990 biomass of Cape Avinof District herring.

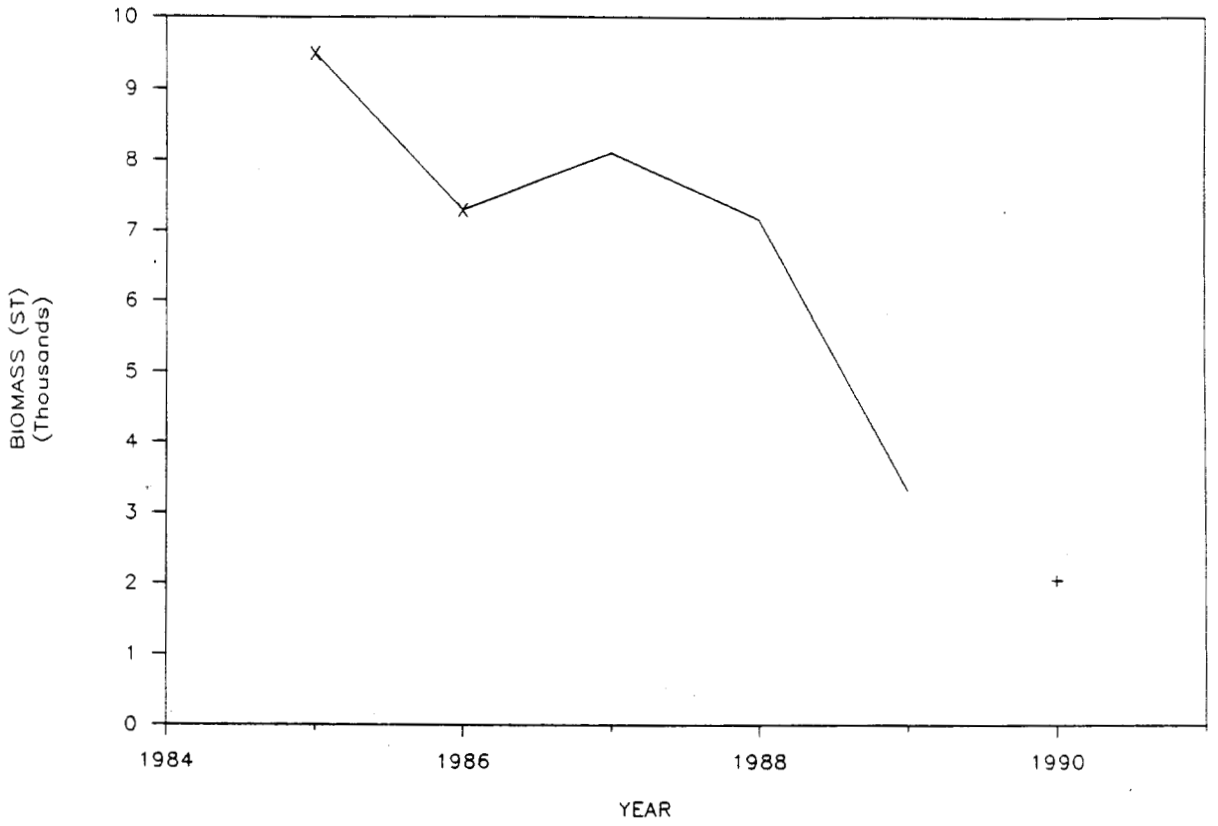

Figure 29. Nelson Island District herring biomass, 1985-1989, with 1990 projected biomass (+). In some years (X), it was not possible to obtain an aerial survey estimate of biomass; therefore the preseason projection was used instead.

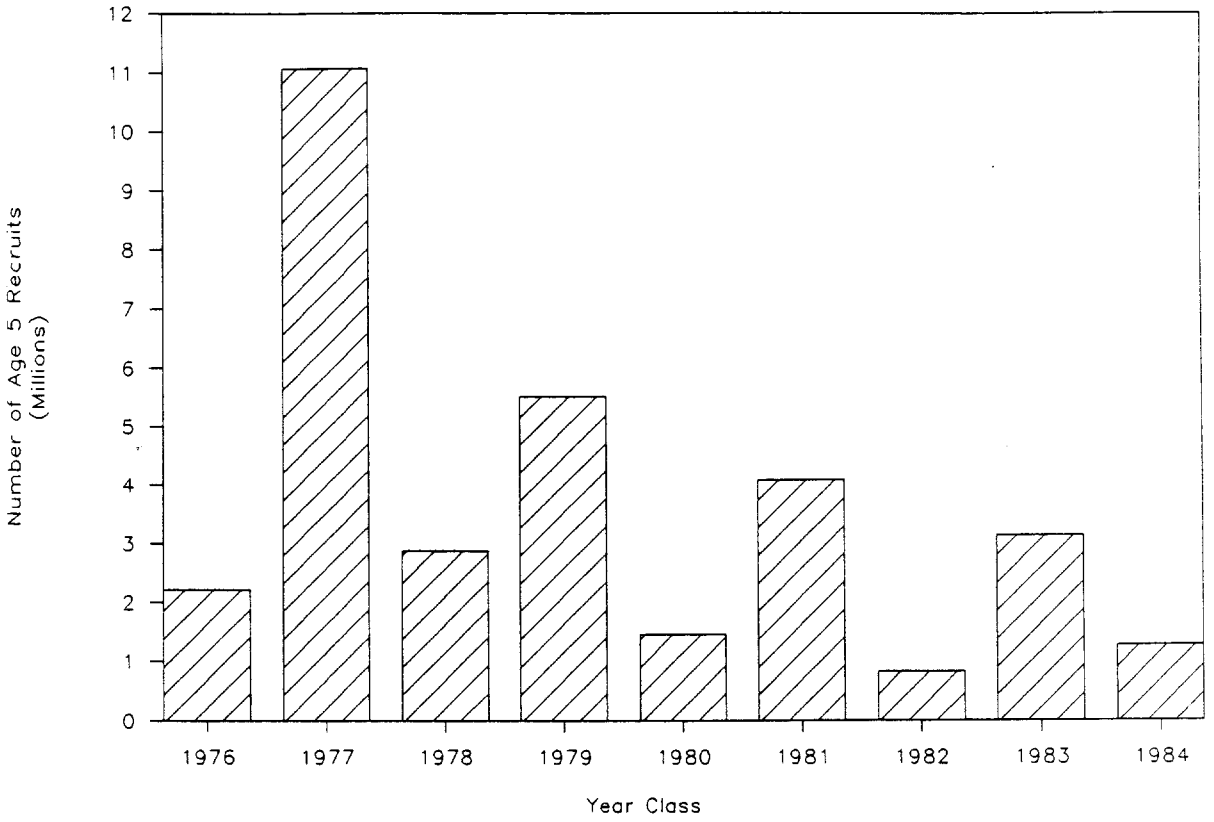

Figure 30. Historical year class strength of Nelson Island District herring in numbers of 5-year-old fish.

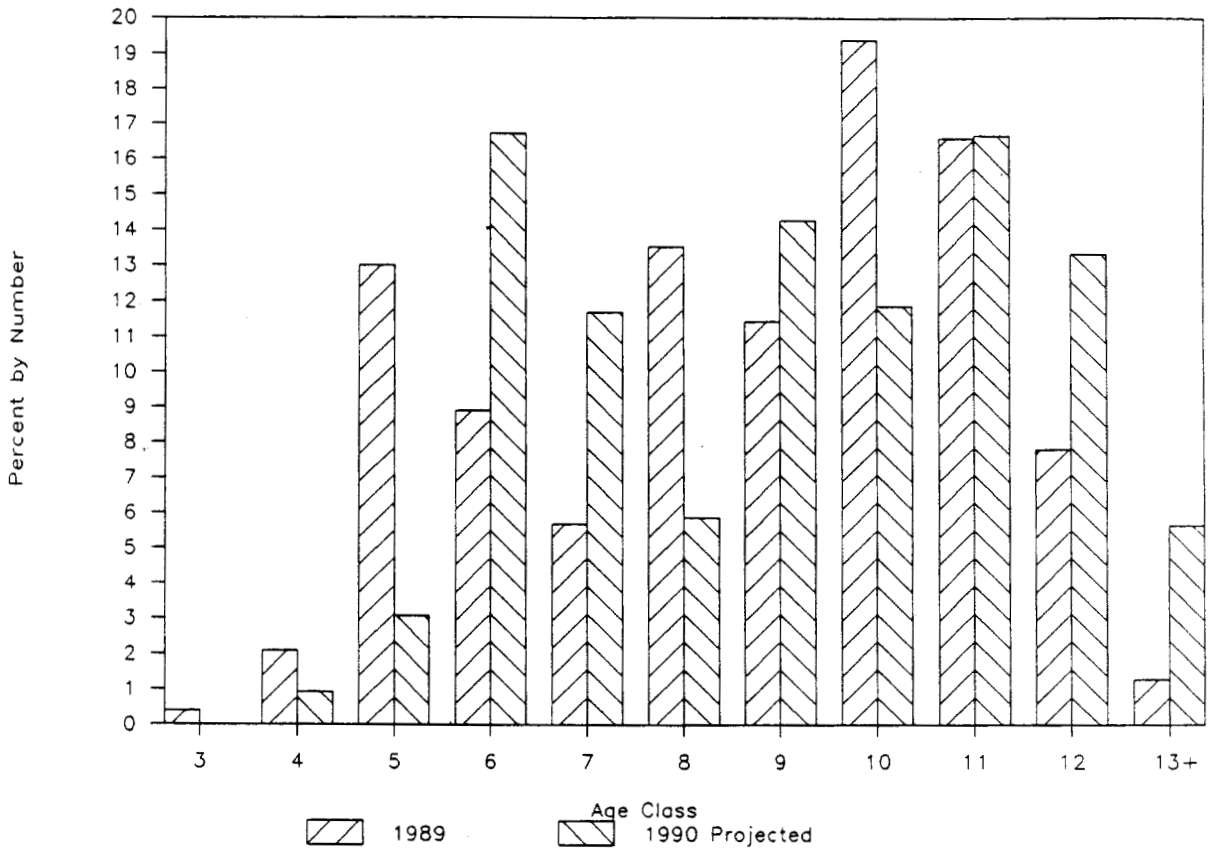

Figure 31. Age composition of Nelson Island herring population in 1989 and projected 1990 return.

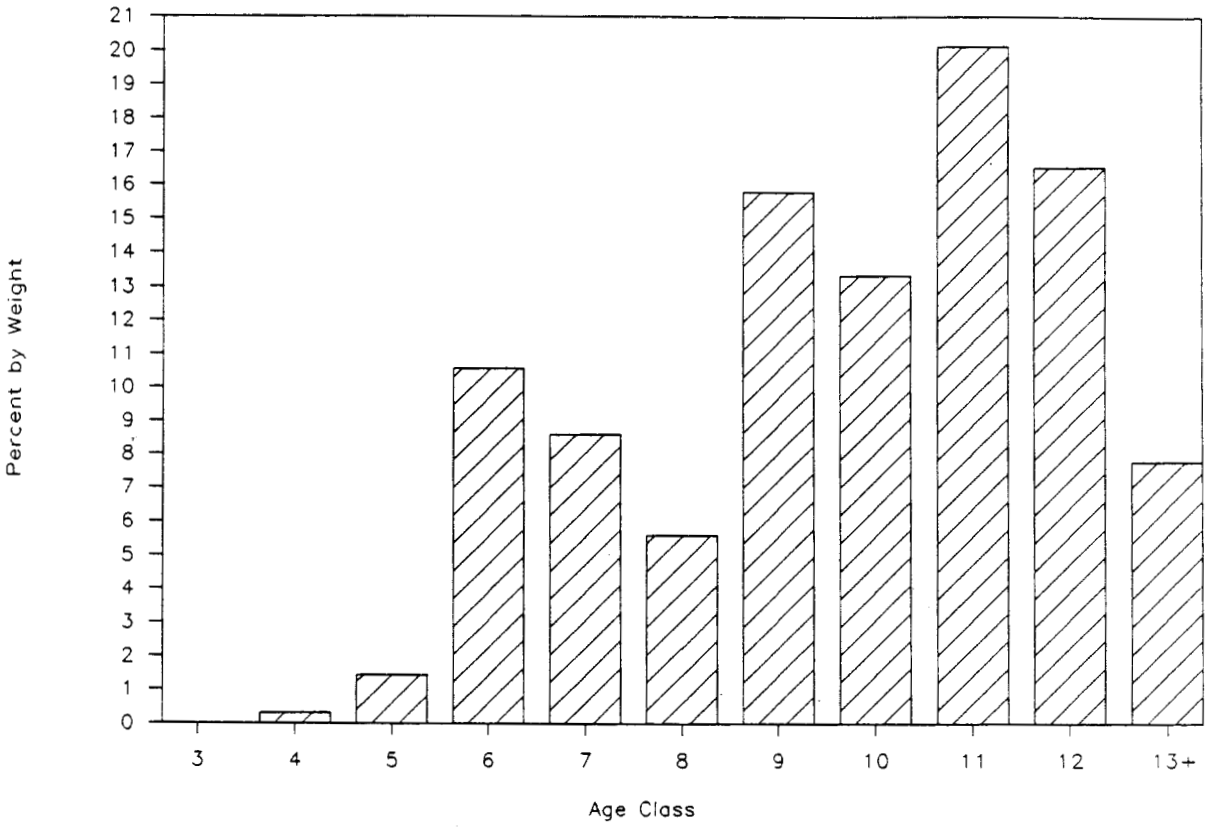

Figure 32. Age composition by weight of the projected 1990 biomass of Nelson Island District herring.

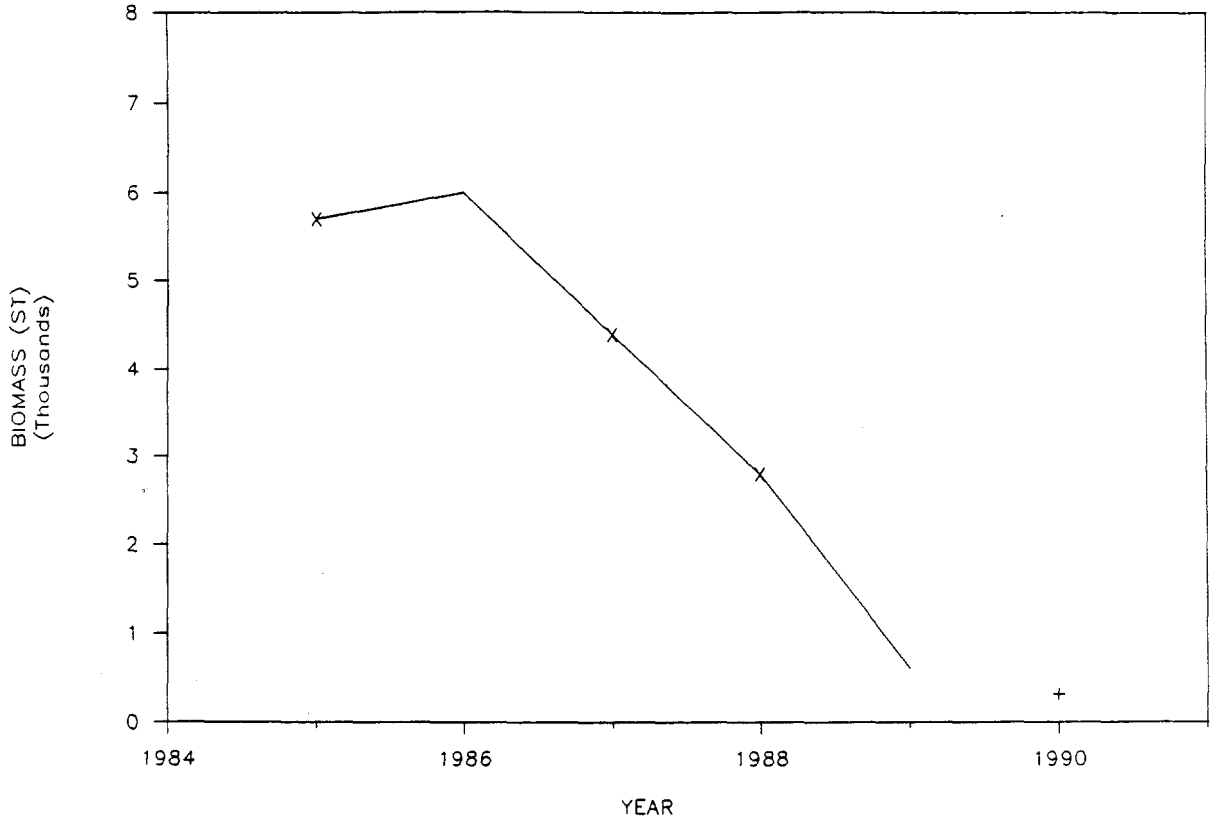

Figure 33. Nunivak Island District herring biomass, 1985-1989, with 1990 projected biomass (+). In some years (X), it was not possible to obtain an aerial survey estimate of biomass; therefore the preseason projection was used instead.

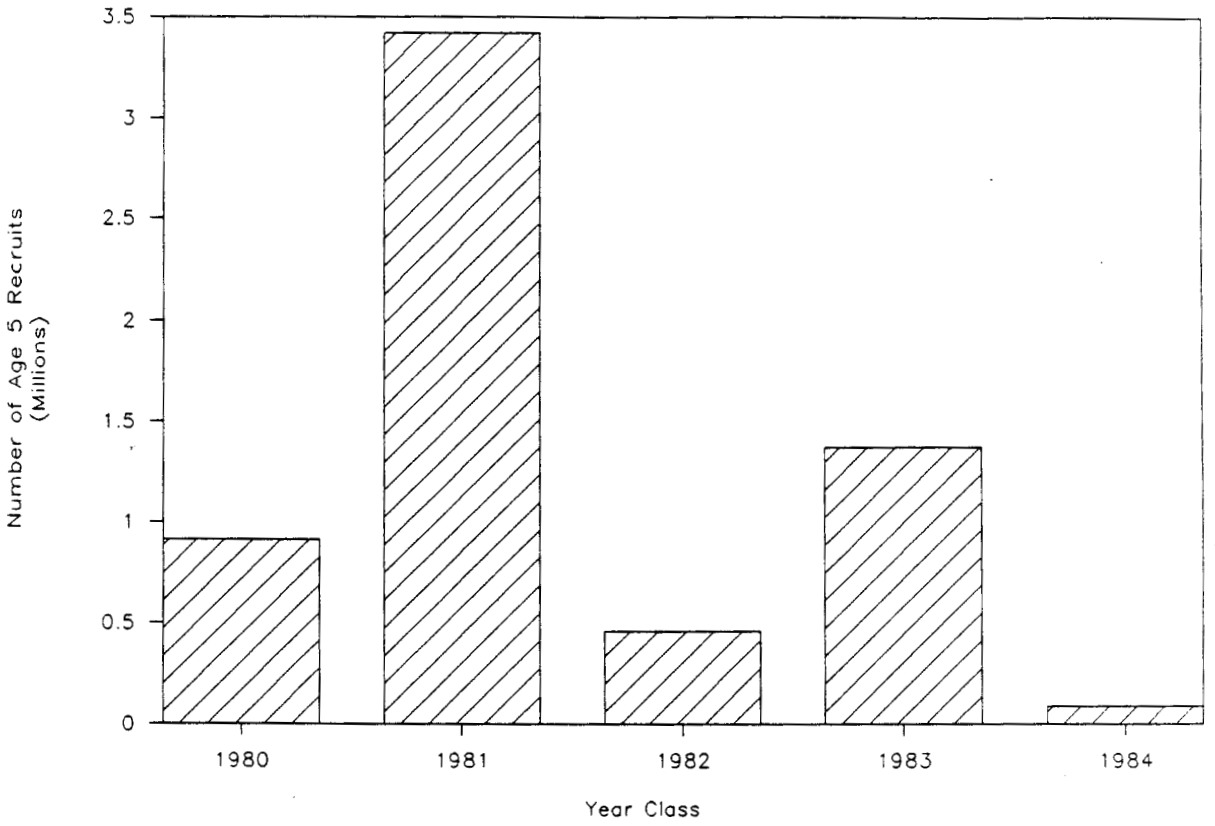

Figure 34. Historical year class strength of Nunivak Island District herring in numbers of 5-year-old fish.

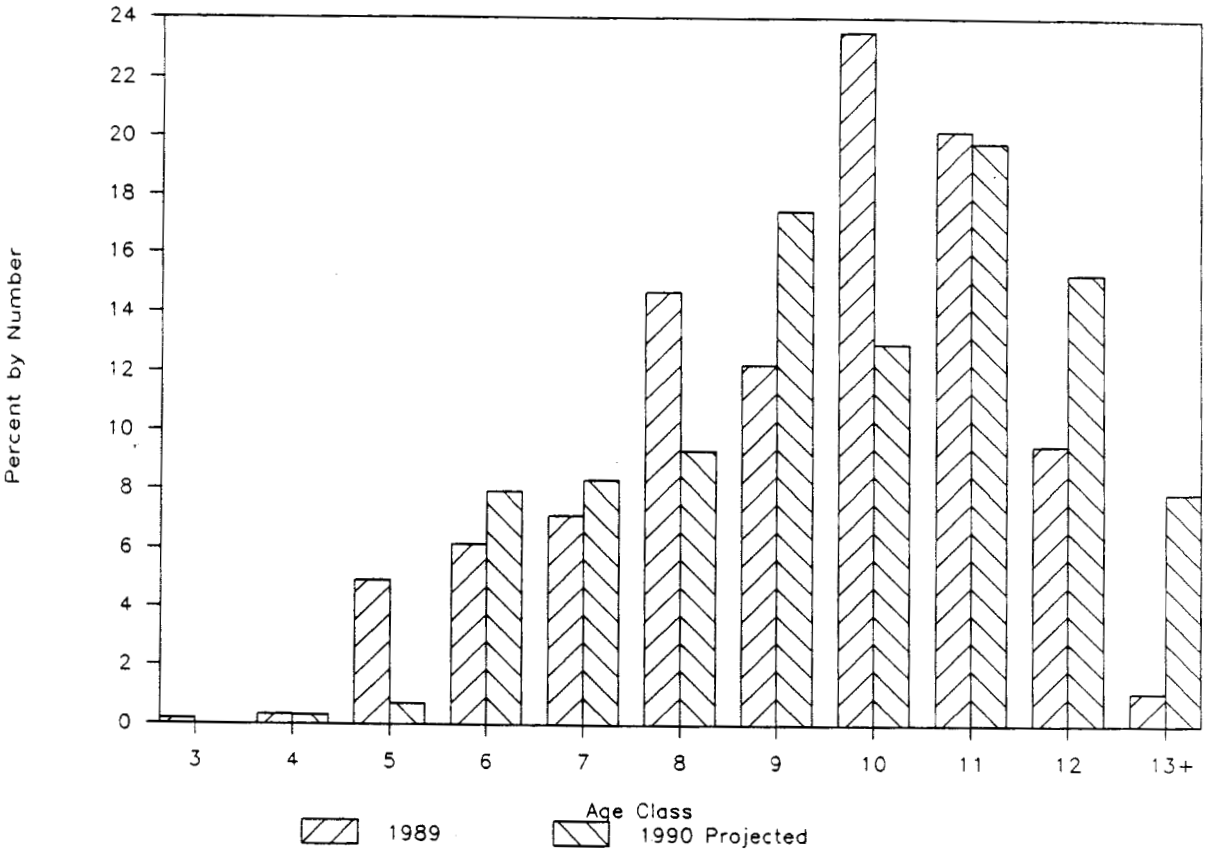

Figure 35. Age composition of Nunivak Island herring population in 1989 and projected 1990 return.

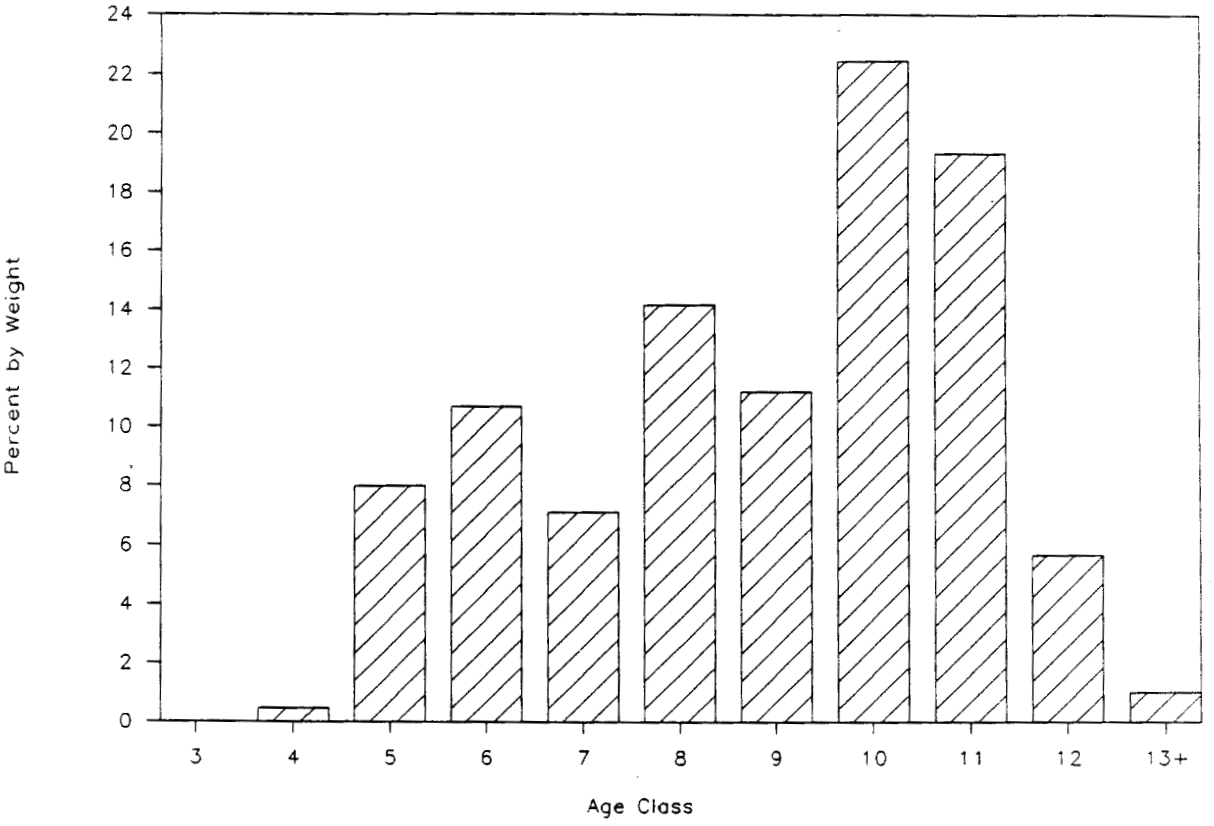

Figure 36. Age composition by weight of the projected 1990 biomass of Nunivak Island District herring.

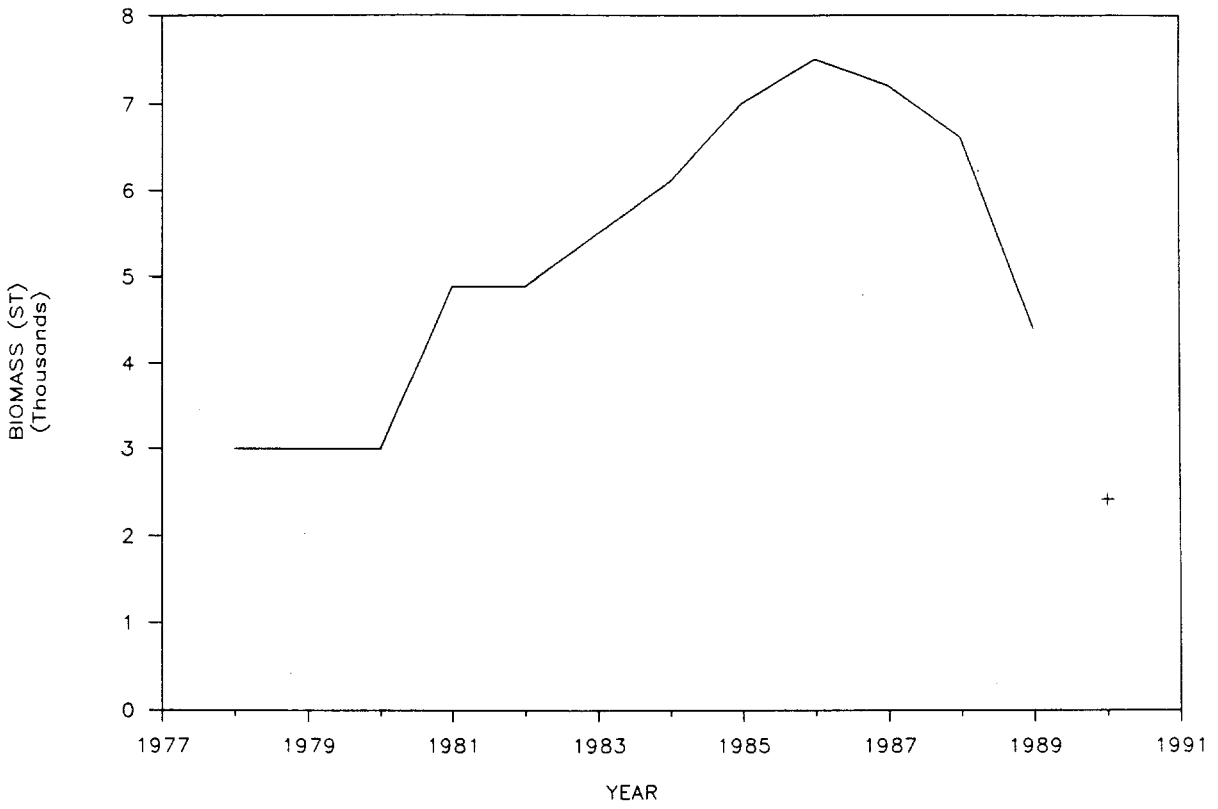

Figure 37. Cape Romanzof District herring biomass, 1978-1989, with 1990 projected biomass (+). All biomass estimates in this District are based on spawn deposition, catch rates and age composition, except 1987, which is from aerial survey.

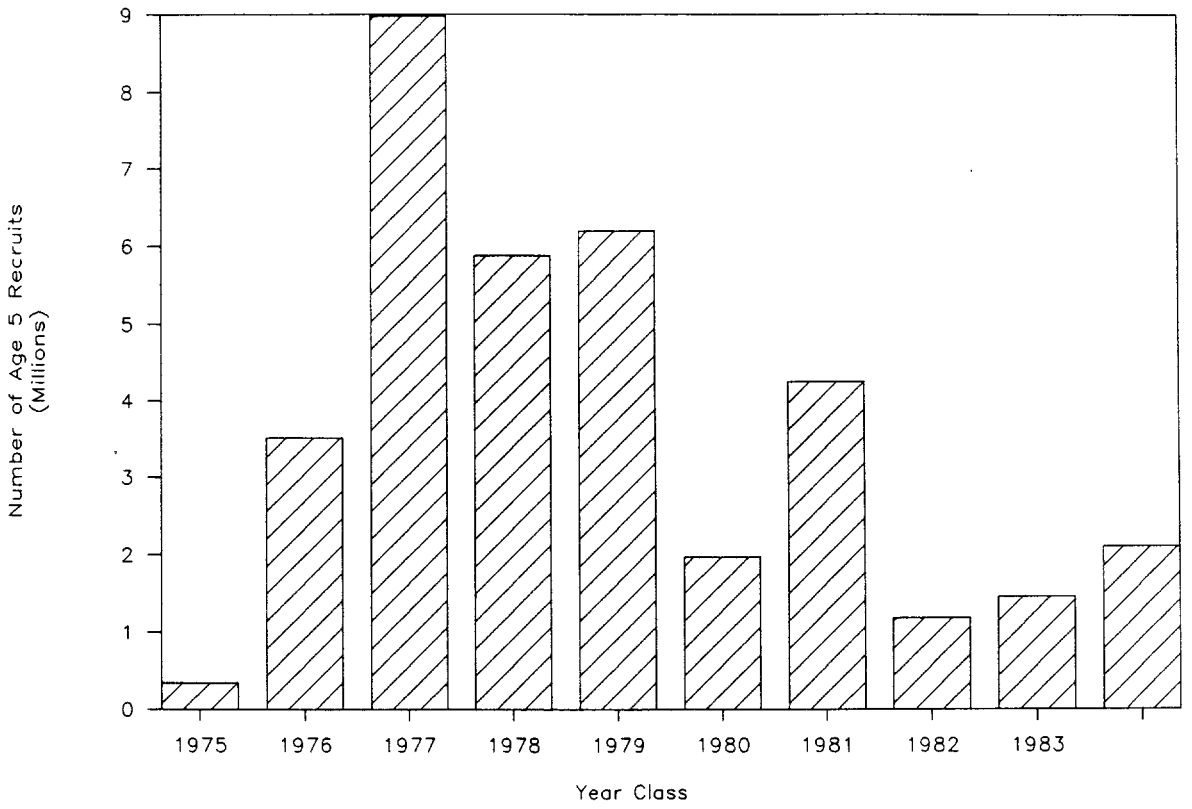

Figure 38. Historical year class strength of Cape Romanzof District herring in numbers of 5-year-old fish.

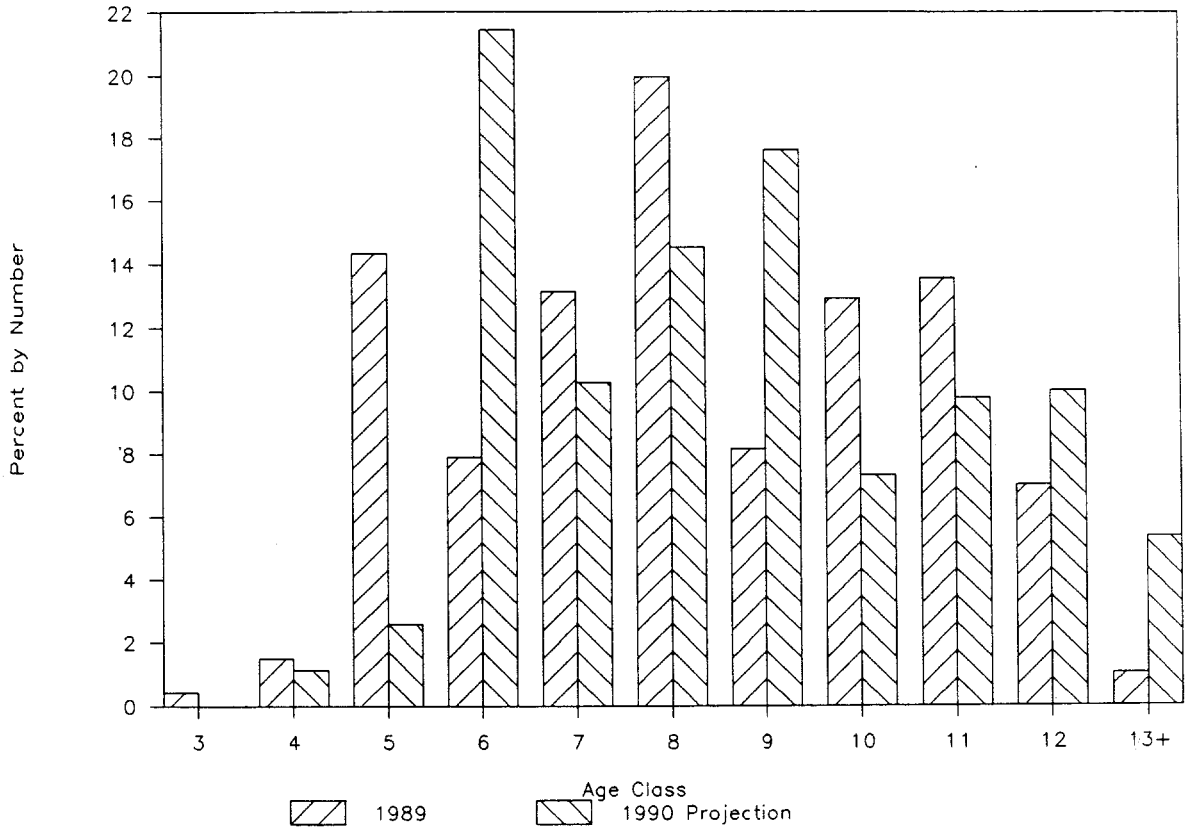

Figure 39. Age composition of Cape Romanzof herring population in 1989 and projected 1990 return.

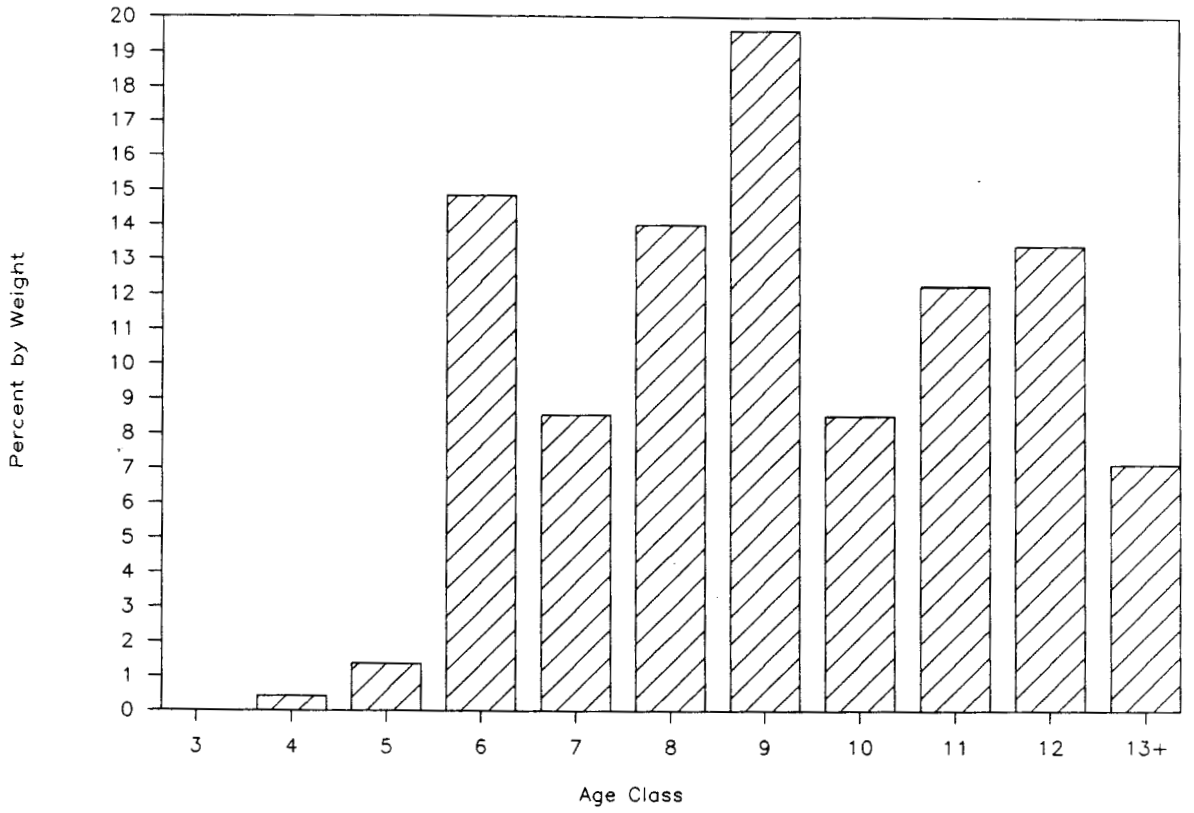

Figure 40. Age composition by weight of the projected 1990 biomass of Cape Romanzof District herring.

Figure 41. Norton Sound District herring biomass, 1978-1989, with 1990 projected biomass (+). Years of minimal biomass estimates due to poor survey conditions are marked (X).

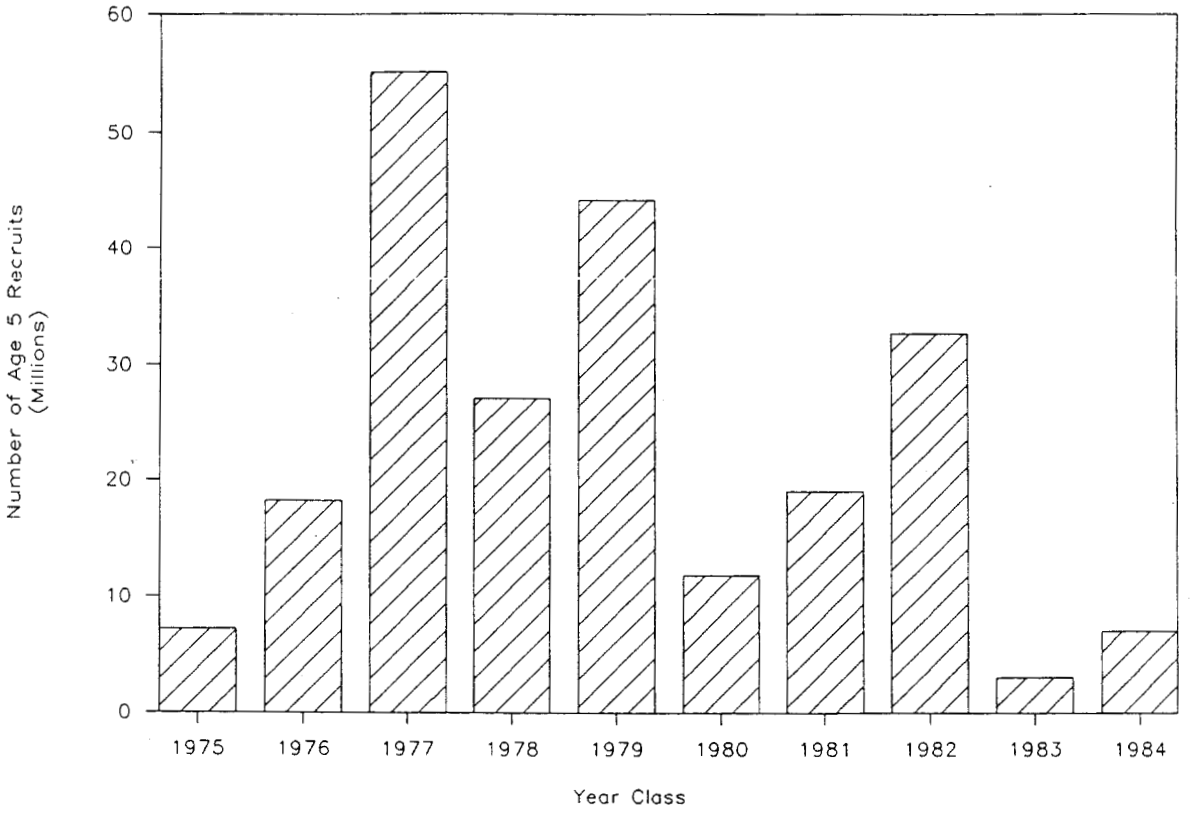

Figure 42. Historical year class strength of Norton Sound District herring in numbers of 5-year-old fish.

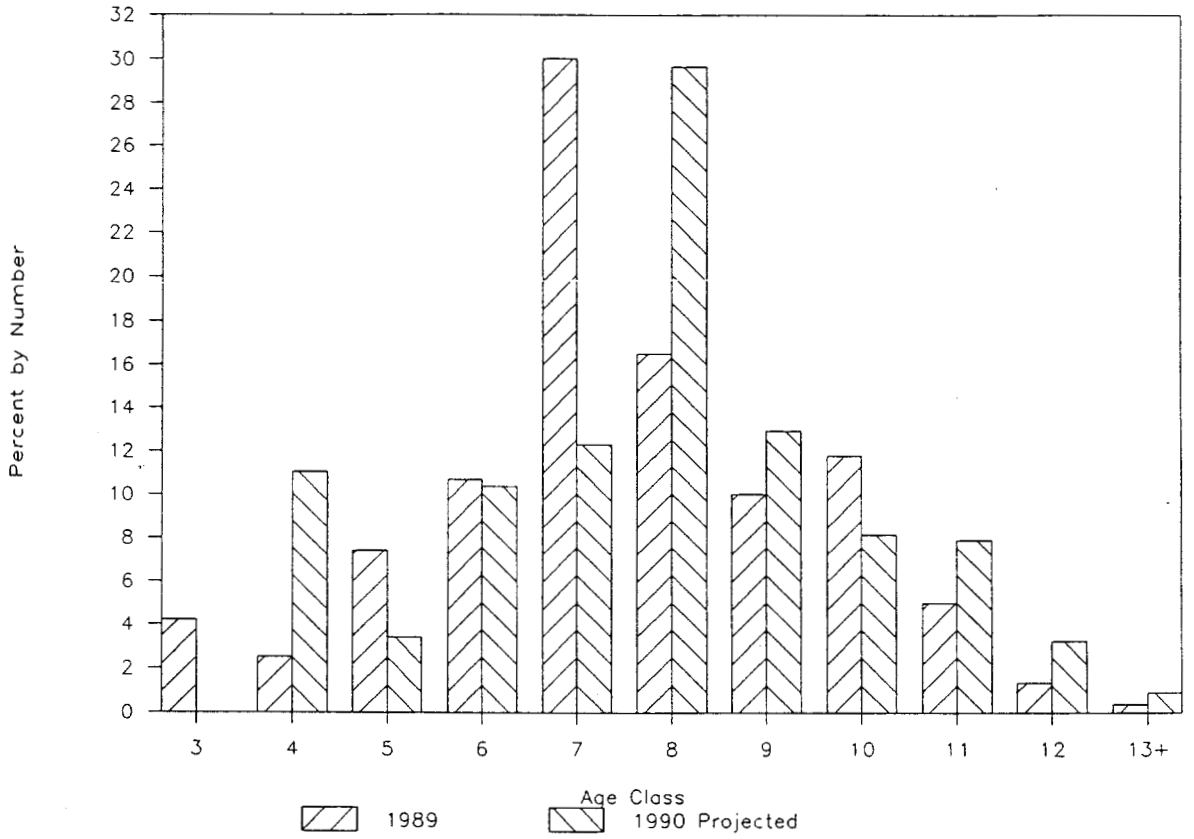

Figure 43. Age composition of Norton Sound herring population in 1989 and projected 1990 return.

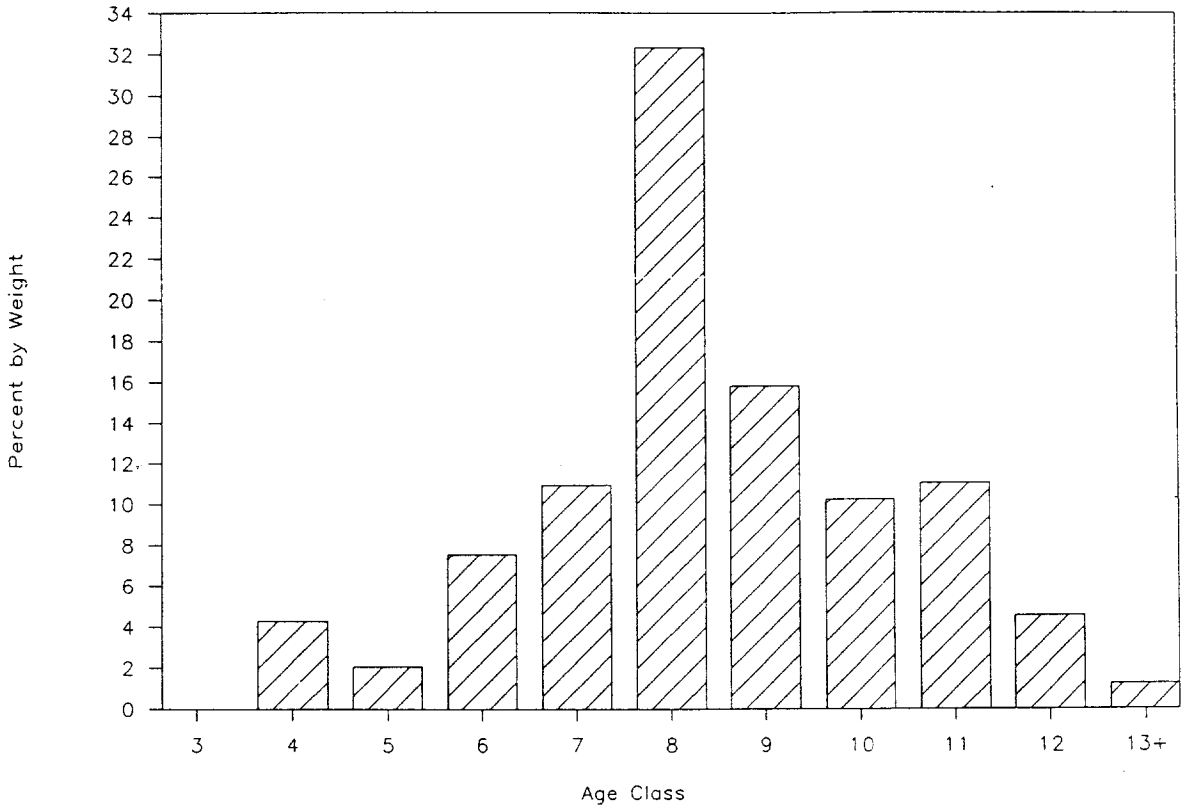

Figure 44. Age composition by weight of the projected 1990 biomass of Norton Sound District herring.