

KODIAK MANAGEMENT AREA
ANNUAL HERRING MANAGEMENT REPORT, 1996

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SAC ROE HERRING FISHERY

Area Description

The Kodiak Management Area (KMA) comprises the entire Kodiak archipelago and that portion of the Alaska Peninsula which drains into Shelikof Strait between Cape Douglas and Kilokak Rocks at Imuya Bay. The archipelago is approximately 150 miles long and extends from Shuyak Island south to the Trinity Islands. The Alaska Peninsula portion is about 160 miles long and is separated from the archipelago by the Shelikof Strait which averages 30 miles in width (Figure 1).

Historical Perspective

The Pacific herring *Clupea pallasii*, sac roe fishery began in Kodiak in 1964. From 1964-1996 sac roe herring harvests have averaged 1,909 short tons (Table 1; Figure 2). Prior to 1974, the fishery was unregulated regarding harvest quotas, gear types, seasons, and fishing periods. From 1964-1977 purse seine gear was used exclusively, with an average annual harvest of 898 tons and up to ten vessels participating in the fishery. Starting in 1974 purse seine gear was restricted to 150 fathoms in length and 1,000 meshes in depth. Between 1974 and 1978 the season ran from March 1 through June 30 with a harvest quota of 3,400 tons. Annual harvests, along with effort levels, fish abundance, prices and processor interest, fluctuated greatly from 1964 through 1977. Improved market conditions in 1978 prompted increased effort in this fishery with 28 purse seiners and 7 gillnetters participating. It was during this time period that spotter aircraft and tenders became involved in the fishery.

Between 1977 and 1982 the regulatory and management strategy went through a rapid developmental phase. Regulatory changes focused on gear efficiency, gear conflicts between seiners and gillnetters, gear level restrictions (exclusive registration and limited entry) and closed waters. In 1979 the sac roe season was reduced to May 1 through June 30, and the overall Guideline Harvest Level (GHL) was reduced to 2,400 tons distributed throughout the management area. A limit of 300 fathoms was also placed on the maximum length of gillnets and fishing periods were first limited to 48 hours open followed by 24 hour closures.

The maximum lengths for gillnets and purse seines were reduced again in 1981 to 150 fathoms and 100 fathoms, respectively. In addition, trawl and beach seine gear were eliminated as legal gear during the sac roe season. Fishing periods were established by emergency order in 1981, in which 24 hour fishing periods were followed by 24 hour closures. Beginning in 1982 the starting date for the season was changed from May 1, to April 15. In 1985 the fixed overall GHL of 2,400 tons was replaced by the current harvest strategy where GHL's are set annually on a stock by stock basis.

With the implementation of limited entry following the 1981 sac roe season, new entry into the fishery was restricted to past participants until permanent transferable permits could be awarded. Since 1982, gear levels have been relatively constant with 90 to 144 units of gear fished annually. Transferrable permits for both gear types are still increasing as the Limited Entry Commission continues its determinations of participants who may qualify for a transferable permit (Table 2).

The overall regulatory effect during the developmental phase (1977-1982) has been the emergence of a relatively stable commercial sac roe herring fishery through 1991. During the last four years the herring stocks have dramatically increased with record to near record harvests occurring in 1992 through 1995, averaging 4,927 tons.

New Regulations

With the increase in herring stock biomass and effort levels, competition in this fishery has dramatically increased and changes in the fishing schedule were made inseason in 1995. The fishing schedule change was effective from April 21 through May 2 and limited fishing time to ten hour periods from 12:00 noon until 10:00 p.m. on odd numbered days of the month. This change in the fishing schedule was prompted by: 1) ADF&G's inability to monitor the purse seine fleet during the night, 2) near record numbers of purse seine gear participating in the fishery, and 3) low roe recovery standards which were set by some processors, (Gretsch 1995). With the changes in the fishing schedule coupled with a diminishing percentage of the catch going to the gillnet fleet, tension between the two gears types escalated. During the Fall of 1995 the Kodiak Fish and Game Advisory Committee established a work group comprised of gillnet and seine fishers along with ADF&G staff to work on a resolution to better manage the sac roe herring fishery which was to be presented to the Alaska Board of Fisheries (BOF).

The BOF met in Kodiak in December 1995 and after lengthy discussions adopted new regulations concerning gear specifications for seine and gillnets, fishing periods, and a harvest strategy which guides management of the sac roe herring fishery. The new gillnet specifications regulation (Regulation 5 AAC 27.520 c) limits gillnets to a maximum of 230 meshes in depth, the previous regulation had no depth requirements. Additionally the time limit allowed for gillnetters to remove their gear from the water after an emergency closure was increased from two hours to four hours (Regulation 5 AAC 27.520 d) (ADF&G 1996).

The new seine specifications regulation (5 AAC 27.525 a) limits the depth of seines, whereby no purse seine shall exceed 20 fathoms stretch measure in depth or 100 fathoms of length. The depth shall be determined by using a stretch measure of the web from the corkline to the bottom of the net including any lines that hang below the lead line. The previous regulation only specified a seine depth limit of 1,025 meshes with no limits on the size of mesh. This regulation allowed fishers to use larger mesh in part of their seines to increase the depth and efficiency of the gear.

The new fishing periods regulation (5 AAC 27.510) (1) establishes fishing periods from April 15 through May 4 for purse seines to run from 12:00 noon until 10:00 p.m. on odd-numbered days, and from 9:00 a.m. until 12:00 noon on even-numbered days if a harvestable surplus is available; from May 5 through June 30, the fishing period for purse seines is 12:00 noon on odd-numbered days until 12:00 noon on even numbered days; the commissioner may open or close, by emergency order, the season before or after May 5 depending on the assessment of effort, harvest rate, and ADF&G's ability to monitor the fishery. This new regulation eliminates the majority of the night fishing for purse seiners during the time period when gear levels are at the highest. For gillnetters (2) from April 15 through June 30, fishing periods will run from 12:00 noon on odd-numbered days until

12:00 noon on even-numbered days. Gillnet fishing periods remain unchanged from when first established in 1981.

Lastly, the BOF put into regulation a harvest strategy (5 AAC 27.535 e) which in essence has been used by ADF&G staff to manage the sac roe fishery since the early 1980's. The harvest strategy outlines how ADF&G shall manage the sac roe fishery as follows; the commissioner shall issue emergency orders as necessary: 1) depending on the ADF&G's assessment of effort levels, harvest rates, and its ability to monitor the fishery; the length of the fishing periods for either or both gear groups may be increased or reduced; 2) the ADF&G shall establish guideline harvest levels (GHL's) by section based on information such as historical data, current and past fishery performance, sampling of commercial catch, and aerial surveys; 3) an individual section shall be closed to fishing once its GHL has been achieved; the GHL for an individual section may be adjusted up or down inseason depending on observed stock abundance; the ADF&G may make adjustments in the management of a section based on inseason changes in fish behavior or harvest patterns; these changes may result in an adjacent section closure; 4) a section that does not have an extensive history of sac roe production may be designated as exploratory with no specified GHL; 5) a section that has been closed because its GHL has been achieved may be reopened, if ADF&G determines that additional herring arriving on the grounds have increased the available biomass to the point that the initial exploitation rate has dropped below 10 percent for that stock; any reopening will require information indicating that juvenile herring, post spawners, or other forage fish are not present and that the ADF&G has the ability to monitor and regulate the reopening on the grounds; ADF&G shall give at least 24 hours advance notice before a section is reopened; 6) the KMA sac roe herring fishery is intended to occur in an orderly fashion, with minimal waste of the resource and within conservation limits as determined by ADF&G without regard to roe recovery standards.

Fishery Characteristics

The current KMA sac roe herring fishery occurs from April 15 through June 30 in 40-50 bays and coastal locations. The fishery opens at 12:00 Noon on April 15, with the entire management area opened at one time, excluding those areas where local stocks require protection. A unique characteristic of this fishery is that it typically commences prior to any major build-up of herring. This allows for a greater distribution of effort, which should reduce harvest rates within individual bays. Both gear types fish the same areas during the same time periods, except for April 15 to approximately May 4 time period when purse seine fishing is closed from 10:00 p.m. to 9:00 a.m. during an opening.

The overall trend in harvest during 1979-1991 was a relatively stable catch level, averaging 2,101 tons per year (Table 3). With the increase in the herring stock's biomass starting in 1992 catches also increased and averaged 3,891 tons for the years 1992 through 1996. Prior to 1978, the entire sac roe herring harvest was taken by seine gear. In 1978 seven units of gillnet gear accounted for 3% of the total harvest. From 1979 to 1995 the percentage of the total harvest by seine gear ranged from a high of 85% to a low of 60% and averaged 76%. Gillnet percentage of total harvest peaked in 1988 at 40%, and averaged 24% from 1979-1995. For the 1996 fishery 69% of the harvest was from seine gear and 31% was from gillnet gear.

To reduce operational costs and to cover more areas, most purse seiners form combines of two to ten vessels. These combines include one or several tenders and spotter aircraft. By 1979 the use of small, single engine, float equipped airplanes became more prevalent. Airplanes are the most productive way to find and direct seiners to harvestable herring. In 1986, several seiners started using side scanning sonar to locate schools of herring. This technology enabled fishermen to work during any time of the day or night and in adverse weather conditions which were unworkable for airplanes. Sonar technology continues to improve and most seiners are now equipped with scanning sonar equipment.

Gillnet vessels generally work independently and usually rely on processors to provide tenders to deliver their fish to the processing location. A few gillnetters are equipped with scanning sonar but the majority of these fishermen rely on color down-sounding sonar to locate herring schools, or fish areas where seiners are making sets. During the last five years the use of mechanical shakers has increased. The shaker is a common tool and greatly reduces the time and effort needed to remove herring from the net and greatly increases gear efficiency.

From 1978-1983 herring were harvested at or near their spawning area. As fishermen's knowledge increased in identifying these areas, gillnet gear has been fished in deeper waters, (15-25 fathoms) further from the spawning destination. Fishing deeper waters and nets has increased the amount of herring harvested with low roe recovery. In most cases this fish is dumped. If ADF&G field crews document this, then the poundage is subtracted from the management unit GHL. In some cases the low quality herring is sold as bait, which is also subtracted from the management unit GHL.

The ADF&G relies on the fishing industry to establish roe recovery standards. Generally, tenders will have a processor representative onboard to ensure that marketable quality herring are harvested. Competition among shore-based and floating processors results in this fishery having one of the highest exvessel values per ton in the state. The quality of Kodiak sac roe herring is generally high, due to inseason handling of relatively small amounts of herring, over a long time period.

Fishery Monitoring

The ADF&G Commercial Fisheries Management and Development Division (CFMDD) manages this fishery from its Kodiak Office. From 1974-1993 ADF&G used one state vessel to monitor this fishery. In 1994 and 1995 a second state vessel was utilized to monitor the early portion of the fishery. The ADF&G vessel R/V Resolution was used in 1994 and the Fish and Wildlife Protection (FWP) vessel M/V Trooper assisted in 1995, with an ADF&G biologist aboard. For the 1996 season both the R/V Resolution and the M/V Trooper with biologist aboard monitored the fishery. From 1979-1995, in conjunction with the state vessels, several two person ADF&G field crews were also utilized to monitor this fishery.

Field and vessel crews are stationed in management units which have historically produced the major harvests for a district. These crews are positioned in remote bays by chartered float planes or vessel and are equipped with an inflatable boat or aluminum skiff. Daily contact with fishermen, spotters, and tender operators is maintained to acquire fishery data. Current harvest, effort levels, and fleet movements are reported via single side band (SSB) radio at least three times per day. The

use of field crews has been a key element in preventing an excessive harvest from occurring and exceeding the GHL. Field crews also identify herring spawning areas and collect age-weight-length (AWL) samples from the commercial harvest. The ADF&G aerial surveillance of the entire area supplements, and often directs, placement of fishery monitoring field crews. The ADF&G office staff tally field crew, processor, and tender reports to assess herring harvests and decide which management units need to be closed to fishing. Industry spotter reports are also used to provide information concerning all aspects of the fishery. A "Kodiak Sac Roe Herring Harvest Strategy" is distributed annually, which describes in detail the guideline harvest levels, regulatory changes, and expected fishing periods (Gretsch et al. 1996).

Fishing Seasons and Weekly Fishing Periods

The KMA sac roe herring fishery opens by regulation on April 15 and closes by regulation on June 30 (ADF&G 1996). Fishing periods are established by emergency order. For the previous 15 years fishing periods have started at 12:00 noon on odd numbered days and closed at 12:00 noon on even numbered days of the month, for both gear types. The 1996 fishery was conducted with the new BOF regulations in effect, which may restrict fishing time from April 15 through May 4 for purse seiners from (10:00 pm to 9:00 am) during an opening. Gillnet fishing periods remain unchanged. Staggered days of fishing provide clearly defined closed periods, which allows ADF&G staff time to assess, summarize, and update all harvest data from previous fishing periods.

For the 1996 season, purse seine periods were allowed from 12:00 noon to 10:00 pm on odd-numbered days and from 9:00 am until 12:00 noon on even-numbered days through April 30. During the early portion of the season as many as 79 seiners were involved in the fishery and effort levels diminished by late April to approximately 15 vessels, with many vessels leaving the KMA for the Togiak herring fishery. With the reduction in seine effort beginning on May 1 fishing periods were increased to 24 hours in duration for the remainder of the season.

Districts and Management Units

The KMA is divided into 13 districts which define geographical areas used in managing the sac roe and food\bait herring fisheries (Figure 4). For the sac roe fishery, each district is then divided into management units which are intended to define the spawning area used by a stock of herring or may be used to define a geographical area. The descriptions of districts and management units is based upon the 1983 datum baseline on current NOAA marine charts and all coordinates are listed in decimal degrees and minutes. There are a total of 81 management units.

Guideline Harvest Levels

Preseason guideline harvest levels (GHL's) are established for all management units which have produced consistent herring harvests in previous seasons. These GHL's reflect the status of a particular stock of herring by management unit or district. Criteria for establishing the 1996 GHL include: 1) 1995 expected biomass vs. actual biomass estimates, 2) trends in age composition, 3)

level of recruitment primarily (age-3), 4) proportion of the spawning population age-5 and younger, 5) proportion of age-2 fish in the spawning biomass (indicator of future recruitment), and 6) spawn observations (extent, frequency, amount deposited). This information is supplemented by fishery performance information, i.e. the expected vs. actual harvest timing, duration, and level. Some management units are designated "exploratory" and are assigned no GHL because these areas have had sporadic or no harvest of herring in past years. Inseason closures in these exploratory areas are used to ensure that excessive harvests are minimized. If at any time during the season it appears that preseason expectations are incorrect, GHL's can be adjusted above or below preseason levels.

From 1979-1982 the KMA GHL was fixed at 2,400 tons. From 1983-1996 the GHL has varied each year (based on the criteria listed above) from a low of 1,640 in 1987 and a high of 4,550 in 1994. The preseason GHL has accurately reflected the actual harvests (Figure 5). These preseason harvest projections aid fishermen and processors in planning prior to the start of each season.

Inseason Fishery Management

Inseason management of the sac roe fishery relies primarily on ADF&G field crews stationed in management units where harvests are anticipated. Mobility of field crews to cover management units has improved in recent years with the use of three, 21' skiffs and state vessels. Presently two skiffs are used by field crews and a third skiff works from the ADF&G vessel R/V K-Hi-C. These skiffs allow field crews to monitor more management units and under rougher sea conditions than the 12 foot inflatable boats. Two crews still utilize inflatable boats which permit the crews to be rapidly moved by aircraft. The R/V K-Hi-C acts as mobile field station along with providing logistical support to field crews.

Generally, once the preseason GHL has been achieved for a management unit, it is closed for the season. Due to the rapid pace at which some fisheries occur, in-period closures are frequent. In management units which have an ADF&G field crew present, in-period closures may occur with as little as 15 minutes advance notice. In management units which do not have field crews present in-period closures may occur by: 1) announcement on single side band frequency 4.125 Mhz following the marine weather forecast at 8:00 a.m. or 6:00 p.m. daily and at 11:00 P.M. by ADF&G announcement, or 2) field announcement with the arrival of an ADF&G representative.

Processors and independent tender operators are required to provide daily tallies of herring deliveries by management unit and accurate estimates of herring onboard tenders that have not yet delivered to the cannery. Timely and accurate harvest reports from ADF&G field crews, fishermen, spotters, and processors are critical for assessing herring harvests which guide the management of the fishery. To date industry cooperation has been excellent in support of this fishery.

Actual fishery performance is used to evaluate the health of a particular fishery. Key components include: 1) duration of fishing time to harvest the management unit GHL, 2) catch per unit of effort, and 3) quality of herring harvested (including roe recovery, weight, and age composition).

Fish Ticket Data

Commercial catch data is compiled by ADF&G, CFMDD personnel. Actual dock weights of delivered herring are used inseason to verify initial harvest estimates. All final data are compiled post season from sales receipts (fish tickets) received from processors of purchased tonnages of herring. Fish ticket data is then compiled, and a summary of the herring harvest is generated. The ADF&G staff edits this summary for errors and lost fish tickets.

Biomass Estimates

The ADF&G has attempted in previous years to conduct aerial surveys to assess the total KMA herring biomass. The results of aerial assessments provided only a limited evaluation of the biomass and did not give a true representation of the total. Problems associated with aerial surveys in the KMA include: 1) herring tend to spawn in the evening, night, and early morning hours, limiting the time fish are visible in shallow water, 2) most management units have many distinct schools of herring which will spawn from April through June, 3) large numbers of juvenile herring, spawning herring, spawned out herring, and other fishes such as capelin *Mallotus villosus* can be found in sac roe herring fishery areas (fish may stay within an area for the duration of the sac roe season or may move, so that aerial biomass estimates may be duplicated or be incomplete), 4) the large geographical area for the KMA (57 management units which have identified spawning stocks), and 5) adverse weather conditions. Industry spotters have helped greatly in past seasons by providing biomass estimates, spawn observations, fleet movements, and harvest estimates. These spotters are very experienced, many having been involved for several seasons in the KMA and other statewide herring fisheries. Biomass estimates are compiled for each district from surveys flown by industry and ADF&G spotters. It has been estimated by both ADF&G and industry spotters that only 25% to 50% of the actual biomass is observed for the KMA herring stocks. There appears to be a significant amount of subtidal spawning occurring in waters 10-20 fathoms in depth. These fish and spawning activity may not be detected from aerial surveys. Previous attempts to assess this subtidal spawning with divers were not successful.

Commercial Catch Sampling

Commercial catch samples are taken from purse seine harvests, except when a management unit has only a gillnet harvest. Seine caught herring are preferred for samples, since this gear type is less size selective than gillnet gear. Field crews collect samples from multiple seine sets within a management unit to obtain a representative sample of all age classes in the catch. Samples are also obtained from tenders and/or fishing boats delivering to the processor if it is known that the catch being delivered came from a single management unit. Catch samples are frozen upon arrival in Kodiak and are analyzed by the end of the sac roe season. Commercial catch samples are thawed and analyzed for age, weight, length, sex, and sexual maturity.

A single scale is removed from the preferred area, located on the left side of the fish, three rows below the lateral line and three scales posterior to the center of the opercular plate (J. Brodie, ADF&G, Kodiak, personal communication 1994). The scale is visually analyzed with the aid of a microscope to estimate the age of the fish.

Standard length measurements are taken on all herring sampled. This length is the straight line distance from the anterior most part of the fish, including the lower jaw with the mouth closed, to the end of the vertebra (hypural plate). Lengths are taken on all samples using a herring measuring board to the nearest millimeter (mm).

Weight measurements are taken on a Mettler balance to the nearest gram (g) of all fish within a sample.

The sex and sexual maturity of all sampled herring are recorded. Each fish is slit open and visually inspected for relative gonad maturity; relative maturity is broken down into a scale of key characteristics ranging from virgin herring through spawned out herring, with eight levels of maturity identifying gonad key characteristics.

1996 Season Summary

The 1996 KMA sac roe herring season was 69 days in duration and a total of 3,386 tons of herring were harvested, which was 19 percent lower than the preseason GHL of 4,180 tons (Table 3). This was the fifth largest harvest for the fishery, exceeded by the 1992-1995 seasons which averaged 4,927 tons annually. Seine caught herring totaled 2,322 tons, (69% of the total harvest), while gillnet gear accounted for 1,064 tons or 31%. Harvest by gear type from 1979-1995 has averaged 76% (2,140 tons) and 24% (626 tons) for seine and gillnet gear, respectively (Figure 6; Table 3). The 1996 roe recovery averaged 10.9% for seine caught fish which is about a 1% increase from the 1995 fishery and 10.6% for gillnet caught fish which is slightly down from the 1995 fishery. The average price per ton paid for 10% roe recovery herring was approximately \$2,000 per ton. This was the highest price per ton paid in the history of the fishery. The average exvessel earnings for purse seine fishers was a record \$81,500 and for gillnetters a record \$28,800. The total exvessel value of the fishery was estimated at a record \$6.8 million, which is over twice the 1986-1995 average value of the fishery at \$2.8 million. (Table 3).

A total of 78 seiners and 74 gillnetters participated in the 1996 fishery, approximately 21 seiners did not make a delivery during the season. The 1996 seine effort was the highest experienced since 1981. A total of 102 tenders registered to transport herring within the KMA in 1996. There were 11 floating processors and seven shorebased plants, representing 15 companies registered to process herring within the KMA.

The increase in seine and floating processor effort can mainly be attributed to the closure of the Prince William Sound Management Area sac roe herring fishery. The relatively high preseason GHL for the KMA attracted seiners and processors to Kodiak. The floating processors operated in the vicinity of Port Bailey in Kupreanof Strait, near the major harvest locations of west Afognak Island and the Uganik District. The floating processors departed the KMA at the end of April to participate in the Togiak herring fishery.

District Summaries

The majority of the 1996 harvest was taken in the West Afognak, Uganik, Alitak, and Eastside Districts (Figure 7). Of the 81 management units in the KMA, herring were harvested from 43 units (Table 4), 20 of these units were closed inseason by emergency order (Appendix A), and 20 units were closed prior to the start of the season due to low stock abundance.

West Afognak District. The bays along the westside of Afognak Island are among the earliest areas in which herring are harvested in the KMA. Fishery monitoring crews were stationed in management units which were anticipated to have the earliest harvests. A field crew monitored the Raspberry Strait management unit, the R/V Resolution monitored the Paramanof and Foul Bay units, and the M/V Trooper monitored Malina Bay (Figure 8). For the first fishing period on April 15, a large portion of the seine and gillnet fleet fished the Paramanof Bay management unit and harvested approximately 460 tons. Although the initial harvest was near the 500 ton GHL the fishery performance along with biomass observations indicated that the stock status for this unit was better than expected and the fishery was allowed to reopen on April 17. The second opening lasted 21 minutes and closed at 12:21 PM, with approximately 235 tons harvested. The seasonal total harvest was 695.4 tons. Fishery activity was slow in the remaining management units of this district through the first week of the season and most of the effort moved to the Uganik District after the Paramanof Bay closure. A total of 118.3 tons (GHL of 200 tons) was harvested from Malina Bay and poor fishery performance and low biomass estimates prompted the closure of this unit on April 26. The M/V K-Hi-C monitored the Foul Bay management unit in late April to early May, which had a harvest of 123.9 tons (GHL of 150 tons) and this unit was closed on May 4.

The Raspberry Strait management unit for the second year in a row experienced poor fishery performance with only 7 tons harvested during the last two seasons combined. The 1994 biomass observations and fishery harvests indicated a strong stock status for this unit. There is no clear explanation for the dramatic change in the Raspberry Strait stock status and the decline in the Malina Bay stock.

Of the six management units in this district which have GHL's, three were closed with the assistance of ADF&G field crews and the remainder were open through June 30. The total GHL for the district was 1,180 tons and a total of 944 tons were harvested. Purse seiners accounted for 81% of the harvest and gillnetters accounted for 19%.

North Afognak District. There are five management units within this district and four were closed prior to the start of the 1996 season (Figure 8). Herring stocks in these sections have declined in recent years, and a closure of these units was initiated in 1995 in an attempt to rebuild these stocks. There was no herring harvest from the one open management unit, the Shuyak Island Section.

South Afognak District. There are six management units within this district and all were closed prior to the start of the 1996 season (Figure 8). The herring stocks in this district have also declined and all units were closed starting in 1995 to help rebuild these stocks.

Uganik District. A field crew was stationed in the Terror Bay management unit and the R/V K-Hi-C was stationed at the Village Islands management unit to monitor the fishery within the Uganik District (Figure 9). On April 15 a large concentration of herring were present within the Village Island management unit, however the herring were in deep waters and were difficult to catch with 35

tons harvested through the first opening. With the closure of Paramanof Bay on April 17 this fleet moved to the Village Islands where the effort levels grew to approximately 75 seiners, 30 gillnetters, and 40 tenders. Fishery activity intensified near darkness with many sets being made at the 10:00 p.m. seine period closure time. After tallying the harvest, the Village Islands management unit was closed at 11:00 p.m. with a total catch of 332.6 tons, (GHL 250 tons). The fleet next dispersed to the Terror Bay, East Arm Uganik, and South Arm Uganik management units. The East Arm Uganik Bay management unit was closed on April 20 with a harvest of 112.7 tons (GHL 125 tons). The Viekoda Bay unit was closed on April 26 with a harvest of 70.9 tons, (GHL 50 tons). The R/V K-Hi-C was then moved to the Foul Bay management unit in late April while the field crew continued to monitor Terror Bay through May 11. The South Arm Uganik management unit was closed on May 4 with a harvest of 283.3 tons, (GHL 180 tons). Catches slowly accumulated in the West Uganik Passage and this unit was closed on May 10 with a harvest of 36.2 tons, (GHL of 40 tons). Fishery performance for the Terror Bay management unit was below expectations for the season with 116.6 tons harvested, (GHL of 250 tons), however fisher and spotter observations of Age-2 and -3 herring within this unit indicated good recruitment. The Northeast Arm Uganik Bay management unit remained open through June 30 and experienced a harvest of 10.3 tons, (GHL 30 tons). Of the eight management units in the Uganik District with GHL's, five were closed with the assistance of ADF&G field crews and the remainder were open through June 30. A district total of 963 tons were harvested from a district GHL of 935 tons, 74% of this harvest was from purse seine gear and 26% by gillnet.

Uyak District. The Uyak District was the largest herring producing district within the KMA through the 1980's (Figure 9). Since 1991 fishery performance and spotter observations have indicated a decline in abundance of herring in this district. The ADF&G responded to this decline by reducing the GHL's for these management units from 1992-1994. The entire district was closed during the 1995 and 1996 herring seasons as a further step to promote the recovery of these stocks.

Alitak District. The Alitak District is comprised of ten management units, two are exploratory areas, and eight have GHL's (Figure 10). Fishing activity started within this district at the end of April and the majority of the seine fleet departed Alitak in early May to participate in the Togiak herring fishery. The Sulua Bay management unit has been the most productive unit within the Alitak District during the last two years with 288 tons harvested in 1996, (GHL of 240 tons) and this unit was closed on May 4. An ADF&G skiff equipped fieldcrew was stationed in the Inner Deadman Bay management unit on May 11. The Geese/Twoheaded management unit was closed on May 10 with a harvest of 33.2 tons, (GHL 15 tons). The Portage Bay section, (GHL 75 tons) was closed inseason on May 22 with a harvest of 75.9 tons, (GHL of 75 tons). All remaining management units of the Alitak District remained open through June 30. The fishery performance for the Inner and Outer Deadman Bay management units was poor and the harvest totaled 13 tons (GHL 40 tons) and 23.8 tons (GHL 95 tons) respectively. The ADF&G crew moved from Inner Deadman Bay to Olga Bay on May 30 to monitor the herring fishery and to begin installation of salmon weir projects. The Olga Bay herring stock has declined over the last five years and the GHL has been adjusted lower to reflect this changing stock status. A total of 10.2 tons were harvested this season and the GHL was 40 tons. The Inner Alitak exploratory unit had a harvest of 3 tons and the Lower Olga/ Moser unit had a harvest of 2.2 tons. The two remaining management units within this district had no harvest. The Alitak District total GHL was 530 tons with 449.3 tons harvested. Seine gear accounted for 57% of the harvest and gillnet gear 43%. Of the eight management units in the Alitak District with

GHL's, one was closed with the assistance of the ADF&G field crew, two were closed by ADF&G office staff, and the remainder were open through June 30.

Eastside District. In general the Barling Bay and the East and West Sitkalidak Strait management units experience early herring harvests, however this season these fisheries appeared to have developed later as catches for the early openings were small. The R/V Resolution deployed a two person ADF&G field crew at Ameer Bay within the East Sitkalidak management unit (Figure 11). This crew was equipped with a 21 foot skiff which enabled them to monitor seven management units along the eastside of Kodiak Island. A raft equipped field crew was also flown into Kiliuda Bay. On April 21 the Barling Bay management unit (GHL of 50 tons) was closed with a harvest of 54.3 tons. The Shearwater Bay management unit was closed prior to reaching the GHL due to an error the fieldcrew made in assessing the harvest, with a closure occurring on May 2 with a harvest of 53.5 tons, (GHL 90 tons). The Outer Kiliuda management unit was closed on May 7 with a harvest of 103.8 tons, (GHL of 90 tons). The Outer Ugak Bay management unit was closed on May 8 with a harvest of 54.2 tons, (GHL of 60 tons). The Three Saints Bay unit was closed on May 9 with a harvest of 47.3 tons, (GHL of 40 tons). The Inner Kiliuda Bay management unit was closed on May 11, with a harvest of 79.9 tons, (GHL of 90 tons), and the field crew was moved to the Inner Ugak Bay management unit. Fishery activity remained relatively slow in the East and West Sitkalidak Strait management units and the fieldcrew was moved to the Alitak District on May 11. On May 13 the Inner Ugak Bay management unit was closed with a harvest of 94.1 tons, (GHL of 90 tons) and the fieldcrew returned to Kodiak. Of the 14 management units with GHL's in the Eastside District, six units were closed with assistance of ADF&G field crews, one unit was closed by the ADF&G office staff, and the remaining units were open until June 30. The total GHL for the Eastside District was 1,190 tons. A total of 825.5 tons were actually harvested, with 49% of the harvest from purse seine gear and 51% from gillnet gear.

Northeast District. There are five management units in the Northeast District and four have GHL's (Figure 12). The Woman's Bay management unit was closed on June 4, with a harvest of 49.9 tons, (GHL of 50 tons). Harvests also occurred in the Kalsin Bay and Middle Bay management units of 4.4 tons (GHL of 10 tons) and 0.2 tons (GHL of 10 tons) respectively. Four management units were open through June 30.

Inner Marmot District. There are five management units within the Inner Marmot District and only one unit has a GHL (Figure 8). The Anton Larsen Bay, Sharatin Bay, and Kizhuyak Bay management units were closed prior to the start of the season due to low stock abundance. The Spruce Island management unit had the only harvest 0.5 tons, (GHL of 10 tons). Seine gear and gillnet gear accounted for 40% and 60%, respectively, of the total district harvest, both units were open through June 30.

North Mainland District. The North Mainland District is comprised of four management units (Figure 13). One unit has a GHL, two units are exploratory, and one unit is offshore. The offshore unit is not expected to produce a sac roe herring harvest. The three Mainland Districts experience more extreme weather conditions than the other districts around Kodiak and Afognak Islands. Sea conditions encountered while crossing the Shelikof Strait to reach these districts greatly reduces the mobility of vessels fishing this district. The Mainland Districts frequently experience high winds, low cloud ceilings, and limited visibility, greatly limiting the effectiveness of spotters. Fishing effort

in these three districts generally involves only one or two seine combines and 5-10 gillnet vessels annually. No field crews are stationed in these districts due to the high expense of placing and supplying crews in this remote area. The weather conditions, combined with the small number of vessels which fish these units reduces the likelihood that excessive harvests will occur. A total of 11.9 tons were harvested by gillnetters from the Inner Kukak Bay management unit (GHL 50 tons). There were no other harvest from this district.

Mid-Mainland District. The Mid-Mainland District is comprised of six management units. Two units have a GHL, two units are exploratory, and two units are offshore. The offshore units are not expected to produce a sac roe herring harvest (Figure 14). The Inner Katmai management unit had a harvest of 63.3 tons, (GHL 50 tons) and was closed on May 13. The Alinchak management unit had a harvest of 20.2 tons (GHL 40 tons) and remained open through June 30. There were no other harvests from this district and all harvests were from purse seine gear.

South Mainland District. The South Mainland District consists of two management units, one has a GHL and the second is an exploratory unit (Figure 15). These two management units on the southern part of this district are the farthest units from the port of Kodiak. A total of 54.6 tons were harvested with seine gear from the Wide Bay management unit (GHL 95 tons).

Sturgeon/Halibut District. The Sturgeon/Halibut District on the southwest portion of Kodiak Island has no management units or GHL and consists mostly of offshore areas that are not likely to produce a sac roe herring harvest (Figure 14).

Age Composition, Weights, and Lengths

During the 1996 season, age-3 herring were the dominant age class (39%) found in the purse seine harvest (Figure 16). The remaining age classes represented the following percentages of the harvest: age-2 (1%), age-4 (6%), age-5 (12%), age-6 (5%), age-7 (2%), age-8 (23%), age-9 (10%) and Age-10+ (2%). In general, the West Afognak and Uganik Districts had a dominance of age-8 and age-3 herring while the Eastside District management units had a dominance of age-3 and age-9 herring (Figure 17 and Table 5).

Age-3 herring are considered "recruit herring", entering into the commercial fishery and spawning for the first time. When compared to the previous two brood years, age-3 herring showed a slight decrease in average weight in the 1996 harvest at 93 grams (Table 6). The 1991 age-3 harvest of 81 gram average weight herring coincided with the strong age class which contributed to four years of record harvests. The 1996 lower age-3 weights combined with a high percentage of age-3 herring caught in the fishery may indicate a strong recruitment of age-3 herring into the KMA. Age-5 herring caught in the 1996 fishery were the largest by weight for the years 1989-1995. All other age classes had comparable growth to the past seven years.

Spawning Biomass

In 1996 the spawning biomass index for that portion of the KMA fished, after the 1996 fishery, was estimated to range from 26,000 to 36,000 tons, as determined by industry spotter and ADF&G

surveys. The 1996 biomass is similar to the 1992 estimated biomass of 32,000 tons, a year which had a harvest of 4,283 tons. The indexed biomass has increased dramatically from 5,500 tons to 15,500 tons in 1990 and steadily increased to a high which ranged from 42,500 to 56,000 tons in 1993. The estimated biomass has declined during the last three years. A breakdown by district where data is available includes; 7,000-10,000 tons in the West Afognak District, 8,000-10,000 tons in the Eastside District, 8,000-10,000 tons in the Uganik District, 2,000-4,000 tons in the Alitak District, and 1,000-2,000 tons in the Mainland Districts. The 1996 sac roe herring harvest of 3,386 tons represents a total indexed exploitation rate ranging from 9% to 13% of the 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, so there is more opportunity for observing a greater and more consistent proportion of the actual total biomass. The exploitation rates achieved in these fisheries would be more comparable between areas.

Enforcement Issues

The Alaska Department of Public Safety, Fish and Wildlife Protection (FWP) substantially increased their enforcement coverage of the KMA herring fishery during the last two seasons. As previously mentioned, the FWP vessel M/V Trooper worked jointly with ADF&G in monitoring the fishery and conducting enforcement work, with an ADF&G biologist onboard. Additionally, the FWP vessel M/V Spiridon and a FWP float equipped Cessna 185 provided surveillance of the fishery.

The presence of FWP greatly reduced the burden on ADF&G field crews, especially during openings, closures, and emergency closures. With the new seine depth regulation in effect for the 1996 season many purse seiners voluntarily had their nets checked for legal depth in Kodiak by FWP. During the fishery the majority of the enforcement activity occurred on late (after the closure time) purse seine sets. There were some problems with fishers determining management unit boundaries within the Uganik and West Afognak Districts, which will need to be corrected during the next BOF meeting. It is hoped that FWP will continue this level of enforcement activity which contributed to a more orderly fishery.

1997 Management Plans and Issues

Based on the age class data collected, fishery performance, spawn observations, and juvenile herring observations in 1996, the preliminary GHL for the KMA in 1997 is expected to be approximately 3,500 tons, down from the 1996 GHL of 4,180 tons. The 1997 harvest is expected to be comprised of 40-50% age-3 and age-4 herring along with 20-30% age-9 and age-10 herring. The observations of age-2 and-3 herring during the 1996 season indicate a good level of recruitment for KMA, which suggests that the fishery will support harvests of 3,000-3,500 tons over the next few seasons.

The ADF&G will continue to rely greatly on industry spotter pilots, processors, and fishermen to provide information to help manage this fishery. The ADF&G will be conducting an Age Structured

Analysis Study for the West Afognak District in 1997 to better evaluate the status of the herring stocks and aid in the setting of GHL's for this district. The ADF&G will also be conducting a test fish program to generate funds for herring research in 1997. Research activity will involve an increase in aerial surveys of closed management units to assess trends in the stock status. Further, to help evaluate the stock status in the Uyak District a purse seine vessel may be contracted to conduct hydroacoustic surveys and collect AWL samples in 1997.

The KMA harvest strategy has been tested with record harvests and high gear levels during the last four years. The competition between fishers is intense and gear conflicts between fishers occasionally occur. A report which reviews the results of the 1996 fishery and evaluates the BOF approved harvest strategy was published in October 1996, "Kodiak Management Area 1996 Commercial Sac Roe Herring Fishery Season Summary" (Gretsch and Brodie 1996).

HERRING FOOD/BAIT FISHERY

Historical Perspective

The earliest recorded food/bait herring harvest for the KMA occurred in 1912 (Table 7). In the early 1920's the fishery expanded and large herring were sought for food products, such as salted and pickled herring which were much in demand after World War I. By the late 1920's the demand for herring food products had declined and the fishery switched from a food product to reduction products, such as fish meal and oil. During the peak years of the reduction fishery (1934-1950) the average harvest was 31,600 tons which vastly surpasses the current food/bait herring harvests (Figure 18). During the reduction fishery the major harvest areas were located in eastern Shelikof Strait and adjacent bays and straits along the west side of Kodiak and Afognak Islands. Quotas and harvest weights were measured by barrels (where 250 lbs. of herring equals one barrel) until 1956 when the unit of measure was changed to short tons. Historically large, approximately 70 foot, "sardine seiner" type vessels were used in conjunction with holding pounds to supply herring to five major reduction plants. In addition, small seine and gillnet vessels participated in a portion of the food fishery and delivered to floating and shore based salting and pickling operations.

From the early 1960's to 1973, there were no harvest quotas or closed seasons. Beginning in 1974, an open fishing season was established between August 1 through February 28 which remains in effect; however no regulatory GHL's were in effect until 1979. In 1979 and 1980, the GHL was 12,600 tons for the food and bait season. As a result of the rapidly developing sac roe fishery, the GHL for the food/bait season was reduced to 1,000 tons in 1981 and remained at that level through 1987. Regulatory GHL's for the food/bait herring fishery were replaced with a regulatory harvest strategy in 1988.

Gear used in this fishery includes trawl, gillnet, and seine. Gear for this fishery was first regulated for the 1986/87 season when seine gear was restricted to 100 fathoms in length and 1,025 meshes in depth. Gillnet gear was also restricted to 150 fathoms in length with no depth requirements. For the 1993/94 season, purse seine specifications were increased to 150 fathoms in length and 1,625

meshes in depth. There are no trawl restrictions. The entire KMA is open to continuous fishing on August 1 for all legal gear types and there are no exclusive gear areas.

Fishery Characteristics

The current food/bait herring fishery can be characterized as a secondary commercial fishery on herring concentrations located in KMA waters. It is primarily a bait fishery providing a frozen product for longline and crab/cod pot fishers. Effort and harvest levels are at historical lows for the food/bait fishery, which is converse to the sac roe fishery. The food/bait fishery is an open-to-entry fishery, while the sac roe fishery has been limited-to-entry since 1981. Existing regulations designate priority status to the sac roe fishery.

Management Plan History

During the Fall and Winter months of the early 1980's major concentrations of herring were observed in eastern Shelikof Strait and adjacent bays along the west side of Kodiak and Afognak Islands. The biomass exceeded that of known KMA spawning stocks. These herring were targeted by food/bait fishers and questions arose concerning the stock of origin of these fish. In 1986, a stock identification study based on scale pattern analysis was performed on herring harvested from a large biomass located in the east part of the Shelikof Strait (Johnson et al. 1988). The study suggested that at least 80% of the East Shelikof herring sampled were of Kamishak Bay spawning stock origins, which is within the Lower Cook Inlet Management Area.

In 1988, the BOF allocated not more than two percent of the previous season's total available spawning biomass from Kamishak to be harvested during Kodiak's food/bait herring fishery. For local Kodiak spawning stocks, which are exploited during the sac roe fishery, the food/bait GHL on those same stocks is 10% of the previous seasons sac roe herring harvest.

Problems arose from this management plan because it was difficult to assign harvest from the intermixed stocks to Kodiak or Kamishak. This plan was in effect through the 1992/93 season.

In 1992, the BOF approved the Kamishak Bay District Herring Management Plan (5AAC27.465) which outlines criteria for the management of the Kamishak Bay sac roe herring and the Shelikof Strait food/bait fishery (ADF&G 1996). This plan defines allocations to these fisheries based on biomass estimates.

In 1993 the BOF placed into regulation a harvest strategy defining the criteria for managing the Kodiak food/bait herring fishery (5AAC 27.535). This strategy combines the Kamishak stock GHL with the Kodiak stock GHL for food/bait management units FB 1, FB 4, and FB 5 (Figures 8 and 9). When this combined GHL is achieved, the Shelikof Strait food and bait management units are closed collectively. This plan alleviates the problem of identifying the spawning stock of a harvest in areas where intermixing may occur.

The allocation of Kamishak Bay herring stocks to the Shelikof Strait food and bait fishery is based on the spawning biomass of age-5 and older herring and not on the biomass of juveniles. The quantity of herring stocks aged four years and younger caught during the food/bait fishery are adjusted to approximate the biomass of a similar number of age-5 herring. Age-4 and younger herring were selected because in the Kamishak spawning stocks, herring are not considered to have attained complete recruitment into the spawning biomass until they have reached age-5.

1996-97 Season Summary

The 1996/97 allocation for Kamishak herring stocks over wintering in Shelikof Strait was 380 tons. In addition, the GHL for Kodiak stocks in food/bait management units FB 1 and FB 4 was 190 tons for a combined GHL for both stocks affected by (5 AAC 27.465) of 570 tons. A "KMA Commercial Food/Bait Herring Fishery Harvest Strategy" is distributed annually, which describes in detail the guideline harvest levels, regulatory changes, and registration requirements (Gretsch et al. 1996).

The Kodiak spawning stocks total GHL was 333 tons, which represents 10% of the previous spring's sac roe herring harvest on a stock by stock basis. The total GHL for the KMA was 713 tons (380 tons Kamishak allocation and 333 tons Kodiak stocks).

The KMA food/bait herring season began August 1, 1996 and remained open until February 28, 1997. Fishing periods were 24 hours per day and seven days a week. Three emergency orders (E.O.'s) were issued during the season which closed districts after the GHL was harvested. The East Afognak (Food/Bait unit #3), North Afognak (Food/Bait unit #2), Uyak (Food/Bait unit #5), and the Inner Marmot (Food/Bait unit #10) were closed prior to the start of the season. The sac roe herring stocks within these districts have declined during the last five years so these units were closed to prevent further exploitation during the food/bait fishery.

All permit holders and buyers are required to register at the Kodiak ADF&G office prior to fishing or purchasing herring. At that time, management plans are issued and catch reporting procedures and current regulations are reviewed. Each landing is sampled for age, weight, length (AWL) information and skipper interviews are conducted to evaluate which sac roe stocks are being impacted. For the 1996/97 season a total 651 tons were harvested in the KMA. From 1965 through 1995 the food/bait harvest has averaged 205 tons (Figure 19). Eight vessels and five buyers/processors registered for this fishery. Purse seine gear accounted for 68% of the total harvest and trawl gear 32%. The total exvessel value of this fishery was approximately \$260,000 dollars.

The food\bait management districts FB1, FB4, FB11, and FB12 which are affected by the combined harvest of Kodiak-Kamishak herring stocks, were closed on September 16 with a harvest of 511 tons, (GHL of 580 tons). As stated in the Kamishak Bay District Herring Management Plan (5 AAC 27.465) the quantity of age-4 and younger herring harvested is adjusted to a similar number of age-5 herring. This estimated adjusted harvest totaled 626 tons. During this fishery purse seine gear harvested primarily age-3 and age-4 herring while trawl gear harvested a mix of age classes, primarily age-6 and age-8 (Table 8).

The Alitak food\bait management district FB7 was closed on October 30 with a harvest of 53.3 tons (GHL of 44 tons). This harvest by purse seine gear was primarily of age-2 and age-3 herring (Table 9).

The Eastside food\bait management district FB8 was closed on November 3 with a harvest of 86.6 tons (GHL of 80 tons). This harvest by purse seine gear was primarily of age-8 and age-9 herring (Table 10).

No biomass surveys were conducted by the ADF&G in 1996 on overwintering herring concentrations.

1997/98 Management Plans and Issues

The success of purse seine gear in this fishery during the last four years will likely encourage other seiners to participate next season. On-grounds monitoring by the ADF&G of the fishery may be necessary as gear levels escalate. Improvements in catch reporting will be needed with increasing effort levels to help limit harvests to guideline levels.

HERRING SUBSISTENCE/PERSONAL USE FISHERY

Fishery Characteristics

The subsistence and personal use fishery for herring is regulated only during the sac roe herring fishery season, April 15 through June 30. During this time period, a permit is required for individuals who are not sac roe commercial fishermen to harvest herring. Sac roe commercial fishermen may retain herring from their lawfully taken commercial catch to fulfill their subsistence or personal use needs. Most of the herring caught during this time period are used for bait in commercial longline fisheries. However small amounts are used for food, sport fishing bait, and fertilizer.

1996 Season Summary

A total of 22 permits were issued in 1996 and 3 permits were returned with harvest data. The total harvest was 550 pounds from the South Afognak, Inner Marmot, and Northeast Districts. Generally, most permits are returned during the spring months and the actual harvest will likely be higher than reported at this time.

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APPENDIX