

REGIONAL INFORMATION REPORT NO. 5J95-13



**Preliminary Forecasts of Catch and Abundance  
for 1994 Alaska Herring Fisheries**

**Edited**

**by**

**Fritz Funk**

**May 1995**

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PRELIMINARY FORECASTS OF CATCH AND ABUNDANCE  
FOR 1994 ALASKA HERRING FISHERIES

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REGIONAL INFORMATION REPORT NO. 5J95-13

Alaska Department of Fish and Game  
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May 1995

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## TABLE OF CONTENTS

|  | <u>Page</u> |
|--|-------------|
| LIST OF TABLES .....   | iv          |
| LIST OF FIGURES .....  | v           |
| ABSTRACT .....   | vii         |
| INTRODUCTION .....   | 1           |
| Herring Management and Harvest Policies .....                              | 1           |
| Stock Assessment and Forecast Methods .....                                | 2           |
| Statewide Harvest Trends .....   | 3           |
| Additional Forecast and Regulatory Information .....                       | 3           |
| SOUTHEAST REGION .....   | 5           |
| Introduction .....   | 7           |
| Southeast Alaska Winter Food/Bait Fishery .....                            | 8           |
| Southeast Alaska Sac Roe Herring Fisheries .....                           | 9           |
| Southeast Alaska Spawn-on-Pound-Kelp Fisheries .....                       | 10          |
| CENTRAL REGION .....   | 13          |
| Prince William Sound Sac Roe, Spawn-on-Kelp, and Food/Bait Fisheries ..... | 15          |
| Lower Cook Inlet Herring Fishery .....                                     | 17          |
| Togiak District, Bristol Bay, Sac Roe and Spawn-on-Kelp Fisheries .....    | 18          |
| ARCTIC-YUKON-KUSKOKWIM REGION .....  | 23          |
| Introduction .....   | 25          |
| Security Cove Sac Roe Fishery .....  | 27          |
| Goodnews Bay Sac Roe Fishery .....   | 28          |
| Cape Avinof Sac Roe Fishery .....  | 29          |
| Nelson Island Sac Roe Fishery .....  | 30          |
| Nunivak Island Sac Roe Fishery .....                                       | 32          |
| Cape Romanzof Sac Roe Fishery .....  | 33          |
| Norton Sound Sac Roe Fishery .....   | 34          |
| Port Clarence Sac Roe Fishery .....  | 36          |
| WESTWARD REGION .....  | 37          |
| Kodiak Management Area .....   | 39          |
| Kodiak Food/Bait Fishery .....   | 39          |
| Kodiak Sac Roe Fishery .....   | 40          |
| Port Moller (North Peninsula) Sac Roe Fishery .....                        | 43          |
| South Peninsula Sac Roe Fishery .....                                      | 43          |
| Dutch Harbor Food/Bait Herring Fishery .....                               | 44          |
| LITERATURE CITED .....   | 45          |
| TABLES AND FIGURES .....   | 47          |

## LIST OF TABLES

| <u>Table</u>   | <u>Page</u> |
|--|-------------|
| 1. Summary of harvest and value for 1993 Alaska herring fisheries . . . . .  | 49          |
| 2. Summary of harvest, value, and participation in 1993 Alaska sac roe<br>herring fisheries by area . . . . .  | 50          |
| 3. Summary of harvest, value, and participation in 1993 Alaska spawn-on-kelp<br>herring fisheries by area . . . . .  | 51          |
| 4. Summary of harvest, value, and participation in 1993–1994 Alaska food/bait<br>herring fisheries by area . . . . .   | 52          |
| 5. Forecasts of harvests and abundance for 1994 Alaska sac roe herring fisheries . . . . .   | 53          |
| 6. Forecasts of harvests and abundance for 1994 Alaska spawn-on-kelp and<br>food/bait herring fisheries . . . . .  | 54          |
| 7. Glossary of some terminology used in describing herring stock assessment . . . . .  | 55          |
| 8. Summary of harvest policy and fishery regulations for Alaska sac roe<br>herring fisheries . . . . .   | 56          |
| 9. Summary of Alaska harvest policy and fishery regulations for Alaska<br>spawn-on-kelp and food/bait herring fisheries . . . . .  | 57          |
| 10. Alaska herring fisheries, area management offices, and fishery managers<br>to contact for additional information . . . . .   | 58          |
| 11. Herring spawning threshold levels for major herring stocks in Southeast<br>Alaska and Yakutat . . . . .  | 59          |
| 12. Escapement of herring in 1993 and projection of spawning biomass for<br>1994 herring spawning at Craig, Revilla Channel, Sitka, and Seymour<br>Canal in Southeast Alaska . . . . .                       | 60          |
| 13. Allocation of allowable harvest for Prince William Sound in 1994 under<br>the “moderate” forecast scenario of a 29,786-ton run biomass . . . . .   | 61          |
| 14. Forecast of 1994 Kamishak Bay District herring abundance and projected<br>harvest by age . . . . .   | 62          |
| 15. Allocation of the projected 1994 Kamishak Bay herring harvest . . . . .  | 63          |
| 16. Togiak District year class composition of the 1993 Pacific herring harvest,<br>and aerial survey estimates of 1993 escapement and total run biomass and<br>the 1994 projected biomass from ASA . . . . . | 64          |

## LIST OF FIGURES

| <u>Figure</u>   | <u>Page</u> |
|---|-------------|
| 1. Locations of Alaska herring fisheries . . . . .  | 65          |
| 2. Alaska Department of Fish and Game management regions and herring<br>regulatory statistical areas . . . . .  | 66          |
| 3. Herring harvests from all Alaska herring fisheries, 1900–1993 . . . . .  | 67          |
| 4. Alaska sac roe herring harvests from all areas, 1963–1993, with the<br>projected 1994 sac roe harvest . . . . .  | 68          |
| 5. Harvest policy for Southeast Alaska herring fisheries showing the<br>relationship between the allowable exploitation rate and the mature biomass,<br>expressed as a multiple of the cutoff threshold level . . . . .                           | 69          |
| 6. Forecast age composition of the commercial catch for 1994 Southeast<br>Alaska herring fisheries . . . . .  | 70          |
| 7. Map of Prince William Sound, Alaska, and the major herring spawning<br>areas . . . . .   | 71          |
| 8. Eggs spawned from egg-deposition surveys and the ASA model (top) and<br>spawning biomass estimated by the ASA model under three scenarios<br>(bottom), showing the 1993 milt survey biomass and fall 1993 acoustic<br>survey biomass . . . . . | 72          |
| 9. Predicted age composition for Prince William Sound spawning herring<br>for the spring of 1994 . . . . .  | 73          |
| 10. Kamishak Bay, Southern, Outer, and Eastern Districts of the Lower Cook<br>Inlet Management Area . . . . .   | 74          |
| 11. Kamishak Bay herring run biomass, 1985–1993, with 1994 forecast (top)<br>and age distribution of forecast biomass (bottom) . . . . .  | 75          |
| 12. The Togiak fishing district of Bristol Bay, Alaska . . . . .  | 76          |
| 13. Biomass of Togiak District herring from aerial surveys and from the age-<br>structured assessment (ASA) model . . . . .   | 77          |
| 14. Forecast age distribution and weight at age of the commercial herring<br>harvest for the Togiak District . . . . .  | 78          |
| 15. Year class strength of Togiak District herring in numbers of five-year-old<br>recruits . . . . .  | 79          |

## LIST OF FIGURES (continued)

| <u>Figure</u>  | <u>Page</u> |
|--|-------------|
| 16. Security Cove District herring biomass, 1981–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age . . . . .  | 80          |
| 17. Goodnews Bay District herring biomass, 1981–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age . . . . .   | 81          |
| 18. Cape Avinof District herring biomass, 1985–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age . . . . .    | 82          |
| 19. Nelson Island District herring biomass, 1985–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age . . . . .  | 83          |
| 20. Nunivak Island District herring biomass, 1985–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age . . . . . | 84          |
| 21. Cape Romanzof District herring biomass, 1981–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age . . . . .  | 85          |
| 22. Norton Sound District herring biomass, 1981–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age . . . . .   | 86          |
| 23. Sac roe harvest in the Kodiak Management Area, 1964–1993 . . . . .   | 87          |
| 24. Sac roe harvest by district and year for the Kodiak Management Area, 1989–1993 . . . . .   | 88          |



## ABSTRACT

The Pacific herring *Clupea pallasii* sac roe harvest in Alaska for 1994 is projected to be 55,105 tons (1 ton = 2,000 lbs). Herring food/bait harvests for 1994 are projected to be 4,393 tons. Herring spawn-on-pound-kelp fisheries are expected to produce 74 tons of product and spawn-on-wild-kelp harvests are expected to produce an additional 220 tons. The 1993 herring harvest had an estimated value to fishermen of \$20,652,185. Of the total 1993 value, sac roe fisheries contributed \$16,178,604, spawn-on-pound-kelp fisheries \$2,388,275, food/bait fisheries \$1,638,446, and spawn-on-wild-kelp fisheries \$446,860.

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

## INTRODUCTION

Commercial sac roe and food/bait fisheries for Pacific herring *Clupea pallasii* are conducted in more than 20 locations in Alaska (Figure 1). This publication summarizes the 1993 commercial fisheries in each of the areas and describes harvest projections for the 1994 commercial herring fishing season. Harvest and forecast summaries for individual herring fishing areas in this report are grouped into four management regions for administrative and regulatory purposes (Figure 2).

### *Herring Management and Harvest Policies*

The Alaska Constitution mandates that fisheries resources are to be managed on a sustained yield basis. To ensure sustained yield and prevent localized depletion, most herring fisheries in Alaska are regulated in management units or *regulatory stocks* (i.e., geographically distinct spawning aggregations defined by regulation). Those aggregations may occupy areas as small as several miles of beach or as large as Prince William Sound.

Herring sac roe and spawn-on-kelp fisheries are always prosecuted on individual regulatory stocks. Management of food/bait herring fisheries is more complicated because they are conducted in the late summer, fall and winter, when herring from several regulatory stocks may be mixed together. If more than one herring fishery harvests a particular regulatory stock, Alaska Board of Fisheries regulations usually allocate percentages of the allowable harvest to each fishery.

In general, Alaska herring fishery quotas are based on a variable exploitation-rate harvest policy. The Alaska Board of Fisheries has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20%. Fisheries are closed if stock size falls below the *threshold level* — the minimum stock size thought necessary to guarantee sustained yield from the stock. Lower exploitation rates are usually used when herring stocks decline to near-threshold levels. In some areas, the amount an exploitation rate is reduced when stocks decline has been explicitly specified by the Board of Fisheries. The exploitation rate is multiplied by the forecast biomass to determine the annual quota. Occasionally a harvest quota is modified if new biomass information becomes available before the fishery begins.

The Alaska Board of Fisheries also enacts regulations that control the types and amounts of fishing gear that may be used, allocates the allowable harvest among user groups, and determines the range of dates allowed for fisheries. Within the board's harvest policy framework, the Alaska Department of Fish and Game (ADF&G) sets the allowable harvest each season based on the abundance of each regulatory stock. ADF&G also determines the exact opening and closing times each season. For sac roe fisheries, openings are timed to occur when herring have produced the maximum amount of roe. The duration of openings is also set to achieve harvest quotas as closely as possible. Entry into most herring fisheries in Alaska has been limited under the authority of the Commercial Fisheries Entry Commission.

### *Stock Assessment and Forecast Methods*

For major herring stocks, 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 for areas in which they occur.

Two primary methods are used to estimate herring abundance in Alaska. The spawn-deposition survey method back-calculates herring abundance from the number of eggs deposited. When herring have completed spawning, ADF&G divers estimate the density of eggs deposited, the area of the spawning beds, and the total number of eggs deposited. Estimates of fecundity are then used to convert the number of eggs into the number of spawning female herring; estimates of the sex ratio and weights of herring are used to convert the number of females into total spawning biomass.

In the aerial survey method for estimating abundance, ADF&G biologists, flying in small aircraft, estimate the surface area of herring schools. These areas are then converted into biomass using data from individual schools that were captured by purse seines and weighed. Typically, herring accumulate on the spawning grounds over a number of days prior to spawning, so only the peak biomass observed during the buildup is used. At the end of the season the peak biomasses from each "spawning event" are added together to estimate the total spawning biomass for the season. The peak biomass accounting method becomes complicated when herring from more than one spawning event are present in one area. When this occurs, information on age and size composition are used to attempt to distinguish the herring associated with each spawning event.

Since detailed stock-assessment programs are not conducted on smaller stocks, ADF&G prepares informal harvest outlooks based on recent average harvest levels and other available information. While harvest projections represent what is thought to be the best use of available information, caution is advised when interpreting the results: many of the projections are based on preliminary information, and harvests have, on occasion, substantially differed from initial projections.

The 1994 herring forecasts are based on the spring 1993 biomass estimates where growth, mortality, harvest removals, and recruitment over the year are accounted for. While there is some uncertainty in each of these factors, recruitment — i.e., the number of newly matured fish returning to spawn for the first time — may vary tremendously from year to year. Only a fraction of herring are sexually mature and recruited to the fishery by the time they are 3 years old. For example, in Gulf of Alaska areas most herring are recruited by age 4, while in the Bering Sea herring are not fully recruited until at least age 5. Projections are most reliable for herring year classes that are fully recruited; i.e., consist of older age groups. Forecasts for some Alaska herring stocks attempt to predict the number of herring that will recruit for the first time, but the reliability of these predictions is not high. In other areas recruitment is conservatively assumed to be zero. In a few instances additional growth and age-composition information is obtained from overwintering herring stocks, which is then used to further refine recruitment estimates.

### *Statewide Harvest Trends*

The largest harvests of Alaska herring occurred during the reduction fisheries in the 1930s and during the foreign herring fisheries in the Bering Sea in the late 1960s (Figure 3). Reduction plants, which processed herring for fish meal and oil, ceased production by the mid 1960s. When domestic, inshore sac roe fisheries began to fully utilize Bering Sea herring around 1980, foreign harvests were eliminated under provisions of the Magnuson Fishery Conservation and Management Act. Since that time statewide commercial harvests in all herring fisheries have averaged about 50,000 tons. In recent years sac roe fisheries have accounted for about 85% of the total herring harvest, averaging about 42,000 tons annually (Figure 4).

The 1993 herring harvest had an estimated value to fishermen of \$20,652,867 (Table 1), a substantial decline from the 1992 value of \$31,504,867. Of the total 1993 value, sac roe fisheries contributed \$16,178,604 (Table 2), spawn-on-pound-kelp fisheries \$2,388,275 (Table 3), food/bait fisheries \$1,638,446 (Table 4), and spawn-on-wild-kelp fisheries \$446,860.

The total harvest for 1994 is projected to be 55,105 tons of herring from sac roe fisheries (Table 5) and an additional 4,393 tons from food/bait herring fisheries (Table 6). Herring spawn-on-kelp fisheries are projected to harvest 294 tons of herring spawn on kelp (Table 6). The projected 1994 herring sac roe catch is larger than the 1993 harvest of 46,329 tons of herring. The projected 1994 herring bait harvest is smaller than the 5,627 tons harvested in 1993. The 1994 projected spawn-on-kelp harvest is also smaller than the 1993 harvest.

### *Additional Forecast and Regulatory Information*

A number of specialized terms used in this report are defined in Table 7. All harvests and biomasses in this report are reported in tons (2,000 lbs), units used extensively in the herring industry. The 1993 harvest totals refer to the January 1, 1993, to December 31, 1993, calendar year. However, the seasons for some food/bait herring fisheries occasionally span into the early part of the following calendar year. In recent years this has only occurred for the Kodiak food/bait herring fishery. For the 1993–1994 Kodiak food/bait herring fishery, all of the harvest occurred during 1993, although the fishery technically remained open during the early part of 1994.

A booklet describing regulations for all of Alaska's herring fisheries is available from ADF&G offices. Summaries of harvest policies and regulations for Alaska sac roe herring fisheries are given in Table 8 and for Alaska spawn-on-kelp and food/bait herring fisheries in Table 9. 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 (ADF&G 1994). In other cases separate fishery management plan publications are available from area management offices near where the fishery occurs.

For many herring fisheries, fishermen and processors are required to register with the local area manager prior to the start of the fishing season. For each principal herring fishery, Table 10 lists the appropriate fishery manager to contact for more information on the fishery. During the herring season prerecorded telephone messages describing the progress of the herring fisheries are available from most ADF&G area offices. These telephone numbers are also listed in Table 10.

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## SOUTHEAST REGION

### *Introduction*

Herring have been commercially harvested in Southeast Alaska since the 1880s. From the 1890s to the mid 1960s the catch was used primarily for reduction to meal and oil. The reduction fishery harvested feeding herring during the summer. During the 1920s and 1930s the reduction fishery production peaked when annual harvests commonly exceeded 100,000 tons. The reduction industry was phased out in the mid 1960s because of a decline in the abundance of herring and development of the Peruvian anchovy-reduction industry.

The commercial utilization of Southeast Alaska herring resources is very controversial. Although the subsistence and personal use harvest levels are a minor portion of the total annual catch, they are important to local residents. Commercial harvesting, however, is viewed as an unnecessary reduction in the local availability of herring. Additionally, herring are a major forage fish, and their abundance is necessary to ensure healthy populations of predatory fish, such as salmon and halibut.

Currently, most of the annual herring harvest is taken in the spring sac roe fishery that developed in the early 1970s. The sac roe fishery takes herring immediately prior to spawning, when egg maturity is highest. A spawn-on-wild-kelp fishery occurred during the 1960s; however, this fishery was phased out in the early 1970s. New herring spawn-on-pound-kelp fisheries were approved by the Alaska Board of Fisheries to begin in Hoonah Sound in the spring of 1990 and in the Craig area in the spring of 1993.

Southeast Alaska herring supply a substantial proportion of the bait used in the longline and crab fisheries statewide. Bait harvests occur during the fall and winter, when herring are in a condition best suited for bait. Most of the bait harvest is taken by purse seines. Relatively small quantities of herring are harvested in a fresh-bait pound fishery, where herring are captured with purse seines and held alive in net enclosures until the bait is needed. Existing regulations also provide for a herring fishery to produce frozen-tray packs of herring bait for use in sport and commercial troll salmon fisheries. However, no harvest has occurred for this purpose in recent years.

Management of Southeast Alaska herring fisheries is based on assessing populations to ensure minimum spawning threshold biomasses exist prior to allowing a commercial harvest. Current threshold levels range from 1,000 tons for herring harvested in the Hoonah Sound spawn-on-pound-kelp fishery to 7,500 tons for Sitka Sound herring (Table 11).

When herring spawning biomass is projected to be below 2,000 tons, a herring fishery is not opened for commercial harvest. There are many locations where the biomass of spawning herring has historically been below 2,000 tons. Under the harvest policy, a herring biomass of 2,000 tons of mature fish would permit an annual harvest of 200 tons of herring. This lower limit was established since harvests cannot reliably be constrained to amounts smaller than 200 tons because of the large number of highly efficient fishing vessels involved.



Annual harvest quotas are determined from a variable exploitation-rate harvest policy. A 10% exploitation rate is allowed if herring abundance is just above the threshold level. When herring are more abundant, the exploitation rate increases, up to a maximum of 20% when the biomass is six times the threshold level. The increases in exploitation rate amount to adding 2% to the exploitation rate every time the spawning biomass increases by an amount equal to the threshold (Figure 5).

An age-structured assessment (ASA) model was used to forecast spawning biomass of herring for four areas in 1994: the sac roe fishing areas at Sitka, Cat Island/Kah Shakes, and Seymour Canal, and the bait and spawn-on-pound-kelp fishing area at Craig. For the remaining food/bait fisheries, estimates of biomass from spawn-deposition surveys alone were used to determine whether the spawning biomass would be above threshold and to calculate the quota. In 1993 spawn-deposition surveys were conducted for ten areas.

The ASA model yields estimates of survival, recruitment, and maturity that were then applied to estimates of 1993 abundance to provide forecasts. Survival, maturity, and recruitment were determined during the process of estimating historic annual abundances that agreed most closely with spawn-deposition, age-composition, and weight-at-age data.

The 1988 year class continues to predominate in many northern Gulf of Alaska herring stocks, from northern British Columbia through Southeast Alaska to Kodiak. In many areas of the eastern Gulf of Alaska a four-year cycle of peak recruitment has occurred since 1980. There is some evidence that the four-year abundance cycle may be continuing, particularly for Sitka Sound herring. Approximately 6% of the herring caught in a January 1994 test fishing program in Sitka Sound were age 2. Samples taken in February 1986 were composed of 22% age-2 herring.

### ***Southeast Alaska Winter Food/Bait Fishery***

Winter herring fishing is allowed by regulation in Districts and Sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11-B, 11-C, 12, 13-A, 13-B (only south of the latitude of Aspid Cape), 13-C, 14, 15-A, and 16 in the Southeast Alaska area and in the entire Yakutat area. The general fishing season is specified to occur from October 1 through February 28. In the Southeast Alaska area, regulations specify that actual open fishing periods be established by emergency order. In recent years all harvests have occurred in January. Although existing regulations specify purse seines, set gillnets, and trawls as legal allowable gear, only seines have been actively used to harvest herring in recent years.

Three locations were identified as having harvestable quantities of bait herring during the 1993–1994 bait season. In the Craig/Klawock area the spawn-deposition survey estimated spawning biomass was 6,956 tons in 1993. The ASA forecasted the 1994 biomass at 8,024 tons of age-4 and older herring. This estimate produced a winter bait quota of 760 tons for the traditional harvesting areas between Bocas de Finas and Meares Pass after subtracting 15% (135 tons) for the spawn-on-kelp allocation. The fishery was opened December 8, 1993, approximately a month earlier than normal, to allow fishermen to attend the Southeast herring meeting of the Alaska Board of Fisheries. The fishery progressed slowly because fish

remained beneath the seines' effective fishing depth, finally closing for the season on January 29, 1994, with a catch of 670 tons.

The spawn-deposition survey in Port Houghton/Hobart Bay determined that 2,238 tons of herring spawned in that area, allowing for a harvest of 230 tons. To provide a greater opportunity to harvest herring from Port Houghton/Hobart Bay, the commercial fishery was opened on October 17, and by the end of the regular season, 140 tons had been harvested.

Visual estimates of herring abundance through hydroacoustic surveys and test fishing in the Necker Bay/Whale Bay areas determined that the spawning biomass was in excess of the 2,000-ton threshold. The fishery was opened December 8, 1993, with a guideline harvest level of 50 tons from Necker Bay and 150 tons from Whale Bay. The area closed on February 9, 1994, after harvesting about 103 tons. Surveys conducted in the Tenakee Inlet, Ernest Sound, and Lisianski Inlet areas determined that herring abundance was below the minimum threshold level.

Based on the ASA, the forecasted 1994 Craig spawning biomass is estimated to be 8,024 tons (Table 12). With a threshold of 6,000 tons, the harvest rate at Craig would be 11.1%. This would provide a total quota of 894 tons. Of this quota 85% (760 tons) is allotted to the bait fishery and the remaining 15% (135 tons) is allotted to the pound fishery. The mean weight of individual herring is estimated to be 102 g (Figure 6).

### *Southeast Alaska Sac Roe Herring Fisheries*

Four sac roe herring fishing areas exist by regulation in Southeast Alaska. They include two exclusive purse seine areas (Sitka Sound and Lynn Canal) and two exclusive set gillnet areas (Kah Shakes/Cat Island and Seymour Canal). Both gear types are under a limited entry system. One hundred permanent and 14 interim-use gillnet permits and 45 permanent and 6 interim-use purse seine permits were issued for the 1993 season.

A harvest of 12,096 tons of herring occurred during the 1993 season. This harvest resulted from a 1993 Sitka Sound catch of 10,186 tons and a catch at the Kah Shakes/Cat Island area of 737 tons (Table 2). In Sitka Sound, a 20% harvest rate was applied to the 1992 spawning biomass estimate of 48,450 tons to establish a quota of 9,691 tons for the Sitka herring purse seine fishery. The fishery was placed on a 2-h notice at 8:00 a.m., Friday, March 26. Based on intensive spawning on March 27 and good roe percentages from the test fishing, the fishery opened at 2:00 p.m. and closed at 6:00 p.m. on March 27. The processors and fishermen agreed on a cooperative/competitive fishery to maximize the value of the product. The fishery was opened on a daily basis and closed on April 3 with a total catch of 10,186 tons, the second highest sac roe harvest since inception of the fishery.

For the Kah Shakes/Cat Island area fishery, an exploitation rate of 10.7% was applied to the 1992 biomass estimate of 8,100 tons, resulting in an overall quota of 835 tons. The Metlakatla Indian Community (MIC) expressed a desire to continue a sac roe fishery along the Annette Island shore for

herring ultimately spawning on Annette Island and Cat Island. The state unilaterally reduced the Cat Island quota by 150 tons to 717 tons to account for any possible catch on Annette Island. The MIC ultimately caught 365 tons of good-quality sac roe herring, most of which was presumed to be bound for the Cat Island spawning grounds. The Cat Island area was placed on a 2-h notice at noon, March 31, 1993, when 20 large herring schools were observed near Mary Island. The fishery was opened at 10:00 a.m. on April 10, at which time 104 boats harvested 737 tons of 16.2% mature roe herring. Approximately 14 linear mi of spawn was observed in the Cat Island area; no spawn was observed along the Kah Shakes shore.

Based on the ASA, the 1994 spawning biomass of herring for Sitka is projected to be 27,066 tons (Table 12). Given a threshold of 7,500 tons for Sitka, and using the sliding-scale harvest rate, the projected biomass provides a harvest rate of 15.2% and a quota of 4,119 tons. The mean size of individual herring in the 1994 Sitka fishery is expected to be about 119 g (Figure 6).

For Cat Island/Kah Shakes, the projected spawning biomass for 1994 is 9,299 tons (Table 12). Based on a threshold of 6,000 tons, the harvest rate would be 11%. This allows for a quota of 1,032 tons. However, since 1992, herring that formerly spawned along the east shore of Annette Island have apparently shifted their primary spawning location to the Cat Island area. Although the herring did not spawn along the east coast of Annette Island in 1993, fishermen harvested herring at Annette Island prior to the presumed movement of the herring to the Cat Island spawning grounds. Therefore, as was done in 1993, it is expected that the 1994 quota will be reduced somewhat to account for the potential catch near Annette Island. The mean size of individual herring in the 1994 Cat Island/Kah Shakes catch is estimated to be 126 g (Figure 6).

The spawning biomass of herring at Seymour Canal is projected to be 3,552 tons in 1994 (Table 12). Given a threshold of 3,000 tons at Seymour Canal, the harvest rate would be 10.4%. This provides a quota of 368 tons. This is the first time since 1990 that the projected biomass was above threshold levels and a fishery permitted. The estimated 1994 mean weight of individual herring at Seymour Canal is projected to be 106 g (Figure 6).

### *Southeast Alaska Spawn-on-Pound-Kelp Fisheries*

There are three types of herring pound fisheries in Southeast Alaska: tray-pack bait, fresh bait, and spawn-on-kelp pounds. The tray-pack pound fishery was created in 1979 when the Board of Fisheries allocated a harvest of up to 100 tons. Only limited catches occurred in the early 1980s. In recent years there has been no participation.

The fresh-bait pounds are allowed by regulation under a permit system in six areas, including Tee Harbor, Indian Cove, Farragut Bay, Scow Bay, Sitka Sound, and Lisianski Inlet. Current regulations specify annual harvest quotas of 100 tons each for Farragut Bay, Scow Bay and Sitka Sound, 60 tons each for Tee Harbor and Indian Cove, and 25 tons for Lisianski Inlet. The average annual catch for the past

10 years (since 1983) has been 43.8 tons for all areas combined. In 1993 the only fresh-bait pound operated was in Sitka Sound.

There are two spawn-on-kelp pound fisheries in Southeast Alaska: Craig and Hoonah Sound (Figure 1). The spawn-on-kelp fishery for the Craig area was initiated in the spring of 1992. An amount of herring equivalent to 15% of the total guideline harvest level for Craig/Klawock herring was allocated for this fishery.

For the 1993 season, 389 fishermen applied for Craig/Klawock permits and were eligible to participate in the fishery. On March 10, 209 herring pounds were on the grounds; they each received allocations of 292 blades of kelp and 1.15 tons of herring. Harvest of herring began on April 17 and closed on April 28, 1993. A total of 5.2 tons of spawn on kelp, worth approximately \$43,368, was harvested by 21 participants. The low volume of the Craig/Klawock fishery in 1993 was due to poor weather, the major spawn occurring in the closed waters around Fish Egg Island, and the small size of the total herring return. The majority of the spawn occurred from March 26 to April 21.

Based on the ASA, the 1994 Craig spawning biomass is estimated to be 8,024 tons (Table 12). With a threshold of 5,000 tons, the harvest rate at Craig would be 11.1%. This would provide a total quota of 895 tons. Of this quota, 15%, or 135 tons, is allocated to the pound fishery.

For the Hoonah Sound area, 1993 was the fourth year of the spawn-on-pound-kelp fishery. The amount of herring allowed for the fishery is fixed at 150 tons, or 12 tons of spawn-on-kelp product. The fishery opened by emergency order on April 6, 1993, with the herring harvest occurring from April 26 through May 3, when fishing was closed by emergency order. A total of 14.2 tons of spawn on kelp, valued at \$344,907, was harvested by 65 participants. The average price per pound was \$12.00, up from the \$6.80 paid in 1992.



## **CENTRAL REGION**

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## CENTRAL REGION

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

Pacific herring spawn throughout Prince William Sound each year from mid April through early May. All herring that spawn within the coastal waters of Prince William Sound between Point Whitt and Cape Fairfield are managed as a single regulatory stock (Figure 7).

A harvest policy framework has been established by the Alaska Board of Fisheries' Prince William Sound Herring Management Plan (5 AAC 27.365), which allows for an exploitation rate ranging from 0% to 20% of the projected spawning biomass if the spawning biomass is above the threshold level. Prior to 1994 the cutoff threshold level was 8,400 tons. In February 1994 the Alaska Board of Fisheries increased the cutoff threshold to 22,000 tons. If the expected spawning biomass is between 22,000 and 42,500 tons, the exploitation rate is set between 0% and 20% based upon the ADF&G assessment of stock status. If the projected spawning biomass exceeds 42,500 tons, the exploitation rate is set at 20%. The allowable harvest of herring is allocated as follows: 16.3% to the fall food/bait fishery, 8% to the spawn-on-wild-kelp fishery, 14.2% to the spawn-on-pound-kelp fishery, 58.1% to the purse seine sac roe fishery, and 3.4% to the gillnet sac roe fishery.

Beginning in late March ADF&G staff survey the coastline of Prince William Sound twice weekly from small aircraft until a significant biomass of herring is observed. After herring are first sighted, aerial surveys are conducted daily to measure the accumulation of herring biomass, document herring distribution, and map the observed miles of spawn. When the herring have completed spawning, ADF&G divers conduct spawn-deposition surveys. Additional sampling is conducted to estimate the age, weight, length, and sex composition of the harvest and spawning population.

Aerial survey estimates of herring biomass date back to 1974 and have ranged from 1,323 tons in 1975 (an estimate thought to be low because of poor visibility) to 77,810 tons in 1981. Estimates of the number of miles of spawn date back to 1978 and have ranged from 47.4 mi in 1978 to 166.3 mi in 1988. Spawn-deposition surveys were conducted in 1983, 1984, 1988, 1989, 1990, 1991, and 1992. Spawn-deposition survey biomass estimates ranged from 1.45 to 2.18 times larger than aerial survey biomass estimates from 1984 to 1990.

Commercial herring fisheries utilized only 4,748 tons of herring in 1993, the lowest since 1983. The roe fisheries were hampered by the unusually small size and poor quality of the herring that returned to spawn in 1993. During the course of sampling at Montague Island, abnormal behavior and surface hemorrhages on herring were noted. Pathology tests on samples of these herring indicated the presence of the viral infection Viral Hemorrhagic Septicemia (VHS). It is not known if the virus caused the poor quality of herring in 1993 or if herring were already in a weakened condition for unknown reasons and therefore more susceptible to viral infection. The 1993 season can be characterized by an earlier-than-average spawning period, a biomass significantly less than that forecasted, a lower-than-expected percentage of 5-year-old herring, low annual growth for all age classes, a tight market, and low-quality



herring. There was no commercial purse seine sac roe harvest for herring in 1993. The gillnet sac roe fishery harvested 1,030 tons and the fall 1993 food/bait fishery harvested 1,087 tons.

The 1993 spring spawning biomass of herring was dramatically lower than forecasted. Possible causes include high overwinter mortality, unusually low spawning recruitment, or extensive spawning in locations not observed in aerial surveys. The herring spawning population, as expected, was dominated by the 1988 year class, which returned as 5-year olds. Five-year-old herring represented about 65% of the spawning population samples. All age classes showed low annual growth.

No spawn-deposition surveys were conducted in 1993. The aerial survey program was conducted throughout April. The peak aerial survey estimate was 20,375 tons, the lowest since 1986. Approximately 70% of the peak aerial survey estimate was sighted at Montague Island. The total spawning biomass as estimated from the ASA model is 30,004 tons. The total linear mi of spawn observed from aerial surveys was 204, the lowest ever recorded, and the total mile-days of spawn was 40.8, the third lowest on record. A total of 13.2 mi of spawn were recorded in the Montague area, 5.5 mi in the Northeast area and 1.7 mi in the Southeast area. There was no spawning activity on the North Shore or at Naked Island.

An ASA model was used to forecast the abundance of herring expected to return to spawn in Prince William Sound in 1994 (Funk *in press*). The ASA model used was similar to that used for the 1993 forecast (Funk 1994). The forecast for 1994 has a higher-than-normal amount of uncertainty because little stock-assessment information was collected during the spring of 1993 and circumstantial information indicated a drastic decline in survival rate between the spring of 1992 and the spring of 1993. The ASA model determines abundance estimates that best fit egg-deposition survey estimates from 1984 and 1988–1992, as well as age compositions from commercial and test fisheries and spawning herring. For the 1994 forecast, the ASA model was first fit to 1980–1992 data to attempt to convert the spring 1993 aerial survey miles of milt index to absolute abundance. The ASA model was then fit to 1980–1993 data using the 1993 milt survey biomass estimate and an acoustic biomass estimate from the pilot hydroacoustic program conducted in the fall of 1993. It was assumed that the survival rate returned to its previous higher level after the spring of 1993, based on qualitative observations of fish condition in the summer and fall of 1993. The spring 1993 milt index and the fall 1993 acoustic biomass estimate are consistent with each other under this scenario.

Abundance trends from age-composition and egg-deposition surveys have been very different since at least 1988. Abundance trends from age compositions were felt to be more reliable because cohort abundance was consistent from year to year in the age-composition data, and the abundance trends inferred from age-composition data agreed with common knowledge of recruitment events and strong year classes seen in the commercial fishery. The egg-deposition survey data were used only to provide average absolute abundance, not to determine trends in abundance. Three forecast scenarios were prepared using different assumptions about the strength of the 1991 year class and the influence of the 1993 milt and acoustic surveys. Forecast biomass ranged from 20,445 tons under a “pessimistic” scenario, to 51,093 tons under an “optimistic” scenario. A moderate scenario of 29,786 tons (Table 13) was used as the basis for the 1994 forecast of approximately 30,000 tons. In all of the forecast scenarios, biomass declines drastically between 1992 and 1993 (Figure 8).

With a spring 1994 spawning biomass of 29,786 tons, a 15% exploitation rate would be allowed, resulting in a 4,500-ton overall harvest quota. Under Board of Fisheries regulations, 733 tons were allocated to the fall 1993 food/bait fishery; 360 tons of herring to the spring 1994 spawn-on-wild-kelp fishery (45 tons of spawn-on-kelp product); 639 tons to the spawn-on-pound-kelp fishery (51 tons of spawn-on-kelp product); 2,615 tons to the purse seine sac roe fishery; and 153 tons to the gillnet sac roe fishery. The spawning population is expected to be dominated by the 1988 year class, which will be age 6 in the spring of 1994 (Figure 9).

### *Lower Cook Inlet Herring Fishery*

The Lower Cook Inlet Management Area is subdivided into the Kamishak Bay, Southern, Outer, and Eastern Districts (Figure 10). Only the Kamishak Bay District has consistently supported sac roe fisheries. Formal abundance forecasts are prepared only for the Kamishak Bay District.

The present-day sac roe fishery started as early as 1969 in the Eastern and Southern Districts and in 1973 in the Kamishak Bay District. During 1978 herring biomass fell to low levels and all fishing districts were closed to commercial fishing. The Kamishak Bay, Eastern, and Outer Districts were reopened in 1985. The Southern District was reopened to fishing only during 1989. The Eastern and Outer Districts were closed again in 1990. Currently, all of the lower Cook Inlet sac roe harvest is from the Kamishak Bay District, where roe-recovery rates are higher because the fish are older.

Herring that spawn in Kamishak Bay support a spring sac roe fishery in Kamishak Bay in the Lower Cook Inlet Management Area, and a fall food/bait fishery in Shelikof Strait in the Kodiak Management Area. The Kamishak Bay Herring Management Plan (5 AAC 27.465) stipulates both fisheries will be closed if the Kamishak Bay herring biomass forecast is less than 8,000 tons. If the projected biomass is more than 8,000 tons but less than 20,000 tons, harvest rates will be 9% of the forecast for the spring Kamishak sac roe fishery and 1% for the fall Shelikof Strait food/bait fishery for a total exploitation rate of 10%. If the forecast is more than 20,000 tons but less than 30,000 tons, the total exploitation rate increases to 15%. If the forecast is more than 30,000 tons, the total exploitation rate is 20%. The allocation rate between the two fisheries remain the same. Board of Fisheries regulations allow only purse seine gear in the lower Cook Inlet sac roe fisheries.

In 1993 stock-assessment activities were hampered by bad weather. Aerial surveyors were grounded for 12 consecutive days between 28 April and 9 May. The 1993 run biomass was estimated by dividing daily aerial survey estimates of run biomass by preliminary estimates of expected daily proportion. The difference between the run biomass estimate, 32,439 tons, and the harvest, 3,570 tons, was escapement biomass. Age-composition samples were not available after the fishery was completed in April 1993.

In 1994 ASA was used for the first time to prepare the Kamishak Bay herring forecast. This methodology estimates mortality rates and population abundance using age-composition data in conjunction with selected biomass estimates from good aerial survey years. This methodology can be used to produce a

forecast in years when aerial-assessment estimates have been compromised by poor weather conditions. A regression model was used to predict 1994 mean weights from 1993 data.

A biomass of 25,344 tons of herring is forecasted to return to the Kamishak Bay District in 1994 (Table 14 and Figure 11, top). Herring mean weight is predicted to be 189 g. The 1988 year class (age 6) is forecasted to represent 70% of the biomass and 68% of the individuals (Figure 11, bottom). Total allowable harvest is projected to be 3,800 tons and represents an exploitation rate of 15%. In accordance with the Kamishak Bay Herring Management Plan, the harvest allocation is 3,422 tons for the Kamishak spring sac roe fishery and 380 tons for the fall Shelikof Strait food/bait fishery (Table 15).

Kamishak Bay herring biomass peaked in 1987 followed by a downturn that reversed itself beginning in 1991 (Figure 11). The recent upturn is expected to continue in 1994 because of the strong recruitment of age-4 herring in 1992.

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

The Togiak District of Bristol Bay extends from Cape Constantine to Cape Newenham (Figure 12) and supports the largest spawning population of Pacific herring in the eastern Bering Sea. Herring move into the Togiak District during the spring to spawn. These herring then undertake a feeding migration southward along the Alaska Peninsula, concentrate in the vicinity of Unalaska Island in late summer, and return to their overwintering grounds near the Pribilof Islands in the fall. These herring are harvested at various points during their migration. The primary harvest occurs in the Togiak District by a sac roe fishery during the spring. Lesser harvests are taken during the summer in the Dutch Harbor food/bait fishery and as bycatch from the domestic pollock trawl fishery.

Commercial harvest levels for herring that spawn in the Togiak District have been set by the Alaska Board of Fisheries in the Bering Sea Herring Management Plan (5 AAC 27.060) and the Bristol Bay Herring Management Plan (5 AAC 27.865). These regulatory plans specify a maximum exploitation rate of 20% and a threshold biomass of 35,000 tons before a harvest can occur. Before opening the sac roe fishery, approximately 1,500 tons of herring are set aside for the Togiak District herring spawn-on-kelp harvest and 7% of the remaining available harvest is set aside for the Dutch Harbor food/bait fishery. The remaining harvestable surplus is allocated to the sac roe fishery by gear type: 25% for the gillnet fleet and 75% for the purse seine fleet. In years when circumstances prevent adequate biomass assessment during the season, the fishery harvest will be based on the preseason forecast. Should a manageable separation of the year classes occur, a harvest of up to 20% of the younger age classes (age 4 or less) may be allowed if at least 20,000 tons of these younger herring are present in the district.

Beginning in late April the nearshore area of the Togiak District is surveyed daily from small aircraft to monitor the relative abundance, distribution, and spawning of Pacific herring. Biomass estimates are derived from the number and size of herring schools observed during these surveys. Use of aerial surveys to estimate the Togiak herring spawning biomass began in 1978. Aerial survey estimates of abundance

have ranged from 242,298 tons in 1979 to 76,960 tons in 1980 (Figure 13). The 1980 biomass was probably underestimated due to the poor survey conditions experienced that season.

The 1993 age distribution was estimated from herring collected daily from commercial fishing locations throughout the Togiak District. Herring were retained from the commercial fishery by processors and fishermen for delivery to the ADF&G field site. Due to the nonselective nature of the gear, herring collected from commercial purse seines were used to determine age composition of the biomass. Samples were pooled across three- to five-day periods, where possible, to represent major fluctuations in estimated biomass for each fishing section. Approximately 6,300 herring were sampled for biological data from April 27 through May 8, 1993.

Warmer-than-normal weather conditions in the eastern Bering Sea the previous winter was probably an important factor contributing to an early return of herring to the Togiak District. The first significant herring biomass, estimated at 74,500 tons, was observed in Togiak Bay on April 24. The run built quickly, with the peak biomass estimate of 164,100 tons occurring only two days later on April 26. A secondary peak abundance of 42,250 tons was estimated five days later on May 1. Daily biomass estimates ranged between 5,000 and 30,000 tons through the date of the final survey on May 7.

Herring were first sampled for age composition on April 27, one day after the peak biomass was observed. Assuming that herring did not leave the fishing district until after the April 27 and 28 spawning events, samples collected through April 29 were used to represent this peak biomass. Age composition of the composite sample from this period was 33% age-5 and -6 herring and 66% age-9 and older herring. Contribution of age-5 and -6 year classes gradually increased with progression of the run. For the May 4 aerial survey, age-5 and -6 herring represented 81% of the samples while age-9 and older herring contributed only 12%. This significant change in age composition suggested that a complete turnover of the biomass had occurred by May 4. The final, revised aerial survey biomass estimate for the 1993 season totaled 193,847 tons and was the sum of (1) the peak aerial survey biomass estimate from April 26 (164,130 tons) and (2) the aerial survey biomass estimate from May 4 (29,717 tons).

In 1993 the presence of herring in the Togiak Fishing District preceded the arrival of fishermen, processors, and ADF&G personnel. The fishery first opened on April 27 for purse seine gear and on April 29 for gillnet gear. The commercial sac roe harvest for the Togiak District totaled 17,925 tons during the 1993 season. Herring sold as a sac roe product composed 99.8% of the harvest with the remaining 0.2% sold for food and bait. Roe recovery averaged 9.6% for the purse seine catch and 10% for the gillnet catch. The purse seine harvest of 14,361 tons was taken by 176 permit holders during 17 fishing periods for a total of 33.8 h. The gillnet harvest of 3,564 tons was taken by 99 permit holders during 9 fishing periods for a total of 144.5 h of fishing time. Fishing ceased for the season on May 9.

By combining estimates of age composition, catch, and aerial survey biomass, the 1993 Togiak District spawning run was estimated to consist of 496,000,000 herring with a biomass of 193,847 tons (Table 16). Herring ranged in age from 3 to 18 years. Sixty nine percent of the biomass and 54% of the population was composed of herring age 9 and older. The contribution of the 1977 (age 16) and 1978 (age 15) year classes, which dominated the biomass between 1984 and 1990, decreased from 20% in 1991 to 13% in

1992 and 1993. The significant recruitment of age-4 and -5 herring into the fishery observed in 1992 was again evident in the abundance of the returning 1987 (age 6) and 1988 (age 5) year classes. The combined contribution of these year classes represented 29% of the biomass and 42% of the total population. Spawning escapement was estimated to be 172,996 tons after subtracting Togiak District sac roe harvests and Dutch Harbor food/bait harvests from the estimated spawning biomass.

Forecasts in past years were calculated by applying estimates of mortality, availability, and recruitment for specific age classes to the previous year's aerial survey estimate of escapement biomass. Forecasts have consistently been lower than the subsequent season's aerial survey biomass estimates. Large variations of abundance observed each year are at least partly due to the current biomass-estimation technique that is vulnerable to poor weather conditions. Additional problems with past forecasting methods have occurred due to unexpected high survival rates of the 1977 and 1978 year classes and the inability to predict the abundance of younger year classes recruiting into the fishery.

Beginning in 1992 ASA has been used to generate the Togiak herring forecast. This methodology estimates mortality and population abundance using age-composition data in conjunction with biomass estimates selected from the best aerial survey years. These aerial survey years were rated by the length of the survey time series during the season, the visibility and weather conditions during the peak aerial surveys, and the area of the fishing district covered during the peak surveys. Forecasts can therefore be made even when aerial-assessment estimates have been compromised by poor weather conditions. Abundance of age-4 herring is forecasted using the median value of historical abundances estimated by the model. Using this method the 1993 forecast using this method was only 2% by number and 23% by weight less than the final, revised aerial survey biomass estimate. The forecasted Togiak District herring biomass for 1994 is 142,498 tons.

Herring age 9 or older are expected to account for 29% of the 1994 biomass. Herring age 15 and older, which include the strong 1977 and 1978 year classes that will return as age-17 and -18 herring, are expected to contribute 10% of the run in biomass and 6.2% of the total population in number of herring. The 1987 and 1988 year classes returning as age-6 and -7 herring are expected to represent 66% of the biomass and 72% of the total population in number of herring. The 1984 and 1983 year classes returning as age-10 and -11 herring are expected to be the dominant older age classes, representing 12% of the biomass and 9% of the total population in number of herring. Average weight of an individual herring in the commercial fishery is expected to be 298 g and 286 g in the biomass (Figure 14).

Because the abundance of a newly recruited year class of Togiak District herring cannot be reliably determined until herring are 5 years old, differences among year classes were examined by plotting estimated numbers of age-5 herring for all available year classes that were derived from past aerial surveys and annual age-composition estimates. The 1974 year class was the most abundant in this series, having an estimated 586,000,000 age-5 herring in 1979. Strong recruitments were detected in the Togiak District in 1982 and 1983, when the 1977 and 1978 year classes began to enter the spawning biomass, and in 1992 with entrance of the 1987 year class. The 1977 year class was estimated to consist of 197 million age-5 herring in 1982 (Figure 15). The 1978 year class was estimated to consist of 189 million herring in 1983. The 1987 year class was estimated to be 149,000,000 age-5 herring in

1992. Since 1983 annual recruitment has averaged only 29,000,000 herring. The number of 5-year-old herring (1988 year class) in the 1993 spawning biomass was estimated to be 51,000,000 herring (Figure 15).

For 1994 the total allowable harvest based on the forecast is 28,499 tons (20% of forecasted biomass). In accordance with existing regulatory management plans, 1,500 tons will be allocated to the Togiak District spawn-on-kelp fishery, 25,109 tons to the purse seine and gillnet sac roe fisheries, and 1,890 tons to the 1994 Dutch Harbor food/bait fishery. The Togiak sac roe and Dutch Harbor food/bait guideline harvest levels will be revised if a reliable biomass can be obtained during the spring of 1994.



**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: Security Cove, Goodnews Bay, Cape Avinof, Nelson Island, Nunivak Island, Cape Romanzof, Norton Sound, and Port Clarence (Figure 1).

The Alaska Board of Fisheries established threshold biomass levels, below which harvests are not allowed under the Bering Sea Herring Fishery Management Plan (5 AAC 27.060) for all districts with the exception of the Port Clarence District. Exploitation rates are limited to a maximum of 20% in all areas. In some areas the Board of Fisheries has further restricted exploitation rates to protect subsistence harvests. A moratorium was placed on entry into the Nelson Island, Nunivak Island, Cape Romanzof, and Norton Sound herring fisheries in 1987. The Commercial Fisheries Entry Commission has been issuing limited entry permits for these fisheries. All AYK Region commercial herring districts, except Security Cove and Port Clarence, are designated as superexclusive-use areas.

The arrival of herring in the northeastern Bering Sea is greatly influenced by climate and oceanic conditions, particularly the extent and distribution of the Bering Sea ice pack. Most herring appear immediately after ice breakup, which generally occurs between mid May and mid June. Spawning usually begins in the Security Cove District and generally progresses in a northerly direction. In some areas spawning may continue as late as July.

Aerial surveys have been used since 1978 in the Bering Sea to estimate herring spawning biomass. However, it is often difficult to obtain biomass estimates from aerial surveys in the AYK Region because of poor survey conditions caused by unfavorable weather, ice conditions, or turbid water.

Herring school surface areas are recorded in relative abundance index (RAI) units of 538 ft<sup>2</sup> per unit. In the AYK Region, RAI units are converted to biomass using conversion factors of 1.52 tons per RAI unit for water depths of 16 ft or less, 2.58 tons per RAI unit for water depths between 16 and 26 ft, and 2.83 tons per RAI unit for water depths greater than 26 ft per RAI unit. Because purse seine gear is needed to estimate the conversion factors and purse seine gear is generally not fished in the AYK Region, these conversion factors were estimated from sampling performed in the Togiak District. Ground surveys are conducted in some districts to obtain information on the distribution and density of kelp beds and herring spawn deposition.

During 1993 106 aerial surveys totalling 118.4 h of flight time were flown in the AYK Region: 12 (6.1 h) in Security Cove, 12 (5.9 h) in Goodnews Bay, 10 (2.7 h) in Jacksmith Bay, 6 (4.4 h) in Cape Avinof, 15 (6.2 h) in Nelson Island, 11 (16.9 h) in Nunivak Island, 7 (1.9 h) in Cape Romanzof, 32 (71.3 h) in Norton Sound, and 1 (3 h) in Port Clarence. A total biomass of 76,712 tons of herring was estimated to have been present in the surveyed portion of the AYK Region herring districts. Though this estimate is lower than the record biomass of 90,243 tons observed in 1992, it is the second highest

on record. Ages 5, 6, and 9 dominated the herring biomass in most districts south of Cape Romanzof. The biomass in Cape Romanzof was dominated by older fish and ages 5 and 11 composed the major age groups in the Norton Sound biomass. The number of recruits, ages 2 through 5, was over 35% of the spawning population in all AYK districts with the exception of Cape Romanzof, where recruits composed 18% of the population.

The 1993 herring harvest for the AYK Region was approximately 7,363 tons with an estimated exvessel value of \$2,089,000. The 1993 harvest greatly exceeded the 1992 harvest of 2,828 tons when the Norton Sound fishery did not open. However, the 1993 harvest was near average when compared to the previous five years. Excluding 1992, the value of the fishery was the lowest since 1984. Fishermen received approximately \$150 less per ton for sac roe herring than they received in 1992. The price paid to fishermen in AYK fishing districts was approximately \$300 per ton for herring with 10% roe content  $\pm$  \$30 a percentage point and \$50 per ton for bait-quality herring. Food and bait sales during the sac roe fishery totaled 391 tons, with the remaining harvest sold as sac roe product. Harvest identified as food and bait primarily occurs during the sac roe fisheries when fish are sold with a roe content that is below buyers' acceptable minimums.

A total of 546 fishermen participated in AYK sac roe herring fisheries during the 1993 season. Effort was low in all districts, as fishermen were discouraged by the low prices and fewer buyers. In addition, an exceptionally early return to the Togiak fishery surprised managers, fishermen, and buyers and resulted in an extended season that kept the fleet from arriving in Security Cove District until the end of the spawning migration. Only 9 fishermen participated in the Security Cove fishery compared to a five-year average of 61. Surveyed subsistence fishermen from selected Yukon-Kuskokwim River Delta villages harvested approximately 89 tons of herring.

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

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

Gillnets are the only legal gear in the AYK Region with the exception of Norton Sound, where a small portion of the harvest is taken by beach seine. An attempt was made to sample at least 420 herring from each commercial gear type, fishing period, and district or subdistrict. The sampling goal for test fish

catches was to sample a minimum of 60 herring per day or 420 per week from each district or subdistrict. Herring from test fish and commercial catches were sampled in all but the Port Clarence District to estimate age, sex, size, and sexual maturity of herring and to note the occurrence of other schooling fishes. Approximately 15,981 herring from commercial and test catches were sampled from seven of the eight AYK herring districts during the 1993 fishing season.

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

Variability in the quality of aerial survey assessments of biomass and deviations from the assumed survival or recruitment rates may result in the observed biomass being either above or below these projections. Harvest levels will be adjusted during the season according to observed herring spawning biomass. In addition, in accordance with the AYK Region harvest policy, newly recruited age classes will not be targeted by the commercial fishery. If it is not possible to determine herring abundance using aerial survey methods, stock abundance will be assessed using information from the projected biomass, test and commercial catches, and spawn-deposition observations.

### *Security Cove Sac Roe Fishery*

The Security Cove District consists of all waters between Cape Newenham and the Salmon River. The estimated biomass of herring in the Security Cove District has ranged from 2,300 tons in 1987 to 8,300 tons in 1981.

The Alaska Board of Fisheries has established a threshold biomass level of 1,200 tons for the Security Cove sac roe fishery. Commercial fishing is not allowed until aerial survey biomass estimates reach 1,200 tons or, if weather conditions prevent biomass assessment, significant spawning activity is documented and the forecast biomass is expected to exceed 1,200 tons. The maximum exploitation rate is restricted to 20% of the available biomass. The commercial herring fishery in the Security Cove District has been regulated by emergency order since 1981 to provide for an orderly fishery and periodic reassessment of herring biomass. Emergency order authority is used to adjust the occurrence and length of fishing periods commensurate with stock strength, fishing effort, and spawning activity.

During the 1993 season, 12 aerial surveys were flown in the district between April 28 and May 17 to estimate herring biomass and spawning activity. Only four of these were flown under acceptable survey conditions. On April 29, 2,774 tons of herring were observed during an aerial survey. Another 4,216 tons were seen during a May 16 survey. Total biomass present in the district was estimated to be 6,995 tons by combining these two surveys with the harvest. A total of 12.7 mi of spawn was observed in the district, with peak spawning activity occurring on May 4 when 2.7 mi of milt were documented.

Only 5 tons of herring were harvested during four openings for a total fishing time of 24.5 h in the Security Cove District in 1993. The low harvest in the Security Cove District was probably due to the relatively late arrival of fishermen and processors. The district was placed on a 2-h advanced notice for commercial fishing on May 5; however, fishermen did not arrive in the district until May 12. The average time between the first commercial periods in the Togiak and Security Cove Districts is four days (range two to nine days). This year there were 15 days between the first opening at Togiak and Security Cove. A total of 11.7 mi of spawn was observed in the district before May 12. The total exvessel value of the catch for 9 fishermen was approximately \$2,000 (compared to \$285,000 in 1992). The exploitation rate is estimated to be 0.1% of the observed biomass.

The Security Cove test fish crew fished from May 4 to May 26 with variable-mesh gillnets. From this catch, 1,294 herring were sampled for biological data. Ages 5 and 6 dominated the return in both biomass (33.0% and 23.2%, respectively) and numbers of fish (38.3% and 21.4%, respectively). Age-9 and older herring composed 24.9% of the biomass. Recruit herring represented 61.9% of the return in numbers of fish. A sample of 98 herring was taken from the commercial catch. Age-9 and older herring represented 76.2% of the harvest. Recruit herring were only 1.4% of the catch.

The 1994 projected return to the Security Cove District is 7,638 tons (Figure 16, top). A 20% exploitation rate would result in a harvest of approximately 1,528 tons, which would be a historic record for this district. A larger catch may occur if the biomass is assessed to be greater than the projection. Commercial fishing will not be allowed until the observed biomass reaches 1,200 tons or significant spawning activity is observed. The occurrence and length of fishing periods will depend on stock strength, fishing effort, and spawning activity. Age-5, -6 and -7 herring are expected to dominate the return (Figure 16, bottom). Age-9 and older herring are expected to compose approximately 16.1% of the biomass.

### *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 Ukfigag River and the Tunulik River. Since 1981 the estimated biomass of herring in the Goodnews Bay District has ranged from 2,000 tons in 1987 to 6,211 tons in 1993.

The management strategy for this district is similar to that used for Security Cove. The Alaska Board of Fisheries has established a threshold biomass level of 1,200 tons for the Goodnews Bay fishery. Commercial fishing is not allowed until aerial survey biomass estimates reach 1,200 tons or, if weather conditions prevent biomass assessment, significant spawning activity is documented and the forecast biomass is expected to exceed 1,200 tons. The exploitation rate is restricted to a maximum of 20% of the available biomass. Emergency order authority is used to adjust the occurrence and length of fishing periods commensurate with stock strength, fishing effort, and spawning activity.

During the 1993 season 12 aerial surveys were flown between April 28 and May 27 in the Goodnews Bay District. Only one of these surveys was flown under satisfactory aerial survey conditions. The ADF&G

test fish crew first documented spawning activity on May 4. On May 14, 5,970 tons of herring were observed during an aerial survey. No spawn was observed during aerial surveys of the district. The total biomass of 6,211 tons was calculated by adding the harvest of 241 tons, which occurred prior to the peak aerial survey, to the peak aerial survey.

In 1993, 954 tons were harvested in a record 20 commercial periods for a total fishing time of 123 h. A meeting with fishermen and processors was held on May 11. The catch consisted of 945 tons of sac roe-quality herring with an average roe content of 10.3% and 9.3 tons of bait. Catches ranged from 130 tons on May 18 to 0 tons on May 27 and May 28–29. During the fishery, roe contents ranged from 9.6% to 12.1%. Three processors bought herring from 63 permit holders who made 705 deliveries for an estimated exvessel value of \$293,000. The exploitation rate was 15.4% of the available biomass.

Department test fishing was conducted from May 18 to May 29, 1993. A total of 1,497 herring were sampled for biological data. Age-5 herring dominated both the biomass (30.9%) and the return in numbers of fish (38.6%). Age-9 and older herring represented 25.9% of the biomass. Recruit herring were 49.5% of the spawning population. A sample of 745 herring was taken from the commercial catch. Age-9 and older herring made up 61.4% of the catch by weight. Recruits composed only 4.5% of the harvest.

The 1994 projected return of herring to the Goodnews Bay District is 5,679 tons (Figure 17, top). A 20% exploitation rate would result in a harvest of 1,136 tons, a record harvest for this district. A larger catch may occur if the biomass is assessed to be greater than the projection. The management strategy for this district will be similar to that used for Security Cove. The season will open and close by emergency order when a biomass of 1,200 tons is observed or substantial spawning activity occurs. Age-6 and -7 herring are expected to be the dominant year classes in the return (Figure 17, bottom). Age-9 and older herring are expected to compose approximately 20% of the biomass.

### *Cape Avinof Sac Roe Fishery*

In the fall of 1989 the Alaska Board of Fisheries extended the eastern boundary of the Cape Avinof District to the Ishkowik River (162°44' W. longitude). The Cape Avinof District consists of all waters extending inshore of Kikegteg, Pingurbek, and Kwigluk Islands from the Ishkowik River to the Ursukfak River. This was the sixth year of commercial herring fishing in the Cape Avinof District. Aerial surveys have been conducted by the department in the Cape Avinof area since 1985, and biomass estimates have ranged from 1,225 tons in 1987 to 4,108 tons in 1988. Weather and ice conditions in 1986, 1989, 1990, and 1993 precluded biomass estimates by aerial survey.

The Alaska Board of Fisheries has established a threshold biomass level of 500 tons for the Cape Avinof sac roe fishery. Commercial fishing is not allowed until aerial survey biomass estimates reach 500 tons or, if weather conditions prevent biomass assessment, significant spawning activity is documented and the forecast biomass is expected to exceed 500 tons. The exploitation rate is restricted to a maximum of

15% of the available biomass. Openings of the Cape Avinof District commercial herring fishery are regulated by emergency order.

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

In 1993 fishermen caught 215 tons of herring in 16 commercial openings for a total of 106 h of fishing time. In the Cape Avinof District, 97 fishermen made 478 deliveries to one processor for an exvessel value of approximately \$75,000. The exploitation rate was 7.6% of the available biomass. Most of the harvest took place in the Kipnuk area; however, during the first five openings, approximately 12 permit holders made 41 deliveries for a total of 18 tons of sac roe herring with a 12.1% roe content in the Kwigillingok area.

The department's test fisheries near Kipnuk and Kwigillingok captured 1,575 herring between May 18 and June 9, 1993, to sample for biological data. Age-5 herring dominated the return in both biomass (26.2%) and numbers of fish (33.9%). Age-9 and older herring composed 35.1% of the biomass. Recruit herring represented 50.9% of the return in numbers of fish. A sample of 980 herring was taken from the commercial catch. Age-9 and older herring made up 82.3% of the catch by weight. Recruit herring composed only 3.0% of the harvest.

The projected 1994 biomass for the Cape Avinof area stock is 2,827 tons (Figure 18, top). Either significant spawning activity or a biomass of 500 tons must be observed before the commercial herring season can be opened. The season will open and close by emergency order. The exploitation rate will be set at 15% because of the limited data base for this area and the priority of subsistence fishing. Assuming a 15% commercial exploitation rate, the projected harvest will be 424 tons of herring. Age-6 herring are expected to be the largest year class in the returning population (Figure 18, bottom). Age-9 and older herring are expected to compose approximately 29.4% of the returning population.

### *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. The commercial harvest of herring began in the Nelson Island District in 1985. Since 1985 biomass estimates in the Nelson Island District have ranged from 2,385 tons in 1991 to 9,500 tons in 1985.

The Alaska Board of Fisheries has established a threshold biomass level of 3,000 tons for the Nelson Island fishery. Commercial fishing is not allowed until aerial survey biomass estimates reach 3,000 tons or, if weather conditions prevent biomass assessment, significant spawning activity is documented and

the forecast biomass is expected to exceed 3,000 tons. The exploitation rate is restricted to a maximum of 15% of the available biomass. This is lower than the 20% maximum exploitation rate used in most other areas to allow for subsistence harvests. The Nelson Island commercial fishery is regulated by emergency order.

In 1993, 15 aerial surveys were flown in the Nelson Island area between May 8 and June 1. Four of these surveys were flown under acceptable aerial survey conditions. During an aerial survey on May 17, 4,944 tons of herring were observed in the district. A total of 13.0 mi of spawn was observed during aerial surveys of the district. Peak spawning was observed on May 25 when 5.5 mi of spawn were sighted.

In 1993 there were 16 commercial openings from May 17 to June 3 for a total fishing time of 63.5 h. The total catch of 739 tons consisted of 613 tons of sac roe-quality herring with an average roe content of 10.6%, 52 tons of bait and 74 tons of waste. One processor paid approximately \$198,000 to 73 fishermen. The exploitation rate was 14.9% of the available biomass.

Test fishing with variable-mesh gillnets occurred from May 22 to June 12, 1993. A total of 1,400 herring were sampled for biological data. Age-5 fish dominated the return in both biomass (33.3%) and numbers of fish (41.8%). Age-9 and older herring composed 35.2% of the biomass. Recruit herring represented 62.5% of the spawning population in numbers. A total of 547 herring was sampled from the commercial catch. Age-9 and older herring were 85.3% of the catch. Only 0.6% of the harvest was recruit-aged herring.

The spawning biomass projected to return to the Nelson Island District in 1994 is 4,888 tons (Figure 19, top). At an exploitation rate of 15%, the harvest will be 733 tons of herring. A larger catch may occur if the assessed biomass is greater than the projection. Age-6 herring are expected to be the dominant age group (Figure 19, bottom). Age-9 and older herring are expected to compose approximately 16.7% of the biomass in 1994.

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

1. The commercial fishery will not be allowed to take more than 15% of the herring biomass, compared to up to 20% for most other fisheries having stocks of similar size and condition.
2. Periodic closures of the commercial fishery will be scheduled during which time only subsistence fishing will be allowed.
3. Several important subsistence-use areas occur throughout the district, including the waters north of Cape Vancouver. Specific areas may be closed to commercial fishing to ensure the adequacy of subsistence harvests.



4. The department will by all available means, including input from local residents, ensure 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 3 mi seaward of mean low water from Kikoojit Rocks to the small bay approximately 2 mi east of Ingrirak Hill. Commercial fishing for herring in the Nunivak Island District began in 1985. Since 1985 the estimated biomass in the Nunivak Island District has ranged from 422 tons in 1990 to 6,000 tons in 1986.

The Alaska Board of Fisheries has established a threshold biomass level of 1,500 tons for the Nunivak Island fishery. Commercial fishing is not allowed until aerial survey biomass estimates reach 1,500 tons or, if weather conditions prevent biomass assessment, significant spawning activity is documented and the forecast biomass is expected to exceed 1,500 tons. The exploitation rate is restricted to a maximum of 15% of the available biomass. This is lower than the 20% maximum exploitation rate used in most other areas to allow for subsistence harvests. The Nunivak Island commercial fishery is regulated by emergency order.

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

The Nunivak Island District had no commercial herring periods in 1993. Between May 13 and May 16, approximately six fishermen attempted to locate herring between Cape Manning and Cape Corwin. A total of 13 samples averaged 4.9% roe content. A large percentage of males, combined with immature and spent fish, made location of market-quality herring difficult. The tender left the Nunivak Island District for the season on May 17.

Test fishing with variable mesh gillnets occurred from May 16 to June 2. From this catch, 263 herring were sampled for biological data. Age-5 fish dominated the return in both biomass (25.7%) and numbers of fish (37.9%). Age-9 and older herring composed 48.4% of the biomass. Recruit herring represented 47.7% of the spawning population in numbers of fish.

The projected biomass of herring returning to the Nunivak Island District in 1994 is 4,909 tons (Figure 20, top). The commercial season will open when the biomass reaches 1,500 tons or when significant spawning is observed. A 15% exploitation rate would result in a 736-ton harvest. A larger catch may occur if the assessed biomass is greater than the projection. Age-6 herring are expected to be the dominant age group (Figure 20, bottom). Age-9 and older herring are expected to compose 39.5% of the return.

### *Cape Romanzof Sac Roe Fishery*

The Cape Romanzof District consists of all waters between the latitude of Dall Point and 62° N. latitude. Since 1980 the estimated biomass of herring in the Cape Romanzof District has ranged from 3,000 tons in 1980 to 7,500 tons in 1986. Because of excessive water turbidity in the Cape Romanzof area, it is generally not possible to estimate herring biomass from aerial surveys. Biomass has been estimated using information from test and commercial catches, spawn-deposition surveys, and age composition. The Alaska Board of Fisheries has established a threshold biomass level of 1,500 tons for the Cape Romanzof sac roe fishery. The maximum exploitation rate is restricted to 20% of the available biomass.

Seven aerial surveys were flown during the 1993 season from May 10 through June 3. A total of 1.9 h were spent surveying the district. All surveys were unacceptable due to poor weather and/or turbid water conditions. Since it was not possible to estimate the biomass inseason, the projected biomass of 2,449 tons was used to manage the fishery.

Daily qualitative spawn-deposition surveys were conducted from May 12 until June 2, 1993. The first observations were recorded on May 14 in Kokechik Bay. A gradual increase in spawn deposition followed, both in layers of eggs and distribution. Spawn deposition peaked on approximately May 27, with an average of 3.4 egg layers on *Fucus* substrate and an average of 2.2 egg layers on rock substrate, depending on location.

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

A total of 371 tons of herring was harvested by 41 fishermen utilizing 41 fishing vessels in 1993. All 371 tons were purchased as sac roe. The average sac roe recovery of 9.6% was the second highest on record. Approximately 2 tons of herring were discarded in an abandoned gillnet. The commercial fishery consisted of six periods between May 17 and May 23, 1993. Fishing periods ranged from 1 h to 4 h in duration for a total fishing time of 12.5 h. The commercial harvest was managed to achieve the preseason harvest projection of 367 tons since no inseason biomass estimate was obtained. Fishing gear was restricted to one 50-fathom gillnet per vessel throughout the commercial season. Low effort, stormy weather, and a relatively small tendering capacity resulted in low period catches. Fishing effort in 1993 was the lowest on record and was 44% below the 1992 effort level. Local Alaskan residents (defined as residents of Chevak, Hooper Bay, and Scammon Bay) accounted for 95% (39 permits) of the effort and 91% (338 tons) of the harvest. The estimated value of the total harvest to fishermen was \$106,403. Two companies purchased herring. These companies were represented by two processing vessels and four tenders during the fishery.

Test fishing with variable-mesh gillnets was conducted by ADF&G from May 13 to June 4. A total of 4,077 herring were caught, of which 1,349 were sampled for biological data. Age-9 and older herring composed 74.0% of the run by weight. Recruit herring represented 18.4% of the spawning population in numbers. A total of 886 herring were sampled from the commercial harvest. Age-9 and older herring made up 93.3% of the catch by weight. Herring recruits composed only 0.5% of the harvest.

The projected return for 1994, based upon limited data, is 2,758 tons (Figure 21, top), which would result in a 414-ton harvest at a 15% exploitation rate. Emergency order authority will be used to regulate the occurrence and length of fishing periods. Aerial biomass assessment cannot be used to determine the opening of commercial fisheries due to typically poor survey conditions caused by turbid water. Therefore, spawn-deposition observations and test and commercial catch rates will be used to determine timing and duration of commercial fishing periods. If stock abundance is judged to be lower or higher than the projection, the projected harvest of 414 tons will be modified accordingly. Age-10 and -12 herring are expected to dominate the biomass (Figure 21, bottom). Age-9 and older herring are expected to compose 62.7% of the biomass.

### *Norton Sound Sac Roe Fishery*

The Norton Sound District consists of all waters of Alaska between the westernmost tip of Cape Douglas and Canal Point Light. Historically, the primary spawning areas within Norton Sound have been from Stuart Island to Tolstoi Point. Additional spawning areas have been documented along Cape Denbigh and upon several bedrock outcroppings along the northern shore of Norton Sound between Bald Head and Topkok. Use of these areas increases when sea ice has remained near shore in the traditional areas into June.

The Alaska Board of Fisheries has established a threshold biomass level of 7,000 tons for the Norton Sound fishery. The maximum exploitation rate is restricted to 20% of the available biomass. Emergency order authority is used to adjust the occurrence and length of fishing periods. Board of Fisheries regulations allocate 10% of the preseason projected harvest to beach seine gear and the remaining harvest to gillnet gear.

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

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

There were 264 fishermen who made at least one delivery during the season. This is the lowest effort since 1985, excluding 1992 when there was no fishery. Fishing effort has been declining since limited entry was put into effect. This season's low effort was in part due to the poor price projected prior to the season, the lack of a commercial herring fishery in 1992, and an extended commercial season in 1993.

During the 1993 season 256 fishermen used gillnets, landing a total of 4,292 tons. The average sac roe recovery for the gillnet fishery was 10.0%. Seven fishermen participated in the beach seine fishery, landing 742 tons of herring. The average sac roe recovery for the beach seine fishery was 8.9%. One educational gillnet permit was issued by the Commercial Fisheries Entry Commission and fished by the Bering Straits School District commercial fisheries vocational class on May 30 and 31. A total of 9 tons was landed on this permit and is included in the total gillnet harvest.

The average sac roe recovery for all gear types was 9.9%. The average price paid to the fishermen for a short ton of herring with 9.9% roe recovery was approximately \$294. Of the 5,034 tons harvested, 321 tons were purchased as bait herring (with roe content less than 7.0%). The total value of the herring harvest to Norton Sound fishermen was approximately \$1,411,142. Six companies registered 10 processors and 48 tenders to operate in Norton Sound. The exploitation rate for the 1993 Norton Sound sac roe fishery was 10.9%.

Two ADF&G field crews were operational during the 1993 season. One crew operated from Cape Denbigh and the second crew operated from Klikitarik. Test fish crews sampled 2,597 herring caught with variable-mesh gillnets for biological data. Age-11 herring composed 22.1% of the biomass. Age-5 herring dominated (28.0%) the return in numbers of fish. The biomass consisted of 58.4% age-9 and older herring. Recruit herring represented 36.2% of the return in numbers of fish. A total of 2,630 herring were sampled from the commercial harvest. Age-9 and older herring dominated (94.5%) the gillnet harvest. Age-5 and -11 herring composed 23.5% and 18.1% of beach seine catches, respectively.

The Norton Sound projected return is 39,061 tons (Figure 22, top). A 20% exploitation rate would result in a harvest of 7,812 tons. The 1994 biomass is expected to be dominated by 6- (24.5%) and 12- (16.5%) year-old herring (Figure 22, bottom). Age-9 and older herring are expected to compose 47.2% of the biomass. Inseason assessment of herring biomass will supersede projected biomass for management of the Norton Sound herring fishery, except where weather prevents obtaining an inseason estimate. The beach seine harvest is, by regulation, 10% of the projected harvest, or 781 tons. The 1994 herring fishery

will be opened by emergency order. The fishery will close by emergency order when up to 20% of the available herring biomass has been harvested. Varied harvest rates may be applied to individual subdistricts based on biomass distribution, roe quality, weather, and sea-ice conditions.

### ***Port Clarence Sac Roe Fishery***

The Port Clarence District consists of all waters between Cape Douglas and Cape Prince of Wales. Generally, it is not possible to survey this district because of ice, water stain, and poor weather. In addition, other species, such as saffron cod, whitefish, and other pelagic species, are typically present in the area, making the species identity of aerial sightings difficult to determine. A record biomass for this district of 1,652 tons was sighted during an aerial survey in 1992. One aerial survey was flown in 1993. Under fair aerial survey conditions on June 15, 822 tons of herring were observed; no herring spawn was sighted.

A commercial sac roe fishery in the Port Clarence District has not occurred since 1988 because buyers have not been present in the district. During 1993, 1 ton of bait-quality herring was harvested between April 15 and November 15.

The department does not generally project an outlook for the Port Clarence fishery due to the lack of data on Port Clarence herring and the very limited scope of the fishery. The guideline harvest of 165 tons established by the Board of Fisheries in 1981 will determine the allowable harvest in 1994. This harvest guideline is based on two years of research by the department in both the Port Clarence and Kotzebue Districts. Although this guideline has not appeared in the regulation book since 1984, it still represents the best estimate of harvestable biomass at this time.

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## WESTWARD REGION

### *Kodiak Management Area*

The Kodiak Management Area comprises the entire Kodiak archipelago and that portion of the Alaska Peninsula that drains into Shelikof Strait between Cape Douglas and Kilokak Rocks at Imuya Bay. The archipelago is approximately 150 mi long, extending from Shuyak Island south to the Trinity Islands. The Alaska Peninsula portion is about 160 mi long and is separated from the archipelago by the Shelikof Strait, which averages 30 mi in width (Figure 1). The Kodiak Management Area is divided into seven districts that define geographical areas used in managing the sac roe and food/bait herring fisheries. For the sac roe fishery, each district is further broken into management units that are intended to define the spawning area used by a stock of herring or may be used to define a geographical area. There are a total of 74 management units. Herring fisheries in the Kodiak Management Area in 1993 are described in detail in Gretsche et al. (1994).

### **Kodiak Food/Bait Fishery**

The Kodiak food/bait herring fishery is primarily a bait fishery providing a frozen product for longline and crab/cod pot fishers. Effort and harvest levels in this open-to-entry fishery are at historical lows.

The current management approach to Kodiak food/bait herring fisheries recognizes that the fishery occurs on a mixture of herring that spawn in the Lower Cook Inlet Management Area and within the Kodiak Management Area. Ten percent of the allowable harvest from Kamishak Bay herring is allocated to the Kodiak food/bait herring fishery. This allocation is based on the spawning biomass of age-5 and older herring and not on the biomass of juveniles. The Kamishak allocation is combined with the allowable harvest from Kodiak-spawning herring from food/bait management units FB 1, FB 4, and FB 5. When this combined quota is achieved, the Shelikof Strait food/bait management units are closed collectively. This plan alleviated problems with an earlier management approach that required determining the stock of origin of catches in areas where intermixing occurred.

By regulation, the Kodiak area food/bait herring season extends from August 1 through February 28. The entire Kodiak area is open to continuous fishing on August 1 for all legal gear types, which include purse seine, gillnet, and trawl. Purse seines are restricted to 150 fathoms in length and 1,625 meshes in depth. Gillnets are restricted to a length of 150 fathoms. There are no restrictions for trawl gear.

The 1993–1994 allocation for Kamishak Bay herring stocks overwintering in Shelikof Strait was 380 tons. In addition, for the Kodiak stocks in food/bait management units FB 1, FB 4, and FB 5, there was an additional allowable harvest of 272 tons. This resulted in a combined quota of 652 tons. For the Kodiak spawning stocks the total quota was 489 tons, which represents 10% of the previous spring's sac roe harvest on a stock-by-stock basis. The total quota for the Kodiak Management Area was 869 tons (380 tons Kamishak allocation and 489 tons Kodiak stocks).



Kodiak's food/bait herring season started on August 1, 1993, and remained open until February 28, 1994. During the 1993–1994 season the entire harvest occurred in October. For the 1993–1994 season a total of 837 tons were harvested in the Kodiak Management Area. Eleven vessels and five buyer/processors registered for the fishery. Trawl gear accounted for 56% of the total harvest and purse seine gear 44%. The total exvessel value of this fishery was \$335,000.

Food/bait management units FB1, FB2, FB4, FB5, FB11, and FB12, which are affected by the combined harvest of Kamishak Bay herring stocks, were closed on October 19, 1993. The actual harvest was 707 tons. As stated in the Kamishak Bay District Herring Management Plan (5 AAC 27.465), the quantity of age-4 and younger herring harvested will be adjusted to a similar number of age-5 herring; this adjusted harvest totaled 764 tons. The combined quota for these units was 652 tons. The Alitak food/bait management unit FB7 was closed when the 77-ton quota was achieved. Age-weight-length data from this harvest revealed a high percentage of age-5 and -6 herring, which was identical to the sac roe herring harvest from the Alitak District. A large portion of the 1993 harvest was delivered to Homer and processed in plants at Kenai and Homer. Quotas for the 1994–1995 Kodiak food/bait herring fishery will be established after additional information is collected during the spring 1994 spawning period.

### **Kodiak Sac Roe Fishery**

The current Kodiak sac roe herring fishery occurs from mid April to late June in 40–50 bays and coastal locations. The fishery is limited to entry for both gillnet and purse seine gear. The fishery opens by regulation on April 15 at which time the entire management area is opened, with the exception of those areas where herring require biological protection. A unique characteristic of this fishery is that it commences prior to any major buildup of herring. This allows for a more general distribution of effort and reduces harvest rates within a bay. Both gear types fish the same areas during the same time periods. Fishing periods are established by emergency order with 24-h fishing periods beginning at noon on odd-numbered days of the month followed by 24-h closures.

In 1985 the fixed, overall quota of 2,400 tons was replaced by the current harvest strategy where quotas are set annually on a stock-by-stock basis. Preseason guideline harvest levels are established for all management units that have produced consistent herring harvests in previous seasons. These quotas are meant to reflect the status of a particular stock of herring by management unit or district. Criteria for establishing a guideline harvest level include: (1) 1992 expected biomass versus actual biomass estimates, (2) average school size, (3) trends in age composition, (4) level of recruitment (age 3), (5) proportion of the spawning population age 5 and younger, (6) proportion of age-2 fish in the spawning biomass (indicator of future recruit strength), and (7) spawn observations (extent, frequency, amount deposited). This information is supplemented by fishery performance information, namely the expected versus actual harvest timing, harvest duration, and harvest level. Some management units are designated *exploratory* and are assigned no quota because there have been sporadic or no harvests of herring in past years. Inseason closures in these exploratory areas are used to ensure excessive harvests are minimized. If it appears that preseason expectations were incorrect, quotas can be adjusted above or below preseason levels during the season. Actual fishery performance is used to evaluate the health of a particular fishery

with key components, including (1) duration of fishing time to harvest the management unit quota; (2) catch per unit of effort; and (3) quality of herring harvested that considers factors such as roe-recovery percentages, weights, and age compositions.

The Kodiak herring sac roe fishery began in 1964 and has averaged 2,356 tons per year (Figure 23). However, during the past two years harvests have substantially increased, nearly doubling the long-term average. Prior to 1978 the entire sac roe harvest was taken by seine gear. The percentage of the total harvest by seine gear ranged from a high of 85% to a low of 60% and averaged 75% from 1979 to 1993. The gillnet percentage of total harvest peaked in 1988 at 40% and averaged 25% from 1979 to 1993.

Since 1982 the number of permits fished has been relatively constant with 90 to 120 units of gear fished annually. Transferrable permits for both gear types are still increasing as the Commercial Fisheries Entry Commission continues its determinations of participants who may qualify for a transferable permit. Since 1979 seiners have gradually increased seine depths to the legal limit of 1,025 meshes, which includes 25 meshes of chaffing gear. Seines are restricted to 100 fathoms in length and gillnets to 150 fathoms. Similarly, the gillnet fleet has evolved from floating nets of 80–100 meshes in depth to sinking nets with 120–160 meshes in depth. Gear efficiency appears to have reached its maximum under the current regulations; no limit on gear depth exists for gillnets, but additional gear depth would be difficult to operate because of the small size of boats used in the fishery. The use of mechanical shakers has increased over the last few years. The shaker greatly reduces the time and effort needed to remove herring from the net and greatly increases the gear efficiency.

Herring originally were caught at or near their spawning area from 1978 to 1983. As a fisherman's knowledge increased in identifying these areas, the herring were harvested in deeper waters (15–20 fathoms) further from their spawning destination. ADF&G relies on the fishing industry to establish roe-recovery standards. Generally, tenders will have a processor representative onboard to ensure marketable sac roe-quality herring are harvested. Competition among shorebased processors and the high quality of sac roe results in this fishery having one of the highest exvessel values per ton in the state. The high quality of fish results from inseason handling of a relatively small amount of herring over a long time period.

A total of 4,929 tons of herring were harvested in the 1993 Kodiak sac roe fishery, 40% higher than the preseason quota of 3,525 tons. This is the second consecutive year that a new record-high harvest has occurred. Forty-one seiners caught 4,203 tons, which was 85% of the total harvest, while the 86 gillnetters accounted for 726 tons, which was 15% of the total harvest. Eight buyers/processors operating 10 processing plants purchased herring in the 1993 season. In 1993 roe recovery averaged 9.8% for seine-caught fish and 10.4% for gillnet gear for a combined average roe recovery of 9.9%. The average weight of commercially caught herring was 156 g. The average price per ton paid at the dock was difficult to establish due to such factors as the size of herring harvested and delivery method. Prices ranged from \$100 to \$1,200 per ton; for ADF&G's purposes an average price of \$550 per ton was used to calculate estimated values of the fishery. The total exvessel value of the fishery was estimated at \$2,700,000.

The distribution of herring harvested by district has increased over the last two seasons in the Afognak, Uganik, General, and Alitak Districts (Figure 24). The Uyak District has experienced a decline in harvest and the Mainland District is comparable to the past five years. Of the 74 management units in the Kodiak Management Area, 50 units had a herring harvest, of which 31 were closed inseason by emergency order.

During the 1993 season age-5 herring composed 64% of the commercial seine harvest. In general, a majority of management units had a dominance of age-5 herring while the eastside Kodiak Island management units had a dominance of age-6 herring.

In 1991 age-3 herring showed a decrease in average weight when compared to previous brood years. This trend continued in 1992 and 1993 when these same fish were harvested at age 4 and 5, respectively; they were the smallest by age observed in this fishery. All other age classes in the 1993 fishery had comparable growth rates to the past four years.

In 1993 the spawning biomass index for that portion of the Kodiak area fished was estimated to range from 42,500 to 56,000 tons as determined by industry spotter and ADF&G surveys. This is the highest biomass estimate recorded for this fishery since 1978. Since 1988 the indexed biomass has increased dramatically from 5,500 tons to 15,500 tons in 1990 and doubled by 1992 to 32,000 tons. A breakdown by district includes: 10,000–13,000 tons in the Afognak District, 10,000–14,000 tons in the General District, 12,000–15,000 tons in the Uganik District, 1,500–2,000 tons in the Uyak District, 7,000–9,000 tons in the Alitak District, and 2,000–3,000 tons in the Mainland District. The sac roe harvest of 4,929 tons represented a total indexed exploitation rate that ranged from 9% to 12% of the spawning biomass. This is similar to the past three seasons, yet lower than most years, which have ranged from 28% to 41% exploitation of the indexed spawning biomass.

These exploitation rates should be qualified, since surveys represent an unknown and undoubtedly highly variable proportion of the actual biomass. These exploitation rates can be used for trend evaluation, but should not be compared to the spawning biomass indices achieved by ADF&G in Prince William Sound, Cook Inlet, and Bristol Bay. These areas have a relatively large biomass available for aerial indexing and the observed biomass is annually less variable; i.e., there is more opportunity to observe a greater and more consistent proportion of the actual total biomass. The exploitation rates achieved in these fisheries would be more comparable between areas.

Based on the age-class data collected in 1993 and the increasing biomass estimates for the past three years, the preliminary quota for 1994 is 4,000 tons, an increase of 14% over the 1993 season. The 1994 harvest is expected to target the dominant age-6 and 7-year-old fish, which should compose 70–80% of the harvest. These age compositions, spawn observations, and fishery performances indicate that the Kodiak area biomass should support a stable sac roe fishery over the next few years. Observations and harvests of age-2 and -3 herring during the 1994 season will provide the best insights into future production of this fishery.

### ***Port Moller (North Peninsula) Sac Roe Fishery***

There are three commercial herring fishing districts defined in the fishing regulations for North Peninsula waters: Port Heiden, Port Moller, and Amak. In 1993 no catches were reported nor were herring observed in the Amak District or Port Heiden Districts. In all districts, herring may be taken with purse seines and gillnets, both gear types sharing common time and area openings. Herring fisheries that occurred in the North Peninsula area in 1993 are described in detail in McCullough and Campbell (1994).

The 1993 guideline herring harvest for North Peninsula commercial herring fisheries was 3,500 tons. The Amak District was open for exploration continuously from April 15 through June 30. In 1993 the Port Moller District was first opened by emergency order on May 7, but no herring were harvested until May 8. Herring fishing periods continued until June 9, when the last processor quit purchasing herring. A total of 536 tons of herring were harvested in North Peninsula waters. Five companies purchased herring, with an exvessel value totalling \$160,650.

The 1994 North Peninsula forecasted catch is 1,200 tons. The forecast is based on the 5-year (1989–1993) average catch of 1,367 tons. The forecast has been reduced by 167 tons to account for North Peninsula herring that are probably harvested during the Dutch Harbor herring food/bait fishery. Non-Togiak herring stocks compose about 22% of the Dutch Harbor herring catch, and due to the July 16 opening date of the food/bait fishery, North Peninsula herring stocks should compose the majority of the non-Togiak herring component. Using a non-Togiak-component midpoint estimate of 11%, the North Peninsula guideline harvest level should be reduced during the sac roe fishery to ensure that North Peninsula herring stocks are not harvested beyond a 20% exploitation rate. Age-class data from the 1993 harvest indicates that in 1994 age-7 herring should dominate Port Moller Bay catches; no other samples were collected in North Peninsula waters. The forecast does not include the Port Heiden District where commercial fishing occurred only during 1992.

### ***South Peninsula Sac Roe Fishery***

In 1993 South Peninsula herring fisheries were opened to sac roe fishing by regulation on April 15 and remained open until the regulatory closure date of July 15, except for the Canoe Bay section which closed on June 23. In 1993 most of the commercial harvest was taken in Canoe Bay, with one small catch in Stepovak Bay. From May 27 to June 9, 97 tons were harvested by three purse seine permit holders, who made 17 deliveries. The average roe recovery was 10.8%. The estimated value of the fishery was \$32,738.

The 1994 South Peninsula forecasted sac roe catch is 200 tons. The forecast is based on the 1989–1993 average herring sac roe catch of 211 tons. Age-class data from the 1993 harvest indicates that in 1994 age-4 and age-9 herring should dominate Canoe Bay catches; no other samples were collected in South Peninsula waters.

### *Dutch Harbor Food/Bait Herring Fishery*

Because the Dutch Harbor food/bait herring fishery harvests primarily Togiak stocks, the Dutch Harbor quota is based on the stock size at Togiak. Board of Fisheries regulations specify that the annual Dutch Harbor quota shall be determined by first subtracting 1,500 tons from the allowable Togiak harvest to account for the impact of the Togiak spawn-on-kelp fishery. Then 7% of the remaining allowable harvest is allocated to the Dutch Harbor fishery. Because other western Alaska stocks may be present in the Dutch Harbor fishery, Board of Fisheries regulations do not allow the Dutch Harbor fishery to open if any western Alaska herring stocks are below threshold levels. For the purpose of determining whether to open the Dutch Harbor fishery, the board established a special 2,000-ton threshold for the Nelson Island herring stock.

Regulations allow the Dutch Harbor fishery to open from July 16 through February 28 during periods specified by emergency order. In recent years the quota has been harvested within a few days after the fishery opened.

Herring were harvested at Dutch Harbor during an earlier fishery that lasted from 1928 to 1945. A large portion of the catch was brined for either food or bait purposes; some product was frozen. The Board of Fisheries reinstituted the fishery in 1981 with no harvest restrictions. In 1983 the board restricted the harvest quota to 3,527 tons and in 1986 reduced the quota to 2,453 tons. For the 1988 season the board initiated an allocation of 7% of the allowable Togiak harvest to the Dutch Harbor fishery.

The 1993 fishery opened on July 16 at 8:00 a.m. through 9:00 a.m. and 3:00 pm through 3:20 p.m. A 2,193-ton quota was allocated to the fishery. The entire allocation was harvested in Unalaska Bay. The commercial catch totaled 2,790 tons, which exceeded the allocation by 597 tons.

Thirteen permit holders made 32 landings for a commercial harvest of 2,790 tons of herring. About 887 tons were processed as food and 1,903 as bait. Prices paid by the five companies that purchased herring during the fishery were about \$300 per ton, resulting in an exvessel value for the fishery of \$836,940.

A total of 629 herring were sampled from the commercial catch. Age-6 herring dominated the catch (52%), followed by age 9 (13.2%) and age 5 (9.5%). The average herring length in the sample was 272 mm and the average weight was 305 g.

For 1994 the preliminary quota for the Dutch Harbor food/bait herring fishery is 1,890 tons. This quota may be revised after data collected during the spring 1994 fisheries are analyzed.

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## **TABLES AND FIGURES**





Table 1. Summary of harvest and value for 1993 Alaska herring fisheries.

| Fishery                 | Harvest                                  |                         | Price Per<br>Ton<br>of Herring | Ex-vessel<br>Value  |
|-------------------------|--|-------------------------|--------------------------------|---------------------|
|                         | Spawn-on-Kelp<br>Product<br>(short tons) | Herring<br>(short tons) |                                |                     |
| Sac Roe Fisheries       |  | 46,329                  | \$349                          | \$16,178,604        |
| Spawn-on-Kelp Fisheries |  |                         |                                |                     |
| Impounded               | 117                                      | 4,197 <sup>a</sup>      | \$569                          | \$2,388,275         |
| Naturally Spawned       | 354                                      |                         |                                | \$446,860           |
| Food and Bait Fisheries |  | 5,627                   | \$291                          | \$1,638,446         |
| <b>Total</b>            | <b>471</b>                               | <b>51,956</b>           |                                | <b>\$20,652,185</b> |

<sup>a</sup> Herring mortality using average product conversions and assuming 100% mortality of impounded herring.

Table 2. Summary of harvest, value, and participation in 1993 Alaska sac roe herring fisheries by area.

|                       | Opening             |                     | Harvest      |        | Roe<br>Percent | Mean<br>Weight<br>(g) | No. of<br>Permits<br>Fished | Price<br>Per<br>Ton | Exvessel<br>Value |
|-----------------------|---------------------|---------------------|--------------|--------|----------------|-----------------------|-----------------------------|---------------------|-------------------|
| Fishery               | Date                | Duration<br>(hours) | (Short Tons) |        |                |                       |                             |                     |                   |
|                       |                     |                     | Catch        | Quota  |                |                       |                             |                     |                   |
| Southeast             |                     |                     |              |        |                |                       |                             |                     |                   |
| Kah Shakes            | 4/10                | 6                   | 737          | 717    | 16.2%          | 140                   | 104                         | \$1,930             | \$1,422,410       |
| Sitka Sound           | 3/27 - 4/3          | 52                  | 10,186       | 9,691  | 10.7%          | 110                   | 50                          | \$200               | \$2,037,200       |
| Prince William Sound  |                     |                     |              |        |                |                       |                             |                     |                   |
| Seine                 | No harvest in 1993. |                     | 0            | 15,586 |                |                       |                             |                     |                   |
| Gill Net              | 4/15 - 4/19         | 36                  | 1,030        | 912    | 11.1%          | 153                   | 24                          | \$400               | \$411,960         |
| Cook Inlet            |                     |                     |              |        |                |                       |                             |                     |                   |
| Kamishak District     | 4/21                | 0:45                | 3,570        | 2,592  | 10.5%          | 200                   | 60                          | \$625               | \$2,230,000       |
| Kodiak                | 4/15 - 6/30         |                     | 4,929        | 3,525  | 9.9%           | 156                   | 127                         | \$548               | \$2,700,000       |
| Alaska Peninsula      |                     |                     |              |        |                |                       |                             |                     |                   |
| North Peninsula       | 5/8 - 6/9           |                     | 536          | 3,500  | 9.9%           | 282                   | 16                          | \$300               | \$160,650         |
| South Peninsula       | 5/7 - 6/9           |                     | 97           | 415    | 10.8%          | 299                   | 3                           | \$338               | \$32,738          |
| Bristol Bay (Togiak)  |                     |                     |              |        |                |                       |                             |                     |                   |
| Seine                 | 4/27 - 5/5          | 34                  | 14,361       | 19,709 | 9.6%           | 305                   | 140                         | \$299               | \$4,300,000       |
| Gill Net              | 4/29 - 5/10         | 144                 | 3,564        | 6,570  | 10.1%          |                       | 75                          | \$224               | \$800,000         |
| Kuskokwim/Yukon Coast |                     |                     |              |        |                |                       |                             |                     |                   |
| Security Cove         | 5/12 - 5/14         | 25                  | 5            | 1,256  | 12.8%          |                       | 9                           | \$385               | \$2,000           |
| Goodnews Bay          | 5/12 - 5/29         | 106                 | 954          | 1,194  | 10.3%          |                       | 63                          | \$307               | \$293,000         |
| Cape Avinof           | 5/23 - 6/01         | 92                  | 215          | 354    | 12.0%          |                       | 97                          | \$349               | \$75,000          |
| Nelson Island         | 5/17 - 6/03         | 50                  | 739          | 742    | 10.6%          |                       | 73                          | \$268               | \$198,000         |
| Nunivak Island        | No harvest in 1993. |                     | 0            | 591    |                |                       |                             |                     |                   |
| Cape Romanzof         | 5/17 - 5/23         | 13                  | 372          | 355    | 9.6%           |                       | 41                          | \$288               | \$110,000         |
| Norton Sound          |                     |                     |              |        |                |                       |                             |                     |                   |
| Gill Net              | 5/25 - 6/05         | 37                  | 4,291        | 8,154  | 10.0%          |                       | 256                         | \$281               | \$1,207,265       |
| Beach Seine           | 5/24 - 6/04         |                     | 743          | 900    | 8.9%           |                       | 7                           | \$267               | \$198,381         |
| Port Clarence         |                     |                     |              | 165    |                |                       |                             |                     |                   |
|                       |                     |                     |              |        |                |                       |                             |                     |                   |
| Statewide Total:      |                     |                     | 46,329       |        | 10.2%          | 209 grams             |                             | \$349               | \$16,178,604      |
|                       |                     |                     |              |        |                |                       |                             |                     |                   |

Table 3. Summary of harvest, value, and participation in 1993 Alaska spawn-on-kelp herring fisheries by area.

**Spawn on Pound Kelp**

| Fishery          | Herring Seining |        | Kelp Harvest Completed | Pound Removal Began | Herring Quota |                | Product Quota (tons) | Kelp Blades Per Permit | Product Harvest (tons) | Price per Pound | Ex-vessel Value | No. of Permits Fished |
|------------------|-----------------|--------|------------------------|---------------------|---------------|----------------|----------------------|------------------------|------------------------|-----------------|-----------------|-----------------------|
|                  | Began           | Ended  |                        |                     | Total (tons)  | Lbs Per Permit |                      |                        |                        |                 |                 |                       |
| Hoonah Sound     | Apr-06          | Apr-28 | May-03                 | May-25              | 150           | 2,650          | 12.0                 | 160                    | 14.2                   | \$12.14         | \$344,907       | 65                    |
| Craig            | Apr-17          | Apr-28 |                        | May-15              | 238           | 2,300          | 19.0                 | 292                    | 5.2                    | \$4.17          | \$43,368        | 21                    |
| Prince Wm. Sound | Apr-10          | Apr-22 | Apr-30                 |                     | 3,809         |                | 305.0                |                        | 98                     | \$10.24         | \$2,000,000     | 52                    |
| Total:           |                 |        |                        |                     | 4,197         |                | 336                  |                        | 117                    | \$10.20         | \$2,388,275     | 138                   |

**Spawn on Wild Kelp**

| Fishery             | Opening  |        |          |                     | Equiv-<br>alent<br>Herring<br>Quota<br>(tons) | Spawn<br>on Kelp<br>Product<br>Quota<br>(tons) | Actual<br>Product<br>Harvest<br>(tons) | Price<br>per<br>Pound | Price<br>per<br>ton | Exvessel<br>Value | No. of<br>Permits<br>Fished |
|---------------------|----------|--------|----------|---------------------|---|--|--|-----------------------|---------------------|-------------------|-----------------------------|
|                     | Location | Date   | Time     | Duration<br>(hours) |   |  |  |                       |                     |                   |                             |
| Prince Wm.<br>Sound |          |        |          |                     | 2,146   | 268  |  |                       |                     |                   |                             |
|                     | Montague | Apr-19 | 12:00 PM | 9:00                |   |  | 18                                     |                       |                     |                   |                             |
|                     | Montague | Apr-20 | 5:00 AM  | 17:00               |   |  | 23                                     |                       |                     |                   |                             |
|                     | Montague | Apr-21 | 5:00 AM  | 18:00               |   |  | 41                                     |                       |                     |                   |                             |
|                     | Montague | Apr-22 | 12:00 AM | 24:00               |   |  | 50                                     |                       |                     |                   |                             |
|                     | Montague | Apr-23 | 12:00 AM | 24:00               |   |  | 27                                     |                       |                     |                   |                             |
|                     | Montague | Apr-24 | 12:00 AM | 12:00               |   |  | 3                                      |                       |                     |                   |                             |
|                     |          |        | Total:   | 104                 | hrs   |  |  | 163                   | \$0.55              | \$1,100           | \$178,860                   |
| Togiak              |          |        |          |                     | 1,500   | 175  |  |                       |                     |                   |                             |
|                     |          | May-01 | 4:30 PM  | 5:00                |   |  | 109                                    |                       |                     |                   |                             |
|                     |          | May-02 | 5:00 PM  | 2:00                |   |  | 83                                     |                       |                     |                   |                             |
|                     |          |        | Total:   | 7:00                |   |  | 192                                    | \$0.70                | \$1,399             | \$268,000         | 173                         |
| Total:              |          |        |          |                     | 3,646   |  | 354                                    | \$0.63                | \$1,262             | \$446,860         | 256                         |

Table 4. Summary of harvest, value, and participation in 1993 Alaska food/bait herring fisheries by area.

| Fishery                      | Openings |          | Harvest<br>(Short Tons) |              | Price<br>Per<br>Ton | Estimated<br>Exvessel<br>Value | Average<br>Weight<br>(g) | No.<br>of<br>Vessels |
|------------------------------|----------|----------|-------------------------|--------------|---------------------|--------------------------------|--------------------------|----------------------|
|                              | First    | Last     | Catch                   | Quota        |                     |                                |                          |                      |
| Southeast                    |          |          |                         |              | \$273               | \$249,106                      |                          |                      |
| Craig                        | 12/08/93 | 01/29/94 | 670                     | 760          |                     |                                | 102                      |                      |
| Necker and<br>Whale Bays     | 12/08/93 | 02/08/94 | 103                     | 200          |                     |                                |                          |                      |
| Hobart Bay/<br>Port Houghton | 10/17/93 | 12/31/93 | 140                     | 230          |                     |                                |                          |                      |
| Prince William Sound         | 10/07/93 | 10/10/93 | 1,087                   | 978          | \$200               | \$217,400                      | 140                      | 8                    |
| Kodiak <sup>a</sup>          |          |          |                         |              |                     |                                |                          | 11                   |
| Shelikof Strait Areas        | 08/01/93 | 10/19/93 | 707                     | 552          | \$400               | \$282,969                      | 196                      |                      |
| Other Kodiak                 | 08/01/93 | 02/28/94 | 130                     | 217          | \$400               | \$52,031                       | 210                      |                      |
| Dutch Harbor                 | 08/16/93 | 08/16/93 | 2,790                   | 2,193        | \$300               | \$836,940                      | 305                      | 13                   |
| <b>Total:</b>                |          |          | <b>5,627</b>            | <b>5,230</b> | <b>\$291</b>        | <b>\$1,638,446</b>             |                          |                      |

<sup>a</sup> By regulation the Kodiak food/bait fishery occurred from August 1, 1993, through February 28, 1994.

Table 5. Forecasts of harvest and abundance for 1994 Alaska sac roe herring fisheries.

|                                | Forecast<br>Harvest      | Spawning<br>Biomass |                 |                                   | Mean<br>Weight | Stock Status |            |
|--------------------------------|--------------------------|---------------------|-----------------|-----------------------------------|----------------|--------------|------------|
| Fishery                        | (short tons - 2,000 lbs) |                     |                 | Exploitation <sup>a</sup><br>Rate | (g)            | Level        | Trend      |
| Southeastern                   |                          |                     |                 |                                   |                |              |            |
| Kah Shakes/Cat I. <sup>b</sup> | 971                      | 9,299               | 6,000           | 10%                               | 126            | Moderate     | Increasing |
| Sitka Sound                    | 4,119                    | 27,066              | 7,500           | 15%                               | 119            | Moderate     | Decreasing |
| Seymour Canal                  | 368                      | 3,552               | 3,000           | 10%                               | 106            | Moderate     | Stable     |
| Prince William Sound           |                          | 30,000              | 22,000          | 15%                               |                | Low          | Stable     |
| Seine                          | 2,615                    |                     |                 |                                   |                |              |            |
| Gill Net                       | 153                      |                     |                 |                                   |                |              |            |
| Cook Inlet (Kamishak)          | 3,422                    | 25,344              | 8,000           | 15%                               | 207            | Moderate     | Stable     |
| Kodiak                         | 4,000                    | Unknown             |                 |                                   |                |              |            |
| Alaska Peninsula               |                          |                     |                 |                                   |                |              |            |
| Port Moller/North              | 1,200                    |                     |                 |                                   |                |              |            |
| South Peninsula                | 200                      |                     |                 |                                   |                |              |            |
| Bristol Bay (Togiak)           |                          | 142,498             | 35,000          | 20%                               | 298            | Moderate     | Decreasing |
| Seine                          | 18,832                   |                     |                 |                                   |                |              |            |
| Gill Net                       | 6,277                    |                     |                 |                                   |                |              |            |
| Kuskokwim Area                 |                          |                     |                 |                                   |                |              |            |
| Security Cove                  | 1,528                    | 7,638               | 1,200           | 20%                               |                | High         | Stable     |
| Goodnews Bay                   | 1,136                    | 5,679               | 1,200           | 20%                               |                | High         | Stable     |
| Cape Avinof                    | 424                      | 2,827               | 500             | 15%                               |                | Moderate     | Stable     |
| Nelson Island                  | 733                      | 4,888               | 3,000           | 15%                               |                | Moderate     | Stable     |
| Nunivak Island                 | 736                      | 4,909               | 1,500           | 15%                               |                | Moderate     | Stable     |
| Cape Romanzof                  | 414                      | 2,758               | 1,500           | 15%                               |                |              |            |
| Norton Sound                   |                          | 39,061              | 7,000           | 20%                               |                | High         | Increasing |
| Gill Net                       | 7,031                    |                     |                 |                                   |                |              |            |
| Beach Seine                    | 781                      |                     |                 |                                   |                |              |            |
| Port Clarence                  | 165                      |                     |                 |                                   |                |              |            |
| <hr/>                          |                          |                     |                 |                                   |                |              |            |
| Total:                         | 55,105                   | 305,519             | (Known Biomass) |                                   |                |              |            |

<sup>a</sup> Exploitation rates include allowances for spawn-on-kelp and/or food/bait fisheries that harvest the same spawning stock as sac roe fisheries at Prince William Sound, Cook Inlet, and Bristol Bay.

<sup>b</sup> The Kah Shakes/Cat Island quota may be reduced to allow for anticipated harvests at Annette Island by the Metlakatla Indian Community.

Table 6. Forecasts of harvest and abundance for 1994 Alaska spawn-on-kelp and food/bait herring fisheries.

| Fishery                       | Product Harvest   | Spawning Biomass | Threshold | Exploitation <sup>a</sup> | Mean Weight | Stock Status |            |
|-------------------------------|---|------------------|-----------|---------------------------|-------------|--------------|------------|
|                               | (short tons - 2,000 lbs)  |                  |           | Rate                      | (g)         | Level        | Trend      |
| <b>Spawn on Pound Kelp</b>    |   |                  |           |                           |             |              |            |
| Hoonah Sound                  | 12  | 1,099            | 1,000     | 14%                       |             |              |            |
| Craig <sup>b</sup>            | 11  | 8,024            | 5,000     | 11%                       |             | Moderate     | Declining  |
| Prince Wm. Sound <sup>c</sup> | 51  | 30,000           | 8,400     | 15%                       |             | Low          | Stable     |
| <b>Total Pound Kelp:</b>      | <b>74</b>   |                  |           |                           |             |              |            |
| <b>Spawn on Wild Kelp</b>     |   |                  |           |                           |             |              |            |
| Prince Wm. Sound <sup>c</sup> | 45  | 30,000           | 22,000    | 15%                       |             | Low          | Stable     |
| Togiak <sup>d</sup>           | 175   | 142,498          | 35,000    | 20%                       |             | Moderate     | Stable     |
| <b>Total Wild Kelp:</b>       | <b>220</b>  |                  |           |                           |             |              |            |
| <b>Directed Food and Bait</b> |   |                  |           |                           |             |              |            |
| Southeast                     |   |                  |           |                           |             |              |            |
| Craig <sup>b</sup>            | 760   | 8,024            | 5,000     | 11%                       | 102         |              |            |
| Necker Bay                    |   |                  | 2,000     |                           |             |              |            |
| Hobart/Houghton               | 230   |                  | 2,000     |                           |             |              |            |
| Prince Wm. Sound <sup>c</sup> | 733   | 30,000           | 8,400     | 15%                       |             |              |            |
| Kodiak                        |   |                  |           |                           |             |              |            |
| Eastern Shelikof <sup>e</sup> | <i>The quota for this fishery will be established in August 1994.</i> |                  |           |                           |             |              |            |
| Other Kodiak <sup>f</sup>     | 455   |                  |           |                           |             |              |            |
| Dutch Harbor <sup>g</sup>     | 2,215   |                  |           | 20%                       | 298         | Moderate     | Decreasing |
| <b>Total Food and Bait:</b>   | <b>4,393</b>  |                  |           |                           |             |              |            |

<sup>a</sup> Pound exploitation rate computed assuming 100% mortality on impounded fish.

The Craig stock is exploited by both a pound fishery and a food/bait fishery. The combined exploitation rate is shown.

<sup>b</sup> Board of Fisheries regulations allocate 85% of the Craig harvest to the food/bait fishery and 15% to the pound fishery.

<sup>c</sup> Biomass and exploitation rate for all Prince Wm. Sd. fisheries. Each fishery allocation is specified by the Board of Fisheries.

<sup>d</sup> Biomass and exploitation rate for all Togiak fisheries. Board of Fisheries regulations allocate 175 tons of roe on kelp product.

<sup>e</sup> Biomass and exploitation rate for Kamishak herring. Shelikof fishery is allocated 10% of the quota for Kamishak herring

<sup>f</sup> The Kodiak food/bait harvest is constrained to 10% of the allowable sac roe harvest by Board of Fisheries regulations.

<sup>g</sup> The Dutch Harbor food/bait fishery harvests primarily Togiak herring and is constrained to 7% of the allowable Togiak harvest.

Table 7. 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 year class was spawned in 1984.  |
| escapement                  | Herring that survive the commercial fishery and return to spawn.  |
| natural mortality           | All mortality not accounted for by commercial catches.  |
| recruits                    | A young age class of fish during the first year in which they appear on the spawning grounds in substantial numbers, usually as 3- or 4-year-olds.  |
| short ton                   | The 2,000-pound unit commonly used to record herring catches.   |
| spawning biomass            | The weight of the spawning herring stock.   |
| spawning population         | The number of fish in the spawning herring stock.   |
| spawn-on-pound-kelp fishery | A fishery that harvests kelp suspended in floating enclosures upon which herring have deposited spawn; herring are captured by purse seines, transferred to the enclosures and held until spawning occurs. Herring are released from the enclosures after spawning. |
| spawn-on-wild-kelp fishery  | A fishery that harvests naturally occurring kelp on which herring eggs have been deposited.   |
| year class                  | Same definition as cohort.  |



Table 8. Summary of harvest policy and fishery regulations<sup>1</sup> for Alaska sac roe herring fisheries.

|        |              |                          | CFEC<br>Permit<br>Code | Ltd.<br>Entry | Super- <sup>2</sup><br>Exclu-<br>sive | Gillnet<br>Shakers<br>Allowed | Max.<br>Ves.<br>Len. | Net Specifications <sup>3</sup> |      |                   |                     | Threshold<br>(tons) |
|--------|--------------|--------------------------|------------------------|---------------|---------------------------------------|-------------------------------|----------------------|---------------------------------|------|-------------------|---------------------|---------------------|
| Region | Mgt.<br>Area | Fishery<br>Location/Gear |                        |               |                                       |                               |                      | Mesh Size<br>(inches)           |      | Maximum           |                     |                     |
|        |              |                          |                        |               |                                       |                               |                      | Min.                            | Max. | Depth<br>(meshes) | Length<br>(fathoms) |                     |
| I      | A            | Kah Shakes               | G34A                   | Yes           | No                                    | Yes                           |                      | 2 1/4                           | 2 ½  | 120               | 50                  | 6,000               |
|        |              | Seymour Canal            | G34A                   | Yes           | No                                    | Yes                           |                      | 2 1/8                           | 2 ½  | 120               | 50                  | 3,000               |
|        |              | Sitka                    | G01A                   | Yes           | No                                    |                               |                      |                                 |      | 1,700             | 200                 | 7,500               |
|        |              | Lynn Canal               | G01A                   | Yes           | No                                    |                               |                      |                                 |      | 1,700             | 200                 | 5,000               |
| II     | E            | Prince Wm. Sound         |                        |               |                                       |                               |                      |                                 |      |                   |                     | 22,000              |
|        |              | Purse Seine              | G01E                   | Yes           | No                                    |                               |                      |                                 |      | 1,000             | 150                 |                     |
|        |              | Gill Net                 | G34E                   | Yes           | No                                    | Yes                           |                      | 2 1/8                           | 3    | 120               | 100                 |                     |
|        | H            | Upper Cook Inlet         | G34H                   | No            | No                                    | Yes                           |                      | 2 1/8                           | 2 ½  | Unspec.           | 105                 |                     |
|        |              | Lower Cook Inlet         | G01H                   | Yes           | No                                    |                               |                      |                                 |      | 1,025             | 150                 | 8,000               |
|        | T            | Togiak                   |                        |               |                                       |                               |                      |                                 |      |                   |                     | 35,000              |
| III    | W            | Purse Seine              | G01T                   | No            | No                                    |                               |                      |                                 |      | 16 fm             | 100                 |                     |
|        |              | Gill Net                 | G34T                   | No            | No                                    | Yes                           |                      | 2 1/8                           | 3 ½  | Unspec.           | 100/50              |                     |
|        |              | Security Cove            | G34S                   | No            | No                                    | Yes                           |                      | 2 1/8                           | 3 ½  | Unspec.           | 100/50              | 1,200               |
|        |              | Goodnews Bay             | G34W                   | No            | Yes                                   | Yes                           | 30'                  | 2 1/8                           | 3 ½  | Unspec.           | 100/50              | 1,200               |
|        |              | Cape Avinof              | G34V                   | No            | Yes                                   | No                            | 30'                  | 2 1/8                           | 3 ½  | Unspec.           | 100/50              | 500                 |
|        | Q            | Nelson Island            | G34N                   | Yes           | Yes                                   | No                            | 30'                  | 2 1/8                           | 3 ½  | Unspec.           | 100/50              | 3,000               |
|        |              | Nunivak Island           | G34U                   | Yes           | Yes                                   | No                            | 30'                  | 2 1/8                           | 3 ½  | Unspec.           | 100/50              | 1,500               |
|        |              | Cape Romanzof            | G34Y                   | Yes           | Yes                                   | No                            |                      | 2 1/8                           | 3 ½  | Unspec.           | 100/50              | 1,500               |
|        |              | Norton Sound             |                        |               |                                       |                               |                      |                                 |      |                   |                     | 7,000               |
|        |              | Beach Seine              | G02Z                   | Yes           | Yes                                   |                               |                      |                                 |      | 850               | 75                  |                     |
| IV     | K            | Gill Net                 | G34Z                   | Yes           | Yes                                   | Yes                           |                      | 2 ½                             | 3 ½  | Unspec.           | 100/50              |                     |
|        |              | Port Clarence            | G01X                   | No            | No                                    |                               |                      |                                 |      | 850               | 150                 |                     |
|        | L            | Kotzebue                 | G34X                   | No            | No                                    | Yes                           |                      | 2 ½                             | 3 ½  | Unspec.           | 100/50              |                     |
|        |              | Kodiak                   |                        |               |                                       |                               |                      |                                 |      |                   |                     |                     |
| IV     | K            | Purse Seine              | G01K                   | Yes           | No                                    |                               |                      |                                 |      | 1,025             | 100                 |                     |
|        |              | Gill Net                 | G34K                   | Yes           | No                                    | Yes                           |                      | 2 1/8                           | 2 ½  | Unspec.           | 150                 |                     |
|        | M            | Chignik                  | G01L                   | No            | No                                    |                               |                      |                                 |      | 1,000             | 100                 |                     |
|        |              | Alaska Peninsula         |                        |               |                                       |                               |                      |                                 |      |                   |                     |                     |
|        |              | Purse Seine              | G01M                   | No            | No                                    |                               |                      |                                 |      | 1,000             | 100                 |                     |
|        |              | Gill Net                 | G34M                   | No            | No                                    | Yes                           |                      | 2 1/8                           | 2 ½  | Unspec.           | 150                 |                     |

<sup>1</sup> This table is an attempt to summarize pertinent herring regulations and management plans. Regulations listed in the appropriate section of the herring regulation book, Alaska Administrative Code, or management plan should be consulted for details.

<sup>2</sup> Superexclusive use restrictions preclude permit holders, crew or vessels which have participated in any other herring fisheries from participating in fisheries that are designated as superexclusive. Superexclusive fishery participants and vessels may not fish in any other herring fisheries. The Nelson and Nunivak Island Districts are a combined superexclusive use area. Although Goodnews Bay is a superexclusive use area, participants and vessels used in the Goodnews Bay fishery may participate in the Security Cove fishery.

<sup>3</sup> Where more than one specification is listed, Board regulations allow net specifications to be reduced by emergency order when needed to more precisely control the harvest.

Table 9. Summary of Alaska harvest policy and fishery regulations for Alaska spawn-on-kelp and food/bait herring fisheries.

| Region  | Mgt. Area | Fishery                      | CFEC        | Limited Entry | Permit Application Deadline | Herring/ <sup>2</sup> Kelp Conversion Factor | Guideline Harvest Level (GHL) Specification | Threshold (tons) |
|---|-----------|------------------------------|-------------|---------------|-----------------------------|--|---|------------------|
|   |           |                              | Permit Code |               |                             |  |   |                  |
| I   | A         | Craig                        |             |               |                             |  |   | 5,000            |
|   |           | Pound Spawn-on-Kelp          | L21A        | No            | Jan. 31                     | 12.5   | 15% of Craig GHL                            |                  |
|   |           | Hoonah Sd. Pound Spawn-on-Ke | L21A        | No            | Jan. 31                     | 12.5   | 150 tons of herring                         | 1,000            |
| II  | E         | Prince William Sound         |             |               |                             |  |   | 22,000           |
|   |           | Wild Spawn-on-Kelp           | L12E        | No            |                             | 8  | 8% of PWS GHL                               |                  |
|   |           | Pound Spawn-on-Kelp          | L21E        | Yes           | March 1                     | 12.5   | 14.2% of PWS GHL                            |                  |
|   | T         | Togiak                       |             |               |                             |  |   | 35,000           |
|   |           | Wild Spawn-on-Kelp           | L12T        | Yes           |                             | 8.6  | 175 tons of kelp                            |                  |
| <sup>1</sup> This table is an attempt to summarize pertinent herring regulations. Regulations listed in the appropriate section of the herring regulation book or Alaska Administrative Code should be consulted for details.<br><br><sup>2</sup> Conversion from weight of herring product to equivalent weight of herring used to determine guideline harvest levels. |           |                              |             |               |                             |  |   |                  |

|   |           |                          | CFEC        |            | Super-     |              | Net Specifications |         |                |                | Guideline Harvest Level (GHL) Specification | Thres-hold (tons) |
|---|-----------|--------------------------|-------------|------------|------------|--------------|--------------------|---------|----------------|----------------|---|-------------------|
| Region  | Mgt. Area | Fishery Location/Gear    | Permit Code | Ltd. Entry | Exclu-sive | Season Dates | Mesh Size (inches) |         | Maximum        |                |   |                   |
|   |           |                          |             |            |            |              | Min.               | Max.    | Depth (meshes) | Length (fath.) |   |                   |
| I   | A         | Southeast                |             |            |            |              |                    |         |                |                |   |                   |
|   |           | Craig                    | H01A        | No         | No         | 10/1-2/28    |                    |         | 1,700          | 200            | 85% of Craig GHL                            | 5,000             |
|   |           | Tenakee Inlet            | H01A        | No         | No         | 10/1-2/28    |                    |         | 1,700          | 200            | Variable Rate                               | 3,000             |
|   |           | Lisianski Inlet          | H01A        | No         | No         | 10/1-2/28    |                    |         | 1,700          | 200            | Variable Rate                               | 2,500             |
|   |           | Port Houghton-Hobart Bav | H01A        | No         | No         | 10/1-2/28    |                    |         | 1,700          | 200            | Variable Rate                               | 2,000             |
|   |           | Fresh Bait Pound         | H21A        | No         | No         | 1/1-         |                    |         |                |                | 445 tons <sup>2</sup>                       |                   |
|   |           | Tray Pack Bait Pound     | H21A        | No         | No         | 7/1-3/31     |                    |         |                |                | 100 tons                                    |                   |
| II  | E         | Prince Wm. Sound         |             |            |            |              |                    |         |                |                | 16.3% of                                    | 22,000            |
|   |           | Purse Seine              | H01E        | No         | Vessel     | 9/1-1/31     |                    |         | Unspec.        | Unsp.          | PWS GHL                                     |                   |
|   |           | Gill Net                 | H34E        | No         | Vessel     | 9/1-1/31     | 2 1/8              | 3       | Unspec.        | 150            |   |                   |
| IV  | K         | Kodiak                   |             |            |            |              |                    |         |                |                | 10% of                                      |                   |
|   |           | Purse Seine              | H01K        | No         | No         | 8/1-2/28     |                    |         | 1,025          | 100            | sac roe                                     |                   |
|   |           | Gill Net                 | H34K        | No         | No         | 8/1-2/28     | 2 1/8              | 2 1/2   | Unspec.        | 150            | harvest                                     |                   |
|   |           |                          | Trawl       | H07K       | No         | No           | 8/1-2/28           |         |                |                |   |                   |
|   | L         | Chignik                  | H01L        | No         | No         | 8/15-2/28    |                    |         | 1,000          | 100            |   |                   |
|   |           |                          |             |            |            |              |                    |         |                |                |   |                   |
|   | M         | Dutch Harbor             |             |            |            | 7/16-2/28    |                    |         |                |                | 7% of                                       |                   |
| Purse Seine   |           | H01M                     | No          | No         |            |              |                    | Unspec. | 250            | Togiak         |   |                   |
|   |           | Gill Net                 | H34M        | No         | No         |              | 2 1/8              | 2 1/2   | Unspec.        | Unsp.          | Harvest                                     |                   |
| <sup>1</sup> This table is an attempt to summarize pertinent herring regulations. Regulations listed in the appropriate section of the herring regulation book or Alaska Administrative Code should be consulted for details. |           |                          |             |            |            |              |                    |         |                |                |   |                   |
| <sup>2</sup> Fresh Bait Pound Quotas are established by area: Farragut Bay (100 tons), Scow Bay (100 tons), Tee Harbor (60 tons), Indian Cove (60 tons), Section 13-B (100 tons) and Lisianski Inlet (25 tons).               |           |                          |             |            |            |              |                    |         |                |                |   |                   |

Table 10. Alaska herring fisheries, area management offices, and fishery managers to contact for additional information.

| Fishery                               | Office       | Manager Name                  | Telephone (907)      |                   |
|---------------------------------------|--------------|-------------------------------|----------------------|-------------------|
|                                       |              |                               | Voice                | Recorded Messages |
| <b>All Southeast Region Fisheries</b> | Juneau       | Doug Mecum                    | 465-4250             |                   |
| Kah Shakes Sac Roe                    | Ketchikan    | Philip Doherty                | 225-5195             | 225-6870          |
| Sitka Sound Sac Roe                   | Sitka        | Robert DeJong                 | 747-6688             | 747-5022          |
| Seymour Canal Sac Roe                 | Juneau       | Don Ingledue                  | 465-4250             | 586-3505          |
| Craig Spawn on Pound Kelp             | Ketchikan    | Philip Doherty                | 225-5195             | 225-6870          |
| Hoonah Sound Spawn on Kelp            | Sitka        | Robert DeJong                 | 747-6688             | 747-5022          |
| Southeast Food/Bait                   | Juneau       | Doug Mecum                    | 465-4250             | 586-3505          |
| <b>All Central Region Fisheries</b>   | Anchorage    | Dennis Haanpaa<br>James Brady | 344-0541<br>344-0541 |                   |
| Prince William Sound                  | Cordova      | Wayne Donaldson               | 424-3213             | 424-7535          |
| Lower Cook Inlet (Kamishak)           | Homer        | Wes Bucher                    | 235-8191             | 235-7307          |
| Upper Cook Inlet                      | Soldotna     | Paul Ruesch                   | 262-9368             | 262-9611          |
| Togiak (Bristol Bay)                  | Dillingham   | Tom Brookover                 | 842-5227             | 842-5226          |
| <b>All AYK Region Fisheries</b>       | Anchorage    | Richard Cannon                | 267-2128             |                   |
| Kuskokwim Area Fisheries              | Bethel       | Kim Francisco                 | 543-2433             | 543-2598          |
| Cape Romanzof                         | Anchorage    | Dan Bergstrom                 | 267-2128             |                   |
| Norton Sound                          | Nome         | Charles Lean                  | 443-5167             |                   |
| Port Clarence                         | Nome         | Charles Lean                  | 443-5167             |                   |
| <b>All Westward Region Fisheries</b>  | Kodiak       | Pete Probasco                 | 486-4791             |                   |
| Kodiak Area Fisheries                 | Kodiak       | Dave Prokopowich              | 486-4791             | 486-4559          |
| Chignik                               | Kodiak       |                               | 486-4791             |                   |
| Dutch Harbor Food/Bait                | Dutch Harbor | Mike Ward                     | 581-1239             | 581-2122          |
| Port Moller (North Peninsula)         | Kodiak       | Jim McCullough                | 486-4791             |                   |
| South Peninsula                       | Kodiak       | Jim McCullough                | 486-4791             |                   |

Table 11. Herring spawning threshold levels for major herring stocks in Southeast Alaska and Yakutat.

| Area and Type of Fishery                                    | Threshold<br>(tons) |
|---|---------------------|
| Hoonah Sound (pound)  | 1,000               |
| Yakutat Bay (winter bait)                                   | 1,000               |
| Deer Island (winter bait)                                   | 2,500               |
| Anita Bay (winter bait)                                     | 2,500               |
| Port Camden (winter bait)                                   | 2,500               |
| Lisianski Inlet (winter bait)                               | 2,500               |
| Seymour Canal (sac roe)                                     | 3,000               |
| Tenakee Inlet (winter bait)                                 | 3,000               |
| Tongass Narrows and George and Carroll Inlets (winter bait) | 3,500               |
| Craig/Meares Passage/Boca de Finas (winter bait and pound)  | 5,000               |
| Kah Shakes/Cat Island (sac roe)                             | 6,000               |
| Lynn Canal (sac roe)  | 5,000               |
| Sitka Sound (sac roe)                                       | 7,500               |

Table 12. Escapement of herring in 1993 and projection of spawning biomass for 1994 herring spawning at Craig, Revilla Channel, Sitka, and Seymour Canal in Southeast Alaska.

| Location                           | Age   | 1993 Escapement   |               |                      | 1994 Projection |           |                      |               |                    |
|------------------------------------|-------|-------------------|---------------|----------------------|-----------------|-----------|----------------------|---------------|--------------------|
|                                    |       | Biomass<br>(tons) | Weight<br>(g) | Number<br>(millions) | Proportion      |           | Number<br>(millions) | Weight<br>(g) | Biomass<br>(tons)  |
|                                    |       |                   |               |                      | Mature          | Surviving |                      |               |                    |
| Craig                              | 3     | 647               | 58            | 10.1                 | 0.21            | 70%       | 9.1                  | 60            | 566                |
|                                    | 4     | 1,080             | 71            | 14.1                 | 0.99            | 70%       | 34.1                 | 78            | 2,921              |
|                                    | 5     | 2,845             | 91            | 28.1                 | 1.00            | 70%       | 10.1                 | 94            | 1,007              |
|                                    | 6     | 930               | 115           | 7.1                  | 1.00            | 70%       | 20.1                 | 119           | 2,599              |
|                                    | 7     | 998               | 121           | 7.1                  | 1.00            | 70%       | 5.1                  | 125           | 705                |
|                                    | 8+    | 1,523             | 134           | 10.1                 | 1.00            | 70%       | 5.1                  | 137           | 792                |
|                                    | Total | 8,023             |               | 77.1                 |                 |           | 83.1                 |               | 8,024 <sup>a</sup> |
| Revilla<br>Channel<br>(Cat Island) | 3     | 1,524             | 70            | 20.1                 | 0.50            | 69%       | 16.1                 | 76            | 1,334              |
|                                    | 4     | 2,250             | 84            | 24.1                 | 0.90            | 69%       | 25.1                 | 95            | 2,584              |
|                                    | 5     | 2,748             | 95            | 26.1                 | 0.99            | 69%       | 19.1                 | 115           | 2,360              |
|                                    | 6     | 227               | 108           | 2.1                  | 1.00            | 69%       | 18.1                 | 136           | 2,756              |
|                                    | 7     | 70                | 144           | 0.1                  | 1.00            | 69%       | 1.1                  | 152           | 222                |
|                                    | 8+    | 113               | 140           | 1.1                  | 1.00            | 69%       | 0.1                  | 169           | 42                 |
|                                    | Total | 6,933             |               | 73.1                 |                 |           | 79.1                 |               | 9,299              |
| Sitka                              | 3     | 487               | 65            | 7.1                  | 0.19            | 53%       | 19.1                 | 59            | 1,211              |
|                                    | 4     | 610               | 81            | 7.1                  | 0.74            | 53%       | 14.1                 | 78            | 1,231              |
|                                    | 5     | 30,212            | 92            | 298.1                | 0.97            | 53%       | 5.1                  | 89            | 471                |
|                                    | 6     | 1,069             | 94            | 10.1                 | 1.00            | 53%       | 163.1                | 120           | 21,536             |
|                                    | 7     | 0                 | 107           | 0.1                  | 1.00            | 53%       | 5.1                  | 134           | 811                |
|                                    | 8+    | 2,925             | 129           | 21.1                 | 1.00            | 53%       | 11.1                 | 150           | 1,807              |
|                                    | Total | 35,303            |               | 343.1                |                 |           | 217.1                |               | 27,066             |
| Seymour<br>Canal                   | 3     | 48                | 50            | 1.1                  | 0.18            | 75%       | 2.1                  | 59            | 129                |
|                                    | 4     | 610               | 74            | 7.1                  | 0.44            | 75%       | 2.1                  | 73            | 124                |
|                                    | 5     | 1,687             | 91            | 17.1                 | 0.72            | 75%       | 9.1                  | 90            | 922                |
|                                    | 6     | 198               | 104           | 2.1                  | 0.90            | 75%       | 16.1                 | 105           | 1,822              |
|                                    | 7     | 166               | 110           | 1.1                  | 0.97            | 75%       | 1.1                  | 123           | 189                |
|                                    | 8+    | 297               | 143           | 2.1                  | 0.99            | 75%       | 2.1                  | 135           | 367                |
|                                    | Total | 3,006             |               | 30.1                 |                 |           | 32.1                 |               | 3,552              |

<sup>a</sup> Age-3 biomass was excluded from total projection because of uncertainty about recruitment.

Table 13. Allocation of allowable harvest for Prince William Sound in 1994 under the “moderate” forecast scenario of a 29,786-ton run biomass.

| Fishery             | Allocation | Quota<br>(short tons)            |
|---------------------|------------|----------------------------------|
| Purse Seine         | 58.1%      | 2,615                            |
| Gillnet             | 3.4%       | 153                              |
| Spawn on Pound Kelp | 14.2%      | 639                              |
| Spawn on Wild Kelp  | 8.0%       | 360                              |
| Food/Bait           | 16.3%      | 733                              |
| Total               | 100.0%     | 4,500 = 15% of 29,786 short tons |

Table 14. Forecast of 1994 Kamishak Bay District herring abundance and projected harvest by age.

| Age   | 1994<br>Forecast<br>No. of fish<br>(x 1,000) | Proportion<br>by<br>Numbers | Predicted<br>Mean<br>Weight (g) | 1994<br>Forecast<br>Biomass<br>(tons) | Harvest<br>Rate | 1994<br>Total<br>Allowable<br>Harvest | Proportion<br>by<br>Weight |
|-------|--|-----------------------------|---------------------------------|---------------------------------------|-----------------|---------------------------------------|----------------------------|
| 3     | 13,768                                       | 0.11                        | 88                              | 1,336                                 | 0.15            | 200                                   | 0.05                       |
| 4     | 843  | 0.01                        | 129                             | 120                                   | 0.15            | 18                                    | 0.00                       |
| 5     | 5,570  | 0.05                        | 152                             | 933                                   | 0.15            | 140                                   | 0.04                       |
| 6     | 83,431                                       | 0.68                        | 193                             | 17,763                                | 0.15            | 2,664                                 | 0.70                       |
| 7     | 7,413  | 0.06                        | 230                             | 1,876                                 | 0.15            | 281                                   | 0.07                       |
| 8     | 2,160  | 0.02                        | 244                             | 582                                   | 0.15            | 87                                    | 0.02                       |
| 9     | 1,047  | 0.01                        | 259                             | 299                                   | 0.15            | 45                                    | 0.01                       |
| 10    | 3,867  | 0.03                        | 291                             | 1,239                                 | 0.15            | 186                                   | 0.05                       |
| 11+   | 3,390  | 0.03                        | 320                             | 1,197                                 | 0.15            | 180                                   | 0.05                       |
| Total | 121,488                                      |                             | 189                             | 25,344                                |                 | 3,802                                 |                            |

Table 15. Allocation of the projected 1994 Kamishak Bay herring harvest.

|                                   | Exploitation<br>Rate | Harvest<br>(tons) |
|-----------------------------------|----------------------|-------------------|
| Kamishak Bay Sac Roe Fishery      | 0.135                | 3,422             |
| Shelikof Strait Food/Bait Fishery | 0.015                | 380               |
| Total                             | 0.150                | 3,802             |



Table 16. Togiak District year class composition of the 1993 Pacific herring harvest, and aerial survey estimates of 1993 escapement and total run biomass and the 1994 projected biomass from ASA.

|                     |     |         |       |       |        |                |         |          |        |        | 1994 Togiak Forecast Herring Biomass |     |         |          |        |        |
|---------------------|-----|---------|-------|-------|--------|----------------|---------|----------|--------|--------|--------------------------------------|-----|---------|----------|--------|--------|
| 1993 Harvest (tons) |     |         |       |       |        | 1993 Total Run |         |          |        |        |                                      |     |         |          |        |        |
|                     |     | Sac Roe |       |       |        | 1993           | Number  |          |        | Number |                                      |     |         |          |        |        |
| Year                |     | Purse   | Gill  | Food/ |        | Escapement     | Biomass | of Fish  | % by   | % by   | Year                                 |     | Biomass | of Fish  | % by   | %by    |
| Class               | Age | Seine   | Net   | Bait  | Total  | (tons)         | (tons)  | (1,000s) | Weight | Number | Class                                | Age | (tons)  | (1,000s) | Weight | Number |
|                     |     |         |       |       |        |                |         |          |        |        |                                      |     |         |          |        |        |
| 1990                | 3   | 0       | 0     | 0     | 0      | 0              | 0       | 0        | 0.0%   | 0.0%   | 1991                                 | 3   | 0       | 0        | 0.0%   | 0.0%   |
| 1989                | 4   | 85      | 0     | 7     | 92     | 826            | 918     | 4,903    | 0.5%   | 1.0%   | 1990                                 | 4   | 3,594   | 22,960   | 2.5%   | 5.1%   |
| 1988                | 5   | 1,424   | 35    | 20    | 1,664  | 10,388         | 12,052  | 50,789   | 6.2%   | 10.2%  | 1989                                 | 5   | 2,973   | 14,500   | 2.1%   | 3.2%   |
| 1987                | 6   | 3,941   | 1,125 | 1,262 | 6,328  | 38,678         | 45,006  | 156,907  | 23.2%  | 31.6%  | 1988                                 | 6   | 35,580  | 143,330  | 25.0%  | 31.7%  |
| 1986                | 7   | 297     | 56    | 125   | 478    | 2,796          | 2,796   | 9,124    | 1.4%   | 1.8%   | 1987                                 | 7   | 57,726  | 182,850  | 40.5%  | 40.5%  |
| 1985                | 8   | 226     | 99    | 161   | 486    | 2,276          | 2,278   | 6,130    | 1.2%   | 1.2%   | 1986                                 | 8   | 1,919   | 5,210    | 1.3%   | 1.2%   |
| 1984                | 9   | 1,924   | 585   | 411   | 2,920  | 27,070         | 27,070  | 65,299   | 14.0%  | 13.2%  | 1985                                 | 9   | 1,205   | 2,920    | 0.8%   | 0.6%   |
| 1983                | 10  | 1,970   | 538   | 208   | 2,716  | 31,439         | 31,439  | 69,387   | 16.2%  | 14.0%  | 1984                                 | 10  | 10,036  | 22,910   | 7.0%   | 5.1%   |
| 1982                | 11  | 617     | 216   | 97    | 930    | 8,221          | 8,221   | 16,479   | 4.2%   | 3.3%   | 1983                                 | 11  | 7,242   | 15,470   | 5.1%   | 3.4%   |
| 1981                | 12  | 1,141   | 288   | 59    | 1,488  | 17,097         | 17,097  | 33,212   | 8.8%   | 6.7%   | 1982                                 | 12  | 864     | 1,740    | 0.6%   | 0.4%   |
| 1980                | 13  | 511     | 185   | 73    | 769    | 8,166          | 8,166   | 15,243   | 4.2%   | 3.1%   | 1981                                 | 13  | 5,231   | 10,030   | 3.7%   | 2.2%   |
| 1979                | 14  | 591     | 133   | 54    | 778    | 9,289          | 9,289   | 16,790   | 4.8%   | 3.4%   | 1980                                 | 14  | 923     | 1,670    | 0.6%   | 0.4%   |
| 1978                | 15  | 1,173   | 240   | 38    | 1,451  | 19,064         | 20,515  | 35,836   | 10.6%  | 7.2%   | 1979                                 | 15+ | 15,205  | 28,110   | 10.7%  | 6.2%   |
| 1977                | 16  | 347     | 67    | 0     | 414    | 6,079          | 6,493   | 11,291   | 3.3%   | 2.3%   |                                      |     |         |          |        |        |
| 1976                | 17  | 100     | 0     | 0     | 100    | 2,170          | 2,270   | 3,994    | 1.2%   | 0.8%   |                                      |     |         |          |        |        |
| 1975                | 18  | 15      | 0     | 0     | 15     | 0              | 237     | 530      | 0.1%   | 0.1%   |                                      |     |         |          |        |        |
|                     |     |         |       |       |        |                |         |          |        |        |                                      |     |         |          |        |        |
| Total               |     | 14,362  | 3,567 | 2,700 | 20,629 | 172,996        | 193,847 | 495,914  | 100.0% | 100.0% |                                      |     | 142,498 | 451,700  | 100.0% | 100.0% |

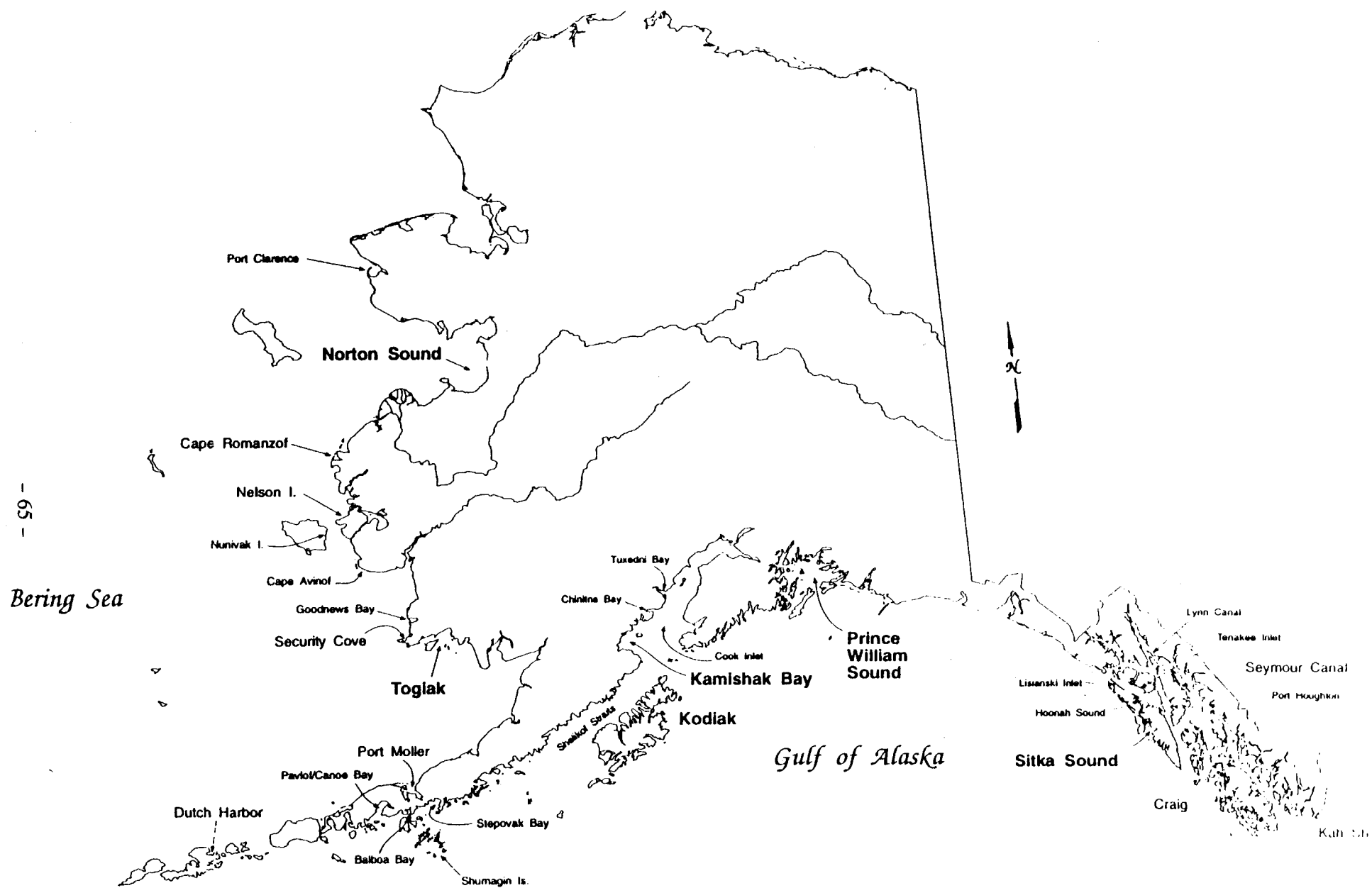


Figure 1. Locations of Alaska herring fisheries.

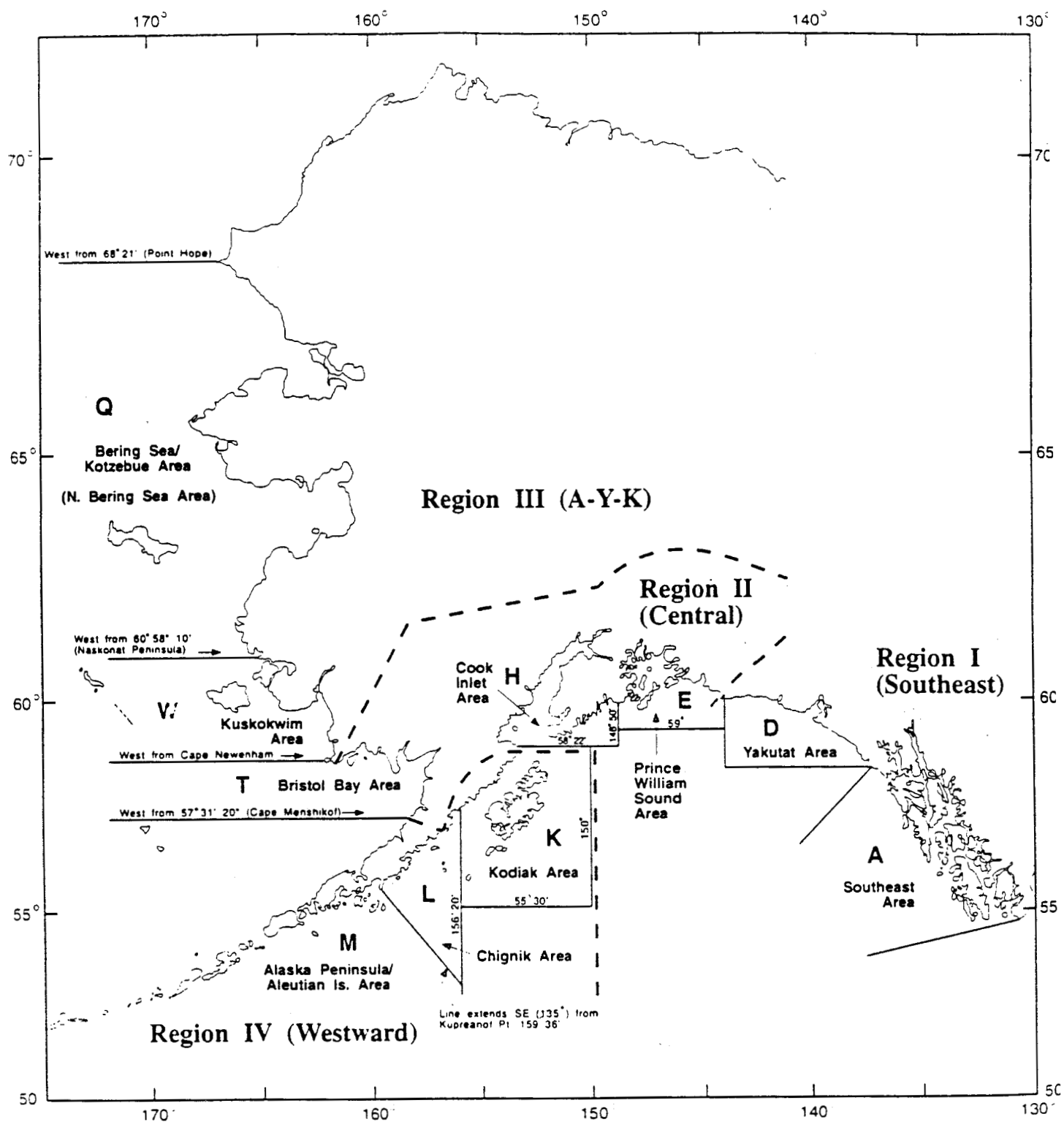


Figure 2. Alaska Department of Fish and Game management regions and herring regulatory statistical areas.

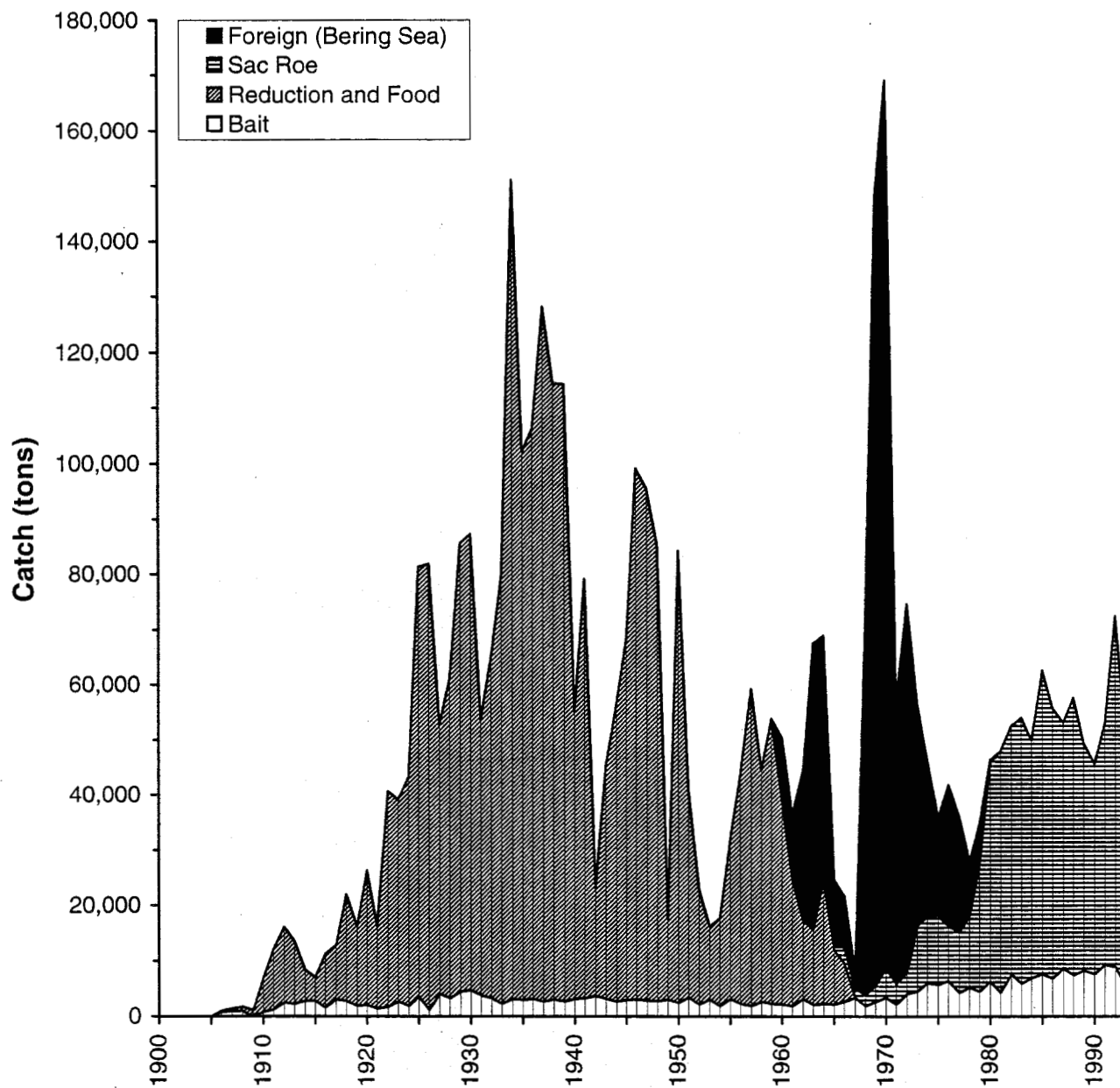


Figure 3. Herring harvests from all Alaska herring fisheries, 1900–1993.

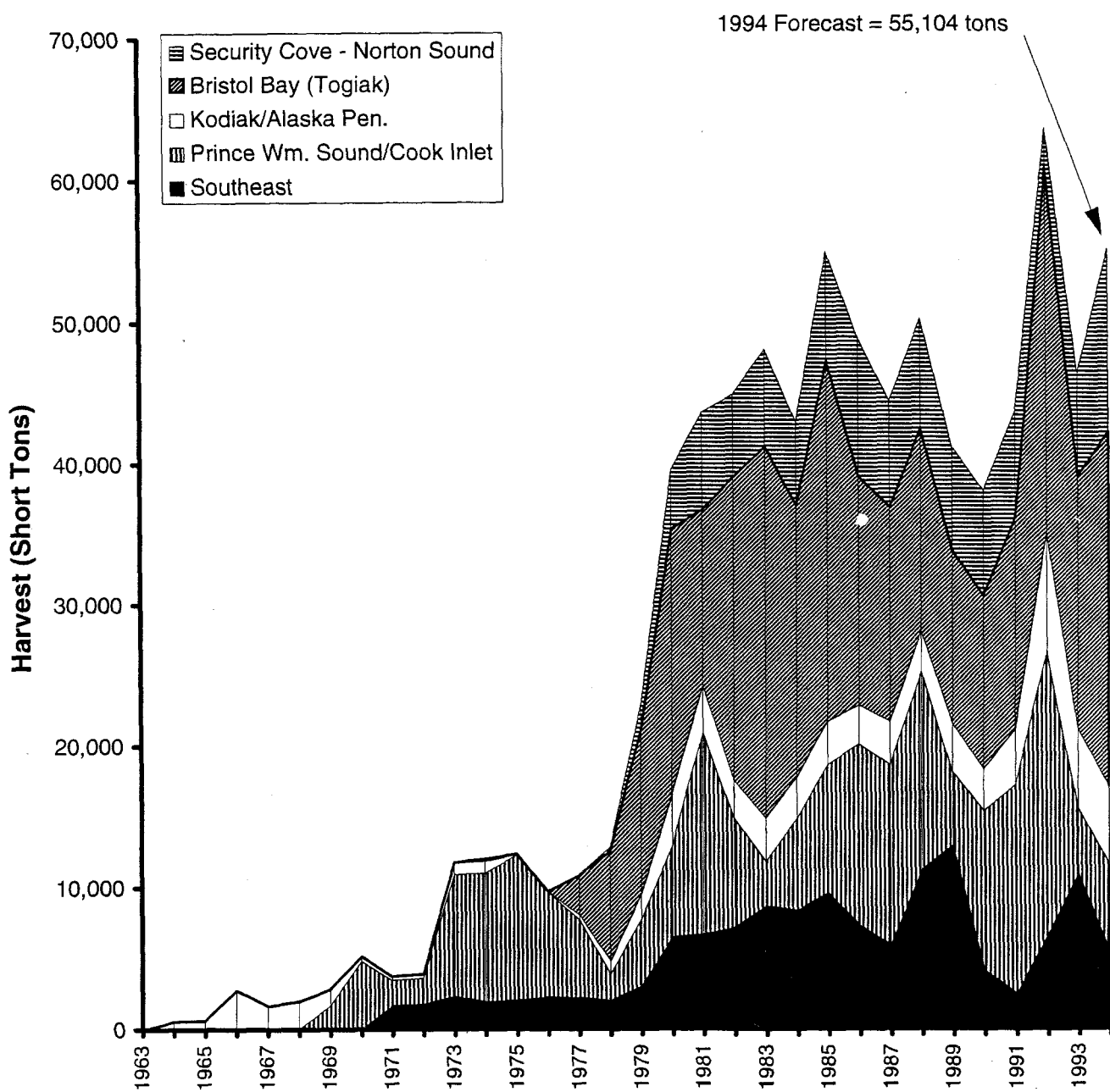


Figure 4. Alaska sac roe herring harvests from all areas, 1963–1993, with the projected 1994 sac roe harvest.

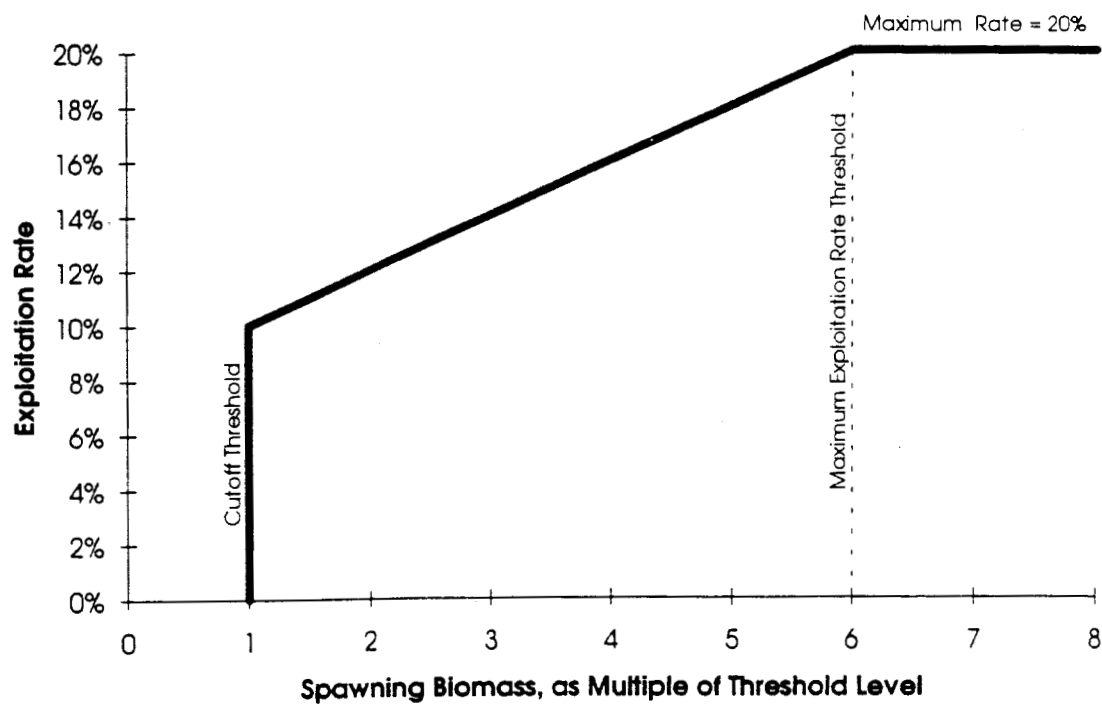


Figure 5. Harvest policy for Southeast Alaska herring fisheries showing the relationship between the allowable exploitation rate and the mature biomass, expressed as a multiple of the cutoff threshold level.

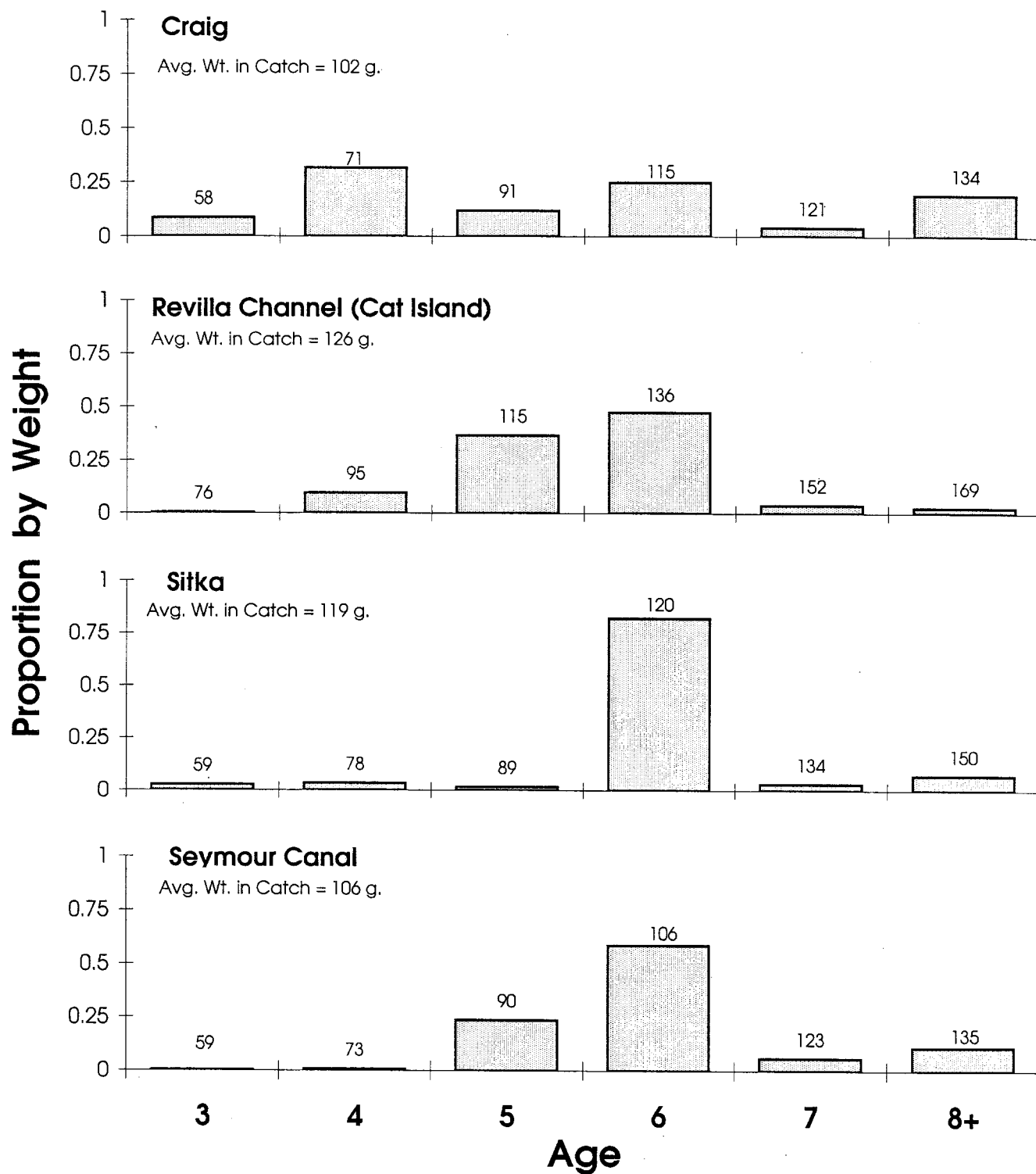


Figure 6. Forecast age composition of the commercial catch for 1994 Southeast Alaska herring fisheries. Numbers above each histogram bar are the forecast weight (g) for that age class.

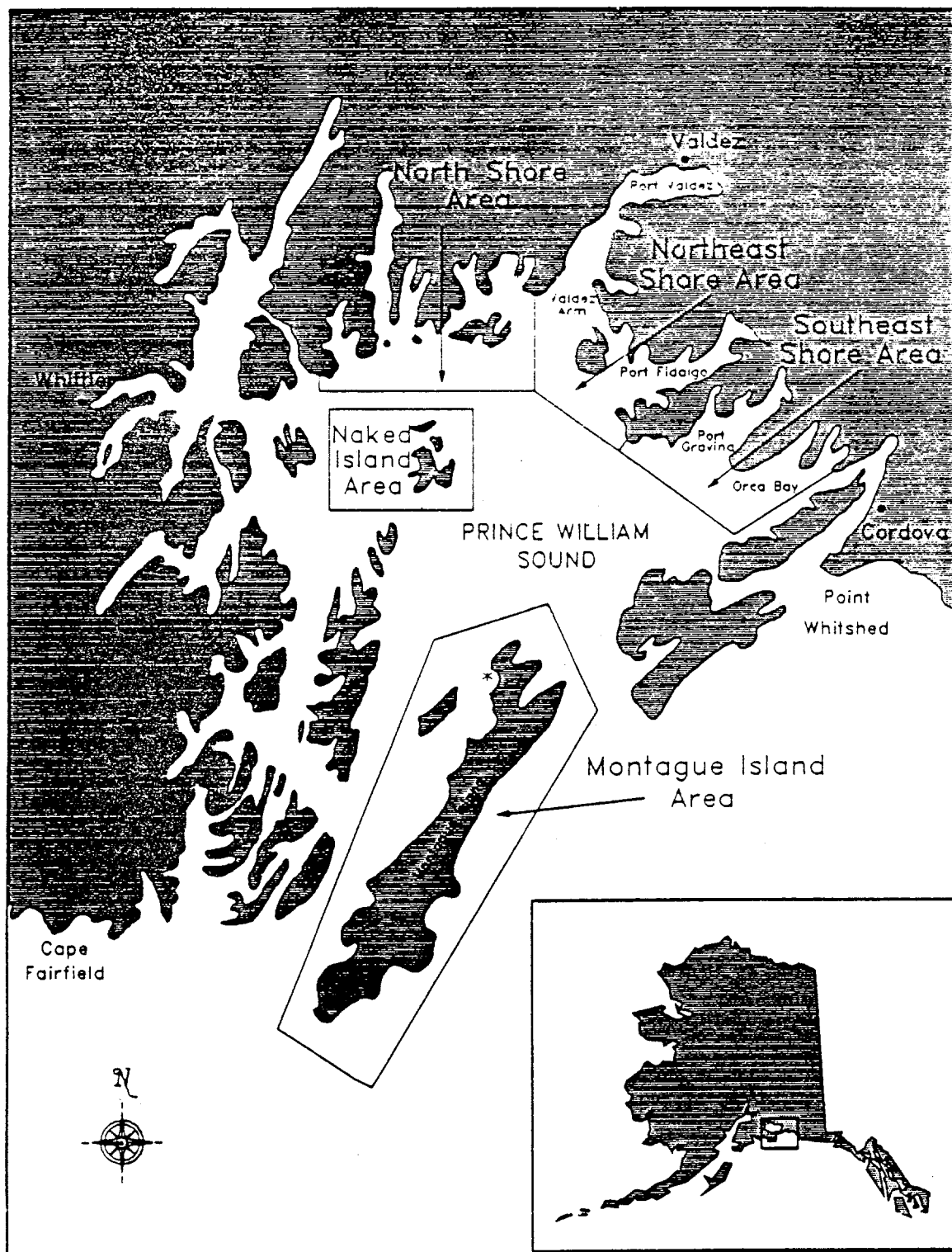


Figure 7. Map of Prince William Sound, Alaska, and the major herring spawning areas.



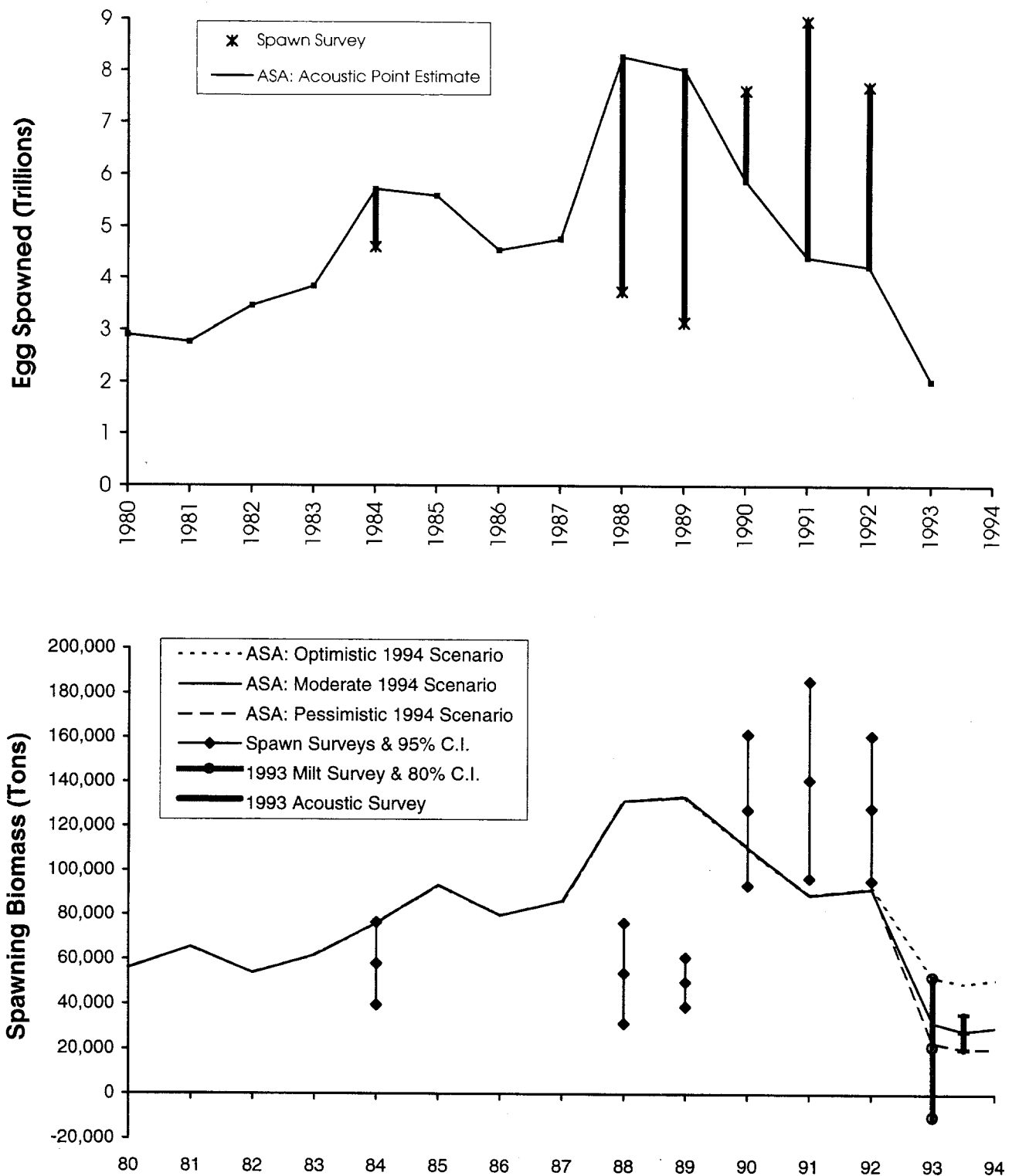


Figure 8. Eggs spawned from egg-deposition surveys and the ASA model (top) and spawning biomass estimated by the ASA model under three scenarios (bottom), showing the 1993 milt survey biomass and fall 1993 acoustic survey biomass.

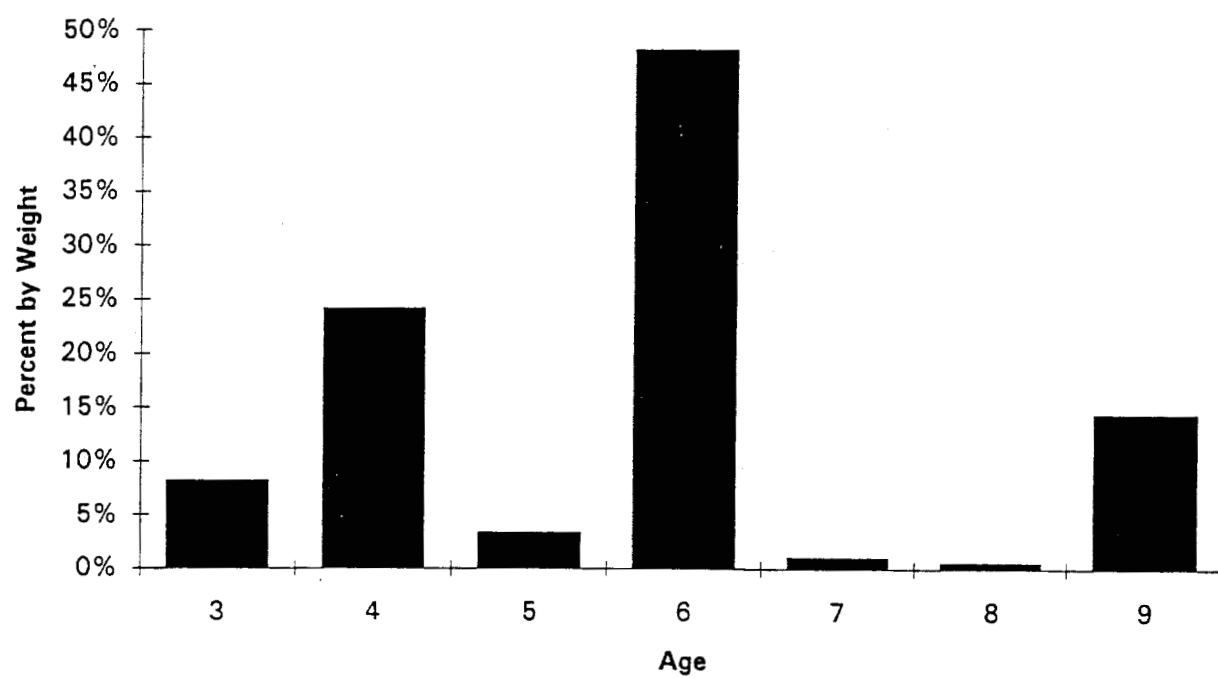


Figure 9. Predicted age composition for Prince William Sound spawning herring for the spring of 1994.

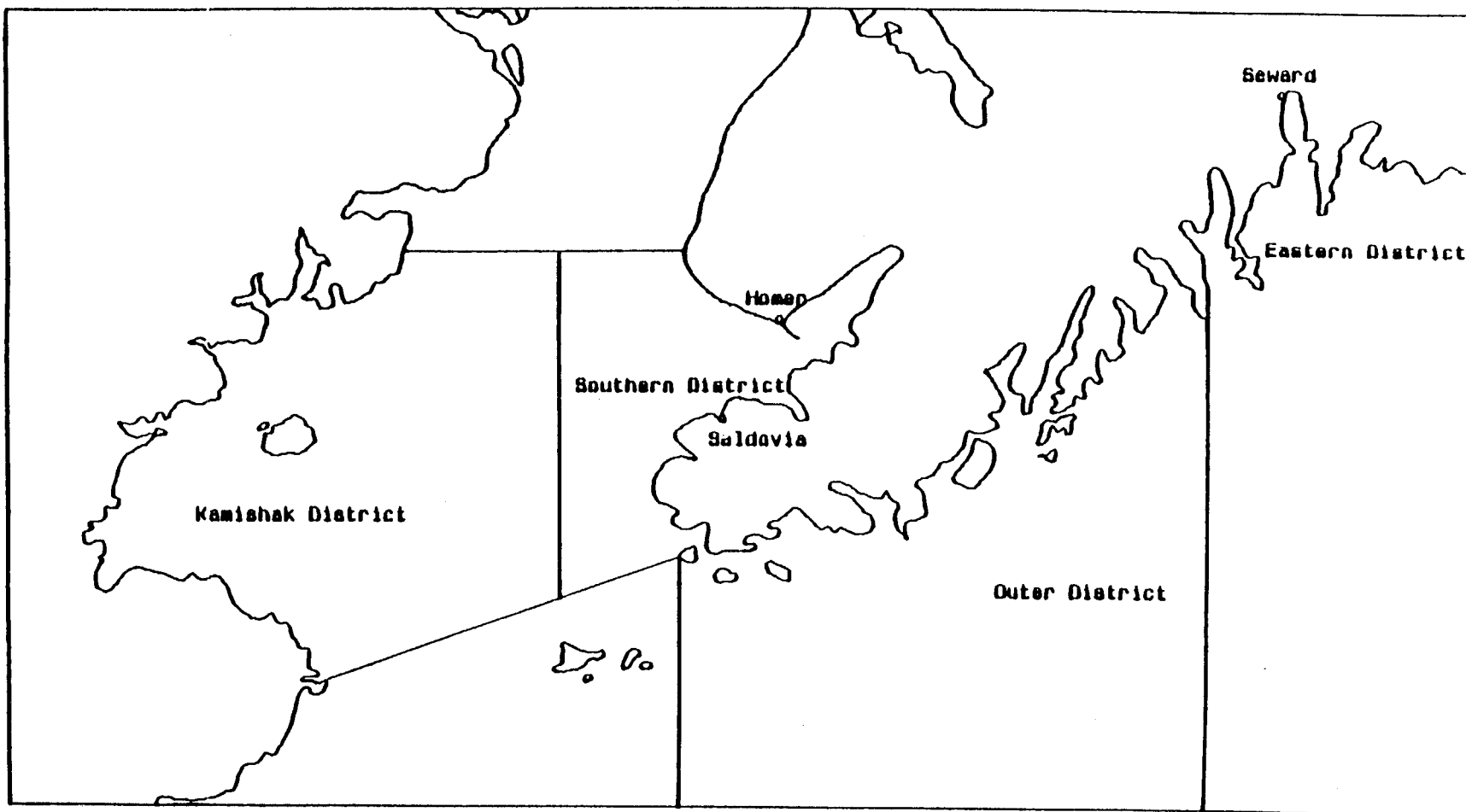


Figure 10. Kamishak Bay, Southern, Outer, and Eastern Districts of the Lower Cook Inlet Management Area.

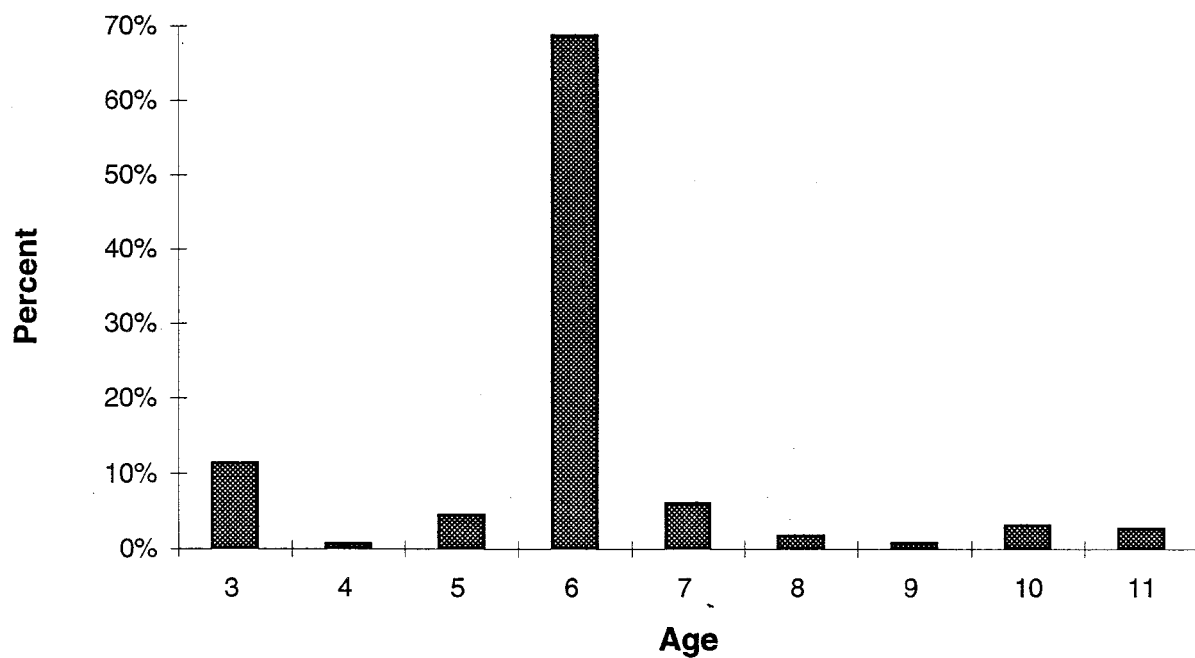
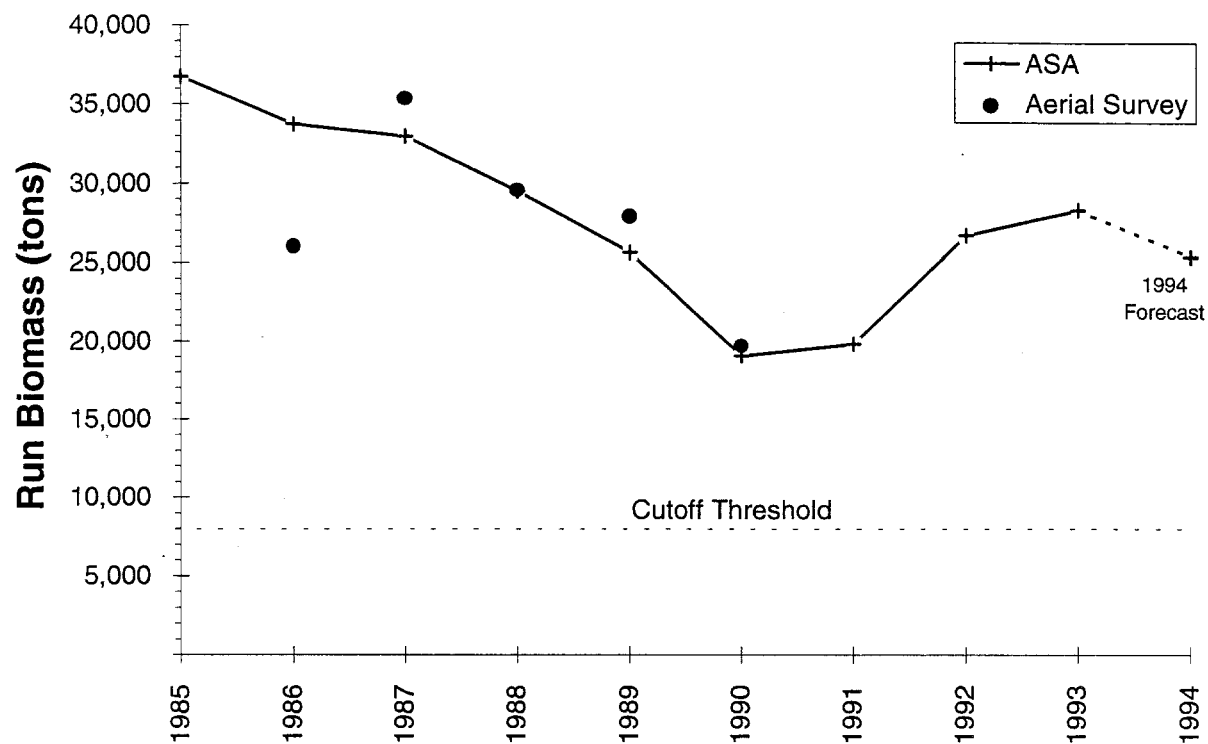


Figure 11. Kamishak Bay herring run biomass, 1985–1993, with 1994 forecast (top) and age distribution of forecast biomass (bottom).

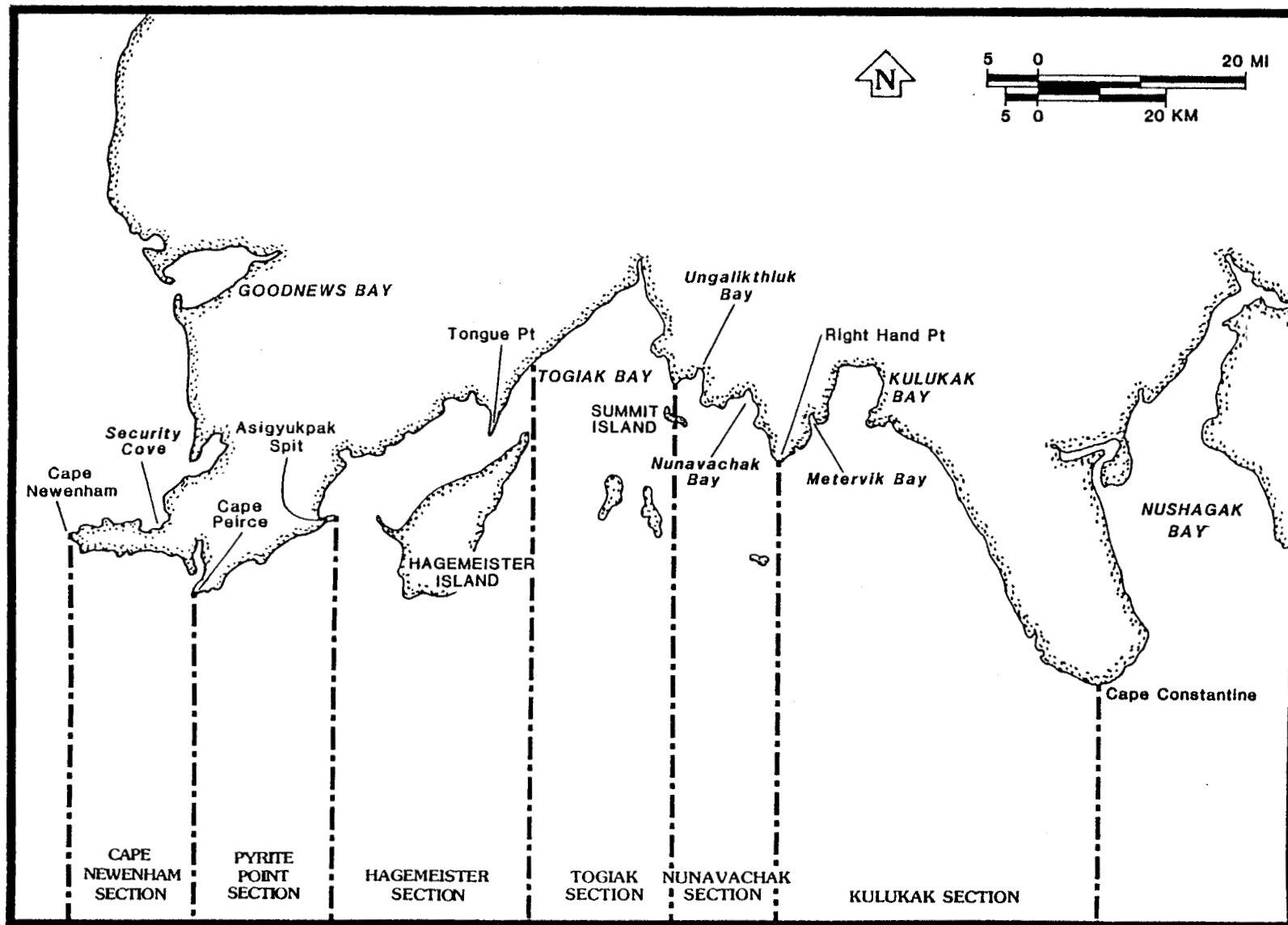


Figure 12. The Togiak fishing district of Bristol Bay, Alaska.

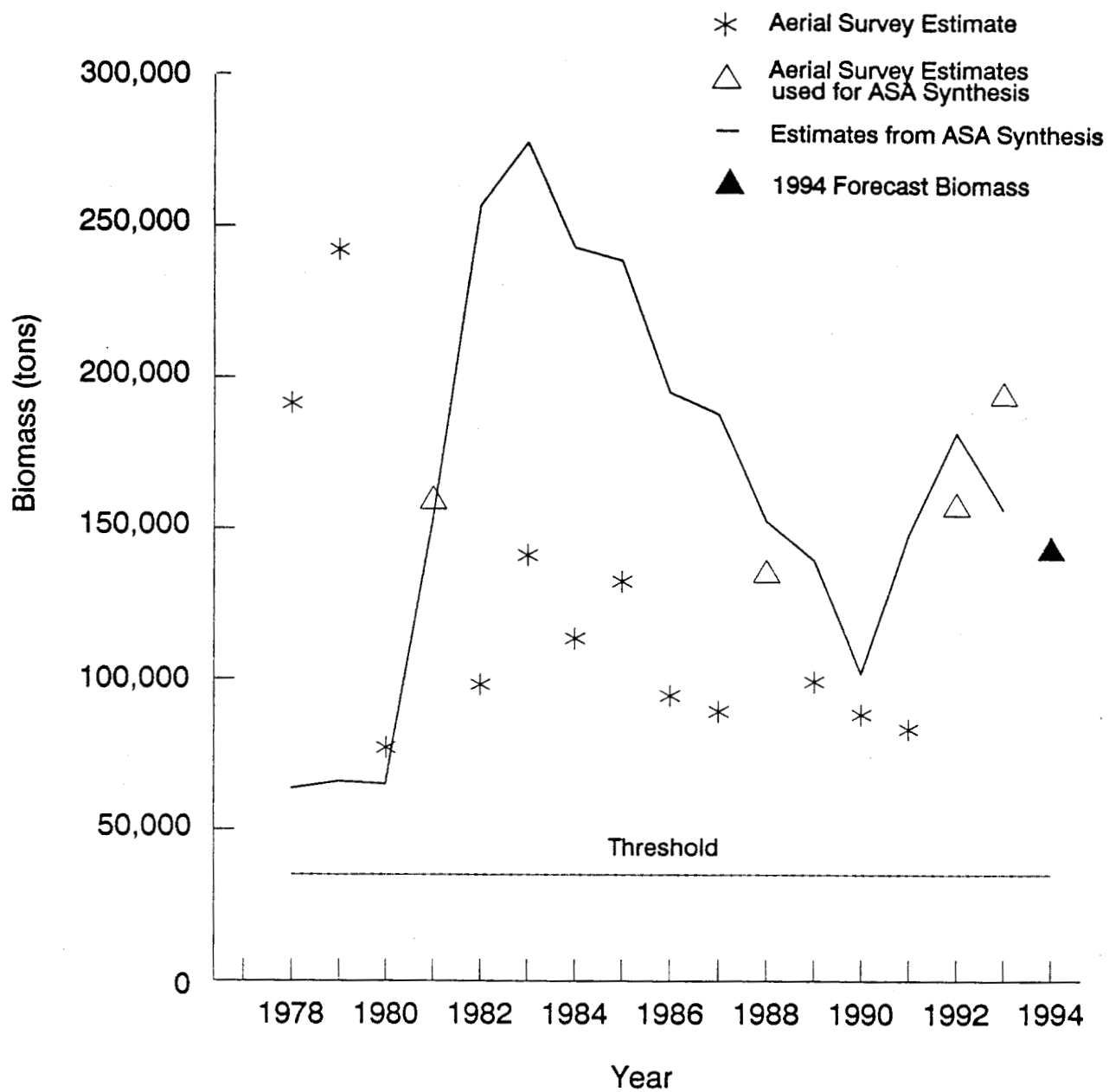


Figure 13. Biomass of Togiak District herring from aerial surveys and from the age-structured assessment (ASA) model.

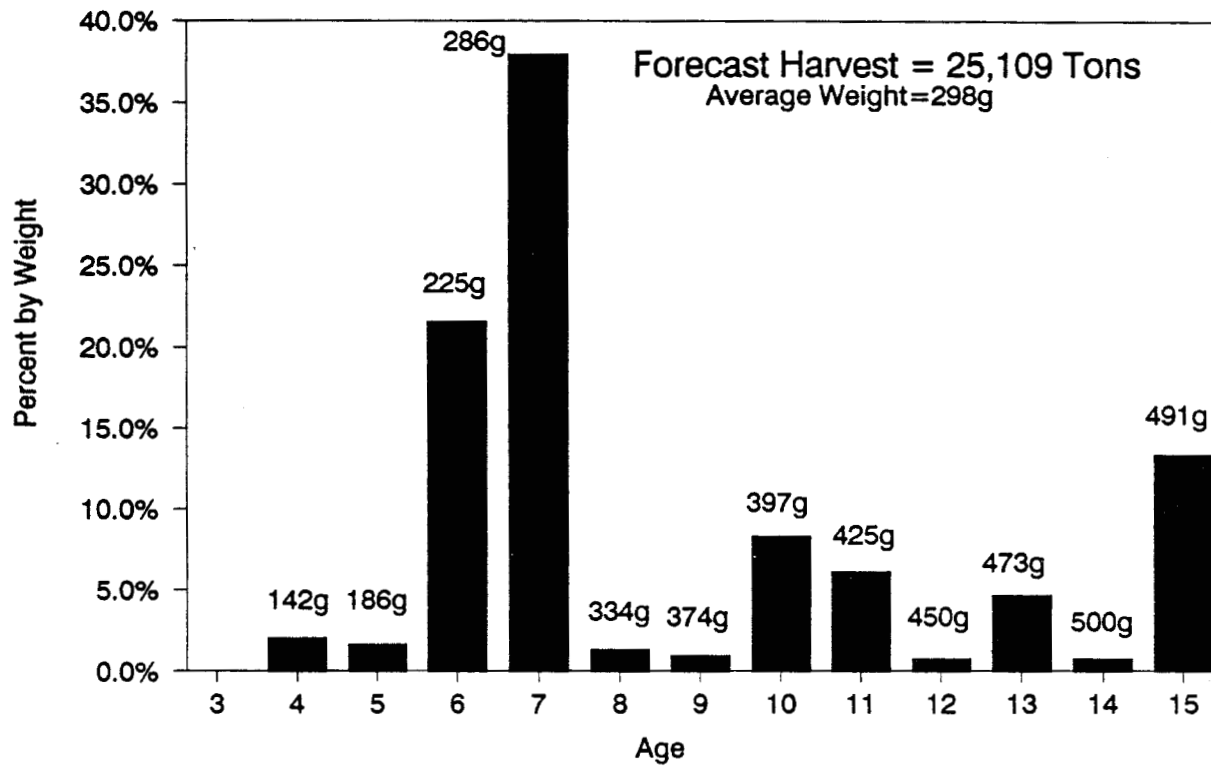


Figure 14. Forecast age distribution and weight at age of the commercial herring harvest for the Togiak District.

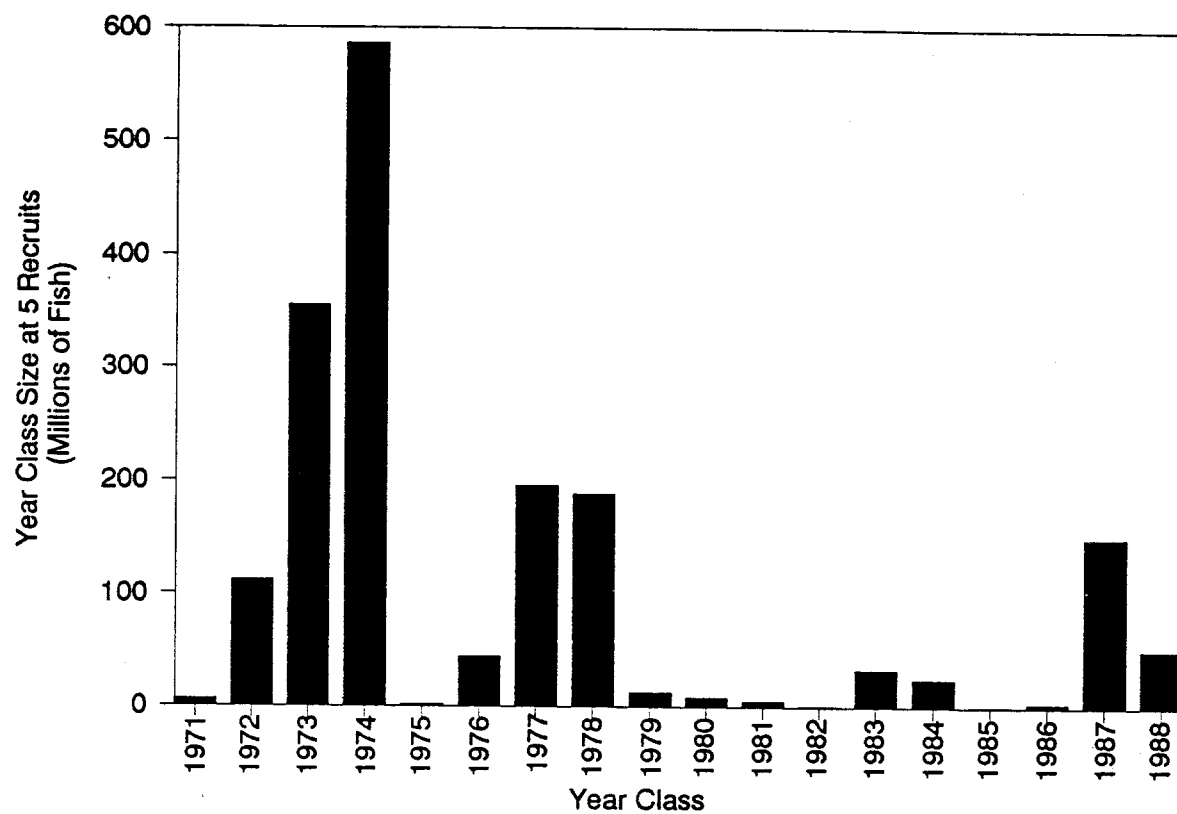


Figure 15. Year class strength of Togiak District herring in numbers of five-year-old recruits.



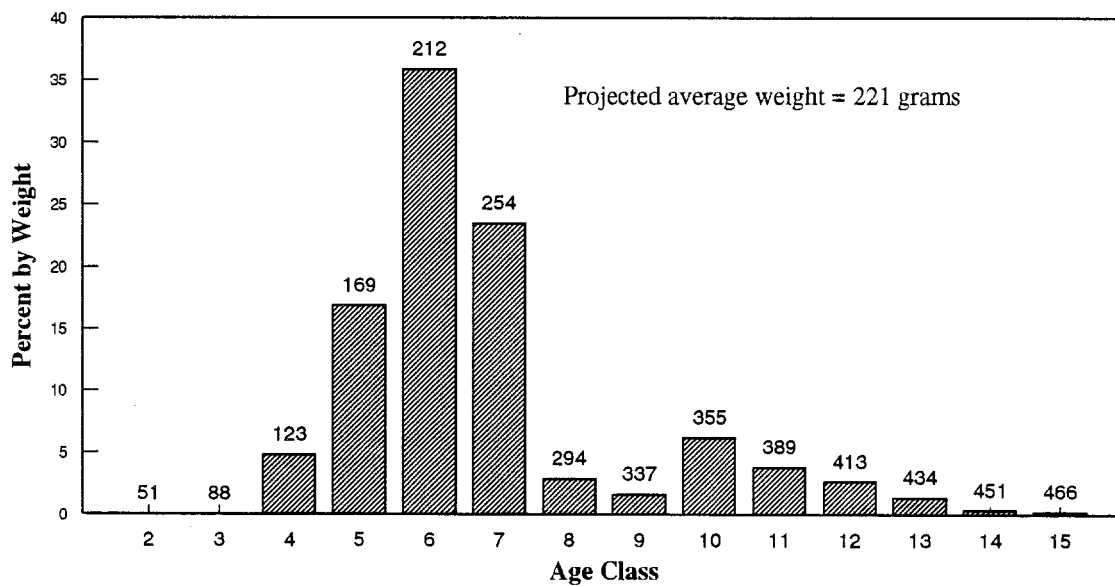
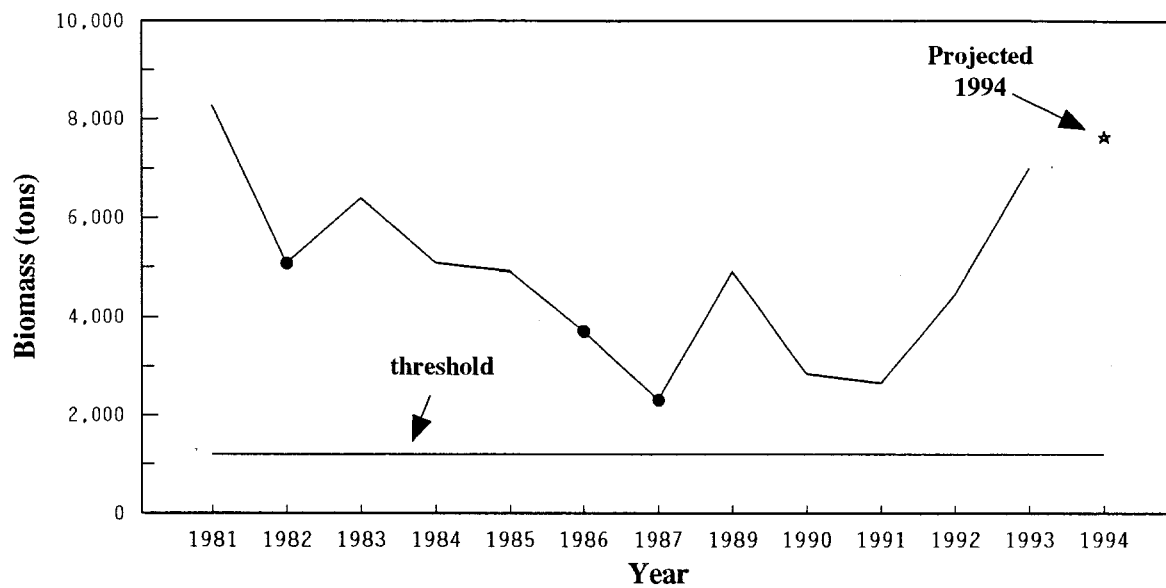


Figure 16. Security Cove District herring biomass, 1981–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age. In some years (●) it was not possible to obtain an aerial survey estimate of biomass; therefore, the preseason projection or some other method was used to estimate biomass.

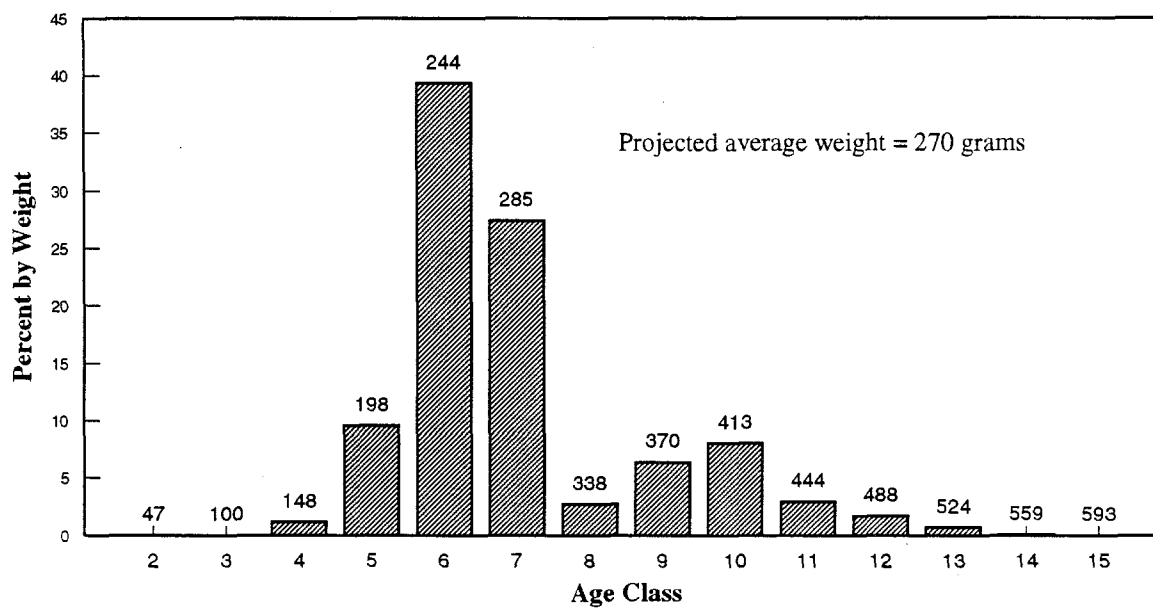
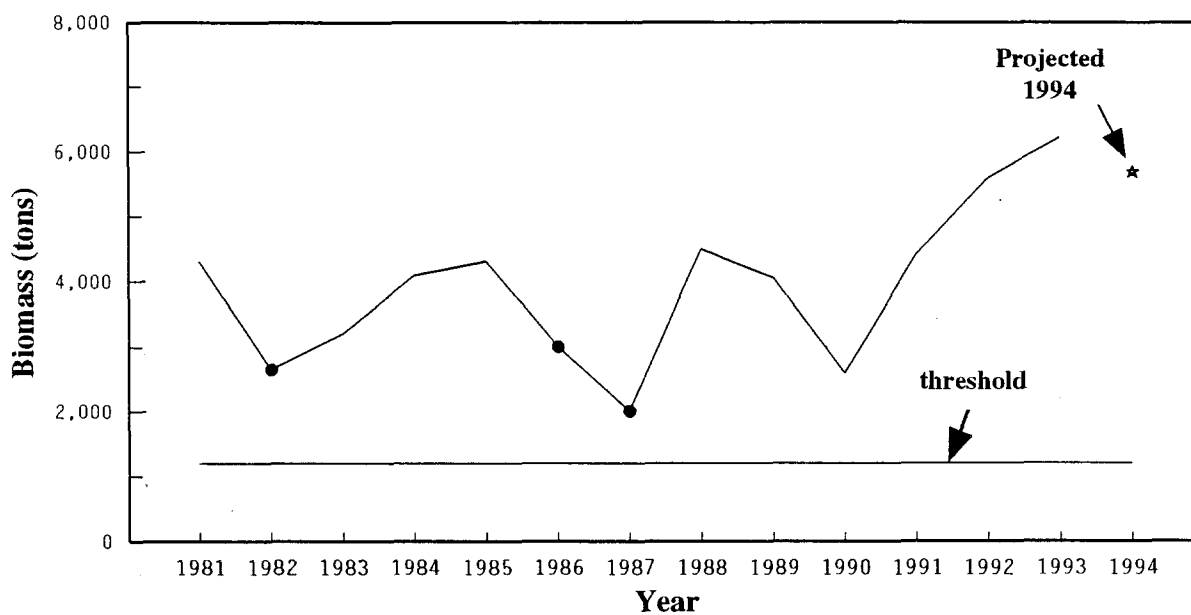


Figure 17. Goodnews Bay District herring biomass, 1981–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age. In some years (●) it was not possible to obtain an aerial survey estimate of biomass; therefore, the preseason projection or some other method was used to estimate biomass.

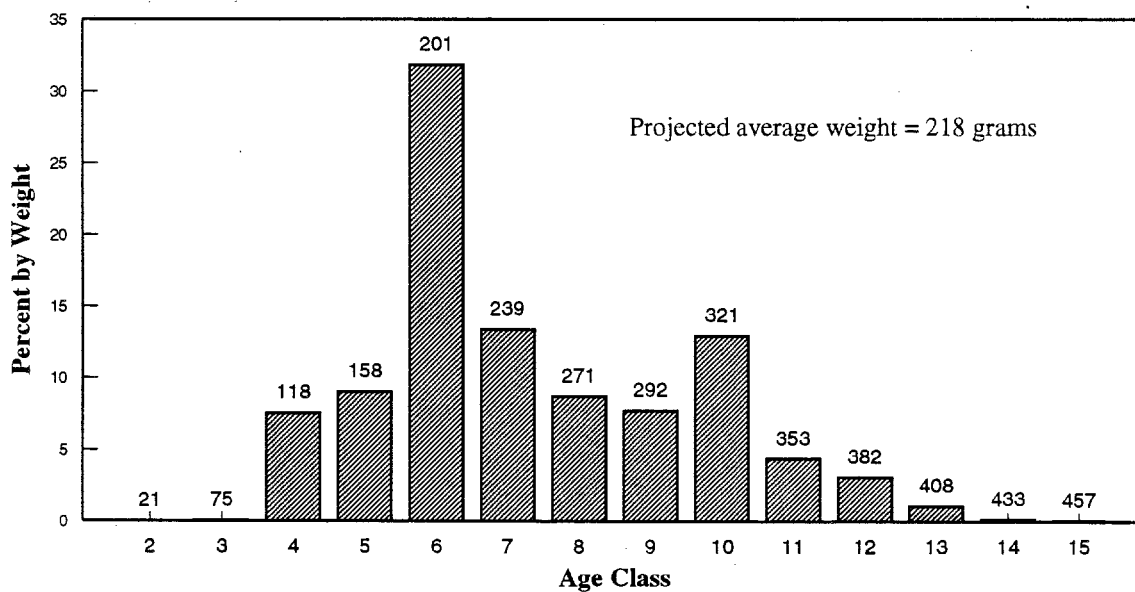
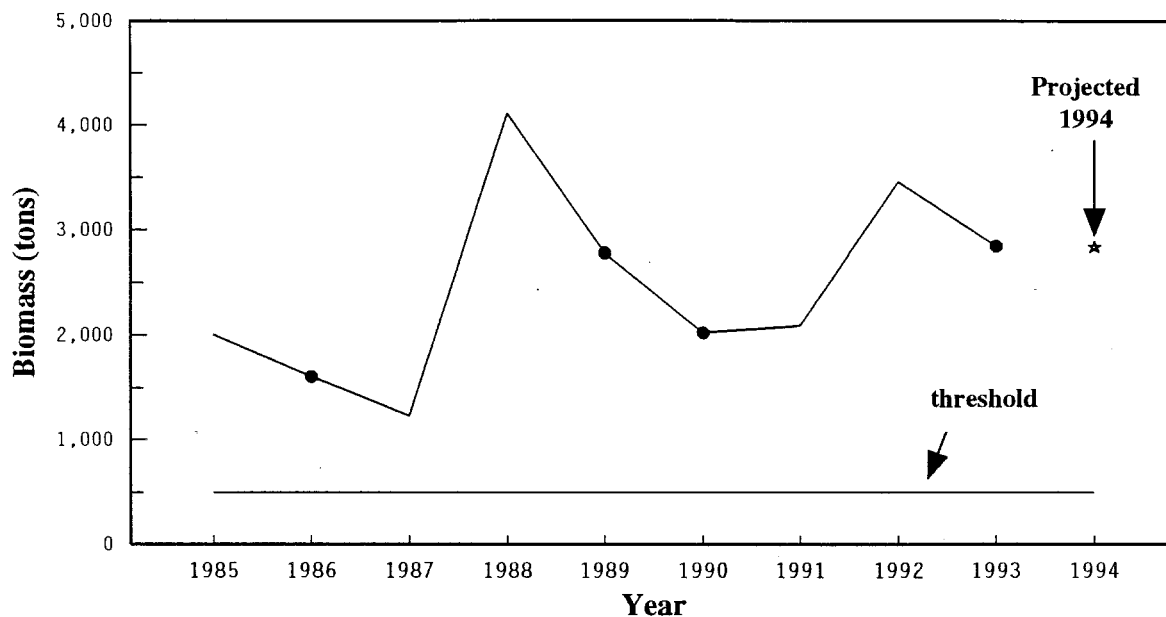


Figure 18. Cape Avinof District herring biomass, 1985–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age. In some years (●) it was not possible to obtain an aerial survey estimate of biomass; therefore, the preseason projection or some other method was used to estimate biomass.

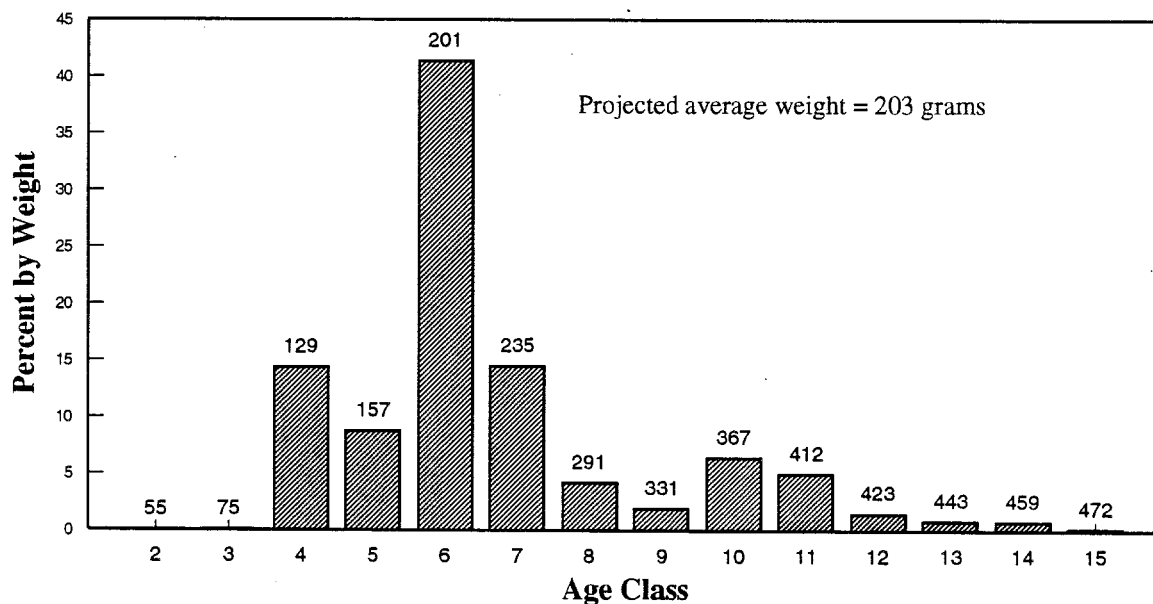
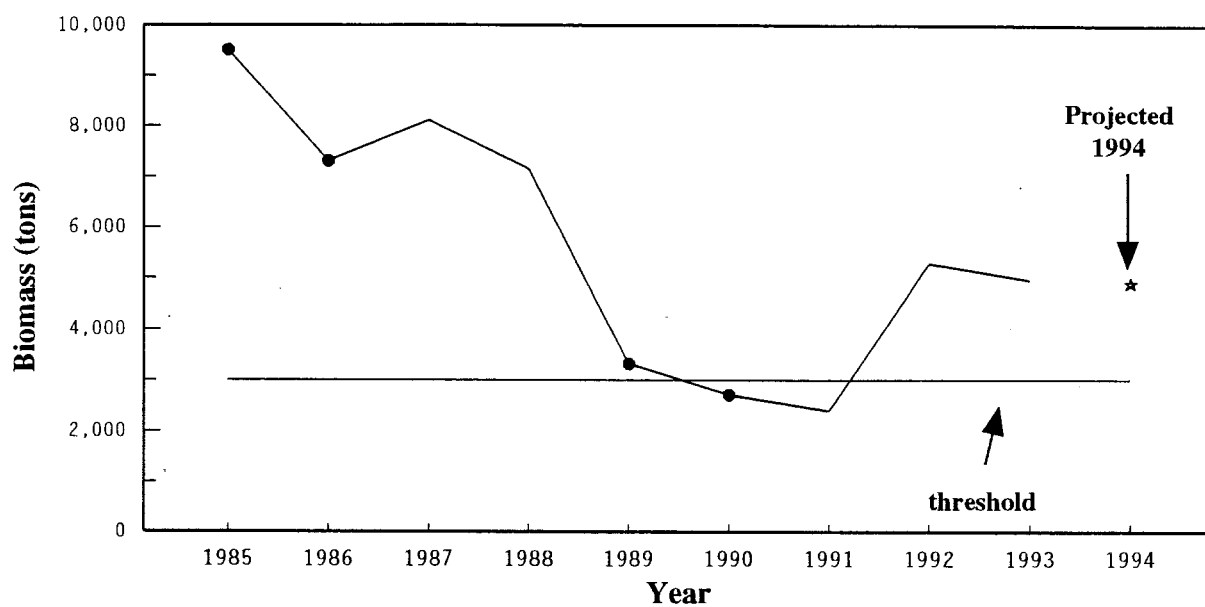


Figure 19. Nelson Island District herring biomass, 1985 -1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age. In some years (●) it was not possible to obtain an aerial survey estimate of biomass; therefore, the preseason projection or some other method was used to estimate biomass.

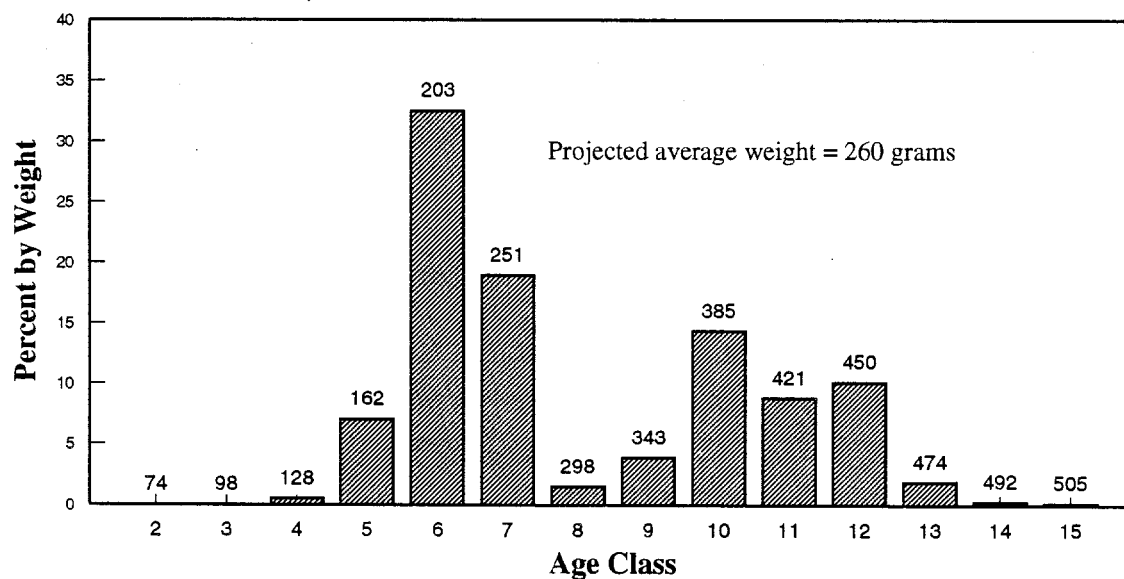
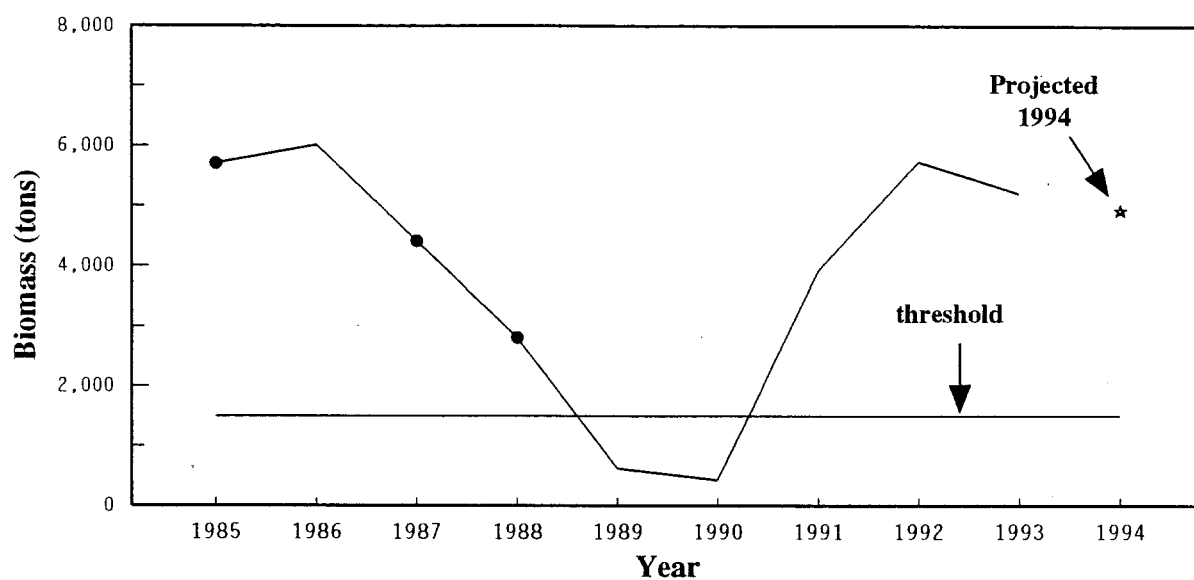


Figure 20. Nunivak Island District herring biomass, 1985–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age. In some years (●) it was not possible to obtain an aerial survey estimate of biomass; therefore, the preseason projection or some other method was used to estimate biomass.

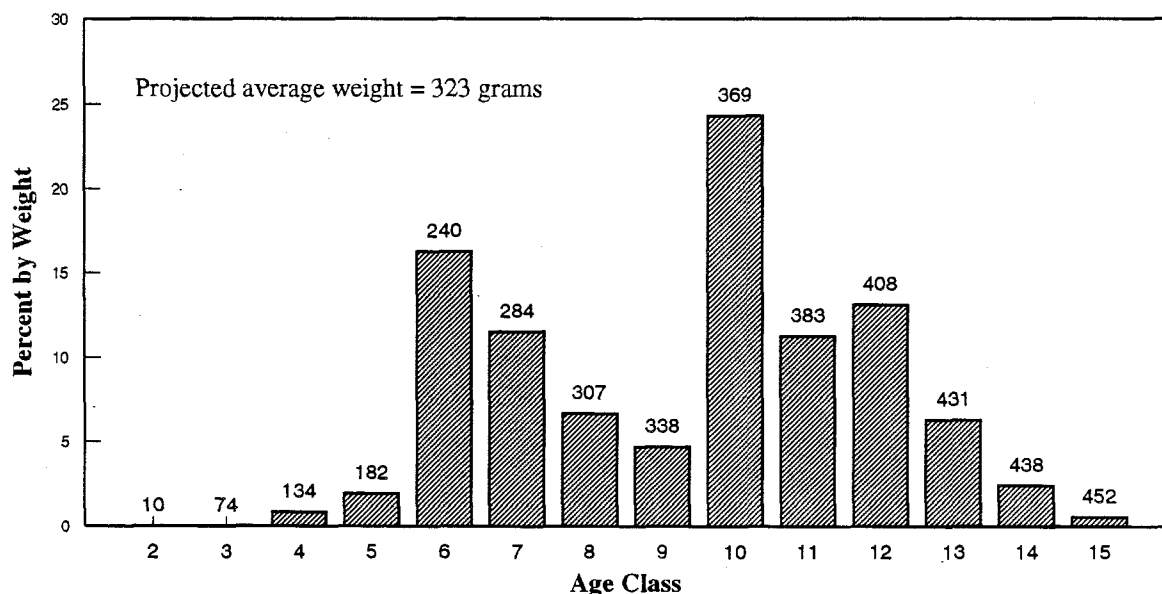
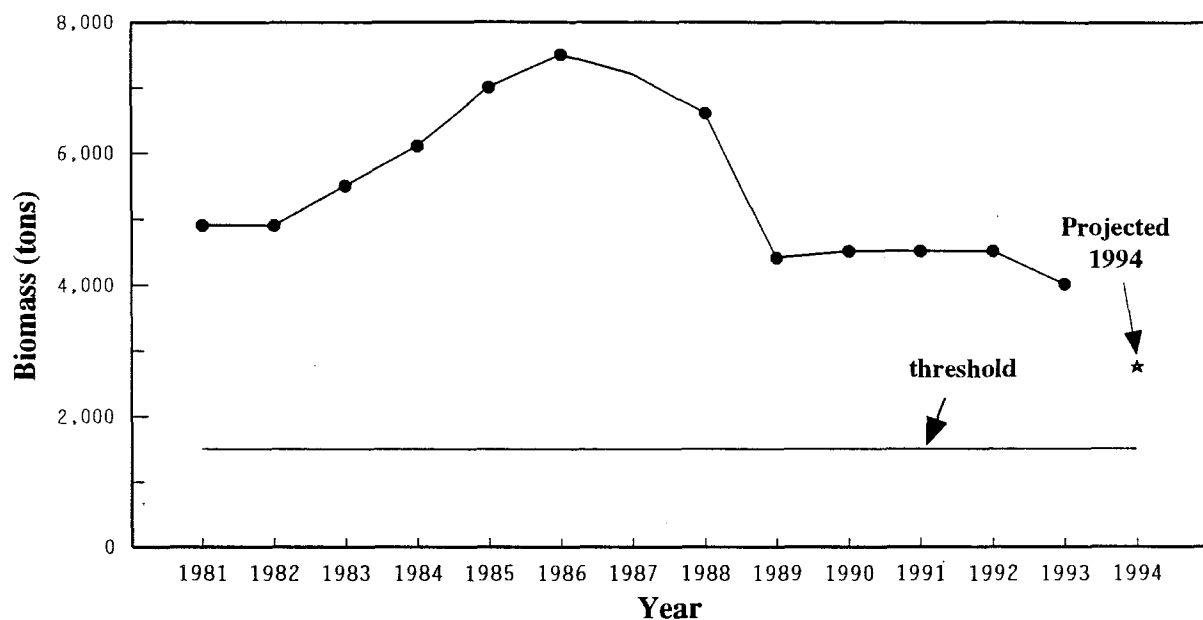


Figure 21. Cape Romanzof District herring biomass, 1981–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age. In all years (●), except 1987, it was not possible to obtain an aerial survey estimate of biomass; therefore, the preseason projection or some other method was used to estimate biomass. Only the Scammon Bay portion of the Cape Romanzof District was surveyed in 1987.

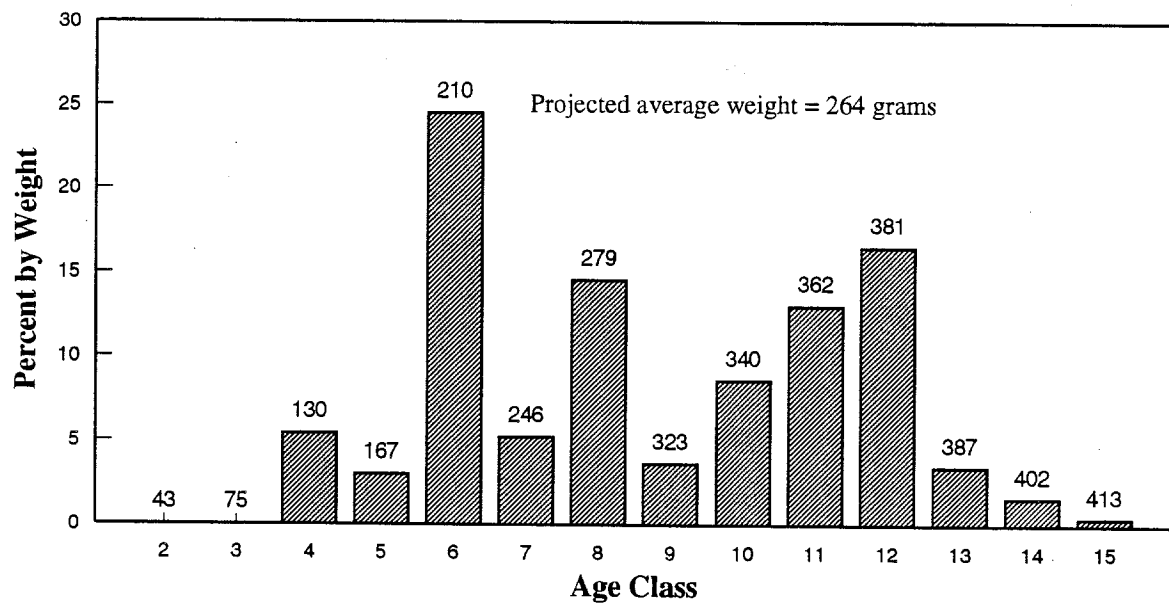
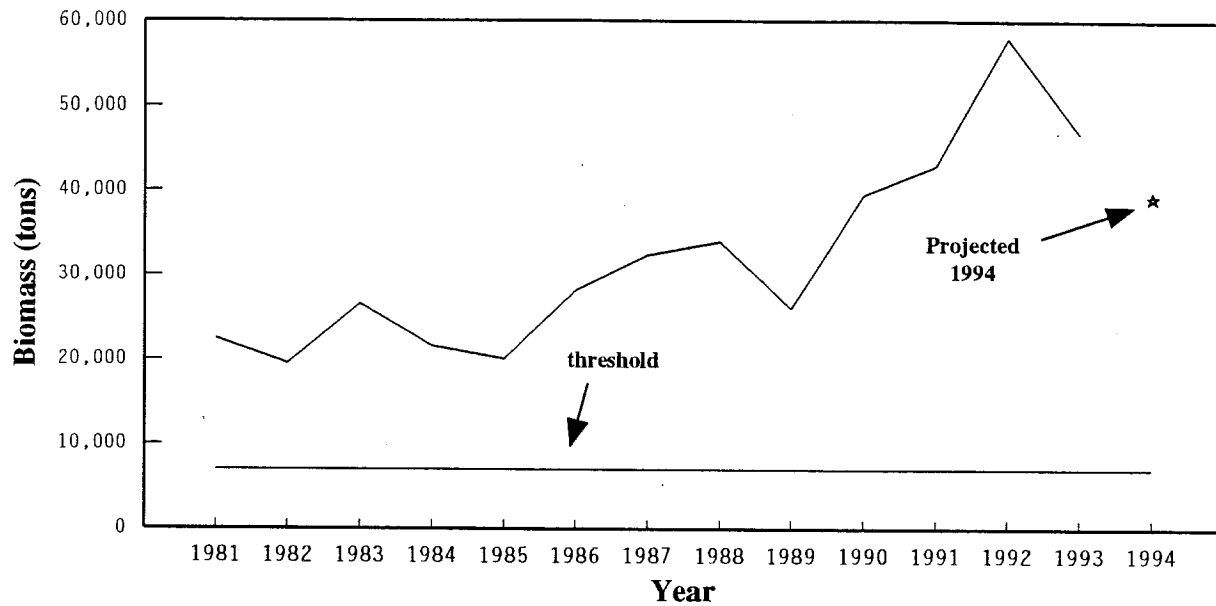


Figure 22. Norton Sound District herring biomass, 1981–1993, with 1994 projected biomass (top) and age composition by weight of the 1994 projected biomass (bottom) showing the projected average weight at age.

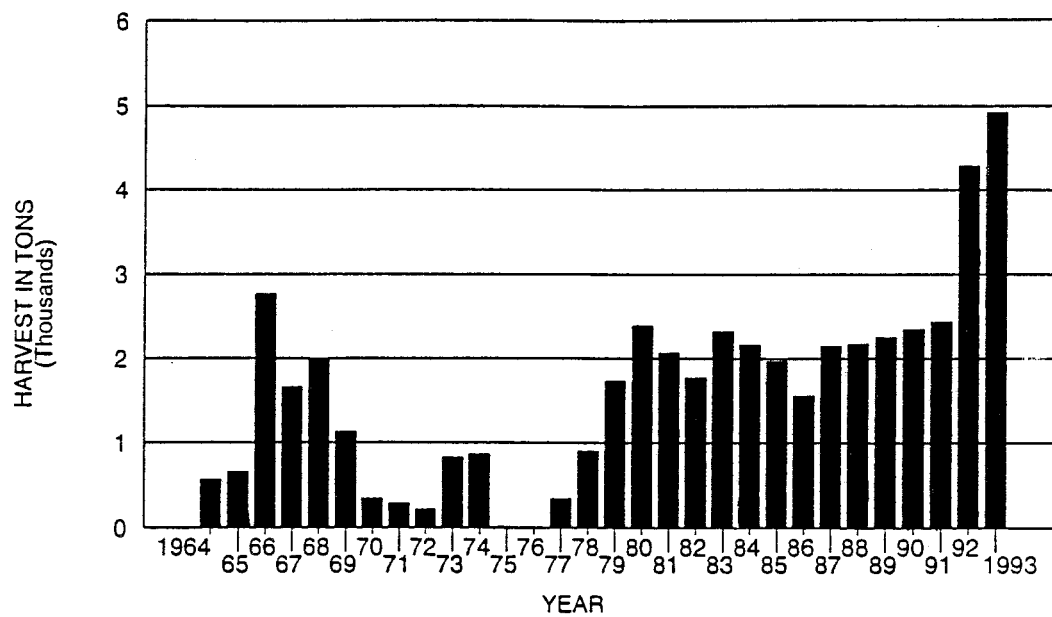


Figure 23. Sac roe harvest in the Kodiak Management Area, 1964–1993.



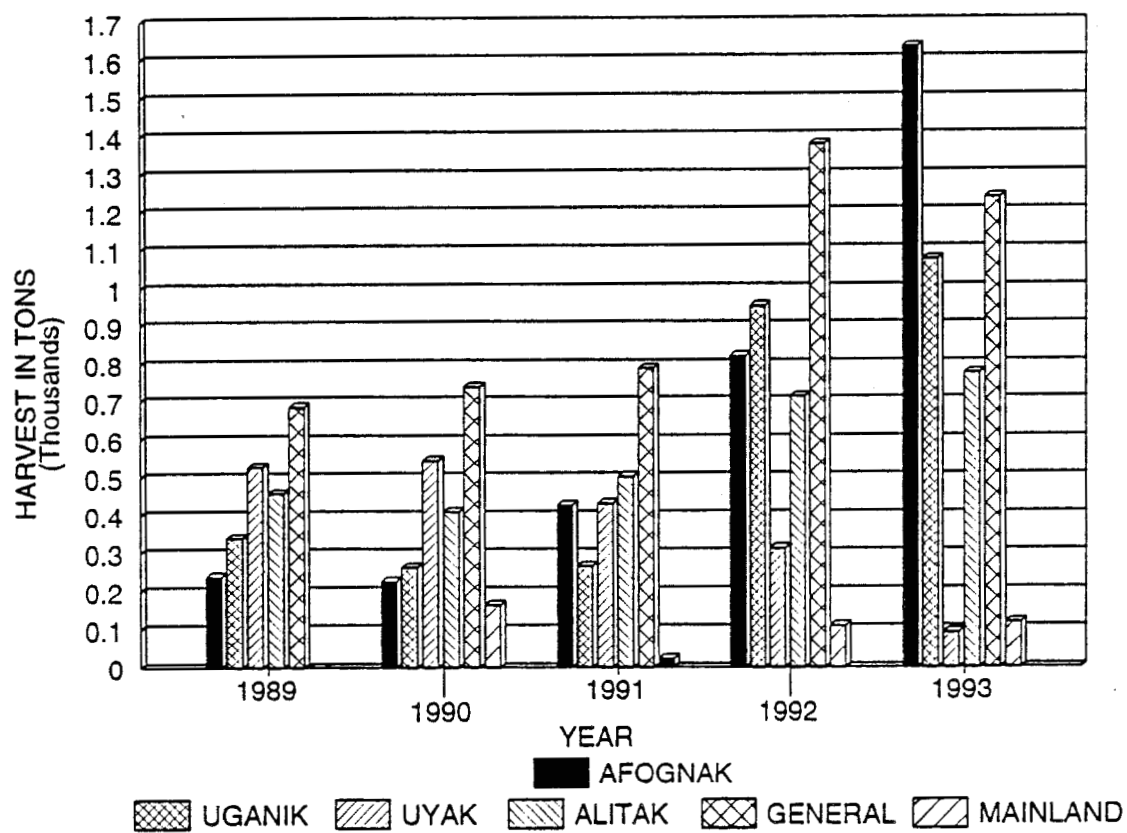


Figure 24. Sac roe harvest by district and year for the Kodiak Management Area, 1989-1993.

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