

PRINCE WILLIAM SOUND MANAGEMENT AREA
HERRING REPORT TO THE BOARD OF FISHERIES



By:

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Regional Information Report No. 2A99-27

Alaska Department of Fish and Game
Commercial Fisheries Division, Central Region
333 Raspberry Road
Anchorage, Alaska 99518

November 1999

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Introduction

This summary recaps the four spring herring fisheries in Prince William Sound. Two fisheries are herring sac roe fisheries using seine or gillnet gear. The remaining two fisheries harvest spawn on kelp. Wild spawn on kelp is taken by divers or by hand picking, depending upon the type of kelp available for harvest and the market demand. Pound spawn on kelp is taken by one of two methods: either by confining herring within a rectangular net pen containing suspended kelp (closed pounding), or by moving a framed structure without web into an area where herring are naturally spawning, (open pounding). Of the four spring fisheries, only the wild spawn-on-kelp harvest is open entry. An open entry food/bait fishery occurs in the fall.

The Prince William Sound Herring Management Plan, 5 AAC 27.365, allocates the projected available herring surplus between the five herring fisheries. This plan allows for exploitation rates from 0 to 20% when the spawning biomass is between 22,000 tons and 42,500 tons. For management purposes, herring in all locations of the Sound are assumed to be one stock. The 1999 spawning biomass was projected to be 39,557 tons based on the age structure of the population and age-3 through age-5 herring were expected to comprise almost 79% of the stock. The age structured analysis (ASA) model forecasts the size of the spawning biomass using observations from hydroacoustic and aerial surveys, herring age and size data, historic spawn deposition estimates and growth and mortality estimates (Figure 1). Historic biomass indices are presented in Table 1. With the spawning biomass approaching the upper threshold of 42,500 tons, the exploitation rate was set at 15%. Fishery allocations were: 967 tons for the food/bait fishery, 3,447 tons for the sac roe-seine fleet, 202 tons for the gillnet sac roe fleet, 843 tons for the pound fishery, and 475 tons were allocated to the wild spawn-on-kelp harvest.

There are 104 permanent and 2 interim purse seine permits in Prince William Sound. Purse seines can be 150 fathoms in length and 1000 meshes deep. Mesh size is not regulated. There are 24 gillnet permits in Prince William Sound. Gillnets are limited to 100 fathoms in aggregate length and 120 meshes in depth. Mesh size is regulated from a minimum of 2 1/8 inches to a maximum of 3 inches. Historic sac roe harvest is presented in Table 2. There are 128 herring pound permits in Prince William Sound. Seine specifications for the closed pound fishery are the same as the sac roe seine fishery. Open and closed pound fisheries can be managed separately or in combination. The size of the pound is limited to 2,000 square feet at the surface and walls of a closed pound cannot exceed 30 feet in depth. The herring allocation for this fishery is divided among the number of permit holders and the department establishes the maximum number of blades of kelp a permit may maintain in the pound. The historic pound spawn-on-kelp fishery is given in Table 3. The wild spawn-on-kelp fishery, utilizing native Prince William Sound kelp, occurs after a major spawning event takes place on marketable species of kelp. Wild kelp is taken by divers or by hand picking depending on the type of kelp available for harvest and market demand. The historic wild spawn-on-kelp fishery harvest is given in Table 4. The food/bait fishery season may run from October 1 through January 31; however, industry concerns over product quality usually results in a delay of the season's opening date until November. Purse seine size is not restricted for the food/bait fishery and trawling or gillnetting may also occur. The historic food/bait fishery harvest is given in Table 5. Historic fishery harvest values for all Prince William Sound fisheries are presented in Table 6.

The management objective for sac roe fisheries is to provide the highest quality product and remain within the harvest guideline. Several processors verbally established their minimum size standards as being between 125 and 130 grams. Sampling would be paramount to conducting a successful fishery and obtaining a high quality product. Daily sampling tracks the roe maturity and identifies locations of larger, older aged fish. Aerial and sonar surveys are used to determine appropriate boundaries for openings in order to keep the harvest within the GHF or within processing capacity limits. Tendering and processing capacity appeared capable of handling a seine harvest of 3,447 tons but a single, large harvest could still negatively impact quality.

Season Summary

During late March the department, along with the Prince William Sound Science Center, conducted herring surveys using BioSonics hydroacoustic gear. The surveys covered Montague Island (Zaikof Bay, Rocky Bay, Stockdale Harbor, Green Island and Port Chalmers) and, to a lesser extent, the areas in eastern PWS (Sheep Bay to Port Fidalgo). Preliminary estimates were between 1,000 and 5,000 tons of herring in the surveyed areas of eastern PWS. At Montague Island, survey estimates were between 11,000 and 19,000 tons of herring in Zaikof Bay. For the past few years, greater numbers of herring have been seen overwintering in both Zaikof Bay and Rocky Bay, as well as in waters around Green Island. In stark contrast, during the spring 1999 survey very few herring were located outside of Zaikof Bay. The department's inability to detect any significant biomass of herring outside of Zaikof Bay was both unusual and troubling.

In general, spring sampling in recent years has indicated that a significant portion of the herring biomass residing in Zaikof Bay were juvenile, pre-recruit herring and that older age classes of herring were commonly found in Rocky Bay and the Green Island area. Sampling for size and age composition (AWL) was conducted in conjunction with the hydroacoustic survey and the first AWL data from Zaikof Bay provided additional troubling results. In late March, herring sampled from Zaikof Bay had an average weight of 132 grams and the predominant age classes were age-4 (26%) and age-5 (32%). Based on past years sampling in Zaikof Bay, the expectation was that a higher percentage of age-3 herring would be found in the AWL sample. The Zaikof Bay sample was less than 2% age-3 fish. While the sample did indicate that marketable sized herring were available, the preseason forecast had anticipated that, in numbers of fish, age-3 and age-4 herring would comprise 73% of the spring spawning population. The lack of age-3 fish in the Zaikof Bay samples was a troubling anomaly. In addition, age-4 herring were expected to be more numerous than age-5 herring whereas, in actuality, the opposite trend was indicated. This sample and subsequent AWL samples from the Montague Island area were indicating that few recruit aged fish were present in the area. The department's preseason expectation was that, because of numerous recruit aged fish, it might be difficult to locate discreet concentrations of marketable sized fish that would meet the processing industry's minimum standards. Once daily sampling commenced to assess roe maturity and average size, very few samples were collected that were below the minimum size standards set by the industry.

Aerial surveys to monitor abundance, distribution and spawning activity began on March 25 and continued throughout the month of April. In eastern PWS, 14.7 miles of spawn were observed between March 25 and April 20. The peak shoreline miles of spawn were observed during the first survey of the season on March 25. As in most years, the first spawn in PWS was seen around the

St. Mathews Bay and the Hells Hole area. April spawning events in other areas of eastern PWS can be characterized as light and intermittent. The peak survey counts in the Montague Island area occurred on April 15 with a large prespawning biomass of approximately 5,500 tons observed along the shoreline, predominantly in Rocky Bay. Peak spawning was observed at Montague Island from April 16 through April 19. Overall, the shoreline mile/days of spawn were significantly less than in previous seasons. A total of 6.1 miles of spawn were documented on Montague Island in 1999 as compared to 16 miles in 1998 (Figure 2). A majority of the spawning activity in the Montague Island areas occurred from April 16 through April 22 versus a much broader timing window of April 5 to April 22 in 1998 (Figure 3). A total of 18 miles of spawn was documented in the Montague Island area in 1997 from April 16 through April 21 (Figure 4).

An aerial survey on April 9 did not observe any herring around the Montague Island area and Zaikof Bay was the only location where marine mammals and sea birds were congregating. The marine mammal activity indicated that the herring biomass detected there during the hydroacoustic survey was still present. A test set was made at Zaikof Bay on Sunday, April 11 over the large biomass at the head of the bay. The average sizes from two samples were 143 grams and 147 grams. Roe maturity was measured at 6.6% mature and 3.7% immature from the first sample and 6.5% mature and 1.8% immature roe for the second sample. The Research Vessel Montague departed Cordova for the Montague Island area on Monday, April 12. As is tradition, the sac roe seine and gillnet fisheries had been placed on 48-hour advance notice on April 1. With the departure of the R/V Montague, advance notice for the sac roe seine fishery was reduced to 24 hours on April 12. If a fishery were likely, advance notice would have been shortened further. Advanced notice of 12 hours or more gave time for vessels and tenders still in area ports to reach the fishing grounds. During an aerial survey on April 12, approximately 250 tons of herring were observed in Stockdale Harbor. This was the first herring observation at Montague Island of any significance outside the Zaikof Bay area.

On April 14 the department announced that advanced notice for the sac roe seine fishery was being reduced from 24 hours to 12 hours the following day. The high tide series for April would begin later in the week. Peak tides would likely be a factor in the timing of a spawning event and, if the herring biomass suddenly improved, the shorter notice would allow the department to react more quickly. Concurrent with the reduced advance notice, the department announced its intention to proceed cautiously in regards to conducting a sac roe harvest. Daily roe maturity and age composition sampling would continue but there was no clear indication that the biomass at Montague Island was even close to matching the pre-season expectations. A roe maturity sample from Stockdale harbor on April 14 showed 8.3% mature roe and 3.3% immature roe with an average gram size of 131 grams. There were 35 males, 25 females and 3 spawnouts in the sample. An age composition sample collected in Zaikof Bay on Sunday, April 11 contained 202 fish: 125 males and 77 females. The average weight was 136 grams with an average length of 216 mm. Age-3 fish comprised 1.5% of the sample, age-4 fish comprised 27.2%, and age-5 fish comprised 35.6% of the sample. To date, all herring samples from Montague Island had been comprised of less than 2% age-3 fish. Age-4 and age-5 herring were the predominant age classes in the samples; however, there were significantly less age-4 herring than expected. The 1999 forecast indicated that age-4 herring would comprise roughly 50% of the spawning biomass. Higher than anticipated mortality in that age class over the preceding 12 months would greatly reduce the spawning biomass population in PWS.

An aerial survey on April 15 noted an increase in the herring biomass in Rocky Bay. It appeared that the prespawning herring that had been maturing in Zaikof Bay had spilled out of Zaikof Bay and entered Rocky Bay. The average size of Zaikof Bay herring had consistently been between 130 and 150 grams and the current AWL samples of Rocky Bay herring were consistent with the age composition of herring seen earlier in Zaikof Bay. An age composition sample collected in Rocky Bay on Thursday, April 15 consisted of 443 fish: 257 males and 184 females. The average weight was 143 grams with an average length of 218 mm. Age-3 fish comprised less than 1% of the sample, age-4 comprised 27%, age-5 comprised 32%, age-6 comprised 4% and age-7 and above comprised 4% of the sample. Marine mammal and bird activity increased inside Rocky Bay and had decreased in Zaikof Bay. Several roe maturity samples from Rocky Bay were also collected on April 15. Pooled sample results showed 9.2% mature roe and 1.1% immature roe with an average gram size of 135 grams. There were 76 males, 62 females, 10 immature and 0 spawn outs in the sample. A second sample showed 11.3% mature roe and 1.6% immature roe with an average gram size of 141 grams. There were 71 males, 34 females, 65 immature and 1 spawn out in the sample. An additional roe sample from Rocky Bay showed 8.3% mature roe, 0.8% immature roe with an average gram of 139 grams. There were 39 males, 29 females, 4 immature and 0 spawn outs.

By late in the evening of April 15, a majority of the biomass appeared to have exited Rocky Bay and moved toward Stockdale Harbor and Port Chalmers. To assess the remaining herring biomass in Zaikof Bay, the department conducted a hydroacoustic survey in Zaikof Bay on the evening of April 15. Preliminary estimates indicated that less than 1000 tons of herring remained in Zaikof Bay. Sampling indicated that the remaining fish were predominately juveniles. In some samples, the average size had dropped to 65 grams. Several roe maturity samples were collected from Zaikof Bay on April 16. The first sample showed 1.8% mature roe and 3.6% immature roe, with an average weight of 104 grams. There were 44 males, 7 mature females, 30 immature females, 10 spawn outs and 5 juveniles. The second sample showed 2.6% mature roe, 3.0% immature roe, with an average weight of 102 grams. There were 52 males, 8 mature females, 24 immature females, 4 spawn outs and 10 juveniles. The third sample showed 1.4% mature roe, 3.6% immature roe, with an average weight of 114 grams. There were 37 males, 6 mature females, 28 immature females, 8 spawn outs and 9 juveniles. From the roe maturity samples and the hydroacoustic survey, it appeared that the spawning biomass had departed Zaikof Bay a few days earlier leaving immature and juvenile fish.

The solitary herring biomass that had been in Zaikof Bay appeared to be the only significant aggregation of herring that was contributing to the spawning population in the Montague Island area. Aerial surveys and AWL samples in the Port Chalmers and Stockdale Harbor areas indicated that those herring were the same fish that has exited Zaikof Bay two days earlier. Approximately one mile of spawn had been observed near Montague Pt. on April 16 and 17. The department announced on April 17 that it would continue to assess the Montague Island area for any improvements in the herring biomass but, unless a marked improvement was noted in the biomass and age structure of the herring population, a sac roe fishery was unlikely to occur. The sac roe seine fleet remained on 12-hour advance notice. The sac roe gillnet fleet remained on 48-hour advanced notice.

Spawning continued on April 17 at the reef near Montague Point. The department conducted a three-hour sonar survey near Green Island and Port Chalmers but did not detect any significant schools of herring. During an aerial survey the same day, approximately 2,000 tons of herring were observed between Montague Point and Graveyard Point. Over the next 48 hours, there was no improvement in the observed biomass in the Montague Island area. With spawning activity well underway near Montague Point and in scattered areas of Stockdale Harbor, the decision was made to cancel both sac roe fisheries effective 12:00 noon on Tuesday, April 20. Because the closed pound fishery was already underway, permit holders who had introduced herring into closed pounds had until Sunday, April 25 to release herring. All pounded kelp was, by regulation, required to be removed from the water at that time (Table 7).

SPAWN-ON-KELP IN POUNDS FISHERY

PWS herring pound permit holders were given the option preseason of choosing to operate an open pound with a kelp quota of 680 blades or a closed pound with a kelp quota of 435 blades. Open pounds would be allowed to fish in the Montague Island area where a majority of the PWS spawning biomass has been located in recent years or in northeast PWS, north and east of a line from Johnstone Point to Point Freemantle. Areas open to closed pounding in northeast PWS would depend on sufficient available spawning biomass and effort that may be poised to take advantage of the biomass. Of the 128 limited entry permit holders, seven indicated their intention to operate open pounds, while 17 permit holders advised the department of their intention to operate closed pounds. Two permit holders declared they would not participate in the 1999 fishery. A total of 102 permit holders did not respond by the April 1 open pound reporting deadline. These permit holders would be granted a closed pound blade quota in the event they decide to participate in the fishery. The closed pound fishery occurred in the waters of St. Matthews Bay in the Eastern District and the open pound fishery took place in Port Chalmers in the Montague Island area. Permit holders began staging pounds on April 15. The two open pound permit holders had their pound and kelp in the water by April 17. Seven permit holders operating closed pound structures also had their kelp in the water by the 17th and began seining herring for the introduction into pounds that day. In part, due to the limited time available to introduce herring to pounds and the low abundance of herring, no more permit holders participated in the fishery.

The first aerial survey of the season was flown on March 25. Approximately five miles of spawn and less than 50 tons of herring were observed from Simpson Bay to Knowles Head. The aerial survey flown on March 28 from Simpson Bay to the Montague Island area, including the northern shore and Naked Island, observed less than one mile of spawn and five tons of herring in Simpson Bay.

On March 30, it was announced that open pounds could be operated in the entire Prince William Sound Management Area beginning 12:00 Noon Thursday, April 1. On April 1, the closed pound fishery was placed on 48-hour notice effective 12:00 noon that day. It was anticipated that the closed pound fishery would occur either in the waters of Port Fidalgo or Port Gravina. The area and duration of openings was dependent on aerial survey results indicating sufficient biomass. An aerial survey flown on Friday, April 2 included only eastern PWS due to deteriorating weather conditions. No herring or spawn was observed. The aerial survey conducted on Sunday April 4

included the eastside of PWS, the north shore, Naked Island and the Montague Island area. Approximately five tons of herring were observed in Beartrap and St. Matthews Bays. Some light and old spawn was also observed in St. Matthews and Sheep Bays.

An aerial survey conducted on Tuesday, April 6 included the east side of PWS, the north shore, Naked Island and the Montague Island area. Approximately 40 tons of herring were observed in Eaglek Bay, 20 tons were seen in St. Matthews Bay and 15 tons were seen in Sheep Bay. Some light spawn was also observed in St. Matthews and Sheep Bays. An aerial survey conducted in eastern PWS on Wednesday, April 7 observed approximately 10 tons of herring and less than a mile of spawn. An additional 50 tons of herring and about a mile of spawn were also seen in St. Matthews Bay. On April 8, an aerial survey of eastern PWS, the north shore, Naked Island and the Montague Island area observed approximately 400 tons of herring along the shoreline between Hell's Hole and St. Matthews Bay. Fifty tons of herring were also seen near the village of Tatitlek and 60 tons were seen in the Montague Island area. Light spawn was also observed in Hell's Hole, Point Gravina and near Tatitlek. On Friday, April 9, an aerial survey of eastern PWS and the Montague Island area conducted under poor to fair conditions, observed herring spawn near Virgin Bay and in St. Matthews, Olsen, Landlocked and Sheep bays. Approximately eight tons of herring were seen in Sheep Bay, 150 tons in St. Matthews Bay, 10 tons in Olsen Bay, 30 tons in Fish Bay and 100 tons were observed in Virgin Bay.

On Monday, April 12 the advanced notice for the closed pound fishery was reduced to 24 hours effective 12:00 noon. The advance notice was reduced as some permit holders had arranged to receive kelp from Southeast Alaska and the observed biomass appeared to be building. Although the peak biomass observed in eastern PWS was less than 500 tons, it was felt that the general trend had been a slow but steady improvement in the size of the herring biomass. The aerial survey flown on April 12 in the Montague Island and eastern PWS area observed approximately 400 tons of herring. An estimated 250 tons of herring on the verge of spawning were observed in Stockdale Harbor. An estimated 150 tons were observed in the west arm of Two Moon Bay. Four tenths of a mile of spawn was observed in Fish Bay and some spawn was seen in Tatitlek Narrows.

On Wednesday, April 14, the advance notice for the closed pound fishery was further reduced to 12 hours effective 12:00 noon, Thursday, April 15. The notice was reduced primarily based on a steady increase in roe maturity and increasing tides. Since it appeared that no more than 17 permit holders would participate in the fishery, and most had kelp in hand or would soon be receiving kelp, the department announced on April 15 that the waters of Prince William Sound north and east of a line from Point Freemantle to Johnstone Point were open to the introduction of herring into closed pounds effective 12:00 noon on Friday, April 16. Waters of Tatitlek Narrows from the ferry dock to Black Point remained closed to seining. An aerial survey was flown on April 16 in eastern PWS and the Montague Island area. Approximately one ton of herring was observed in Fish Bay, one ton in Two Moon Bay, 15 tons between Porcupine Point and Knowles Head and 54 tons were seen from Knowles Head to Hell's Hole. Less than one mile of spawn was seen east of Red Head. On Saturday, April 17, an aerial survey conducted in eastern PWS and the Montague Island area observed approximately 2000 tons of herring from Rocky Bay to Port Chalmers, two tons were seen in Sheep Bay, and 18 tons between Hell's Hole and Red Head. Approximately one

mile of spawn was seen in eastern PWS and about a mile and a half was found around Montague Island.

On Sunday, April 18, the department announced that seining for introduction of herring into closed pounds could begin effective 12:00 noon, Tuesday, April 20. It was further stipulated that all pound permit holders that introduced herring into pounds must release those herring by Sunday, April 25. All kelp, with or without product, was also required to be out of the water by Sunday, April 25. An aerial survey conducted on Sunday, April 18 in eastern PWS and the Montague area observed 20 tons of herring in Sheep Bay, 1 ton in Two Moon Bay, 10 tons near Fish Bay, 10 tons in Galena Bay and 530 tons were seen from Rocky Bay to Port Chalmers. Light spawn was observed in Galena Bay, Fish Bay, near Hell's Hole, near Montague Point, in Port Chalmers and about 2.5 miles of spawn were observed in Rocky Bay. An aerial survey of eastern PWS and the Montague Island area, was flown on Monday, April 19, observed seven tons of herring and a quarter mile of spawn in Sheep Bay, five tons and a half mile of spawn in St. Matthews, 10 tons between Hell's Hole and Redhead, 2 miles of spawn in Fish Bay, 35 tons in Landlocked Bay, 10 tons in Galena Bay, and 75 tons of herring and two miles of spawn were seen in Rocky Bay. Less than a quarter mile of spawn was also observed at the reef on Montague Point and in Stockdale Harbor. On Monday, April 20, an aerial survey of eastern PWS and the Montague Island area was flown. Approximately five tons of herring were observed in Simpson Bay, one ton of herring and less than a quarter mile of spawn in Sheep Bay, five tons of herring in Snug Corner Cove, less than a quarter mile of spawn in Fish Bay, 25 tons of herring in Landlocked Bay, five tons of herring and two miles of spawn in Rocky Bay and one ton of herring and less than a quarter mile of spawn in Port Chalmers. The aerial survey conducted on Monday, April 22 in the Montague Island area under poor conditions observed no herring and less than a half mile of spawn in Port Chalmers. An aerial survey conducted on Monday, April 24 of eastern PWS and the Montague Island area observed no spawn and 15 tons of herring in Landlocked Bay and 8 small schools of herring totaling 50 tons between Rocky Point and Virgin Bay in the Tatitlek Narrows. The last aerial survey of eastern PWS and the Montague Island area for the season was flown on Monday, April 28. In response to reports of herring south of Port Chalmers, the survey was extended to include both Hanning Bay and Macleod Harbor on Montague Island. No signs of herring, spawning activity or sea lion and bird feeding were found on or near Montague Island. The only herring observed during the survey were three small schools totaling approximately eight tons of herring near Virgin Bay.

Harvesting of spawn on kelp from pounds commenced on Saturday, April 24. A total of nine permit holders participated in the fishery. The two closed pounds with three permit holders in one pound structure and four in the another operated the entire season within St. Matthews Bay in Port Fidalgo. The two permit holders operating the single open pound were set up in Stockdale Harbor. The total harvest for the seven closed pound permit holders was 11,000 pounds of product, while the harvest for the two open pound permit holders was 1,200 pounds of spawn on kelp. No value has been assigned to the pound harvest.

OUTLOOK

The preliminary forecast for the year 2000 herring spawning biomass in Prince William Sound is 23,987 tons. By age class, the forecasted contributions to the spring of 2000 spawning biomass are expected to be 7% age-3, 0.1% age-4, 6% age-5, 41% age-6, 23% age-7, 15% age-8, and 8% age 9+. The spring spawning biomass is forecasted to have an overall average size of 112 grams. Although the Age Structure Analysis (ASA) model predicts that the spring of 2000 herring spawning biomass will be slightly above the 22,000 ton minimum threshold, the model assumes that an average age-3 recruitment to the fishery will occur over the coming winter months. As the herring samples collected last spring indicated, very few age-3 herring had recruited to the spawning biomass in 1999. The year 2000 forecast predicts an extremely low contribution from age-4 herring in next spring's spawning biomass. Results from hydroacoustic surveys, aerial surveys, and disease sampling in 1999 appear to indicate that the Prince William Sound herring population suffered a decline of approximately 40%. This decline was centered primarily around age-3 and age-4 herring, and was likely the result of another outbreak of viral hemorrhagic septicemia (VHS). Younger aged herring appear to be particularly susceptible to this virus. While there were very few age-3 herring seen in samples collected in the spring of 1999, the decline may have been equally severe among herring aged 1 and 2. If, next spring, the predicted age-3 recruitment again fails to materialize, the size of the PWS herring population will likely continue to decline, even in the absence of a commercial fishery. Consecutive years of low recruitment will further delay the recovery of the herring population to a sustainable size that is capable of supporting a commercial harvest.

On September 29, 1999 the department canceled the 1999 food/bait fishery, and all 2000 spring herring fisheries including the seine and gillnet sac roe harvests, the spawn-on-kelp pound fishery, and the wild spawn-on-kelp harvest. The department will continue to monitor the PWS herring biomass this fall and next spring to assess growth and recruitment. An ongoing disease study will continue to examine the incidence of VHS in the PWS herring population this fall and next spring.

STUDY OF VIRAL HEMORRHAGIC SEPTICEMIA IN THE SPAWN-ON-KELP POUND FISHERY IN PRINCE WILLIAM SOUND

In the spring of 1993, herring seen near Montague Island were exhibiting odd schooling behavior. When these fish were examined, lesions were observed on the outside of their bodies. Tissue samples sent to the ADF&G pathology laboratory in Juneau revealed that the lesions and odd swimming behavior were due to infection by a virus, viral hemorrhagic septicemia or VHS. Additional herring samples collected in 1994 were examined and found to be infected with both a fungus: *Ichthyophonus hoferi* (29%) and VHS (5%). Laboratory results from the study of *Ichthyophonus* indicate that this infection is not by itself lethal to herring. The same cannot be said of VHS. In laboratory studies, mortality in herring infected with VHS ranged from 20% up to 100%. It appears that the virus that causes VHS may be present in a latent state in the PWS herring stock. Values for latency in juvenile herring range from 10% - 15%. VHS has also been found in herring from Sitka Sound in Southeast Alaska. Stressing herring infected with VHS causes expression of the disease and leads to the transmission of the disease to non-infected herring. Based on results from laboratory and field studies, it is clear that stress caused by capturing and restraining herring in pounds may lead to the

rapid expression of VHSV by these fish. Preliminary evidence indicates closed pounding increases the prevalence of VHS and may hinder population recovery.

In the spring of 1997, a 2-year study was initiated to determine if activities involved with the PWS closed pound fishery were associated with increased VHSV infections among the captured and confined herring. In the spring of 1997, herring and water samples were collected from three closed pounds after the herring were introduced to the pound. Herring density between pounds was variable. Tissue samples from 40 herring per pound were collected daily until the herring were released. Water samples were also collected daily from inside each pound and three meters from the pound. The length, weight and sex of all herring collected were recorded and scale samples were taken to establish the ages of the herring sampled.

In the spring of 1998, the second part of the two-year study was conducted. Sampling methodology was slightly different from procedures in 1997. One difference was that herring were put on ice prior to tissue being taken while in 1997, the herring were kept alive until examined. Another difference was that the water samples collected in 1998 were diluted with a preservative and not frozen prior to analysis. Samples of forty herring were again collected from each of three pounds.

Results from the samples collected in 1997 indicated that the prevalence of VHS in all pounds peaked after four days of confinement and declined to low levels after six days (Figure 5). VHS was even more prevalent in 1998 than in 1997 (Figure 6). Peaks of VHS prevalence as high as 87% were found after eight days confinement in all three pounds following initially low prevalences of VHS. A bimodal VHS prevalence pattern was indicated by significant increases on the second and sixth day of confinement.

Herring age distribution in two of the three pounds studied in 1997 was nearly identical, consisting mostly of 9-year-old herring (40%). The remaining pound contained primarily 3-year-old herring (60%) and only 5% 9-year-old herring. VHS prevalence was associated primarily with 4 to 6-year-old (20% in each year class) and decreased with age. VHS prevalence was significantly greater in females than in males.

The age composition of herring sampled in 1998 was nearly identical between pounds. Age classes were dominated by 3-year-old herring with few herring 7 years or older present. Unlike impounded herring from the 1997 study, prevalence of VHS in males (36.4%) and females (34%) was not significantly different.

None of the water samples collected in 1997 tested positive for VHS. This may be due to the method of collection and transport, as the samples were thawed and refrozen several times prior to analysis. Laboratory studies have demonstrated an approximate 90% decrease in VHS concentration in water samples following freeze-thaw cycles. Samples collected in 1997 underwent at least three freeze-thaw cycles prior to examination.

No VHS was recovered from water samples collected in 1998 from inside the herring pounds prior to the introduction of herring. However, low concentrations of VHS were found in water samples from inside of the pounds when herring were initially put into the pound. VHS was also found outside the pounds as early as the second day after herring had been introduced. Waterborne VHS concentrations inside the pounds followed a bimodal pattern with a small peak occurring within four days after introduction of herring and a second larger peak occurring just prior to the release on the eighth day of confinement. Concentrations of VHS in the water samples from inside the pounds continued to increase throughout the study period. Laboratory tests have found that the concentrations of waterborne VHS found outside the pounds were lethal to native herring.

The results of this study indicate that the confinement of apparently healthy herring in spawn-on-kelp pounds often leads to increased infections of VHS that peak soon after capture. The magnitude, duration, and severity of the infection depend upon many factors including herring age and immune status, shedding intensity, and fish density.

A mechanism to explain VHS infection in closed pounds has been proposed based on the available data. Wild herring, a portion of which carry and shed low levels of waterborne VHS are captured and introduced into a pound. Confinement increases the density, thereby increasing both the stresses on the herring and probability of transmission of infectious waterborne VHS particles. If few fish initially shed virus, and if a portion of the population is already immune to low levels of waterborne virus, relatively few fish are infected immediately after impoundment. These early VHS-positive fish constitute the first prevalence peak and either die from VHS with high viral concentration after a brief period in the pound or recover from the infection. VHS shed into the water from the initial carriers then infects other fish that become infected and shed more VHS, which accounts for the second peak of infection and increasing viral concentration in the surrounding water.

Although density of impounded herring may influence the magnitude of VHS infection, a more important factor is exposure of a susceptible herring population to sufficient levels of waterborne VHS. A group of susceptible herring confined at high densities will not undergo mass and simultaneous infection unless a small percentage of the population is VHS-positive and sheds waterborne virus. Similarly, a group of confined, immune herring will not undergo mass and simultaneous infection even if exposed to waterborne virus shed by a small percentage of VHS-positive fish. Exposure of a susceptible group of herring to waterborne VHS is believed to account for the increased viral prevalence among confined herring, rather than re-activation of latent infections, because isolation studies of individual herring did not result in viral prevalences as high as seen among fish held in a community tank.

Infections of VHSV were less common among older herring than among young herring sampled from closed pounds in 1997 and 1998, indicating that older herring are less susceptible to infection by VHS than are younger herring. Older herring are believed to develop an immunity to VHS through exposure to low level waterborne virus at a young age and subsequent recovery from active, but non-lethal, infections. Low levels of waterborne VHS have been detected near free-ranging herring in PWS, which indicates that exposure of herring to low levels of VHS does occur in nature and constitutes a likely source of infection for subsequent production of protective antibodies. Older herring that have survived prior exposure to VHS have a selective advantage. However, a high proportion of young herring whose immune systems are not fully developed and which do not produce protective antibodies for VHS may die from unusually high VHS exposures that follow capture and confinement.

The utilization of older herring age classes (primarily 5-9 years old) during the 1997 pound fishery resulted in viral prevalence peaks as high as 25%, which was significantly less than the 88% which occurred when younger age classes (primarily 3 year olds) were used in the closed pounds operated in 1998. Therefore, one method to reduce the likelihood of VHS infection occurring in closed pounds would be to base management of the fishery on the age composition of the returning herring. One management option would be to not allow the fishery to occur when the returns are predominately younger fish. Besides increasing the likelihood for massive VHS infection and the potential loss of young fish from the population due to mortality from disease, the use of smaller, younger herring in the pound fishery frequently results in poor quality product. Since the density of herring in the pound is related to expression of VHS, another management

option would be to restrict the tonnage of herring permit holders that may be put into the pound. This option has its own drawbacks as the department and FWP have long acknowledged that short of removing all herring from a closed pound, no method exists to accurately determine the amount of herring put into a pound. In 1996, the Board of Fisheries, in recognition of the potential threat that diseased herring in closed pounds might pose to the general population, provided the department the authority to determine if these impounded herring may be released into the wild. In 1997, the department harvested herring from the disease study pounds to prevent their release into the wild. It was the department's intent to sell the herring, but local processors were unwilling to purchase these low quality herring. The last alternative will be to eliminate closed pounding as a gear type and rely on open pounds as the only legal pound fishery gear.

PWS Herring Biomass Estimates

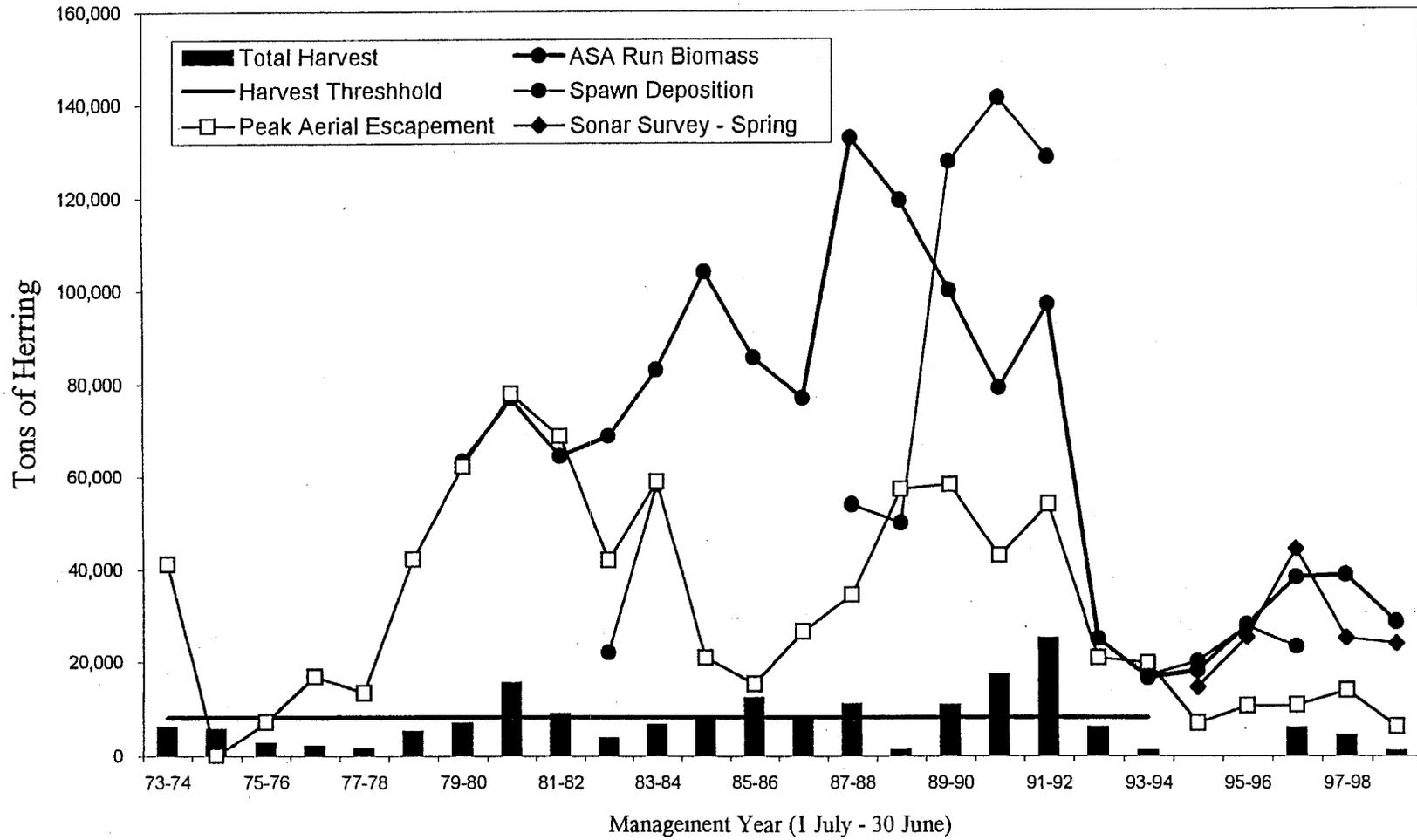


Figure 1. Prince William Sound annual herring biomass indices, harvest, and harvest threshold by management year, 1973 - 98.

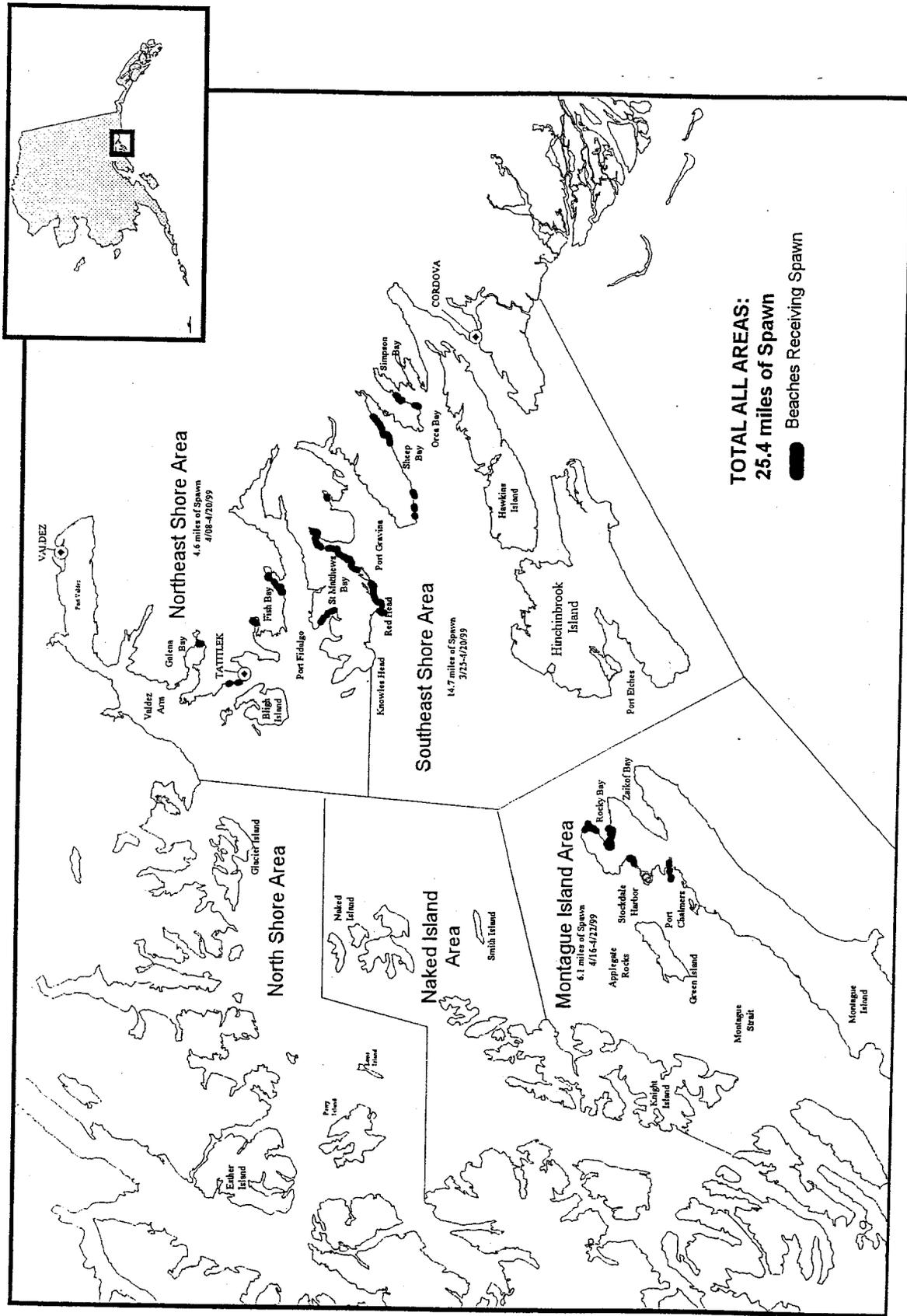


Figure 2. Prince William Sound herring spawn, shoreline mileage, and dates of spawning mapped during aerial surveys, 1999.

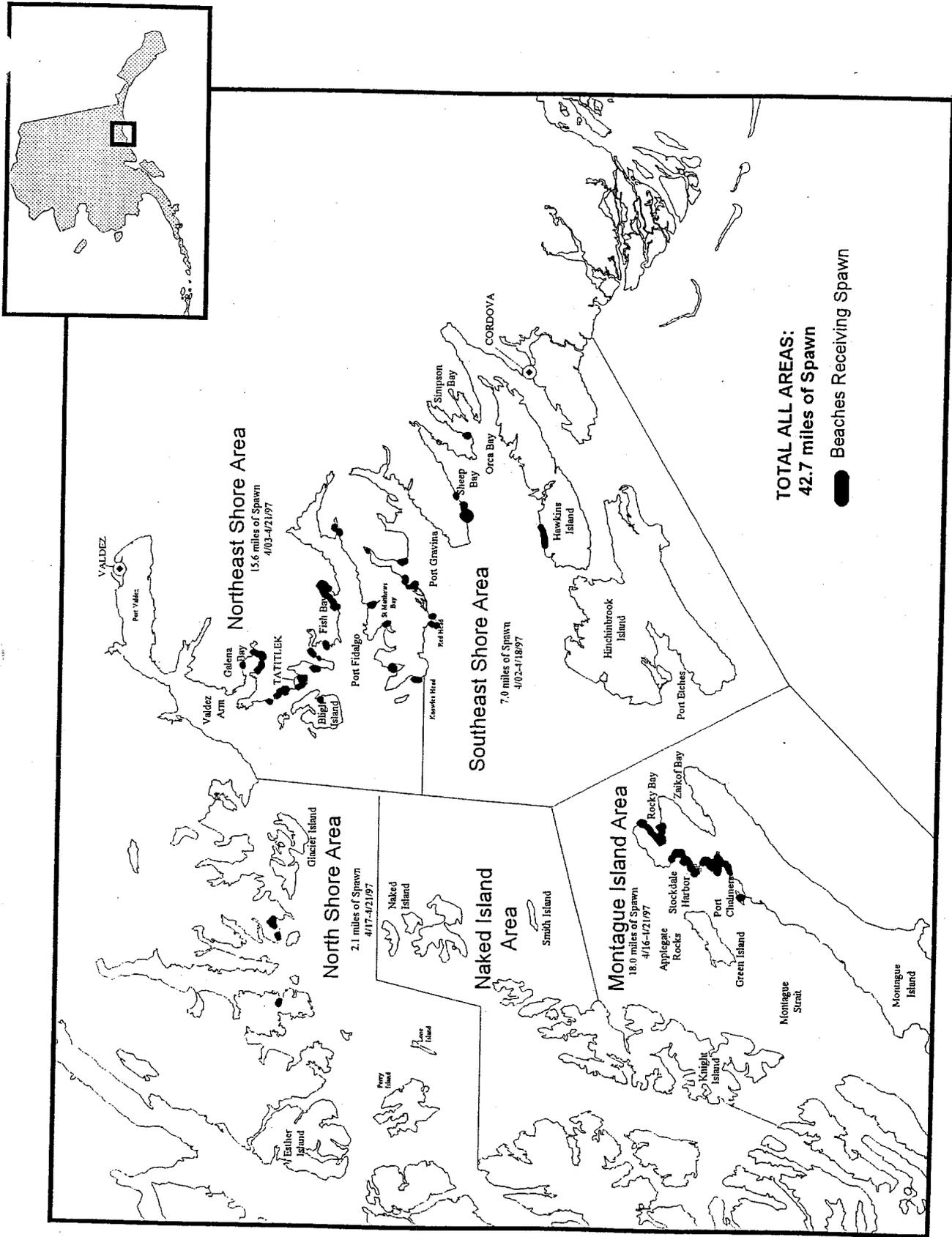


Figure 4. Prince William Sound herring spawn, shoreline mileage, and dates of spawning mapped during aerial surveys, 1997.

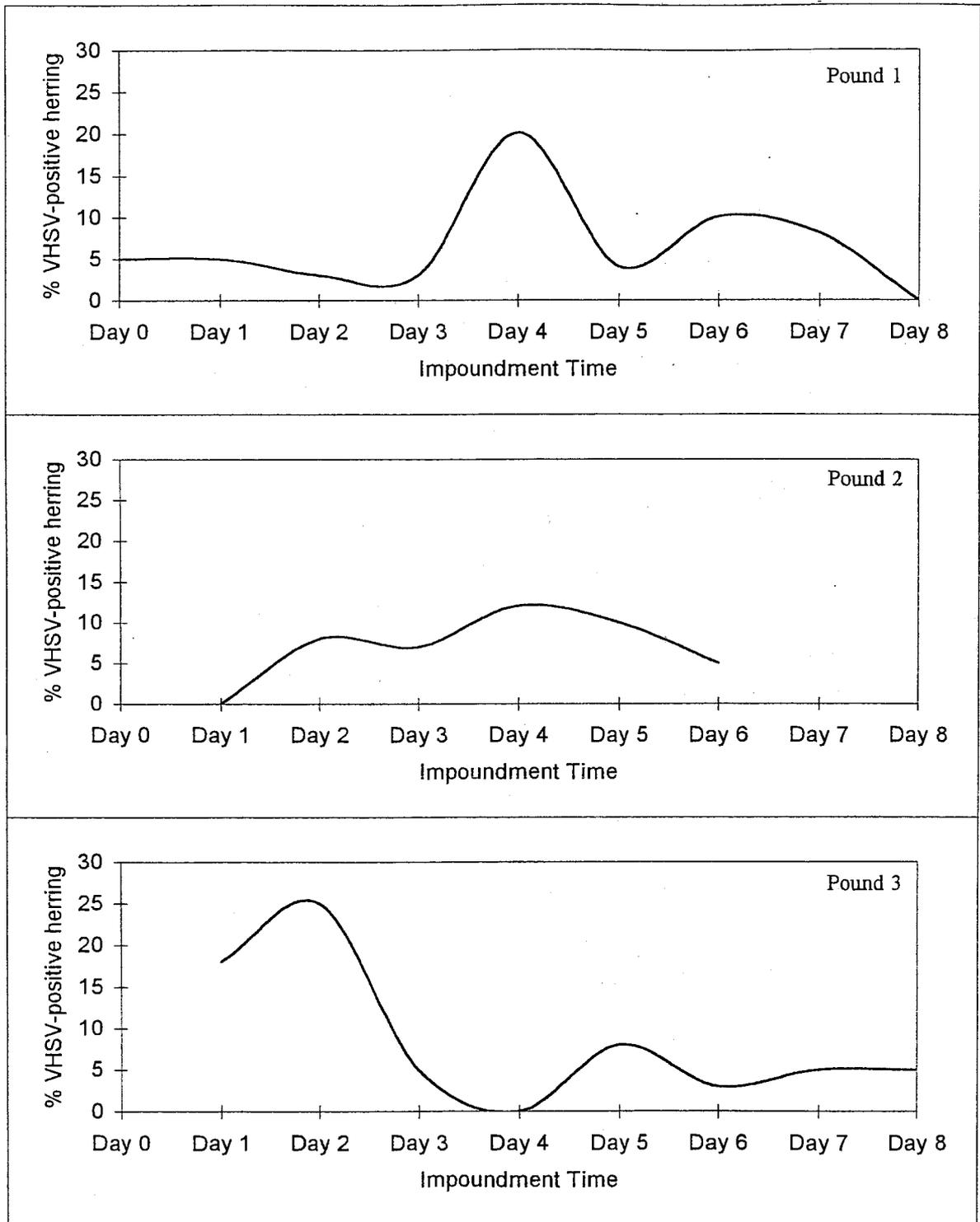


Figure 5. Incidence of Viral Hemorrhagic Septicemia in herring from spawn-on-kelp ponds sampled in 1997.

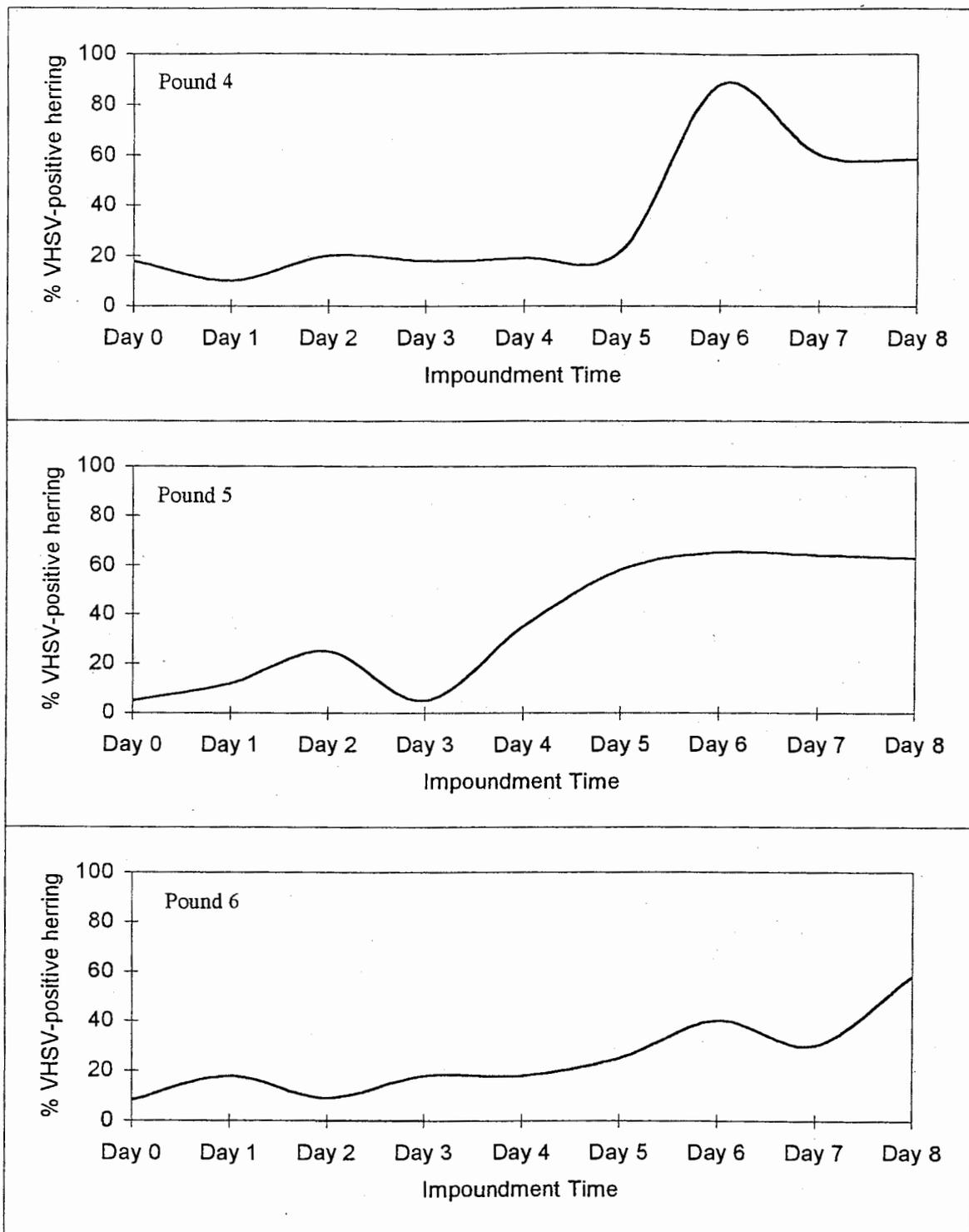


Figure 6. Incidence of Viral Hemorrhagic Septicemia in herring from spawn-on-kelp ponds sampled in 1998.

Table 1. Annual Pacific herring biomass indices, Prince William Sound, for herring management years 1973 - 1998 and the forecast of prefishery run biomass for 1999.

Harvest Management Year	Total Sac Roe Harvest ^a (tons)	Aerial Survey Estimates				Unexploited Escapement Biomass		Pre-Fishery Run Biomass
		Peak Biomass Estimate ^b (tons)	Maximum Possible Observed Biomass ^c	Miles of Spawn ^d	Mile Days of Spawn ^e	Spawn Deposition Surveys ^f (tons)	Age Structured Analysis ⁱ (tons)	Age Structured Analysis ⁱ (tons)
1973-1974	6,375	41,080	107,290	38.5	75.2			
1974-1975	5,854			34.2	42.4			
1975-1976	2,584	7,330	25,247	32.8	33.7			
1976-1977	2,267	16,830	17,460	39.3	73.5			
1977-1978	1,391	13,410	36,540	28.7	36.3			
1978-1979	4,138	42,100	107,390	54.5	73.2			
1979-1980	6,307	62,110	122,050	50.5	73.9		63,290	58,221
1980-1981	14,003	77,810	161,690	85.4	140.1		76,890	63,494
1981-1982	7,542	68,790	97,620	49.0	65.1		64,366	56,823
1982-1983	2,834	41,850	107,710	67.4	99.8	22,000 ^g	68,753	65,949
1983-1984	6,289	58,870	158,760	60.1	86.8	58,089	83,037	77,021
1984-1985	7,177	20,830	60,954	101.2	149.5		104,034	96,694
1985-1986	10,277	15,180	54,820	72.4	152.3		85,543	74,740
1986-1987	5,516	26,530	52,192	65.3	155.9		76,891	71,773
1987-1988	8,330	34,270	67,175	166.3	236.9	53,785	132,633	123,346
1988-1989	^h	56,915	186,708	98.4	185.8	49,914	119,237	119,237
1989-1990	8,868	57,900	145,013	94.1	144.4	127,478	99,783	89,613
1990-1991	12,665	42,765	141,375	58.0	64.8	140,964	78,985	64,836
1991-1992	17,725	53,835	130,569	74.7	99.5	128,263	96,860	77,598
1992-1993	1,030	20,725	109,865	20.4	40.8		24,873	22,735
1993-1994	0	19,640	154,008	14.6	20.0	17,069	16,559	16,559
1994-1995	0	7,113	20,868	20.4	32.3	20,022	18,104	18,104
1995-1996	0	10,691	37,771	27.2	39.1	27,670	27,909	27,909
1996-1997	4,879	10,858	57,114	42.7	56.0	23,171	37,925	33,387
1997-1998	3,744	13,817	50,124	38.7	48.5		38,389	34,726
1998-1999	0	6,366	10,872	25.4	38.0		28,362	28,310
1999-2000								23,987

^a Represents the combined common property seine and gillnet sac roe harvest in short tons.

^b Largest single day aerial estimate of Pacific herring biomass in short tons.

^c The sum of all daily aerial biomass estimates for a given year.

^d Total linear miles of spawn.

^e The sum of the daily observed linear miles of Pacific herring spawn.

^f Estimates are made from underwater surveys of spawn deposition.

^g Partial estimate of spawning biomass from feasibility study.

^h All Pacific herring commercial sac roe and spawn-on-kelp fisheries in Prince William Sound were closed during the spring of 1989 due to the potential for contamination of catches from the *TV Exxon Valdez* oil spill.

ⁱ Forecast from age structured analysis, October 1999.

Table 2. Pacific herring sac roe seine and gillnet fishery effort, anticipated harvest, and actual harvest, Prince William Sound, 1969-1999.

Calendar Year	Seine Fishery							Gillnet Fishery							Total Harvest (tons)
	Opening Dates	Hours	Effort (Boats)	Guideline Harvest ^a	Harvest (tons)	CPUE (tons/Boat Hr)	Estimated Roe %	Opening Dates	Hours	Effort (Boats)	Guideline Harvest ^a	Harvest (tons)	CPUE (tons/Boat Hr)	Estimated Roe %	
1969	3/01 - 6/30		5		325.4										325.4
1970	3/01 - 6/30														
1971	3/01 - 6/30		12		919.2										919.2
1972	3/01 - 6/30		18		1,777.2										1,777.2
1973	4/23 - 5/09		31		6,991.9										6,991.9
1974	4/10 - 4/17		72		6,371.0			4/10 - 4/17		3		3.8			6,374.8
1975	4/15 - 4/22	14.0	76		5,853.8	5.50			14.0						5,853.8
1976	5/08 & 6/01	13.0	66		2,584.2	3.01			13.0						2,584.2
1977	4/09 - 4/10	38.0	58		2,265.6	1.03		4/09 - 04/10	38.0	1		1.6	0.04		2,267.1
1978	4/17 - 4/21 ^b	106.0	75	5,000	1,329.5	0.17		4/17 - 04/21	106.0	38		61.7	0.02		1,391.2
1979	4/07 - 4/19	215.5	89	5,000	4,138.0	0.22		CLOSED ^c							4,138.0
1980	4/01 - 4/09	162.0	76	5,000	6,042.2	0.49		4/17 - 5/05		16		264.4			6,306.7
1981	4/01 - 4/09	60.0	106	5,000	13,768.2	2.16		4/16 - 4/18	53.0	18		234.5	0.25		14,002.8
1982	4/23	2.0	95	5,000	7,148.3	37.62	10-14%	4/24 - 4/26	54.0	18		393.9	0.41	12-15%	7,542.2
1983	4/13	1.0	103 ^d	5,000	2,728.5	26.49	11.0%	4/21 - 4/22	24.0	22		105.4	0.20	11.0%	2,833.9
1984	4/14	3.0	105 ^e	5,000	5,946.1	18.88	10-11%	4/18 - 4/22	59.0	23	250	342.7	0.25	8-14%	6,288.8
1985	4/28 - 4/29	4.0	103 ^f	5,000	6,764.1	16.42	10-12%	4/29 - 5/01	34.0	21	250	413.3	0.58	10-12%	7,177.4
1986	4/17	3.0	106	5-7,000	9,828.1	30.91	11.0%	4/24 - 4/28	90.0	24	3-400	448.6	0.21	11.4%	10,276.7
1987	4/08 - 4/09	1.5	96	3-5,000	4,982.2	34.60	10.0%	4/10 - 4/11	24.0	24	2-300	533.3	0.93	9.5%	5,515.5
1988	4/21 - 4/22	2.0	105	4-5,000	7,977.3	37.99	10.5%	4/23	5.5	24	275	353.0	2.67	10.0%	8,330.3
1989	Season Closed ^g			6,400							375				0.0
1990	4/12	0.3	96	6,038	8,362.1	290.35	10.0%	4/13	4.0	24	353	505.4	5.26	10.6%	8,867.5
1991	4/09, 4/10, & 4/19	1.3	104	11,233	11,923.0	85.32	10.5%	4/18	10.5	24	657	742.0	2.94	11.06%	12,665.1
1992	4/13, 4/17, & 4/21	2.0	104	14,100	16,784.2	80.69	10.0%	4/23 - 4/24	11.0	24	825	940.6	3.56	10.8%	17,724.8
1993	No Harvest			15,586				4/15, 4/17-4/19	36.0	24	912	1,029.9	1.19	11.01%	1,029.9
1994	Season Closed ^h			0	151.0						0				151.0
1995	Season Closed ^h			0							0				0.0
1996	Season Closed ^h			0							0				0.0
1997	4/13, 4/15	1.8	71	2,965	4,703.5	36.80	9.75%	4/09	2.5	22	175	175.7	3.19	8.0%	4,879.2
1998	4/06	0.5	46	3,367	3,329.7	144.77	9.6%	4/11, 4/12	6.5	20	197	415.1	3.19	11.0%	3,744.8
1999	Season Closed ^j			3,447							202				0.0

^a Guideline harvest based on pre-season harvest projection beginning in 1986.

^b An additional opening on 6/14 for 6 hours resulted in no harvest.

^c Gillnet fishery closed by Board of Fisheries action.

^d Of 103 boats participating, 72 actually made deliveries.

^e Of 105 boats participating, 101 actually made deliveries.

^f Of 103 boats participating, 62 made deliveries at Montague Island and 90 made deliveries in the north-shore area.

^g All Pacific herring commercial sac roe and spawn-on-kelp fisheries in Prince William Sound were closed during the spring of 1989 due to the potential for contamination of catches from the T/V Exxon Valdez oil spill.

^h Total for 1991 includes a 92.2 ton test fishing set made by ADF&G for aerial survey calibration.

ⁱ Total for 1992 includes a 192.5 ton test fishing catch made by ADF&G for aerial survey calibration.

^j Season closed due to low herring abundance.

^k Harvest for 1994 consisted of a single test fishing catch made by ADF&G for aerial survey calibration.

Table 3. Pacific herring spawn-on-kelp harvest produced in pounds, Prince William Sound, 1979 - 1999.

Calendar Year	Fishery Dates ^c	Effort				Guideline Harvest (tons)	Blades per Permit Holder		Spawn-on-Kelp Harvest (tons)			Herring Utilized ^b (tons)		
		CFEC Permits ^d	Permits Committed ^e	Producing Permits ^a			Closed ^f	Open ^g	Closed ^f	Open ^g	Ribbon		Macrocystis	Total
				Closed ^f	Open ^g									
1979		2	0											
1980	4/14	14	4	2		8			0.9	0.4	1.3	16.6		
1981	4/14	18	18	7		16			8.6	1.1	9.7	120.7		
1982	4/29-5/10	25	20	18		26			25.1	0.5	25.5	319.2		
1983	4/30-5/04	47	38	26		26			17.7	10.1	27.7	346.7		
1984	4/24-5/08	65	45	37		26			6.4	18.8	25.2	315.1		
1985	4/25-5/07	81	59	50		40			12.1	28.1	40.2	502.1		
1986	4/21-4/28	104	82	81		60			0	72.2	72.2	903.0		
1987	4/10-4/21	111	111	108		85			0	61.2	61.2	765.1		
1988	4/12-4/23	122	122	119		85			0	123.2	123.2	1,540.5		
1989	Season Closed ^h													
1990	4/11-4/26	128	128	122		118			0	98.8	98.8	1,235.3		
1991	4/07-4/20	126	126	119		220	1,200		0	202.4	202.4	2,530.5		
1992	4/07-4/24	127	127	127		276	1,770		0	242.2	242.2	3,027.7		
1993	4/10-4/22	128	124	52		305	1,950		0	106.4	106.4	1,330.5		
1994	Season Closed ⁱ													
1995	Season Closed ⁱ													
1996	Season Closed ⁱ													
1997	4/10-5/6	128	116	7	84	725	410	640	0	34.3	34.3	290.5		
1998	j	128	36	13	20	823	425	660	0	10.7	10.7	104.3		
1999	k	128	27	7	2	843	435	680	0	6.2	6.2	48.8		

^a Number of permits that were successful in producing spawn-on-kelp product. Due to the group cooperation in this fishery, production is frequently reported for a few individuals whose pounds did not produce spawn-on-kelp product.

^b The equivalent harvest of Pacific herring due to stress mortality and the removal of reproductive capacity from the population based on the assumption that 12.5 tons of Pacific herring are used to produce 1 ton of spawn-on-kelp product.

^c Dates that the fishery was opened to seines for the capture and placement of Pacific herring into pounds.

^d Prior to 1994, Commissioner's permits issued to applicants registering prior to the March 1 deadline. After 1994, the number of permits represents limited entry permits. Beginning in 1997, permit holders were allowed to operate pounds in open or closed configuration, and required to state intended configuration prior to season.

^e The number of individuals receiving an equal allocation of the guideline harvest. Prior to 1994 this represents the number of individual pounds constructed by the April 1 deadline. Beginning in 1997, this number represents permit holders stating intended configuration prior to season.

^f A pound fished in a closed configuration consists of a rectangular floating frame with webbing suspended below, that encloses herring and kelp for period of time during spawning.

^g A pound fished in an open configuration consists of a rectangular floating frame with either no webbing suspended below, or with webbing that permits volitional entry and exit of herring on at least one side.

^h All Pacific herring commercial sac roe and spawn-on-kelp fisheries in Prince William Sound were closed during the spring of 1989 due to the potential for contamination of catches from the T/V Exxon Valdez oil spill.

ⁱ Season closed due to low herring abundance.

^j Opening dates for each area were: Montague Island 04/04, Eastern 04/05, Northern 4/09, and Southeastern 04/13. All areas closed by regulation on 12/31/98.

^k Opening dates for each area were: Montague Island 04/01, St. Matthews Bay 04/20. All areas closed by emergency order on 04/25/99.

Table 5. Prince William Sound commercial Pacific herring food/bait fishery effort and harvests, management years 1969-1999.

Harvest Management Year	Fishing Dates		Guideline Harvest	Purse Seine		Pair Trawl		Mid-Water Trawl		Otter Trawl		Total Harvest (tons)
	Opened	Closed		Effort (Boats)	Harvest (tons)	Effort (Boats)	Harvest (tons)	Effort (Boats)	Harvest (tons)	Effort (Boats)	Harvest (tons)	
1969-1970	10/01/69	06/30/70 ^a		-	14.0							14.0
1970-1971	10/01/70	06/30/71 ^a										0.0
1971-1972	10/01/71	06/30/72 ^a		-	20.0							20.0
1972-1973	10/01/72	05/09/73 ^a		-	9.0							9.0
1973-1974	08/27/73	04/17/74 ^a		-	8.5							8.5
1974-1975	07/15/74	03/10/75	^b									0.0
1975-1976	06/01/75	06/25/75 ^c	^b	4	226.7							226.7
1976-1977	02/01/77	03/09/77	^b									0.0
1977-1978	10/01/77	02/28/78	^b	-	17.0	-	145.3					162.3
1978-1979	10/16/78	^d	^b	-	195.4	7	988.7	-	9.4	-	81.0	1,274.4
1979-1980	09/16/79	02/28/80 ^e	1,400	-	510.8	4	145.1	-	103.2	-	2.6	761.7
1980-1981	09/15/80	11/07/80	1,400	-	1,030.4	6	275.7					1,306.1
1980-1982	09/15/81	09/30/81	1,400	7	1,189.4	-	73.1					1,262.5
1982-1983	09/15/82	01/31/83	1,400	6	797.3							797.3
1983-1984	09/15/83	01/31/84	1,400	-	257.6							257.6
1984-1985	09/15/84	01/31/85	1,400	-	936.2							936.2
1985-1986	09/01/85	02/15/86	1,400	6	1,118.1							1,118.1
1986-1987	09/01/86	10/24/86	1,400	6	1,276.2							1,276.2
1987-1988	09/02/87	11/12/87 ^f	1,400	7	1,189.4							1,189.4
1988-1989	11/01/88	11/05/88	1,400	8	1,335.3							1,335.3
1989-1990	11/01/89	01/31/90	1,694	-	646.1							646.1
1990-1991	09/21/90	11/24/90 ^g	3,151	5	1,955.0			-	60.8			2,015.9
1991-1992	10/01/91	10/14/91	3,956	14	4,258.5							4,258.5
1992-1993	10/01/92	10/22/92	3,416 ^h	17	3,900.3							3,900.3
1993-1994	10/07/93	10/10/93	978 ⁱ	8	1,087.0							1,087.0
1994-1995	Season Closed ^j											0.0
1995-1996	Season Closed ^j											0.0
1996-1997	11/01/96	11/03/96	825	6	933.9							933.9
1997-1998	11/1/97,2/19/98	02/28/98	945	12	679.7							679.7
1998-1999 ^k	11/02/98	11/04/98, 11/06/98	967	11 ^l	1,003.3							1,003.3
1999-2000	Season Closed ^j				0.0							0.0

^a Openings set by regulation. Ending date coincides with regulatory ending of sac roe season.

^b No official quota, but unofficial goal was 1,500 tons.

^c Harvest from special June food-and-bait fishery opening. Although this harvest actually occurred at the end of the 1975 management year, it is included in the 1976 harvest management year to be consistent with other food-and-bait harvests which occur after spring sac roe fisheries.

^d Fishery closed from 1 January to 6 January 1979.

^e Fishery closed from 1 January to 15 February 1980.

^f Fishing season opened by regulation on September 1, 1987 in the General District. The north-shore and east-shore Pacific herring districts opened on September 23. The seas was closed by emergency order on October 6 for a period of five weeks, reopened on November 9, and closed for the duration of the 1987-88 season on November 12, 1987.

^g Fishery open from September 21 until November 24. The Montague Island area was open from September 24 until November 24.

^h Preseason guideline harvest level based on spawn deposition biomass estimate. Final guideline harvest based on age-structured analysis was issued in January 1993 and was 4,373 tons.

ⁱ Preseason guideline harvest level based on preliminary aerial survey biomass estimate of 40,000 tons.

^j Season closed due to low herring abundance.

^k Season reopened in spring 1998 based on final age structured assessment modelling. Of the total harvest, 578.1 tons were taken in November 1997 and 101.6 tons were taken in February 1998.

^l Includes sale from ADF&G test fishing near Knowles Head, 31 October 1998.

Table 6. Mean price and estimated exvessel value of the commercial Pacific herring harvest by gear type based on verbal post season estimates from processors and permit holders, Prince William Sound, calendar years 1978-1999.

Calendar Year	Sac Roe Fisheries				Spawn on Kelp Fisheries				Food-and-Bait Fishery			
	Purse Seine		Gillnet		Wild Spawn on Kelp		Pounds		Mixed Gear			
	Price per ton	Total Value	Price per ton	Total Value	Price per lb	Total Value	Price per lb ^a	Total Value	Price per ton	Total Value	TOTAL VALUE	
1978	\$ 720	\$ 956,800			\$ 1.25	\$ 175,000			\$ 380	\$ 489,820	\$ 1,621,700	
1979	\$ 1,260	\$ 5,213,880			\$ 1.74	\$ 821,280			\$ 300	\$ 196,800	\$ 6,231,960	
1980	\$ 320	\$ 1,933,760			\$ 1.09	\$ 667,080			\$ 300	\$ 424,800	\$ 3,025,640	
1981	\$ 400	\$ 5,508,000	\$ 580	\$ 135,720	\$ 1.00	\$ 122,000			\$ 260	\$ 328,120	\$ 6,093,840	
1982	\$ 380	\$ 2,716,240	\$ 640	\$ 251,520	\$ 1.29	\$ 397,320			\$ 220	\$ 194,260	\$ 3,559,340	
1983	\$ 600	\$ 1,634,400	\$ 1,040	\$ 109,200	\$ 2.10	\$ 634,200			\$ 260	\$ 70,980	\$ 2,448,780	
1984	\$ 760	\$ 4,435,360	\$ 640	\$ 218,880	NO HARVEST		\$ 3.50	\$ 176,439	\$ 260	\$ 265,460	\$ 5,096,139	
1985	\$ 760	\$ 5,380,800	\$ 900	\$ 371,700	\$ 0.48	\$ 19,200	\$ 7.09	\$ 569,058	\$ 250	\$ 279,500	\$ 6,620,258	
1986	\$ 820	\$ 8,058,960	\$ 920	\$ 412,160	\$ 1.70	\$ 159,800	\$ 8.00	\$ 1,155,200	\$ 180	\$ 229,680	\$ 10,015,800	
1987	\$ 1,100	\$ 5,480,200	\$ 960	\$ 511,680	\$ 1.70	\$ 299,200	\$ 15.00	\$ 1,836,000	\$ 300	\$ 356,700	\$ 8,483,780	
1988	\$ 840	\$ 6,600,000	\$ 1,400	\$ 537,000	\$ 1.20	\$ 232,000	\$ 18.00	\$ 4,500,000	\$ 300	\$ 400,590	\$ 12,236,500	
1989	SEASON CLOSED								\$ 300	\$ 193,830	\$ 193,830	
1990	\$ 640	\$ 5,351,744	\$ 640	\$ 323,456	\$ 0.90	\$ 213,840	\$ 11.40	\$ 2,305,080	\$ 300	\$ 605,130	\$ 8,799,250	
1991	\$ 600	\$ 7,153,800	\$ 600	\$ 445,200	\$ 0.80	\$ 172,160	\$ 9.00	\$ 2,880,000	\$ 250	\$ 1,064,625	\$ 11,715,785	
1992	\$ 400	\$ 6,713,680	\$ 800	\$ 752,480	\$ 0.46	\$ 232,116	\$ 8.00	\$ 3,875,200	\$ 200	\$ 780,060	\$ 12,353,536	
1993	NO HARVEST		\$ 400	\$ 411,960	\$ 0.55	\$ 178,860	\$ 10.00	\$ 2,000,000	\$ 200	\$ 217,400	\$ 2,808,220	
1994	SEASON CLOSED								SEASON CLOSED			
1995	SEASON CLOSED								SEASON CLOSED			
1996	SEASON CLOSED								\$ 200	\$ 187,000	\$ 187,000	
1997	\$ 200	\$ 940,600	\$ 80	\$ 14,080	\$ 0.61	\$ 32,000	\$ 8.00	\$ 426,816	\$ 250	\$ 170,000	\$ 1,583,496	
1998	\$ 300	\$ 999,000	\$ 375	\$ 156,000	\$ 0.65	\$ 23,000	\$ 5.00	\$ 107,000	\$ 295	\$ 296,000	\$ 1,581,000	
1999	SEASON CLOSED								\$ 8.00	\$ 98,456	SEASON CLOSED	

^a The price per pound for spawn on kelp in pounds is based on the final product weight, not harvest weight.

Table 7. Commercial Pacific herring harvest summary with fishing location and effort by gear type, Prince William Sound, 1999.

Fishery	Fishing Information				Harvest and Use (tons)	
	Area	Date	Duration	Effort	Spawn-on-kelp	Pacific Herring
Sac Roe Purse Seine	NO OPENINGS					
	Total					0.0
Sac Roe Gillnet	NO OPENINGS					
	Total					0.0
Wild spawn-on-kelp	NO OPENINGS					
	Total ^a					0.0
Pound spawn-on-kelp	St Matthews Bay	4/21		7	5.5	
	Montague Island	4/01		2	0.6	
	Total ^c				6.2	48.8 ^d
Food/Bait Fishery	NO OPENINGS					
	Total					0.0
<u>Harvest and Use - Total</u>						48.8

^a The harvest of naturally occurring herring spawn on native kelp in Prince William Sound.

^b The biomass of herring subjected to removal of reproductive capacity of the population based on the assumptions that 10% of the biomass of pre-spawning herring consists of eggs and that 80% of the weight of harvested spawn on kelp consists of eggs.

^c The harvest of herring spawn on kelp produced in net pens or pounds.

^d The biomass of herring subjected to stress mortality and removal of reproductive capacity of the population based on the assumption that 12.5 tons of herring are used to produce one ton of spawn on kelp.